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SEMINAR REPORT

SOCIAL SCIENCE RESEARCH METHODOLOGY

24th August — 13th September
1980

NA-44

PUBLISHED NOVEMBER 1983

**NATURAL RESOURCES, ENERGY & SCIENCE AUTHORITY
OF SRI LANKA**

47/5, MAITLAND PLACE, COLOMBO 7.

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FOREWORD

The Natural Resources, Energy and Science Authority and its forerunner the National Science Council have been providing social science scholars with financial assistance in the form of research grants to carry out research projects. However, it was felt that this alone was not adequate as there were different categories of research workers with varying research experience and backgrounds, some of whom were ill-equipped to carry out the projects they have in mind, requesting financial assistance for research. The Statutory Working Committee on Social Science of the then National Science Council, considering this shortcoming, decided to hold a training seminar on research methodology in order to upgrade the quality of young social scientists engaged in research. The training seminar on social science research methodology held at Peradeniya in August/September 1980 satisfied a felt need and has been the very first of its kind held in Sri Lanka.

The Seminar has had a favourable impact, judging from the responses of the social scientists who participated in it. The lecturers were carefully chosen and the nature and content of their lectures and papers were systematically coordinated and discussed by the organisers prior to the commencement of the programme. This was done to avoid repetition and to ensure that there would be continuity in the different themes.

The Statutory Working Committee on Social Sciences of the then National Science Council received every encouragement including financial support from Dr. Yogesh Atal, Regional Adviser, UNESCO for this seminar. The assistance and support provided by the Vice Chancellor, University of Peradeniya and his staff at this seminar is gratefully acknowledged. The cooperation extended by the lecturers who took great pains to prepare papers and make the seminar a success is also gratefully acknowledged. The papers prepared by the lecturers and delivered at the seminar are now reproduced in this volume.

Finally, I wish to commend the Working Committee on Social Science of the former National Science Council and its Chairman Dr. H. N. S. Karunatilake for organising this useful seminar and making it a success.

Dr. R. P. Jayawardene
Director General

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The Nature of Science and Scientific Method

H. CRUSZ

University of Peradeniya

1. Introduction

The moment the scientist starts reflecting on the nature of science and scientific method, he is in the realm of philosophy. And, a scientist is not worth his salt if he cannot give some account of the outcome of such reflection. Moreover, as Richard has pointed out, “philosophy alone enables the man of science to acquire a notion either of the principles implicit in all experimental knowledge or the true foundations of the special sciences, and to understand the position and bearings of his special science in the sum-total of human knowledge”¹. Maritain (1930, p. 115) has even warned that if at any time philosophy is not allowed “her rightful suzerainty over the sciences”—as what Aquinas called the ‘scientia rectrix’², the leading or guiding science—that period in the history of human culture will inevitably end “in a condition of intellectual chaos and a general weakening of the reasoning faculty”. Indeed, one of the great drawbacks of modern science-education is the neglect of those cultural elements such as the history and philosophy of science, and many other things besides, that go to make the pursuit of science dynamic and meaningful, for which time can be found, if only an honest effort is made.

2. The Nature of Science

Science (from the Latin ‘scientia’) simply means knowledge. It has also been called ‘organised common sense’. There is an element of truth in this but it is too broad a description. Today, science has at least two specialised meanings, namely:—

- (i) Systematised and integrated knowledge, which not only provides *explanations for observed phenomena* but also *establishes generalisations that help us to predict* the relations between these and other phenomena. In this sense, we can speak of moral science, political science, natural science, social science, etc.
- (ii) Systematised and integrated knowledge about *material phenomena*, based mainly on observation, experiment, induction, and deduction, where *more definite and precise prediction is possible*, e.g. physics, chemistry, biology, sociobiology, etc. The word science, as generally used today, seems almost exclusively to mean this category of knowledge.

1. Richard, T. Philosophie du raisonnement dans la science d’après Saint Thomas, p. 14 (quoted by J. Maritain, 1930.)

2. Aquinas, S. Th. (1225—1274), In *Metaph.* (On Aristotle’s *Metaphysics*), Introduction.

The distinction, however, is arguable. Many a social scientist, for instance, will deny that their methodology does not involve 'experimentation'. The mathematicians too, if not positively shocked, will at least raise eye-brows, if we ask: Is mathematics a science? The mathematician Sylvester once took the zoologist Thomas Henry Huxley to task for thinking that "mathematics is the study which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation". "Such a description" says Turnbull (1951, p. 123) "completely misrepresents Mathematics, which in its making increasingly calls forth the highest efforts of imagination and invention. As for induction, there is no more wonderful instance of its use than that of Ramanujan". One can even admit that there are 'experiments' in mathematics. One need not labour this point further. Mathematics rightly claims departmental status in university science-faculties and even arts faculties. "Mathematics . . . standing as it does on the borderland of all that is wonderful in Science and all that is beautiful in Art" (Turnbull, 1951, p. 126); its relation to science is best expressed in the words of Mather (1953, p. 140): "while it would be foolish to deny the name of science to any branch of study merely because it makes little use of measurement, no science can reach its flowering until it becomes quantitative in both its observation and theory".

3. The Scientist and the Scientific Attitude

Science does not exist in a vacuum. There is no science without human beings. It is a human activity involving *an attitude of mind* and *a method of thought and action*. It is not simply an accumulated body of knowledge about the world around us. Indeed, according to Karl Popper (1959) it is 'tentative forever', and tentativeness can exist only in a mind. Science therefore is something dynamic. It is an on-going human process — one of the noblest of human activities.

The scientific attitude involves two important factors, namely (a) a fundamental scepticism towards authority, and (b) a questioning mind and an incessant search for answers.

3.1 Scientific Scepticism

Someone once urged our university students to "cultivate the irreverent mind". I would consider that a rather hazardous occupation for scientists. Questioning authority does not mean at all the abandoning of reverence for the mystery that is nature. The more questions we ask in science, the more answers we get, the deeper the problems become, and, once again, the more innumerable the questions. That alone should make us reverent. But we must treat authority with at least a dash of scepticism. With B. A. Clough we must say: "Thank you very much; but I always like to go and have a look for myself"³. Having said that, of course, we must make sure that we go and have a look for ourselves. We must not accept observations and hypotheses *merely* because someone has plausibly offered them to us. We must look for more and more confirmation of them, or stated more accurately perhaps, try our best to refute them. We must be basically sceptical about

3. Dictum quoted by M. W. Jepps (1956) in *The Protozoa Sarcodina*, Edinburgh & London, Oliver & Boyd.

everything, without being irreverent. Loss of reverence sounds the death-knell of all scientific endeavour. It is often (even conveniently) forgotten that the greatest of the medieval schoolmen, Thomas Aquinas, taught his students this fundamental attitude when he wrote "Never mind who said it, take in what is sanely said"⁴.

This does not mean that we must indulge in the dubious pastime of not proceeding with our scientific work until the work which went before us is confirmed by others in its various aspects related to our own work. It only means that we bear in mind the tentativeness of all scientific statements, whether they be facts, hypotheses, theories, or laws, and that we proceed with the task of furthering our approximations to the 'truth'. It is enough if, on the basis of such scientific findings, things work, even if only for the time being. A greater achievement would be if our work also generates more problems for future investigation.

3.2 *The Questioning Mind*

In science, it is generally not ordinary questions that are asked, and the answers are not ordinary answers. The questions are 'scientific' questions, that is, those prompted by observations and experiments. The answers also must be 'scientific' answers, that is, those that can be tested (or refuted, as Popper would say) by more observations and experiments. Although this seems to be true, a sort of serendipity (that word which came to the English language from Sri Lanka's ancient Arabian name Serendib) — chance observations — and the astonishment and questioning that accompany them — have led to many discoveries such as that of penicillin. No wonder Aristotle said that the beginning of science is in wonder.

This theme of the questioning mind is closely linked with the scientific method. There have been vital and fruitful contributions by philosophers of science within the last few decades, which I shall be briefly touching on towards the end of this paper.

4. *The Scientific Method*

Before discussing, in a final section, the great attempts at generalising about the exact nature of the scientific method, let us consider the several operations that go to make up what is usually known as scientific method. I do not propose to do more than classify them here, and deal very briefly, if need be, with a few that may call for special treatment.

A. GENERAL BASIC METHODS

- (i) *Observation* — facts — it must not be forgotten that even facts are 'judgements' — judgements of coincidence (e.g. fire burns; this is a sheet of paper).
- (ii) *Enumeration* — simple counting of facts.
- (iii) *Classification* — arrangement of facts.

4. Aquinas, S. Th. In a letter to students on how to study, *S. Th. Aquinatis Opera Omnia*, ed. Frere et Mare, Paris, 1872—80.

B. SPECIAL METHODS

(a) *Methods of Probability* (leading to inferences where from true premises we get conclusions that are true in most cases).

(i) *Sampling* — Samples should be large, and random i.e. free from bias.

(ii) *Statistics* — The value of calculating the standard deviation rather than the average, the estimation of probability, etc.

(b) *Methods of Causality* (after John Stuart Mill)⁵

(i) *Method of Agreement* — This only discovers some *common factor*, and *nothing more*. It can only lead to further investigation, e.g. scotch and soda intoxicate; arrack and soda intoxicate; bourbon and soda intoxicate. Therefore, soda intoxicates? If not, what is the common intoxicating factor?

(ii) *Method of Difference*—Here we keep every other factor the same, except that which we assume to be the cause, e.g. in the above instance, change the chaser (soda) in one case. What happens? If intoxication persists, drink them neat without a chaser. What happens? etc. etc. We are dealing here with *the controlled experiment*. I once bemoaned the omission of this method by a scientist whose script was sent to me for assessment: "It was required to test the effect of a certain substance on an organism. The substance was used as a solution in alcohol and the organism apparently registered a sharp reaction to it. But one was at a loss to know how the organism would have behaved under the influence of the alcohol alone, without the other substance. The whole idea of a control experiment missed the mind of the investigator"⁶.

(iii) *Joint Method of Agreement and Difference* — This is supplanted today by the method of statistics. For example :

Agreement (Positive instances) :—

1.	—	a	b	c	d	e	}	<i>a</i> is the common factor
2.	—	f	a	g	d	k		
3.	—	l	m	n	a	e		
4.	—	a	w	x	y	z		

Difference (Negative instances) :

1.	—	b	w	d	c	y	}	<i>a</i> is the missing factor
2.	—	m	f	d	k	e		
3.	—	z	e	n	y	c		
4.	—	l	b	g	f	d		

5. Mill, J.S. (1893) *A System of Logic*, Bk. III, London, Longmans, Green & Co.

6. Crusz, H. (1971) "Some trends in science education and scientific research in Ceylon", Presidential Address to Section D (Natural Sciences), *Proc. Twenty Sixth Annual Sessions (1970) Ceylon Association for the Advancement of Science*, Part II, p. 238.

Therefore, *a* is the cause of the phenomenon shown by the positive cases (say, in patients suffering from a disease, and those without the disease).

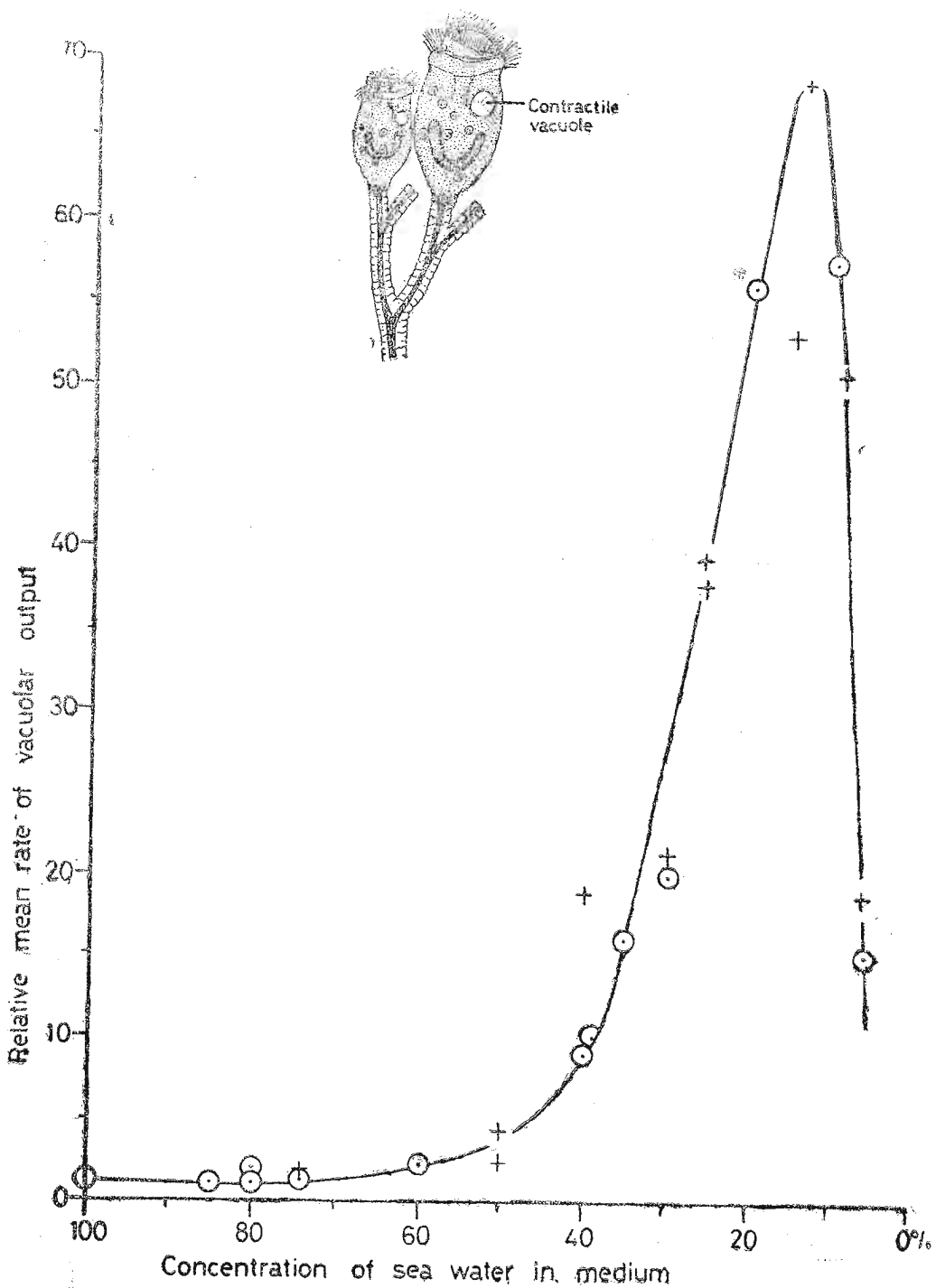
- (iv) *Method of Concomitant Variations*—A variation in the amount of a certain factor produces corresponding or parallel variation in the effect. The factor may be the cause, e.g. varying pulsation rates of the contractile vacuoles in marine protozoans on diluting the sea water medium with varying amounts of fresh water (see Fig. 1). These vacuoles, by accumulating water and regularly emptying it to the outside through a “gullet”, help the organisms to get rid of excess water, and prevent them from bursting.
- (v) *Method of Residues*—After certain causal connections are discovered there remain factors the causes of which are not yet known. The method of residues deals with such factors. The story of human malaria (in which I happened to play an infinitesimally small and modest role) when a residual factor was finally dealt with, is a good illustration of this⁷.

By nearly all the methods outlined above, the life cycle of the human malarial parasite came to be well known, but for one stage. Where are the parasites during the incubation or prepatent period, i.e. from the time of the bite of the parasite-carrying mosquito, to the first evident symptoms of the disease in the patient (high fever and presence of the parasite in the blood)? This missing stage was vividly indicated in an Isotype diagram in the Penguin book *New Biology* (Vol. I, 1945), which had appeared just in time for my teacher and predecessor in office, Dr. D. R. R. Burt, to produce it before the medical members of the Senate of the University of Ceylon when they pooh-poohed his insistence that the life-cycle of the human malarial parasite was not yet completely known. In 1948, as a Ph. D. student at the London School of Hygiene & Tropical Medicine, I cut the very first microtome sections of human liver, for Professor H. E. Shortt, which showed the ‘missing’ stage of the parasite. To be sure, this stage had already been discovered earlier by Shortt for monkey malaria, when the method of residues, after various other internal organs had been tried out unsuccessfully, suggested that the liver was the site of the ‘incubation period’. That did not prove it conclusively for human malaria. The proof was established when Shortt had malarial mosquitoes feed on a general-paralysis-of-the-insane patient (as a cure for this particular illness), did a biopsy after about a week, and obtained the piece of liver which finally settled the issue.

(c) *Methods of Explanation*

- (i) *Analogy* — Ronald Ross was led to the discovery in 1898 of the mosquito vector of human malaria on the analogy of Patrick Manson’s discovery in 1878 that the vector of the filaria parasite was a mosquito. When experiments (e.g. on hormones, cancer, etc) are done on laboratory animals,

⁷ Shortt, H. E. (1951) “History of recent researches on tissue phases of the malaria parasite at the London School of Hygiene and Tropical Medicine”, *Trans. Royal Soc. of Tropical Med. & Hyg.*, 45, p. 175—188.



Marine protozoans:

○ *Z. marinum* + *C. curvula*

Fig. 1—Concomitant variation in vacuolar output and concentration of sea water in two marine protozoans *Zoothamnium marinum* and *Cothurnia curvula*. (After J. A. Kitching, *Biological Reviews*, Vol. 13, p. 403, (1938). Note that after about 20 per cent concentration, i.e. 20 parts sea water and 80 parts fresh water, vacuole functioning breaks down.

before being tried out on humans, the underlying idea is analogical. Analogy is only a first stage in explanation and can only lead to a hypothesis. However, we must guard against false analogies.

- (ii) *Hypothesis* — This is crucial to the scientific method. It is the first significant act of intellection of the scientist in action. If a scientist stops short of formulating a hypothesis, after observing, classifying and experimenting, he fails as a scientist. Let it not be thought, however, that a formulation must be dazzling, in order to earn the name of hypothesis. Even when a taxonomist names a new species of organism, or discovers a pattern in its geographical distribution, he hypothesises. The way a hypothesis is formulated has been the subject of intensive philosophical research and will be dealt with in section 5. Suffice it here to say that one of the first to realise the true nature of the scientific hypothesis and its provisional character was Thomas Aquinas, who saw that the then-reigning hypothesis of the movement of the heavenly bodies could not be taken as certain truth, forasmuch as another hypothesis could well be propounded in the future offering a better explanation of the observed facts.⁸
- (iii) *Theory and Law* — Complete method of explanation, after repeated experimentation; i.e. until the hypothesis is 'fully' verified (this is a pre-Popperian view, to which I shall refer further on). It involves (a) collection and classification of data, (b) formulation of hypothesis, (c) designing and carrying out of experiments for testing the hypothesis (or refuting it, as Popper would say), and (d) continued verification (or continued attempts at refutation) by repeated experiments.
- (iv) *Historical Method*.—This is reconstructing the past on the evidence of the present. The formulation of the Theory of Evolution generally follows the historical method; although the Special Theory of Evolution by Natural Selection has lent itself now to strict experimental testing (attempts at refutation).

5. Philosophy of Science : From Aristotle to Kuhn

Modern science emerged from the marriage of two great ideas-forces: the *Empiricism and Rationalism of the Greeks* (especially represented by Aristotle, who brought down to earth, as it were, the 'ideas' of his master Plato, and thereby paved the way for the extensive exploration of sense data in science) and the *Experimentalism* of the thirteenth

8. Aquinas, S. Th. *De Caelo*, II, 17, & *Sum. Theol.*, I, 32, I.

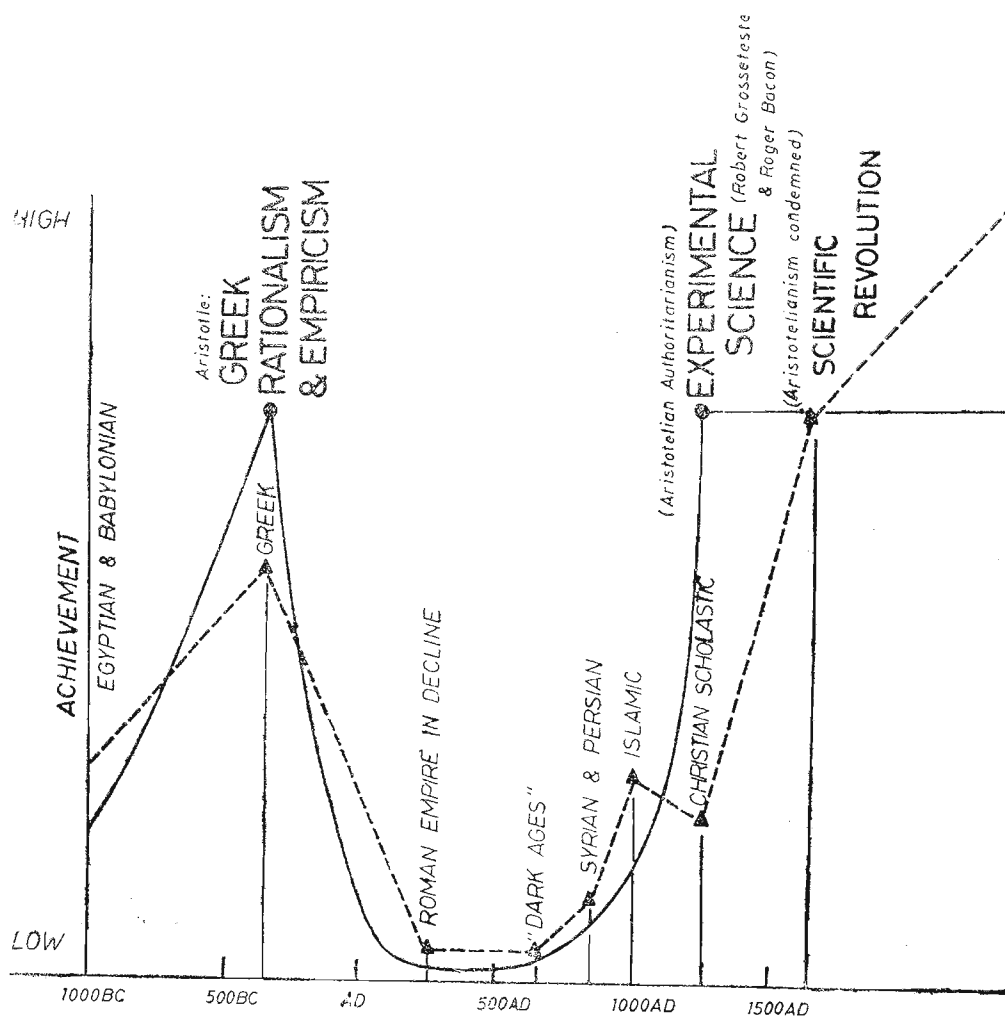


Fig. 2—Achievement in scientific philosophy and methodology (unbroken line) and science in action (research and discovery) (broken line) down the ages. The achievement axis has necessarily to be somewhat arbitrary since it is refractory to precise quantification.

century (especially fostered by the two Christian pioneers of experimental scientific methodology, Robert Grosseteste and Roger Bacon)⁹. When Empirico-Rationalism and Experimentalism met, the Scientific Revolution became possible (Fig. 2). With the rise also of Capitalism, there followed an unprecedented steep rise in scientific achievement, which continues unhindered even today.

5.1 *Deductive and Inductive Methods*

For long, on the basis of the work of Aristotle, who first expounded the deductive method and the importance of the syllogism as the indispensable tool of valid reasoning,¹⁰ and of the work of John Stuart Mill¹¹, who expounded more thoroughly than had Aristotle earlier, the nature and importance of the inductive method, we have become accustomed to think that science takes the well-worn path of observation, collection, and classification of facts, thinking out of hypotheses, and testing these hypotheses by repeated experimentation, until they graduate to the status of theories and laws. Experimentation is crucial to this process and we should not take even observations or facts for granted, for they too could have all the marks of hypotheses requiring to be tested.

In this way we have been led to believe that the findings or 'truths' of science are about the most reliable the human mind can come by, for has not science established its credentials in wonderful and manifold ways. That is not all. We have also been led to believe that the scientific paper is sacrosanct, at least as a true statement of the way a scientist has carried out his work and arrived at his conclusions, most of which at least were not known to him at the beginning of his effort — an open-ended experiment, in modern science-educational parlance.

5.2 *Hypothetico-Deductive Method*

The work of Ludwik Fleck (1935), Karl Popper (1959) and Thomas Kuhn (1962) has seriously affected, if not upset, this rather simple, if not simplistic, view of the scientific enterprise, to such an extent that Nobel laureate Peter Medawar (1963) could talk on "Is the Scientific Paper a Fraud?", and Ian Morris (1966) could write on "Is Science Really Scientific?" Medawar makes out that the conclusion is at least implicitly known to the researcher before he performs his experiments and writes up his research findings; that the usual sequence of Introduction, Materials & Methods, Observations & Experiments, Results & Conclusions, is, purely and simply, putting carts before horses — a sort of fraud — but one that has become an accepted, and even indispensable, convention for making scientific work publicly available to scientists, for repetition (replication) and refutation. What cannot be so repeated and made open to refutation, what is not falsifiable, is not scientific at all (*vide* the sharp criticism on these grounds of the work of the sexologists

9. Crombie, A.C. (1950) "Robert Grosseteste and the origins of English empiricism", *The Cambridge Journal*, 3, (6) pp. 356—367.

10. Aristotle (348—322 B.C.) *Organon* (Treatise on Logic).

11. Mill, J.S. *op.cit.*

Masters & Johnson, as reported in the *Time Magazine* of August 11, 1980). A scientific hypothesis is thus tentative forever. It need not even be a shattering one such as Einstein's $E=mc^2$. It can be as modest as a 'new species' of plant or animal, which could have long-term effects for man and his environment.

This is Karl Popper's teaching in a nutshell. Whether we realise it or not, we *think up our hypotheses* and then try refuting them by experimentation and all the other accompaniments of scientific activity. These methods are strictly logical and rigorous, and depend on deductive arguments. *We do not think out hypotheses* on the basis of observation, classification, etc. The process is therefore, in Popper's view, hypothetico-deductive, and not the other way about. The stress on 'falsifiability' and 'tentativeness forever' led Popper to meet the criticism of how far in that case could we ever have certain knowledge, and trust even the validity of his own theory, with his asserting that "only in our subjective experiences of conviction, in our subjective faith, can we be 'absolutely certain'"¹². The position for the scientist, therefore, is that while science never attains the goal of certain and ultimate truth, scientific discoveries especially when they stand up to repeated attempts at refutation are, at best, only approximations to our notion of what is true, for they are found to work, when wisely used, towards the happiness and progress of mankind.

5.3 *Scientific Revolutions*

In Thomas Kuhn's *The Structure of Scientific Revolutions* (1962)¹³ we see a shift of emphasis, and even an attempted critique of Popper, but the basic tenet that hypotheses are invented, not discovered, that there is an imaginative or inspirational element in hypothesising remains the same. Kuhn distinguishes, however, between '*the scientific revolutions*' which involve what he calls '*paradigm shifts*' ("occasional, discontinuous revolutionary changes, in tacitly shared points of view and preoccupations of science", e.g. the Darwinian revolution) and 'normal science', which is the continuous work of building on and refining these models of the past. He even observes that it is usually the young, or persons new to a discipline and relatively free of established preconceptions, who bring about such 'paradigm shifts'. These shifts occur only when a glaring anomaly, during the continued verification of a paradigm by 'normal scientists', is seen to blur its clarity. Even then, the scientific community is slow to let go the prevailing paradigm. Paradigms die hard. When scientists are forced to abandon them for new ones, we get what Kuhn calls scientific revolutions.

Kuhn counters Popper's view that there are no verification procedures at all, only falsification, which, if successful, results in the rejection of an established theory, with the observation that this is much like the role he himself assigns to 'anomalous experiences', which evoke crises leading to scientific revolutions. A further point of difference of the Popperian scheme from that of Kuhn seems to be the value Popper places on thinking up, and attempting to refute, even the humblest hypotheses in scientific work.

12. Popper (1959).

13. Chicago Univ. Press. Also see Daly, H.E. (Editor) (1973) *Towards A Steady State Economy*, San Francisco: Freeman; where Daly, in his Introduction, discusses Kuhn's insights.

5.4 *Sociology of Science*

Since this seminar deals with the social sciences, I cannot do better than refer finally to the work of Ludwik Fleck, the Polish-Jewish bacteriologist, who in 1935 published a book in German which has now been translated into English under the title *Genesis and Development of a Scientific Fact*¹⁴. Fleck had anticipated many of Kuhn's ideas, and Kuhn (1962) generously acknowledged this as an indebtedness "in more ways than I can now reconstruct or evaluate".

Fleck's importance for all science is such that he does the social scientist proud, although he himself was a practising natural scientist. Steven Shapin (1980) in a rewarding review of Fleck's book in translation, refers to his basic teachings. There are interconnected 'active' and 'passive' elements in human cognition (shades of the 'active' and 'passive' intellect of Aristotelian and Thomistic philosophy). Facts are invented, not discovered, but both inductivist and individualistic views of science are repudiated, for science has a 'holistic character'. That no active social processes are involved in the making of a scientific fact is an illusion. Each individual scientist has a 'thought style' and the scientific community, and indeed even the community at large, have a 'thought collective' (Kuhn's paradigm). The act of cognition is the most socially-conditioned activity of man, and knowledge, including scientific knowledge, is the paramount social creation. "The shape of answers is preformed in the nature of permissible questions" (e.g. questions and answers in ancient and modern times, in regard to syphilis). Fleck explores the illusion that scientific facts are not socially constructed by what Shapin calls "an intriguing analysis of the effect of history and communication in the thought collective".

It is not difficult to see from all this that there are firm grounds for believing that the scientific process, even as it obtains in the natural sciences, is not that simple after all. With Fleck's insistence on the whole man, as well as society, playing a part in it, followed by Popper's focus on the imaginative and inspirational aspects of thinking up its perennially tentative hypotheses (its only element of certainty being in the subjective conviction that it is true), and Kuhn's dramatic analysis of the structure of scientific revolutions, the stage has been set, I should say once again since the time of the ancients, for a more comprehensive and all-encompassing view of what is meant by science and the scientific method.

14. Fleck, L. (1979) *Genesis and Development of a Scientific Fact*, Translated from the German edition (Basel 1935) by F. Bradley and T. J. Trenn, Chicago, Chicago University Press. One might add here that unlike Fleck, Popper and Kuhn's works, Edward O. Wilson's *Sociobiology: The New Synthesis* (Cambridge, Mass., Harvard University Press, 1975) is not a contribution to scientific methodology as such. Sociobiology is a science, not a philosophy of scientific method.

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Patterns and Problems in the Methodology of Science

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1. Introduction

Science is said to begin with a problem and, in general, it is said to end with a hypothesis (a solution). One could question, which comes first; the problem or the hypothesis? I would suggest that science begins with a hypothesis and ends with a hypothesis and that the problem comes in between. The first hypothesis, nowadays, is more fashionably called a paradigm. Thus, the sequence in the method of science is: hypothesis (paradigm) — problem — hypothesis (solution).

According to Kuhn (1970), a pre-paradigm period is a period of pre-science. Science then, begins with a paradigm. Obviously here I am relying on what is called relativism in the philosophy of science — of which Kuhn is a key protagonist,¹ because it is convenient to do so in this exposition although I myself do not subscribe fully to the relativistic thesis.

What is a problem? We might not know what a problem is, but one has enough problems today not to have experienced them or spotted them. The problem of going to Kandy in time for the last *Perahera* night; the problem of being seated in a library when one feels that a cup of tea in the canteen would help better; the problem of inflation; the problem of big power confrontation in the Indian Ocean could be some of them. If one has to live today, (or perhaps at any time) one does not run short of problems. Life itself is a problem. It is a problem in two senses. First, it is a problem in the sense that it is a conglomeration of problems of the kind listed above. Next, let us say, to a philosopher or a theologian it would be a problem in the sense of 'exist what for and how' — 'the mystery of existence' — and may be 'why exist at all?' as well.

2. Paradigm

Problems can be raised in different ways and at different levels. That is where the paradigm becomes relevant. A problem is raised, or a question is asked, based on a paradigm. What is the constitution of water? But why ask this question? Why should water have a 'constitution'? In the good old days, water was an element. After all, was it not the great Thales, who said that all was water? Was it not common knowledge in the ancient world that apo, (water) was the first of the elements? Let me quote from Russell Hanson (1961):

1. One of the contentions of relativism is that a science is based on a paradigm—i.e. it is relative to the paradigm.

“ ‘What caused the clock to stop running ?’ is a request for news about the one thing responsible for the stoppage, the ‘link’ immediately preceding the cessation of movement. One less frequently asks ‘What makes the clock keep running?’ If one does, it is with an awareness that it is different from the former query (Medical students soon learn the difference between: 1. ‘What caused the baby to start breathing ?’ 2. ‘What caused the baby to stop breathing ?’ and 3. ‘What caused the the baby to continue to breathe?’).

Tangibles have become paradigms of what there is ;”

Thus at any stage of a scientific inquiry the problems are problems about nature or society and these problems are mostly dependent on man’s outlook in that sphere at the time in question.

The paradigm — the base hypothesis in a science at a particular time or in a particular school — largely determines the problems. An example can be had from psychology to illustrate the point. The development of psychology as an empirical science begins with Wundt in the last quarter of the last century. Psychology before Wundt and for sometime after him was mainly concerned with consciousness, and the method used in psychological research was introspection. By the second decade of this century, with the advent of behaviourism, the paradigm changed. Both consciousness as the field of investigation and introspection as the method were toppled over. ‘Not for an instant but for fifty years psychologists were blinded with the great hope that they could make psychology a genuine and successful science if only they would follow a number of clear-cut rules. Chief among these rules were elimination of consciousness as the subject matter of psychology on the one hand, and the rigorous use of scientific method on the other; the history of behaviourism is the history of the attempt to treat these two rules as one’ writes Brian D. Mackenzie in his book *Behaviourism and the Limits of Scientific Method* (1977, p. xi).

Behaviourism was influenced by the then current positivism, operationism and physicalism in the philosophy of science. The behaviourist wanted to reduce the complex to its elements. Physics had used this method (what are the forces acting on the billiard ball ?) and so did chemistry (what is the constitution of water?). It should, therefore, work for psychology. But, a little later, the behaviourist paradigm was rejected by the Gestalt psychologists. “The whole is more than the sum of its parts” the latter said. “Put down three dots, each about half an inch apart from the other two, but not in a straight line. What do you see? A triangle — not just three dots.”



Gestalt psychologists are not the best example of those who rejected the behaviourist paradigm. The psychoanalytical school, which originated in Austria at the beginning of this century, would serve us much better in this respect. The behaviourists very consciously wanted to do away with consciousness whereas psychoanalysts made consciousness big

business. The latter sold it in bulk. They sold it in variously flavoured cubes, with fascinating names — the Sub-conscious, the Unconscious, the Ego, the Super-ego and so on. In other words, the psychoanalysts adopted a different paradigm. Thus it can be seen that in the same science, at the same time, three paradigms — three schools — were operating. The problems investigated and the questions asked in each of these were dependent on these different paradigms.

I chose psychology partly because it is considered both a natural and a social science. For those in the social sciences, whether in sociology, economics, political science, history or any other, this type of example should ring very familiar: Marxian social theory vs. Weberian social theory, Marxian economics vs. — — — and so on.

I said that we can give examples of problems, although we may not know what a problem is. I have roughly indicated what could be a paradigm. I would find it difficult to *explain* what a paradigm is. Kuhn who advanced the “paradigm thesis” in very persuasive terms in his classic *The Structure of Scientific Revolutions*, would take, for example, the Copernican revolution, Galilean or Newtonian physics, the discovery of oxygen, etc. as events leading to new paradigms. But Kuhn himself uses the term paradigm in a number of senses, that is, very generally and vaguely. It was Margaret Masterman (1970) who counted the senses in which Kuhn used this term in his book and found that it was quite a count! But that does not invalidate Kuhn’s position.

So, we begin with the paradigm. The paradigm and our experience make us see problems. A problem, then, is usually what is not seen to fit in with the pattern outlined by the paradigm. It is a puzzle (e.g. How and where does this piece fit in? How do the ‘canals’ on Mars fit in with the general scheme of things? Why do tides take place? Why do we dream?) We probe the problems and seek a solution. The solution is a hypothesis. Here one could ask the question, ‘how do we get at these hypotheses? How do we discover our laws and theories in science?’

3. The “Discovery” of Theories

The answer to that question is, “we do not know”. Rather, it has been fashionable for the contemporary methodologists to get out of this problem very briskly and pretentiously smartly by saying, “None of my business”. The methodologist places himself on a pedestal. His business is logic. There is no logic of discovery. There is no general pattern discernible in the great and small discoveries of the past. Did Newton see an apple fall and “realise” the fact of the law of gravitation? That would, at best, be only a half truth. In any case, the story itself is probably historically false. Gravitation was a thought that occurred to many a thinker for centuries before Newton and, in fact, what Newton did was to formulate the correct law of gravitation, rather than to produce *ex nihilo* the concept of gravitation. So it is with Darwin’s theory of evolution. It was not just the trip round the world on board the HMS Beagle that brought him the idea. Evolution was in the air. Darwin arrived at a more specific and acceptable theory. It is a good maxim for a researcher that he must be deeply “involved” with the problem, and do hard work. Massacre the guinea-pigs to find the causes of and cures for diseases.² But there is no

2. Cf. Paul de Kruif, *Microbe Hunters*, Pocket Book, p. 177.

guarantee of success. One is likely to be led up the blind alley more often than not. The *Sleepwalkers* is an apt title given by Koestler (1959) to his book which deals with discovery of Cosmic laws.

Involvement, hardwork, daring and insight may be the foundations of scientific discovery. However, the history of science shows that favourable circumstances, historical and social factors and what we may call chance or luck are equally instrumental in this venture. The time must be ripe; science is also a process in history. Sir Peter Medawar (1969) the noble laureate in Medicine, has attempted to examine the role of intuition in science in his interesting little book on scientific method. But genius does not flourish on barren soil. In 1665 Newton's draft of the Theory of Gravitation went into the drawer for twenty years, partly because predictions based on it did not tally with the observed motion of the Moon. The French estimated the size of the earth more accurately twenty years later and only then did Newton take out his sheets of paper again to gain immortality.³ The story of the theory of evolution is a fine example for this contention. Darwin was cogitating for years after the Beagle until Wallace dropped his bombshell.⁴ And then there is the "accidental" discovery of Penicillin.⁵

Thus there is no logic of discovery. Despite its title, Popper's book *The Logic of Scientific Discovery* does not discuss discovery in this sense.⁶ That discussion is a matter left to the historian and the psychologist.

4. The Deductive Method

In the first chapter of his book, Popper disposes of induction and inductivism, psychologism, and so on. The "Discovery" begins with the hypotheseis. It is the scientist's job to test the hypotheseis. Scientific method is a deductive method.

"A scientist, whether theorist or experimenter, puts forward statements, or systems of statements and tests them step by step. In the field of empirical sciences, more particularly, he constructs hypotheses . . . , and tests them against experience.

I suggest that it is the task of the logic of scientific discovery . . . , to give a logical analysis of this procedure; that is, to analyse the method of the empirical sciences".⁷

"The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it. The question how it happens that a new idea occurs to man . . . may be of great interest to empirical psychology; but it is irrelevant to the logical analysis of scientific knowledge. This latter is concerned not with *questions of fact* . . . , but only with *questions of justification or validity* Its questions

3. Cf. Mason (1953) p. 157.

4. Cf. Darwin (1958); especially the author's observation in his introduction. Also his historical sketch of the progress of opinion on the origin of species.

5. Cf. Bernal (1965) pp. 675-77.

6. Popper (1959).

7. Popper (1959) pp. 27ff..

are of the following kind. Can a statement be justified? And, if so, how? Is it testable? Is it logically dependent on certain other statements? Or does it perhaps contradict them? In order that a statement may be logically examined in this way, it must already have been presented to us. Someone must have formulated it, and submitted it to logical examination.

Accordingly I shall distinguish sharply between the process of conceiving a new idea and the methods and results of examining it logically”⁸

Thus we start with the (given) hypothesis. We study the logic of its justification. Logic, at least for Popper, is deductive logic. It is deductivism which dominated the methodology of science during the first half of this century. Battered though, it is still in vogue. No doubt Popper will go down in history as one of the leading methodologists of this century. However, Popper's is not the only deductivist school. Popper's is what I shall call here the deductivist falsificationist school. I shall begin the discussion of deductivism not with Popper, but with the deductivist verificationists.

The deductivist verificationist thesis is the view subscribed to by logical empiricists like Carl Hempel and Ernest Nagel. They are, in a sense, heirs to the long dethroned logical positivists of the Vienna circle and their successors. According to them the structure of the argument which justifies a scientific hypothesis could be given in the following terms.

A hypothesis is tested by testing the predictions derivable from it. Thus, the hypothesis implies a prediction:

The prediction is true (verification by empirical test)

Therefore, the hypothesis is true

If H stands for the hypothesis, p for the prediction and $\rightarrow$ as the sign of implication then, in symbols, the above reasoning will read as:

H $\rightarrow$ p
p

$\therefore$ H

What this suggests is that the truth of the prediction leads to the truth of the hypothesis. Now, this form does not give a deductively valid argument. The above argument is, in fact, invalid. It is a good example for the common fallacy of asserting the consequent of a hypothetical and then asserting its antecedent. We would thus be led to conclude that this form ultimately gives us only what could be called a piece of inductive reasoning.

8. Popper(1959) p. 31.

The reasoning would be:

$$\begin{array}{c} H \rightarrow p \\ p \\ \hline \therefore (\text{probably})H \end{array}$$

For, a correct inductive piece of reasoning will lead to a probable conclusion. And as more and more predictions given by a hypothesis agree with experience, the probability of the hypothesis increases. Now Popper does not believe in induction and hence he rejects this form. Instead, he maintains that the argument involved in the justification of a hypothesis could be reconstructed in the following form:

$$\begin{array}{c} H \rightarrow p \\ \neg p \quad (\text{by test}) \\ \hline \therefore \neg H \end{array}$$

This is to say that the strategy in science is: construct hypotheses, derive predictions from them, and attempt to falsify the hypotheses by showing that the predictions do not agree with experience.

The above is, of course, a valid deductive form by what is called in logic the rule of modus tollens. This rule says that from a hypothetical and the negation of its consequent, the negation of the antecedent could be validly inferred.

If one is familiar with Popper's Demarcation Principle which distinguishes between science and non-science our line of argument should be evident. For Popper, science is that which is falsifiable by test. The empirical nature of a hypothesis shines when it is actually found to be false.⁹ It is on this basis that, for example, he argues that the Marxist theory of history and Freudian psychoanalytic theory are non-scientific. For he considers that these theories, by their vagueness of formulation, have made it possible for them to be variously adjusted and interpreted, thus making it impossible to falsify them.

Some of us, when introduced to Popperian methodology, find it a little disturbing. For surely, the strategy in science is not to disprove theories but to prove them. Nevertheless, the strength of Popper's view as a reconstruction of the logic of science has been considered with much favour. It has been pointed out that science progresses by elimination. Moreover, it is our experience that even very general and established hypotheses like that of gravitation have been falsified.

5. Verification vs. Falsification

Both the verificationist and the falsificationist forms given above have to be made a little more complex to accommodate the actual situation. Predictions are, usually, predictions of particular facts. A hypothesis is a generalization. It is not possible to derive statements about particular facts from a general statement unless other particular statements are taken in conjunction with it. These particulars are called the initial conditions. Moreover, there are what are called the auxiliary hypotheses which join with the main hypothesis to give a prediction. The reasoning of the deductivist verificationist is

9. "Once a theory is refuted its empirical character is secure and shines without blemish". Popper (1969)

(The hypothesis + The initial conditions + The auxiliary hypotheses) imply the prediction
 The prediction is true (i.e. it seems to agree with experience by empirical test)

Therefore, probably, the hypothesis is true.

If we use $i_1, i_2, i_3 \dots$ to indicate the initial conditions and $a_1, a_2, a_3 \dots$ to indicate the auxiliary hypotheses and $\wedge$ as the symbol of conjunction then the form of the deductivist verificationist reasoning could be represented thus :

$$\frac{H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots \longrightarrow p}{p} \quad (1)$$

$\therefore$ (probably) H

The parallel Popperian formula will be

$$\frac{H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots \longrightarrow p}{\neg p} \quad (2)$$

$\therefore \neg (H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots)$

It will be noticed that in these last formulations there is a difference between what is asserted by the verificationist and what is denied by the falsificationist. Given the more complex formulation the verificationist has two advantages. First, he can maintain that even if the conclusion in (1) is put as:

$$\therefore \text{probably } (H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots)$$

it follows logically that H is true, for the truth of a conjunction implies the truth of each of the conjuncts. Secondly, the conclusion of the verificationist is in any case only a probable conclusion i.e., an inductive one and hence he has an advantage over the Popperian. On the other hand, the conclusion in (2) is the assertion of the negation of a conjunction and the only implication that could be drawn from it is that any one — i.e. a minimum of one — of the conjuncts is false. That is, it could be that H is true but that i_1 is false or a_1 is false and so on. This poses a problem for the strictly deductive view of the falsificationist. How could he assert that H is false?

Of course, Popperians do not think that the above argument challenges their view. They maintain that their formulation assumes the truth of the initial conditions and the auxiliary hypotheses, and that therefore they are entitled to draw logically the conclusion that the hypothesis is false. Although this could be claimed by the Popperian, actual scientific practice does not bear evidence to such a contention. To explain a number of things that I have been maintaining above, let me take an example from the history of science. The example takes two incidents in the history of the theory of gravitation. The theory of gravitation maintains that there is attraction between any two physical bodies, and that the force of attraction between two physical bodies is proportional to the product of the masses of the bodies divided by the square of the distance between them.

In symbols,

$$F \propto \frac{m_1 \times m_2}{r^2}$$

$$\text{This could be reduced to } F = G \frac{m_1 \times m_2}{r^2}$$

If we apply the theory of gravitation to the Solar system we can determine the motion of the planets. Indeed, a prediction that could be derived from the theory of gravitation is that the planets move in ellipses with the Sun as the focus. Now, although the attraction of the Sun is the main gravitational force acting on the planets, the attractions of the planets on each other also influence this motion. To determine the exact orbit and the other details of the motion of the Earth using the theory of gravitation, we will need a large number of initial conditions, viz., the mass of the Sun, the mass of the Earth, the mass of the Moon, the mass of Venus, Mars etc., the distances between these bodies and so on. If, say, the prediction is that of an eclipse of the Sun, then we will also need, for example, auxiliary hypotheses about light, e.g., that light travels in straight lines. It is all these, which together with the main hypothesis, i.e., the theory of gravitation, which give a prediction.

Given the above line of reasoning the first incident that I want to take is the discovery that the theory of gravitation did not give sufficiently accurate predictions about the motion of Uranus. That is, predictions using the theory of gravitation did not agree with the observed motion of Uranus. Three logical possibilities were open. First, there could be something wrong with the observations. Second, there could be something wrong with the initial conditions or the auxiliary hypotheses. Third, the theory of gravitation was incorrect and should be rejected. Now, if repeated observations give the same result, and there is no reason to suspect the observations, one of the other two possibilities has to be the case. Scientists are not prone to giving up their pet theories, any more than we are ready to give up our pet habits. Indeed this is one of the main contentions of the Kuhnian thesis. In any case, it is not easy to give up a theory of the stature of the theory of gravitation. Moreover, scientists give up a theory only when an alternative theory is available. And good theories, and very general theories about the universe, are hard to come by. There are not many Newtons, Einsteins and Darwins amongst us. Therefore, taking the easy way out, the tendency is to suggest that the initial conditions were wrong; in this case, that the astrological chart is wrong. There is another planet haunting the system but hitherto not observed by us. That planet also should figure in our initial conditions. Calculations were made. This, of course, led to the discovery of Neptune in 1848. It was a great triumph for the theory of gravitation and for scientific imagination. So, in practice, contrary to what Popper suggests one is not sure of the initial conditions. The theory need not be false.

However, there is the other side to the story. Similar problems about the predicted motion of Mercury made the scientist look for another planet in the vicinity of Mercury; that is, in the vicinity of the Sun. Calculations were made and telescopes were turned. The child was baptised at conception and before birth. The planet was called Vulcan. But there was no Vulcan! This time, the problem was solved not

by finding a new planet, but by the overthrow of the theory of gravitation. The theory was false. But not until Einstein could come out with the alternative — the Theory of Relativity — was the theory of gravitation rejected. Discrepancy was not sufficient. The alternative had to be there. After all scientists are very practical men.

What I have outlined as the deductivist verificationism and falsificationism come under what is known as the hypothetico-deductive method. The pattern of the method that I outlined could be presented thus:

<i>Stage I</i> <i>Preliminary</i>	<i>Stage II</i> <i>Discovery</i>	<i>Stage III</i> <i>Justification (hypothetico-deductive)</i>	
Paradigm $\rightarrow$ problem	discovery of hypothesis	$H \rightarrow p$	$H \rightarrow p$
		p	$\neg p$
		$\therefore H$	$\neg H$
		(more accurately these forms should include the initial conditions and the auxiliary hypotheses).	

6. Hypotheses

I have to say a few words about the concepts involved in this view of justification. These are hypothesis, prediction, and empirical test. Let me first dispose of the easiest, viz., prediction. What is meant by prediction here is anything that is logically derivable from the hypothesis and empirically testable. Prediction does not mean a future happening or something not observed in the past. In more technical jargon, a prediction is an observational consequence of the hypothesis.

What are hypotheses? Hypotheses are, as Popper calls them, conjectures. Scientific hypotheses are testable conjectures. There are sciences which are not empirical, viz. Pure Mathematics and Logic. Popperian falsifiability does not apply to these sciences. A consistent system of mathematics cannot be proved false. We are, therefore, talking here about empirical sciences. 'Testable' in this case will mean 'empirically testable'. So hypotheses here are empirically testable conjectures.

For logical and epistemological reasons it is best that we consider hypotheses as being acceptable, rather than as being true. At least, when I say that a hypothesis is true I mean that it is acceptable. A hypothesis, when it is found to be acceptable by test, is usually called a theory or a law. The distinction between laws and theories is helpful in understanding the nature of a hypothesis. A hypothesis usually is a generalization. A law is just an empirical generalization which could be reached (inductively) by generalizing from observed particular instances. It is something like the generalization, 'All crows are black'. We observe the individuals, may be a large number of them at different places and different times, and then generalize to get the rule or the law 'All crows are black'. Galileo's law that the acceleration of a body falling near the surface of the Earth remains

constant is another example. So are most laws in the physical sciences, like Boyle's, Charles', Hooke's, or Kepler's. This brings us to another useful concept, that of direct testability or direct verification. A hypothesis is directly testable if it is tested, not by observational consequences derived for it, but by particular instances which inductively lead to it. A theory, on the other hand, usually is only indirectly testable.

The theory of gravitation is not tested by measuring the force of attraction directly, but by testing the observational consequences derivable from it, like the motion of the planets, the path of a projectile and so on.

The main distinction between a theory and a law is that the theory is an explanatory principle, whereas a law is just an empirical generalization. A theory explains facts and, perhaps indirectly, the laws that are subsumed under it. A law does not explain. A theory answers the query "why?". Why does a mango released from the tree fall to the ground, instead of remaining static or moving upwards? Why does the acceleration of a body falling near the surface of the Earth remain a constant? The theory of gravitation answers these "whys". Explanation of why a particular body falls to the earth is an explanation of a fact. The explanation of why the acceleration of a freely falling body near the Earth is a constant is an explanation of a law; in this case, Galileo's law. Galileo's law does not explain why the acceleration of a freely falling body near the surface of the Earth is a constant. It merely asserts this regularity. Similarly, Kepler's laws assert an empirical regularity of the motion of the planets and the theory of gravitation explains Kepler's laws; Boyle's law asserts an empirical regularity which is explained by the kinetic theory of gases and so on. A theory, since it usually encompasses the facts coming under a number of laws, is a more general statement.

There is another distinction made about hypotheses. A generalization could be universal, or it could be statistical. 'All crows are black' is a universal generalization, for it covers each and every crow. Fifty per cent of the atoms of uranium will disintegrate during a specified time is a generalization, but it is not possible to predict the behaviour of any particular atom of uranium using this generalization.

It is beyond the scope of this paper to go into the structure and formulation of hypotheses. I will just mention a few of the characteristics of hypotheses which are of interest. A hypothesis is a statement and hence, an expression in a language. It has to be expressed as clearly as possible or in scientific language. Language has three levels — the syntactic, the semantic and the pragmatic. Researchers use all three of these levels. The possibility of general usage is, at least theoretically, greatest at the syntactic level and lowest at the pragmatic. Normally, the syntactic gives a structural form in symbols, the semantic gives an interpretation of it. For example

X	→	O	
could have either of the interpretations			(syntactic)
What led to inflation ?			(semantic)
or		What led to the disappearance of Hitler's body	(semantic)
Nature of the pragmatic could be indicated by the following.			

The question is asked,

How did Hitler appear?

There may not be uniformity in the understanding of this question. Any of the following answers may be given to it; For Example,

1. A great nationalist with a vision of a great Germany.
2. A nervous megalomaniac.
3. A powerful man and a shrewd strategist.

Well, there is no agreement. This is the characteristic of pragmatic language. Perhaps the story of the seven blind men each describing "his own" elephant is a good example. It is thus clear that science, and especially scientific hypotheses, should employ syntactic and semantic language understood by the population at large.

7. Concepts

Concept formation in science is a matter which is of great interest. As science "progresses" old terms get new meaning and new terms and concepts are created. It is interesting, for example, to consider how 'gravitation' evolved as a concept historically or whether 'air' has the same meaning now as it did have five centuries ago. And what in the world is 'anti-matter'? From the field of social sciences the Id and the Super-ego would make good examples. But we are also entering here a difficult area in the philosophy of science, which, with the advent of relativism, has been saddled with the problem that a hypothesis and its concepts together form a separate language. That is, each theory 'creates' its own concepts. Relativism thus maintains that there are no connections between very general theories and hence deny the possibility of the reduction of one theory to another. More important for our purposes here is the fact that relativists deny the availability of a scientific method in the sense of the deductivists as outlined above. However, it is beyond the scope of this paper to consider these controversies.

8. Analogies and Models

I should also mention the important role of analogies and models in the construction or the formation of hypotheses. Huygen's wave theory of light was developed by analogy with the then familiar notion that sound was a wave phenomenon. Visualizations of the atomic structure had some analogy with the Solar system. Hydrodynamics influenced the conceptions in electrodynamics. There are two types of analogies. In the first kind of analogy the objects in one system are considered to have properties analogous to those in the other. The laws of the first system are then taken as a model to develop a theory for the second system. Thus the kinetic theory of gases uses the ideas about macroscopic elastic spheres like billiard balls. In the second type of analogy the relationship between the two analogous systems is abstract. Often some relationship is seen in the mathematical structure of the systems. For example, Maxwell saw a relation between gravitation and heat conduction. He noticed that the mathematical laws of the uniform motion of heat in homogeneous media are identical in form with those of attractions varying as the square

of the distance. "One had to only to substitute *source of heat* for *centre of attraction*, *flow of heat* for *accelerating effect of attraction* at any point and *temperature* for *potential*, and it was seen that the solution of a problem in attractions is transformed into that of a problem in heat."

9. Observation

A scientific hypothesis, above all, should be testable. That is, it should be possible to derive from it observational consequences which could be tested empirically. This takes us to the third concept, viz., observation. The importance of observation to science is that it is what gives science objectivity. Due to similarities in the nature of the human physical apparatus, we can agree on our perceptions fairly easily. Although there could be other conceptions of objectivity, I think it best to consider objectivity as given by things being inter-subjective.

The relation between observed facts and theories as well as empirical laws and theories has been a matter which has perplexed methodologists for generations. It was once thought that there is an invariant observational language and that concepts in the hypothesis could be given meaning in terms of the observational language. It is now increasingly realized that observation language is theory-laden.

There are various types of tests or observations. Natural observation is distinguished from experiment in that the latter is controlled inquiry. In the naturalistic observation, on which the social or behavioural sciences depend largely, inquiry could base itself on case studies, before-and-after the fact method, the control group method and so on. In observation the aim of the researcher is to focus on raw data in their natural surroundings. The researcher's aim here is careful semantic description of the situation whether he is studying the mating behaviour of birds or the gossiping behaviour of women.

The important thing in tests is that the data should be reliable and durable. For this to happen, detailed, non-distorted, non-participant observation is necessary. Bias in observation is to be minimized by various measures such as repeated observation. Accurate recording is necessary. Classification of data is useful. Today, both in observation and experiment, modern equipment, methods of measurement and analysis play a dominant role in obtaining reliable data. The latter of course, is a key problem in the social sciences.

It is not possible here to discuss at length various problems of empirical test. But I wish to touch on a particular aspect of the role of observation. We saw that the deductivist takes the hypothesis as his logical starting point. But there is also a tradition which says that "science begins with observation". This is the inductivist tradition, which goes back to the writings of Francis Bacon. This view considered the structure of scientific reasoning to be of the inductivist form:

$$O_1 \quad O_2 \quad O_3 \longrightarrow H$$

i.e. particular observations $\longrightarrow$ hypothesis or generalization.

With Galileo and after, inductivism declined. Indeed this view would not be able to accommodate the great discoveries of Newton and others. It is considered to be based on an erroneous view of induction that inductive leap is from the particular to the general. It is also said to confuse discovery with justification. But in the behavioural sciences the inductivist method probably has a role. Perhaps this could be said with more ease today, for deductivism itself is under attack.

10. Causation

There is only one other aspect of science that I wish to touch upon. This is important, especially in seeing the similarity or the contrast between natural and social sciences. This is the problem of causation.

Explanation in science is considered to be causal. Science is said to search for the causes of events. Thus the great methodologist and logician, John Stuart Mill, presented five methods or rules by which the scientist finds the causes of phenomena or the invariable connections in phenomena. On the other hand, causation or, at least, causal regularity, has been under attack since the time of David Hume.

Science was, in some way, associated with determinism. It is possible to predict the past, present and the future motion of a billiard ball, given certain information. Determinism is expressed by what is called the principle of causality which says that every event has a cause. This principle is not in vogue today. The concept of causation is a troublesome concept, but what is taken as associated with causality in science is predictability. But as we know even in the physical sciences there are events which are, in principle, non-predictable.

This brings us to the dilemma of the social sciences. Are causal explanations, causal relations, possible in the social sciences? Some methodologists like Winch think that they are not possible. Hence, social science is not possible as science. It is not possible to predict when a girl will smile or how she will smile. If it is possible to predict laughter, it ceases to be a "laugh". The spontaneity is lost. And then there is the problem of free will and causal determination.

The question which is of interest to us is, does all science need to use the concept of causal connection and if so, how is this connection expressed in science? There are types of explanations which some think are non-causal. They are the teleological and the functional. These are mostly associated with the behavioural sciences. The difference between the causal and the teleological explanation is as follows. A cause is something which precedes — something which "pushes". The teleological "pulls". In teleology things exist for the end, the purpose. The mother's life is explained by the son's triumph. In functional explanation facts are explained in terms of their function, the part which they play in an integrated system, the manner in which they are related to each other within the system. For example, each of the organs in our body has a separate function such as respiration, digestion and so forth. However, their function is meaningful only in terms of the part they play in the life of the organism as a whole.

11. Conclusions

In this paper I have tried to indicate the method of science as seen by the deductivists. There are two deductivist schools, the verificationist and the falsificationist. I said something about hypotheses, concept formation, empirical tests, and causality. I also touched on the views of two other contemporary schools of methodology, viz., relativism and inductivism. Deductivism was an attempt to avoid old-fashioned inductivism, but deductivism is now under attack from relativism. I would like to conclude with the remark that the present crisis in the philosophy of science, if resolved, would perhaps lead to a more satisfying account of the methodology of science.

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Scientific Method and the Social Sciences

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1. Introduction

Conflict, contradiction and variety are important and necessary aspects of the scientific enterprise. That is what gives science and particularly social science its vitality. This is also especially true of the social sciences in a semi-traditional or semi-modernised society like Sri Lanka's where there is a strong tendency for people to speak with one voice, where students for instance almost never question or disagree with their teachers, and are rarely equipped or trained or encouraged to do so, where subordinate officials never challenge their bosses, where criticism and dissent are an expensive luxury enjoyed only by a few well established and often well protected critics.

It may be a useful exercise to begin with a definition of the social sciences or at least to attempt a definition of the social sciences. I would say that in a sense, social science consists of the application of the scientific viewpoint and scientific method to the realm of human society. It consists of a number of fields of study such as Sociology, Anthropology, Political Science, Economics, History, Archaeology, Education, Law, as well as aspects of Geography, Philosophy and Psychology and a number of related sub-disciplines, whose principal objectives are to understand, record, monitor, influence, control and, above all, gain mastery over the various aspects of man's interaction with man and man's interaction with the natural environment. That is a partial generalised definition.

In Sri Lanka, in the last few years, largely due to the mediation of such bodies as the Social Science Research Centre of the National Science Council the concept of the study of society as a scientific enterprise has been for the first time been clearly stated. A scientific perspective is essential for the development of the social sciences. However, in the past these subjects often were classified with the humanities and that, in my view, often hampered the development of a scientific viewpoint in certain social science disciplines. As an Archaeologist this is something which I have often encountered because Archaeology is considered as an extension of the humanities and the arts which is at variance with current international thinking on the subject. However, now, for the first time in Sri Lanka we have begun to develop a concept of social studies as a science.

2. Scientific Method

The application of scientific method in the social sciences includes the systematic observation and documentation of social phenomena, the use of measurement, qualification, classification, analysis, interpretation and generalisation as well as the development of theoretical frameworks and methodologies appropriate to the various fields. Included in this is the formulation of laws and other generalisations relating to the social process

and the application of this body of knowledge to social practice. It is the latter realm of activity, the application of knowledge to social practice, which we call "Applied Social Science". It covers such areas as problem formulation, policy formulation and social engineering by which we mean attempts to refashion society in certain ways. By social control we mean attempts to control the movements and changes within society by means of monitoring, evaluation, criticism and the formulation of alternative policies. However, it is also important to point out that there are significant differences between the natural sciences and the social sciences, and some of these I shall try to indicate.

Firstly, social science deals with various forms of human activities which have a much greater variability than most natural phenomena. Social phenomena are dynamic and human society is generally subjected to far more rapid changes and transformations than the natural world especially when the natural world is left to itself free of human intervention. Secondly, the social scientist is himself a part of the processes that he is studying. The kind of separation that we may find at least superficially between subject and object in the realm of the natural sciences is almost impossible to achieve in the social sciences. Thus there is nothing called 'pure objectivity' in the social sciences; at most we only have a relative and limited objectivity in methods and techniques. That is, the vision of the social scientist always has a social basis, and he always displays a socially induced viewpoint which is as much a part of social reality and a social process as the phenomena to which a social scientist turns his attention. Thirdly, a distinguishing aspect of the natural sciences is the role played by experiments. And by experiments I mean the isolation and reproduction of particular phenomena in laboratory conditions. Often the laboratory of the social scientist is society itself. In the social sciences, the use of experiments is generally limited and, generally speaking, is replaced by observation, prediction and evaluation of ongoing social processes. It is of course true that in some areas of social sciences we are able by the use of techniques such as systems analysis, games theory and computerised mathematical and statistical models to simulate some aspects of social conditions and social interaction. However, the scope for such exercises is limited. Fourthly, in terms of the inductive versus deductive dichotomy there is a difference between the natural sciences and the social sciences. By induction we mean the process by which we arrive at conclusions by observing and putting together a whole class or group of perceivable facts. To put it simply, in induction we move from hard facts to hard conclusions. By deduction we mean the process by which we arrive at conclusions also on the basis of known or supposed facts, but by a series of premises, inferences and propositions. Such an argument consists of a whole sequence of propositions where each proposition is based on the one immediately preceding it. Of course all science is based on a combination of inductive and deductive methods. The two are closely interconnected. However, it is probably correct to assert that in practice deductive reasoning is prominent in the social sciences, while inductive reasoning tends to dominate in the natural sciences. And the reason for this is that by its very nature classes or groups of social facts, or social phenomena, or social processes are much more difficult to isolate than natural phenomena. This is one of the major reasons why social scientists usually use deductive methods in their research work.

3. Paradigms

The work of men like Karl Popper and Thomas Kuhn whose work in the history of philosophy of science demonstrates that the development of science was not a gradual, steady, step by step linear process of development. Just like historical and social change, scientific development proceeds by great periodic leaps and transformations. Such transformations are exemplified in the sciences by the work of men like Copernicus, Galileo, Newton and Einstein each of whom in turn completely overturned the ideas that existed before them and opened up entirely new possibilities and new realms of knowledge and development. Popper spoke of mutations where existing patterns of knowledge took sharp turns and evolved into completely new forms from what had been established and generally accepted up to that time. Kuhn went further than this and proposed his concept of the paradigm. By paradigms he means the entire structure or framework of mental attitudes, ideas, theories, principles, methods and techniques etc. within which the scientific knowledge and scientific practice of a given age took place. These paradigms or frameworks are inherited or implanted in the scientist by virtue of his or her training and by the prevailing intellectual and scientific environment and also by the various institutional and non-institutional channels along which scientific work progresses. It is rarely that the paradigm is questioned, often because it is never explicitly presented or explicitly known as a coherent framework. Indeed, it is not possible to question paradigms, if you do not know what they are. Instead, each generation improves on the work of the previous generation by a variety of additions. The result is a certain, but highly limited form of development; knowledge is increased in quantity and quality but within the parameters, within the boundaries of the established framework. However, at a certain point in this limited form of development that I have described, certain problems and difficulties, certain anomalies and contradictions appear. In other words, there arise contradictions between the data that you are encountering and the theoretical structures and traditions that you have inherited. At this point when these anomalies arise two alternative causes of action are possible. The scientist who is inhibited by his or her training or restricted by conventional intellectual viewpoint either ignores these anomalies, or accommodates them in some way, or explains them away. This is often an unconscious process that arises from the fact that one is prepared to see only what you have been trained to see. The bolder mind on the other hand begins to question the framework or paradigm and finally begins to search for an alternative paradigm. It is the construction of that new paradigm which sooner or later completely overturns the existing or older one. This concept of Kuhn, which I have summarised, perhaps rather crudely, opened out a new dimension in our understanding of the scientific method and of the development of science.

Kuhn's idea of a scientific paradigm was carried a step further, I would say, in the work of Karl Popper who put forward the idea of competing or co-existing paradigms. He calls this, the dynamic or volatile nature of science. Different sets of paradigms and theories exist at the same time and compete with one another which, he thought, would ultimately produce a higher or more developed or more complex paradigm, and therefore a more advanced dimension of scientific knowledge.

4. A Structural Model of the Social Sciences

In order to make this point clearer, I would like to put before you a structural model of the social sciences which, subject to obvious adjustments, is applicable to almost all the disciplines in the social sciences. The model (Fig. 1) begins with theories or paradigms which represent the mental structures within which our work takes place. Sometimes, some of us make these paradigms and theories explicit in our work. But mostly the theoretical standpoint is an unconscious and inherited one. But always an awareness of the nature of this theoretical standpoint improves the quality of the work, a point to which I shall return later in my final remarks.

At the second stage, we have the specific theoretical model or research design or, sometimes we can even say, a problem formulation because we are often faced with ready-made problems which have arisen in the work of other people.

The model we adopt is the conceptual side of our work which is always a product of a paradigm or a general theoretical system. The model provides us with a conceptual framework, and the methodologies with which we begin to examine social realities. It provides the guidelines and principles along which we carry out a study or investigation and sets out the aims and objectives of that investigation. It forms, so to speak, the spectacles through which we are able to view our data. It formulates the kind of question that we are posing and forms the broad principles and working methods that we select in carrying out our investigations. All this, the theoretical model, the research design, policy perspectives, the problem formulation, forms, as it were, only one segment of scientific work.

The next segment constitutes our actual face to face encounter with social reality. It deals with the actual objects of our study and the methods and techniques that we employ in the study. Rightly or wrongly, these working tools constitute the greater part of any basic training programme. Rightly, if we recognise that this is a part of the essential equipment of the social scientist and at the same time we recognise the paradigms that stand behind it. Wrongly if we limit ourselves to these working methods alone and mistake this equipment to be science itself. If we limit ourselves entirely to this realm of scientific activity we remain, at best, technicians and mechanics who do not really understand what we are doing or why we are doing it.

From that point, following my diagram again, we go to the interpretation of the material that we have gathered and analysed, the generalisations and conclusions that we were able to draw from this material and also, once again, a formulation of the problems that arise from it and so on. To recount the steps, we have the theoretical model, we select certain working techniques, we apply them in the field and we draw certain conclusions, policies or programmes, or generalisations from this material. But once the social scientist has reached this point, two possible courses of action are open to him. These two paths which he might follow may be called the prescriptive path and the critical or problematic path. The first of these, the prescriptive path is the one that believes, in a somewhat short-sighted way, that problems have a solution, and that the formulation of their solution, the

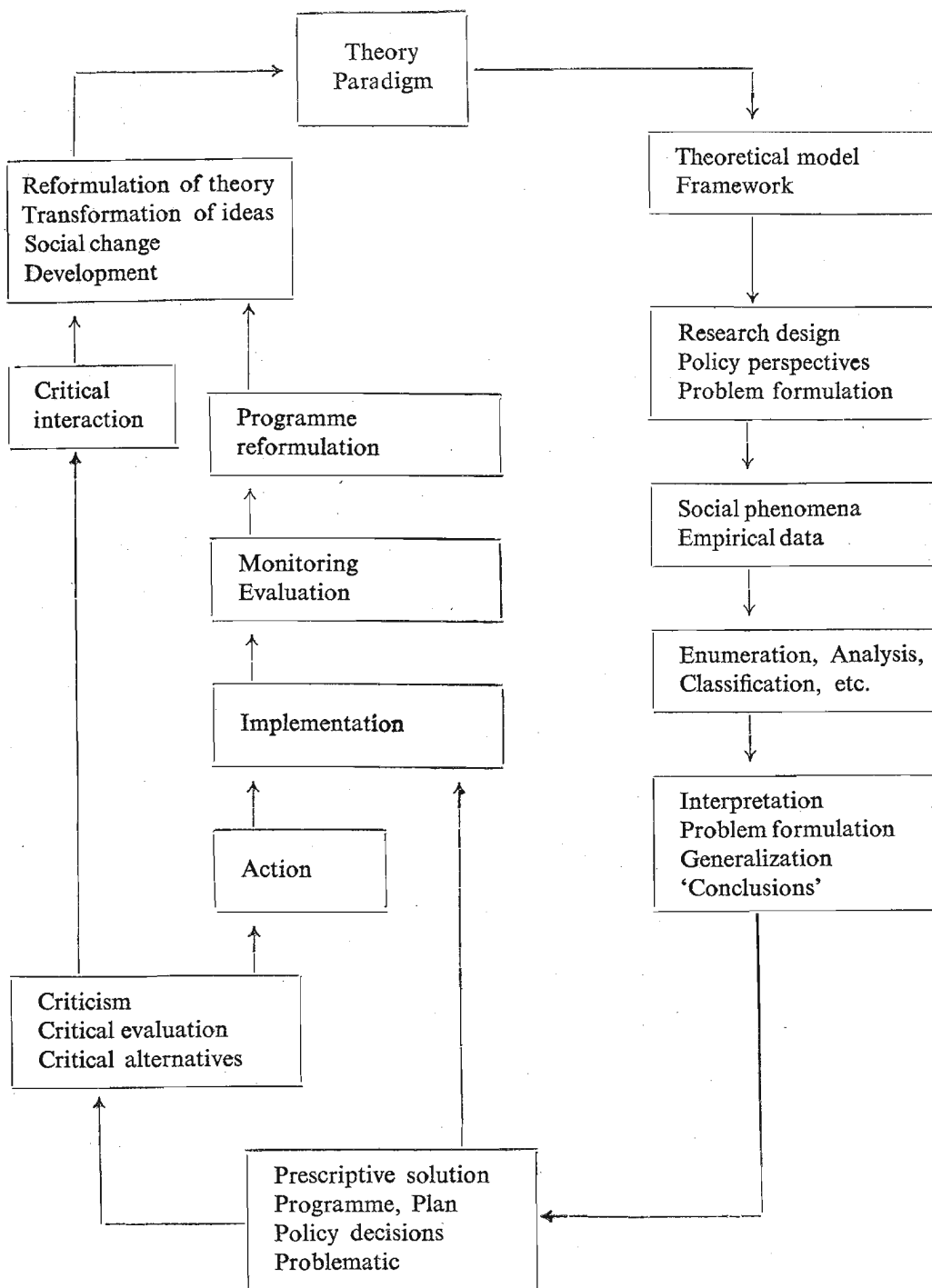


Fig. 1

formulation of a programme, the correct implementation, monitoring and evaluation of that programme and the taking of suitable corrective measures from time to time to adjust that programme are all that is necessary. That is what I would call the prescriptive. And this, I think, is a static and not a dynamic view of society. It is a view that believes that variables are contained within invariables and that human nature is constant. It fails to recognize that the history of man no less than the history of science is a history of development and change and transformation. Invariably such solutions are merely a restatement of the problem, or what such solutions do is create a fresh set of problems for somebody else to solve.

The second, path the critical or problematic path is one that elevates the problem to a level of abstraction, which formulates that problem as a part of a wider problem, a problem that is connected with a whole network of other problems and other dynamics and so on. It is a view that science like society is a continuous process of challenge, struggle and change. It sees the function of science not as a prescriptive or a solution providing process, but as one of continuous development and creativity and criticism. It is based on a dynamic and not a static view of society. It stresses variability. Unlike that view of social science which sees the function of the social sciences to be one of providing policies and programmes, simple generalisations and solutions, the problematic view sees the function of social science as one of continuous interaction between theory and practice. It is precisely such a concept which lies behind my crude model which starts with a paradigm or a theoretical viewpoint and then sets out to use that theory as an analytical tool or to test that theory against social reality itself. The sequence moves from investigation, analysis and interpretation to a process of criticism, and the formulation of problems and back again finally to a re-statement or re-formulation or, one might say, transformation of theory. That is the circular process which I have tried to indicate here.

5. Theory and the Empirical Tradition

This brings me to the final part of my lecture where I would like to deal very briefly with four related subjects. The first of these is the importance of theory, and the difference between the theoretical and empirical traditions. Secondly, the limitations of empiricism and the importance of empirical studies. Thirdly, the necessity and the limitations of statistics and finally, social standpoint and social function of scientific work.

The first of the above four points I would like to discuss in relation to the state of development of social science research in Sri Lanka. We are a poor, and a small and backward country. In such a context it is important for the social scientist to know exactly what the level of development is that we have reached by comparison with the advanced world. Unless we have that viewpoint it is very difficult to make any progress. At the same time, I think that we should be, and I certainly am, tremendously proud of what we have actually achieved. If you look at the history of our country, a 150 years ago we were still in the medieval world. Our entire intellectual world view was something which was entirely different from today's. We in our country, have made, in the course of a century or so, an enormous historical leap in consciousness. Our understanding of the world today is indescribably different from that which Sri Wickrama Rajasinghe had in

1815. I think that, backward and small and poor as we may be, we have made, at least in our own terms, on any world scale a tremendous development. Nevertheless, I would still assert that it is a reflection of the underdevelopment of the social sciences in our country that we have so far in all our social sciences fields paid very little attention to theoretical questions. We have virtually no concept of the paradigm or paradigms which, unknown to us, form the basis of our scientific work. In general, we have no more than a passing acquaintance with the great theoretical systems of our time which have provided the foundations of the social sciences in the 20th century. By theoretical systems, I mean systems like structuralism or structural functionalism as some call it, Marxism, phenomenology and also the traditions of empiricism and eclecticism, as well as a host of theories which in one way or another are products of these theoretical systems, such as a theory of economic growth, a theory of underdevelopment and so on. The nature of these theories, which I would say are the competing paradigms in the social sciences of our times, is an entire subject in itself and, today, I am not going to deal with what the nature of these theories is. I think, in fact, before we start discussing about the competing paradigms of our times, it is important to recognise as a general principle the importance of theory, and the importance of seeking out the theoretical basis of our work. The lack of a theoretical tradition is one of the great weaknesses of social science research in Sri Lanka. The reason for this is, perhaps, the dominant influence of empiricism in our intellectual and scientific environment, especially in the social sciences. I think that in my own field of the historical sciences it is a direct inheritance from the British tradition of empiricism which is very well developed in British historiography.

Empiricism has been called the theory of no theory. What empiricist tradition maintains is that facts alone are what is important, and that the accumulation of facts and of generalisations drawn from these facts will by themselves give an understanding of social reality. In other words if we carefully collect the facts an understanding of what lies behind them will automatically arise. There has been today, in the world as a whole, a tremendous development of interest in the theoretical aspects of the social sciences, and the limitations of empiricism have been clearly recognised. Even in Sri Lanka, the challenge to the empiricist tradition in the social sciences has already begun to be posed in one form or another. This has of course sometimes taken the form of what I would call eclecticism where bits and pieces of various theories and theoretical systems have been grafted on, implanted into the empiricist model. At other times it has taken the form of theoretical formulation or theoretical abstraction which is made without an adequate examination of social reality. That is the other side of the coin. One, a complete disregard of theory or the theoretical tradition, and the other, a complete dependence on and dominance of the theoretical abstractions without any real, considered, systematic investigation of social realities to which they refer. Thus we have had ideas with no basis in social reality, just arisen as notions in people's heads, which they try to project on to selective bits of social reality which they choose to use to develop those theories. What I would say is that a theory without a basis in fact is a false theory, while facts which are not absorbed into a theoretical construct remain useless and meaningless facts. That is why I proposed two important themes here, the limits of empiricism and the importance of both theory and empirical research.

The question of statistics is directly related to empirical research. The statistical method has come to form a particularly important aspect of the social sciences in Sri Lanka just as elsewhere. However, because most of our University curricula and university training programmes and so forth, by necessity, deal with statistical methods, I think it is important to realise that statistical data can never, by themselves, provide explanations. All they do is to demonstrate correlations between different aspects of social realities. It is just a working method. This brings me to my final remarks on the social role of the social sciences.

6. Social Scientist and Society

At the very beginning of my lecture, I said that the social scientist to a greater or lesser extent, to a greater extent than the natural scientist, was part of the very phenomena that he or she was studying. Or very simply, the social scientist is part of society. Therefore, if we see that the social scientist is part of society, we must also see that inevitably the social scientist and social science reflect the views and standpoints of various social interests, social groups, and social institutions which constitute that society. What theories and theoretical systems do is to systematize this viewpoint, and to make it possible for us to examine, not perhaps impartially or objectively but at least scientifically and systematically, these different standpoints so that we can test the validity and the workability or, we might say, the reality of various paradigms, theories and hypotheses and views which lie as bases of our work.

We have today in Sri Lanka at least four institutional areas in which social scientists work. We may list these four areas. First we have the government agencies or government departments or institutions of one kind or another. Secondly, we have the commercial agencies. I think that no matter how you define a social scientist, the largest amount of funding that goes into social science research even in this country today is in the commercial sector. Thirdly, we have research institutions, governmental and non-governmental and, finally, we have the universities. The institutional framework that we have does two things. On the one hand, it makes it possible for us to live and work as social scientists. But at the same time, there is no doubt, it restricts and inhibits us. In government agencies we tend mostly to work within the official policy framework, monitoring achievements or projecting the possibilities for policy based action. In commercial organisations the framework is even more limited to subjects like market research and the sociological investigation of productivity norms and so on. In research institutes, we are restricted by institutional policies and programmes especially in channels along which funding for research is available. And finally in the universities, although we are restricted to some extent by syllabi and curricula, we have a much wider field of operation and much greater freedom, but little resources. Nevertheless, whatever the institutional restrictions are, it is by scientific effort, by theoretical and empirical effort and by an understanding of the totality of science that we can rise above these limitations. I think, institutional limitations are, by the very nature of reality, inevitable and it forms in part, the necessary challenges in our work. But it is really by theoretical and empirical efforts that we have to go beyond these limitations and this is so if we look at the history of science itself, especially at the history of social sciences.

7. Conclusion

I think today there are three trends in the social sciences. The first is the tendency to maintain the *status quo*. Secondly, there is the internal development of science itself which provides one of the biggest momentums. Thirdly, there is a formulation called critical alternatives which can be traced back to the development of the social sciences in the 19th century. That is, today, at one end of the spectrum, there is an attempt to use the social sciences to protect and to reproduce the existing structures; to create equilibrium in situations of contradiction and crisis; to pre-empt the growth of conditions that would require fundamental change, changes in the social structures or changes in the dominant paradigms. At the other end of the spectrum there is an attempt to develop a critical, corrective or transformational role, to confront existing views and ideas and to provide impulses and perspectives for development and change. Science is above all a form or aspect of culture. In all the social forces that are at work in the formation of society and culture, the natural scientist and the social scientist occupy only a very small, if somewhat prominent position. It is not merely the extent to which they reflect the greater social processes that are at work, but also the extent to which they are consciously aware of their relationship to these social forces, that give depth and relevance to their work. In the final analysis, like society and culture, science is involved in a continuous process of development, change and transformation. The significance of our own work is in direct proportion to its relationship with these processes of development and change.

Theoretical and Empirical Perspectives in the Social Sciences

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1. Introduction

Frankly, I have been a little put off by the use of the term 'methodology' in social science research. In the under-developed countries, generally, methodology in the social sciences, it appears, has been equated more or less with the techniques of data collection and measurement. It is customary for the authors to state what their methodology is and by that what they really mean is something like the following: 'I carried out a sample survey of so many households over 3 or 4 months. I employed so many investigators and they processed this information on a computer. I thank so and so, and these are the tables and this is the report'. It turns out to be more a kind of investigative report rather than an attempt to deal with a problem in social science.

I think, in a sense, it is rather presumptuous for those who do research of the type that most of us, including myself, do to claim a methodology because, in the social sciences, methodology, to my mind, is essentially a philosophical question dealing with the classification and arrangement of abstract ideas and concepts in a complex logical system. I use the word 'complex' because the investigation or the analysis of any problem in the social sciences is necessarily complex. The physical scientist is able to carry out controlled experiments within a laboratory in order to isolate various elements in a compound. In contrast, problems in the social sciences are complex because they deal with numerous variables which are inter-linked and cannot be subject to controlled experiment.

The so-called methodology which one refers to in our kind of research is nothing more than the use of simple, well known, and fairly obvious techniques of measuring and summarising observable data. Almost invariably these techniques of measurement are limited in number and there is hardly a choice of alternative. There is not a sharp difference of techniques which might distinguish one social scientist from another in the adoption of these techniques. However, one social scientist differs from another not in the adoption or in the choice of techniques of this kind, but in the whole philosophical approach and his logical thought process. The identification of a problem differs from one social scientist to another. There are numerous ways in which they differ from one another which are hard to identify. It is not the kind of technical, objective technique which might distinguish one engineer from another. It is something more subtle.

I might say that most of the important and controversial problems in the social sciences are not amenable to the use of quantitative and statistical techniques. I am not trying to deny the use of quantitative methods. I regard quantitative methods as a kind of technical

tool which is rather subsidiary. They are subsidiary in relation to the identification of a problem, the conceptualisation of a problem, and the linking of one phase of a problem with another. The mere calculation or the computation part could be given to a technician and you might be able to acknowledge his contribution in a footnote. In fact I might even say that if a problem is amenable to the use of quantitative methods of this kind, then there is hardly a problem because you can say 'these are some data which I collected, I processed them on a computer which gave these results' and, one would have to say 'I will have to take your word for it'. But it is when you try to apply observable data, and it clashes with the concept that you cherish, that genuine investigation in the social sciences begins. Thus, it is really more important to find out the logical faults in the exposition and formulation of problems rather than mechanistic data gathering and summarising. The most exciting and most critical areas in the social sciences are those which are not amenable to mechanistic quantification and that is precisely why the social sciences have continued to be a kind of battlefield of competing ideas and ideologies. You cannot settle these controversies in a laboratory as a physical scientist might do.

Having made these preliminary observations, I shall, in the rest of my lecture, deal with three broad areas. I shall begin with the concept of the social scientist; the limitations of the social scientist himself leads to the limitations of social science. I will then go on to the second part which deals with the methodological procedures which are open to the social scientist. Thirdly, I shall go into the differences between theory and empiricism in the social sciences and, with that is closely linked, the relation between so-called micro studies and macro studies.

2. Social Scientist and Social Change

The study of social phenomena must aim at an understanding of the mechanisms of social change or stagnation taking into account the historical specificity of different phenomena or the historical and social milieu in which a particular phenomenon occurs. This requires the understanding of the mechanism of change or stagnation which necessarily leads one to examine the interests of different social classes and the way in which these interests affect the production and distribution of the national wealth. I am now thinking of economics and economic development.

In the real world economic factors or economic influences do not take place in an institutional or social vacuum, but are inter-meshed with political and social factors. Both production and distribution are obviously conditioned by the underlying social relations and by the political and ideological influences on these relations. Furthermore, there is a perpetual element of conflict in social phenomena, social policies and so on and the social scientist is not outside the pale of these conflicts. Social change impinges upon different interest groups both nationally and internationally. Unlike a business firm, society is not a homogenous entity. What is desirable and profitable for a business firm is more easily decided than what is desirable for society. That is to say there are social groups with contradictory or conflicting interests and individuals or groups may seek to espouse social change because they benefit from the change to the exclusion or to the detriment of others.

If the problems of social development — that is development or under-development in a practical sense — mean different things to different people according to whether they are on the top of the social pyramid or the bottom, the social scientist is not outside the pale of these conflicts and, in fact, he is often influenced by these conflicts. After all the social scientist deals in words, and words as instruments of communication are not neutral or value-free. One whom I regard as a nationalist, you might regard as a terrorist. A liberation to one man may be imprisonment to another. In other words one's social occasion may even limit one's views to those which are partial and incomplete. Social scientists may even leave unanalysed or not refer at all to certain phenomena, the unravelling of which is likely to pose threats to those who hold power. For instance, class exploitation, the subjection of women and notions about productive and unproductive output and consumption, essential imports and non-essential imports and so on.

Social scientists recently have also begun to speak of market economies instead of capitalist and socialist economies, avoiding reference thereby to the possibility of alternative socio-economic structures, with their corresponding systems of property rights and income distribution. One finds that Professor Rostow even tried to discard the word "industrial revolution" by substituting for it the word "take-off". For reasons that are better known to the economists they have also dropped the term "under-developed economies" and substituted the term "developing economies" even though the hard reality of most of these developing economies is that they are really under-developed. With pretensions to objectivity and scientific precision, social scientists have been resorting to a considerable amount of word play by which they try to conjure away the seamy aspects of the existing social order.

The other point which I foreshadowed earlier in one of my remarks is that no area of social science has been as much the subject of conflicting explanation and ideologies as the subject of economic stagnation and change. The purpose of this recapitulation is to indicate how vulnerable is the position of the social scientist himself because he lives in a situation where he is trying to analyse problems of which he is a part or in which he could be partisan. The American historical sociologist, Bernard Stern said that 'in matters concerning the functioning of society, ideas and ideologies served different interests' and he remarked that while science is neutral, scientists were not. They could be Fascists, Communists etc. They may be upholders of vested interests of one kind or another. The scientist is, therefore, not a dispassionate, impersonal individual but, in company with all professional workers, has a large emotional investment in his way of life defined by the institutional norms which govern his activities. Let me illustrate my argument with an example from economics where economists have, over the years, at certain crucial junctures connected with social transformation in history, shifted their ground, shifted their theoretical premises, shifted their whole framework and the so-called methodology and focus of looking at social problems to accord with the dominant mode of production and the social interests which it subserves. There has, thus, even been a re-orientation of economic theory as seen by the changing attitude of economists towards problems of production and, in particular, to the distinction between productive and unproductive labour or, what may loosely be regarded as, essential and non-essential output.

Although the classical economists themselves were either unable to see or were unwilling to admit the historical specificity of capitalism, they criticised the feudal order for the barriers and restraints it imposed on the development of productive forces by the rising bourgeoisie. The classical economists at that stage were concerned with unproductive output and consumption. This was precisely the criticism they levied against the ostentation and profligacy of the feudal aristocracy. Adam Smith disliked state intervention because state intervention gave rise to large sprawling bureaucracies and military establishments which he felt consumed society's resources which could be used for productive investment. Ricardo, who was a stock-broker, was critical of the extravagances of the Roman Catholic Church and he said that men should be given opportunities to worship God in a less expensive way. At that time they were very concerned about maximising capital investment and the whole growth process. However, the whole approach of economic theory itself shifted once the problems of capitalism became essentially not those of production but those of distribution, that is an inability to sell all the goods produced, surplus production, trade cycles and so on. In this new phase, which began about the year 1830 where Britain was concerned, capitalism produced what Marx called 'a herd of vulgar economic apologists', who abandoned the basic concerns of classical economics with problems of production and growth for a formal but distorted analysis of the economy in terms of market relations. The analysis was divorced from the social basis of production, thereby obscuring relationships of exploitation between one class and another, problems which had concerned or were noticed by people like Adam Smith and David Ricardo.

At the level of the market there is merely an exchange of an equivalence, a relation between things substituted for the relation between men and, at this stage, economists also began to predicate their analysis with assumptions about the universality of what is historically specific and transitory. Even the text book definitions of economics have reflected this. For example, Kenneth Boulding defines economics as follows: 'economic analysis is a body of general principles and a discipline of logic which may be applied to the interpretations of all economic problems past or present.' Thus the historical specificity of different social structures in which economic problems operate is completely removed. There is nothing of a social nature so that one cannot therefore distinguish a brothel from a manufacturing enterprise because the same principles of economics could apply. This emphasis on the market as the exclusive arbiter of value led to a jettisoning of the earlier distinction between productive and unproductive labour, or essential and non-essential output.

The attitude of present day economists to this question, the way in which they treat various forms of output, is attributable to their environment and to their social conditioning. One inhibiting element in this ideological stand is the presumption that the capitalist will not incur wasteful expenditures so that whatever expenditure he incurs is as essential to the society as to the capitalist whether that expenditure is in the form of a bribe to an administrator or represents the cost of political lobbying, expense account entertaining, or consumer advertising. For example, one finds that national

income statisticians do not adopt this distinction between productive output and non-productive output. They combine the whole thing and estimate the national income. So much for the vulnerability of the social scientist in the analysis which he purports to make; very often he is part of the problem.

3. Social Science Methodology

I will now try to get on to the second stage and discuss the methodological procedures of social sciences. There is a link between the first part of my lecture to explain that there is no unique analysis or unique solution in problems of social science and methodology in social science. There is a lack of finality in the analysis of the social scientists. The existence of these contending view points is not merely due to the conflict of interests which I have spoken to you about. The existence of these unsettled controversies and issues is also due to the methodologies which are open to the social scientist because, as I said earlier, in social science we cannot make controlled experiments. The variables in a social phenomenon are so numerous and their interrelations so complex that there are no mechanistic or invariant relations between them. Furthermore, observable data are limited. Unlike in the natural sciences, the phenomena cannot be observed in their most typical form. For instance, one cannot re-enact the battle of Waterloo to find out why Wellington won and Napoleon lost nor can one today carry out a survey of the Middle Ages. But if there is nothing else to be done, if there is no other technique, we cannot do any research on the Middle Ages because it is now too late. Of course information on certain contemporary phenomena can be gathered by means of a survey. However, one wonders how representative the data are. Perhaps they may not be so representative not because there has been any bias on the part of the man who conducted the survey, but due to sampling errors and, particularly, non-sampling errors. Thus phenomena in the social sciences cannot be observed in their typical forms because we cannot easily get data which typify the phenomena we are trying to observe, nor can controlled experiments be carried out so as to untangle the specific element of a phenomenon.

The socio-economic process basically is an indissoluble whole composed of the complicated network of human relations and responses whose general character may be disturbed by accidental elements that cannot be isolated. As Marx said, in the analysis of economic forms, neither microscopes nor chemical agents are of use. In the social sciences, facts and incontrovertible truths cannot always be gathered from observable data. However, this does not mean that these problems, which cannot be observed or experienced, cannot be analysed. In the absence of experiments analysis in the social sciences must rely largely on deductive reasoning and therefore becomes a process of distilling in one's mind the numerous properties of a phenomenon so as to capture the essential or the general properties of the phenomenon. Through such a process, the historically specific elements are isolated from the general. Thus if we are trying to study the plantations as a type, we should try to isolate those specific characteristics of a plantation in a specific historical or social situation from the general. In the same way, when you enter medical school, you begin to study the anatomy of the rat before you study the physiology and anatomy

of man because you are trying to reduce things to their basic, essential systems. Science means the study of general, basic, essential properties of a system. To see the basics, we should isolate the accidental disturbances which are not fundamental to the system, but which might arise in a specific situation.

Through such a process of deductive reasoning, distillation in one's mind, the historically specific elements are isolated from the general. Here again I have to refer to an interesting analogy of Marx where he referred to the different ways in which hunger is satisfied in different cultures. He said hunger is hunger. The hunger which is satisfied by the cooked meat eaten with knife and fork differs not from hunger that devours raw meat eaten with hands. We are trying to get to the lowest common denominator of a problem. That means we are trying to abstract the essential properties from non-essential properties. It is abstract concepts embodying the unalterable features of a phenomenon which would enable us to generalize and to see a unity in diversity. The plantations in Malaysia may be different from the plantations in Sri Lanka. Nevertheless, plantations in general could make up a plantation system which is different to non-plantation agriculture.

Generalization is the pre-requisite of science. For example, Marx's methodology was one of detecting the general in the particular and the particular in the general. This process of abstraction also involves questions regarding the priority to be accorded to different elements of a phenomenon. In social science, it is not enough to say that everything is equally important. Everything may be equally important in an abstract situation but in a specific situation you should be able to separate the more essential properties from the non-essential properties. Here I have to quote Oskar Lange — 'abstraction plays a particularly important part in political economy. This is because the economic process is very complex. Only by the use of abstraction can this complex of inter-connected and repeated human activities be unravelled and the economic relations between them together with their regulations be laid bare. The more complicated the subject of investigation, the more numerous the accidental elements which inter-twine with the essential elements'. So much for abstraction, and that leads to something else.

The principle of abstraction itself involves a decision on what to abstract and what not to abstract. This requires the formulation of a hypothesis or a pre-conception of what the problem is. A hypothesis might even be of a rough type but one is necessary because it will discipline you in the search for facts. What facts are you going to collect and what facts are you not going to collect? Two social scientists would differ not in the way they manipulate the facts because those are subject to commonly accepted techniques, but in what facts they leave uncollected, according to their particular view of the problem, the emphasis they place and the slant they give the problem. The hypothesis not merely indicates the kind of facts which might prove to be relevant or fruitful. It also provides a framework for the assembly of facts. It also means that facts cannot speak for themselves. They have to be interpreted within a theoretical or a conceptual framework. Without such a framework the analysis of facts and statistical material, laboriously compiled and elegantly presented, become limited to their algebraic relations, involving descriptive summaries of the data or the explanation of surface phenomena. There is little addition to knowledge beyond what statistics themselves make apparent.

Scientific knowledge, however, is not reducible to given facts. Knowledge is a construction which is based on facts. However, facts themselves are never given, but are always produced. They are the product of different theoretical or ideological practices. Theory is not a mere report of empirical data but an explanation of them. The correlations and co-variances are not self-explanatory. One could have a theory which explains correlations. You have been told how to measure facts and how to summarise them and process them. But the selection of facts and their arrangement or classification is not entirely a statistical matter but partly a philosophical question. It depends on one's hypothesis or pre-conception of the problem and on what aspects one is trying to highlight. The selection, arrangement, or classification of facts is a major practical consideration in the social sciences. The range of facts collected on any problem would require selection or judgement of the relevance of some facts as against others. Such judgement would pre-suppose some prior theoretical stands. The selection may be made arbitrarily owing to considerations of time, or manageability, or according to political criteria. Therefore, it is very important to examine the hypothesis of the social scientist because all the bias and all the errors could creep into the hypothesis long before he goes to the field. The very fact that he selects a given problem for analysis and leaves aside all the other problems means a judgement on his part. Has he selected the most significant problem even to go to the field and, having gone to the field, what are the aspects he is trying to highlight? All these will be reflected in the hypothesis and therefore when trying to evaluate research in the social sciences it is fundamental to identify and examine the hypothesis.

The process of abstraction requires a hypothesis. Then the problem of feeding data into this hypothesis to check the correctness of the hypothesis requires the comparative observation of the phenomenon in a wide range of settings. If you are studying plantation agriculture in Sri Lanka, you cannot really find out what the fundamental characteristics of plantation agriculture in Sri Lanka are unless you know the plantations as a system of production in the general setting extending beyond Sri Lanka. In the social sciences, to understand one situation one has to study numerous similar situations. This procedure of analysis is like examining several photographic slides of a landscape from various angles, each one with a different focus so as to obtain a generalized outline.

The need to formulate a hypothesis and also to look at a problem in numerous comparative situations also means that one needs a total approach to socio-economic problems. A total approach does not preclude an analytical method which extracts a specific element from a larger entity for detailed study. It may be impractical to start with studying the entirety of the under-development of the plantation system. Therefore one might have to study a particular aspect of the plantation system, plantations and labour, plantations and the technology of plantation production and so forth. Thus, one abstracts a particular aspect for convenience, but having abstracted these various aspects for convenience, one should not leave them as isolated studies. As R. Mills stated 'one should put back these fragments or bits and pieces, into the system to which they belong enabling a social phenomenon to be seen as an organic whole with complementary relations or reciprocities between these different parts.'

The next point is the need for multi-disciplinary or inter-disciplinary studies in the social sciences. Here again there was a sharp change which took place in the attitude of social scientists, particularly in the attitude of economists, to economic problems as social phenomena. In the case of the classical economists their approach to social science in general, and economics in particular, was inter-disciplinary. The first to incorporate political economy into their writings were the Scottish moralists including Joseph Hume who were concerned with the effects of the development of commerce and wealth on political power as well as on human happiness. It is also interesting to note that Adam Smith's designation at the University of Glasgow was Professor of Political Economy and Moral Philosophy. At the time he wrote the *Wealth of Nations*, he had a reputation from an earlier work called *The Theory of Moral Sentiments*. In the same way J. S. Mill subtitled his major work *Principles of Political Economy* 'With Some of Their Applications to Social Philosophy'. I am trying to illustrate how economists shifted their ground concerning what they regarded as an economic problem and how they fragmented the social sciences into different fields. For practical purposes, political economy, explained Mill, is inseparably intertwined with many other branches of social philosophy. Adam Smith himself recognized that a community comprised a series of different orders and societies and that the development of trade and manufactures affected the political power of the landed aristocracy. Marx of course conceived of human society as an interrelated system comprising of both economic and non-economic elements, contrary to what is usually thought that he merely concentrated on the economic aspects of the problem and discarded the non-economic aspects. In fact, in this connection, Engels explains that 'political conditions, etc. and even the traditions which haunt the human mind also play a part although not the decisive one. Without making oneself ridiculous, it would be difficult to succeed in explaining in terms of economics alone the existence of every small state in general.'

From the last quarter of the 19th century, in economics, as I mentioned earlier, there was a shift away from the study of production relations into an exclusive concentration on market relations. When economics confined itself mainly to a study of the exchange process, economic problems also began to be examined by taking the existing socio-political framework as given. This tended to detach economics from the other social sciences and led to a fragmentation of the study of the social process itself.

Furthermore, another related change was that economics began to be regarded as a positive science. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking which helps the possessor to draw up correct conclusions. The economist's role became to explain and explore, not to uphold or condemn. Devoid of prescriptive and policy implications and evaluating norms, economics serves to legitimize the political rule of the dominant class because we do not question the social order. Our principles of economics are applied equally to a capitalist economy, stone age to a socialist economy, because they are all reduced to the problem of scarcity, scarce means and unlimited ends.

With this narrowing of the focus of economics, there was also an abandonment of the earlier term for economics which was 'political economy' and they began to use the word 'economics'. Within this restricted intellectual framework, the problem of production

began to be viewed in terms of mechanistic relations between productive factors involving input-output relations and technical coefficients of production while the economic problem was detached from the political and social process. The economic process itself was fragmented so as to place emphasis on the scarcity of one factor or another, such as limitations in markets, or in enterprise, capital and in some more recent models, lack of human capital such as education and skills.

The changes in the framework, the focus, and the methodology of economics about which I have been specifically talking also had a parallel in sociology where a neo-positivist school of thought began to take root. Neo-positivists sought to discard normative elements and to renounce the possible role of the sociologist as an agent of social change. He was expected to be neutral. In spite of this, it is curious that sociology, which has been a late developer among the social sciences has not been pervaded to the same extent as economics by this ahistorical, apolitical, amoral approach. Along with history and politics, sociology has been reaching out, with far less inhibition, to areas of knowledge which require value judgement, investigations of property rights and power relations in society, and the exercise of what one may call the sociological imagination. Problems of development and under-development previously regarded as purely economic problems have also been brought within the purview of sociology. Therefore, sociology seems to pave the way for social action. It is linked up more with philosophy and based on the evaluation of development goals and the rational manipulation of society.

4. Empiricism

Another aspect of this change is — and this brings me to the third and final part of my lecture — that with the formalisation of economics and the abandonment of the framework of classical political economy, economics was also seized by an anti-theoretic tendency. That is to say it began to lean heavily on statistics and observable and quantifiable facts. Thus a great many studies in development economics, despite their title, belong to the field of applied economics and are in the nature of investigative reports devoid of intuition, reasoned thinking, or theory. In my view they have suffered from a severe empiricism based on questionnaires and social surveys. Studies on Sri Lanka's agrarian problems offer a good example. In most of these studies, there is a procession of statistical tables interspersed with explanatory notes on what the tables show. For the benefit of the lazy reader, the same facts are simplified further in charts and diagrams. The analysis remains at a superficial level. A large majority of writings that attempt synthesis and review contain trite statements and do not in any way enrich our understanding of the agrarian scene. Much of the research effort is devoted to the mechanical and repetitive process of data collection. The end result is the production of a conglomerate of statistical tables that overlap and duplicate one another.

Meaningful research in the social sciences require far more than the accumulation of facts and their arrangements under merely commonsense captions and subjecting them to algebraic manipulations. Much of the research and writings on the under-developed countries are either excessively theoretical or excessively empirical. There should be a

fruitful combination of empiricism and theories. Western scholars whose theoretical insights, I think, are sharply developed, are limited in their analysis by limitations in the range of data to which they have access. On the other hand, the scholars in the under-developed countries tend to burden themselves with a load of data to the neglect of a theoretical framework.

5. Macro and Micro Studies

In a macro study it may not be practicable to collect all the required data because you are operating on a vast expanse of problems. You take the whole world as your canvas. But if you are just writing on some village, you can pile up enough data so that empiricism is also linked with a kind of micro approach to social problems. You cannot collect data to write on the general problem of under-development. A macro study involves a theoretical perception of a phenomenon, because once you get on to the theoretical plane, then you are capable of handling a larger situation. A macro study has a character of its own. It is not just the aggregation of numerous micro studies, just as a collection of snapshots does not make a cinematic film. A macro study involves the visualizing of a problem in its totality, the perception at one sweep of a vast array of facts. It also involves a separation of the important and relevant from the trivial. An intertwining of facts and knowledge taken from disparate clusters separated by space and time. Further it requires an appropriate system of classification of such facts and knowledge and an ability to both disaggregate and compress, to synthesize and enlarge.

All this does not imply that micro studies are necessarily unrewarding. A micro study can powerfully illuminate a small area instead of throwing subdued light on a bigger expanse. There is an analogy which I would like to take-over from Professor Denis Robertson of the 'snake and the glow worm'. A snake, it is said, is able to cast its light on a narrowly focused area straight ahead of it while the glow worm can light up the entire surrounding area even though faintly. It does not mean that you can get a macro picture by doing one hundred micro studies. The macro picture has a character and a quality of its own which depends on the hypothesis, the abstraction, the sociological imagination and so forth. The point is there should be a fruitful combination of micro and macro studies.

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Social Science Research in Sri Lanka: A Historical Perspective

H. N. S. KARUNATILAKE

Central Bank of Ceylon

1. Introduction

Compared to many other developing South Asian countries Sri Lanka has had a greater volume of social, economic, demographic and other statistical information which has helped writers in their social science writings and stimulated them to make further investigations. Such data have been available in Sri Lanka over a period of more than one hundred years and the coverage has been extensive. Furthermore, the quality and reliability of early data have been quite satisfactory despite the fact that data and information collection and methodologies have not developed to the present levels of refinement and sophistication. An important consideration was that the writers in social science fields in the 19th century made full use of whatever data that were available and endeavoured to make comprehensive analyses. The British have throughout paid attention to the collection of information and statistics and several regular publications such as the Almanacs, Calendars and, later on, the Blue Books have carried a considerable amount of data with very few breaks in the series. It is therefore not surprising that a great deal of this historical data still awaits analysis and critical evaluation by the social scientist who is more interested in the past than in current developments or rather in the relationship between current and historical trends.

The most comprehensive bibliography on Sri Lanka prepared so far is H. A. I. Goonetilleke's five volume *A Bibliography of Ceylon* (1970). This reveals a wide range of studies in the field of the social sciences in general. Indeed, it is a fair judgement to make that in Sri Lanka research and writing in the social sciences have considerably exceeded those in the pure and applied sciences. In fact, in the period before the Second World War most of the studies on Sri Lanka have been in the fields of history, politics, constitutional change, sociology, culture, religion and allied subjects. A trend which has been increasingly evident today and something which this paper attempts to pinpoint is the increasing tendency for more recent studies in the field of social sciences to heavily lean towards political issues in the country. On the other hand, the studies made before the last three decades especially in the 19th century were less conditioned by political issues. Then the bias was clearly towards the elaboration and analysis of social problems. Studies done in the nineteenth century were primarily concerned with the social framework with the emphasis on the people, their customs, habits, religion, cultural and demographic characteristics.

2. Early Nineteenth Century

Perhaps, the correct approach to an assessment of the social and political influences on social research would be to look at it from a historical perspective evaluating the impact of social and political change on writing in the last 175 years, i.e. from the beginning of the British period.¹ In the early days of the British occupation of the island several books were published on Sri Lanka in quick succession. Their main purpose would seem to have been to give the reading public in Britain, the country from which the authors came, an insight into the history, manners and customs of the people who lived in the newly acquired British colony. The very early writers such as Davy, Cordiner, Percival, all attempted to describe Sri Lanka in all its variegated facets with varying degrees of success.

Most of the books written about the island in the early days of British rule came out between 1800 and 1820. Thereafter, until about 1840 there appears to have been a substantial void in the output of literature on Sri Lanka. This applies not only to books but also to articles and pamphlets. This is not too difficult to explain because these years coincided with a period of very little economic activity and development. The British were perhaps spending a lot of their energy and resources on consolidating the kingdom of Kandy which was ceded to them in 1815. This long spell of literary inactivity from around 1820 to 1840 was only broken by the two volumes written by Forbes, *Eleven Years in Ceylon* which was published around 1840. A brief account of some of the studies in the early British period, written mainly by administrators, government officials and members of the clergy may be relevant in order to indicate that during these early days of British rule social issues rather than political issues predominated and even if references were made to politics it was always in a historical context. The political aspects specifically seem to have received very little weightage because it was an accepted fact that the British had conquered the maritime provinces.

In the context of a situation where information and statistical data on social conditions were virtually absent in the early days of British rule, those who wanted to write on the social aspects made it a point to visit the different parts of the island to gather information and making detailed observation of people and events was the principal means of investigation. This is, to some extent, different from the approach of researchers of modern times who tend to depend, very often, too heavily on published statistical material or secondary sources with very little access to any direct understanding of the conditions about which they are writing.

¹ It is important to note that the first sociological study of Sri Lanka written by an Englishman and indeed the first book written on the island in the English Language was Robert Knox's monumental work entitled *An Historical Relation of the Island of Ceylon in the the East Indies*. The book was written during the Dutch occupation of Ceylon. Robert Knox was held captive for twenty years in the Kandyan Kingdom along with several other Englishmen and in 1681 on his return to England he wrote his book. It is a fascinating narrative of the Kandyan Kingdom, the Kandyan Court, the country, religion, manners and social organisation. It is an unparalleled source book for reconstructing the social and economic history of the society that existed in Ceylon in the seventeenth century. In Knox's study the political context was not entirely eliminated because he dealt with such aspects as the Kandyan king's despotic reign, the wars fought by the king and the attempts at rebellion against him. Knox also dealt with feudalism in the Kandyan Kingdom and with its complicated system of land tenure.

A significant work that emerged in the early days of British rule was the book *A Description of Ceylon* published by Rev. James Cordiner who was the chaplain to the British garrison on the island. This book was published in 1807 and contains a description of the geography of Ceylon, its inhabitants, natural products together with a narrative of a tour of the island in 1800.

There are several other books that came out in the early days of British occupation which are noteworthy and these include a study by Anthony Bertolacci, the first British civil servant who attempted to make a comprehensive study of the commercial and financial aspects of the country. The book is entitled *A View of the Agricultural, Commercial and Financial Interests of Ceylon* and was published in 1817. The book includes a series of appendices containing some of the principal laws, the Kandyan, the economic structure, ports, customs house regulations, and statistics relating to exports, imports, public revenue and expenditure. The information in these early books constitute primary information and much of it has been gathered by the writers themselves because, in the first decade of British rule, very little social and economic information had been published and what little that was available was largely confined to government revenue, exports and imports.

During this period none of the Almanacs, Calendars and Blue Books that carried basic data on the economy during the latter half of the 19th century had yet come out. Some statistical documentation and general information appeared for the first time after 1820. Anthony Bertolacci's book was followed by *An Account of the Interior of Ceylon and its Inhabitants* by John Davy who happened to be a doctor to the British forces that were stationed in the Island at that time. In this study too, in the absence of other forms of economic information, the writer has made use of his travels in the country to make extensive observations of the social conditions.

3. 1840 - 1899

The upsurge in economic activity that was associated with the growth of the coffee plantations after the mid 1830s presumably stimulated literary activity in the island. Most of the publications that came out during this period too continued to give accounts of the country as the British administration progressed. Here, again, the objective seems to have been to keep the people in Britain informed of conditions in Sri Lanka. In 1843 J. W. Bennet wrote *Ceylon and its Capabilities*. This study included an account of the natural resources, indigenous production, commercial facilities and a fair amount of statistics. This again was another reasonably comprehensive account of the economic and commercial situation in the island at the end of the first forty years of British rule of Sri Lanka.

In 1846 Henry Marshall wrote *Ceylon—A General Description of the Island and its Inhabitants*. This was a description of the island which included a historical sketch of the British conquest of the country. In 1849 Charles Pridham published *An Historical, Political, and Statistical Account of Ceylon and its Dependencies*. The tendency in the studies after 1840 was for economic aspects to predominate and this was largely because the economic environment after the 1840s had become quite different from what it was in

the early days of British rule. Two other books were published in the same period basically in the tradition in which the other books of the forties and fifties were written. The first was a two volume work, *Ceylon and the Cingalese*, by Henry Charles Sirr. This book again deals with the economic capabilities of the island and describes the economic conditions that prevailed at that time and the potential for further development. About the same time, two volumes entitled *Ceylon By an Officer Late of the Ceylon Rifles* were published.

During this period, by far the most important work that emerged in the shape of a comprehensive and incisive social and general commentary was the two monumental volumes on Sri Lanka by Sir James Tennent published in 1859. Entitled *Ceylon : An Account of the Island, Physical, Historical and Topographical*, this is probably one of the most popular and best known books on the country. It is highly prized and recognized as a comprehensive and authoritative work on the historical, social, economic and political conditions of the island in the middle of the last century.

In the first half century of British rule social studies about the island and its inhabitants came out mostly in the form of books. There were very few periodicals and journals. Most of the periodicals came to be published in the second half of the nineteenth century, especially after the sixties. One of the foremost journals that continues to be published even up to this day is the *Journal of the Royal Asiatic Society (Ceylon Branch)* (*JRAS*) which, from its first year of publication in 1845, has become a vehicle of sound historical, social and economic research on the island. From its inception, the objective of the Royal Asiatic Society has been to institute and promote inquiry and research into Sri Lanka's history, religion, language, literature, arts and the social condition of the present and former inhabitants of the island. The research studies it has frequently published in its Journal have been on such diverse fields as history, geology, epigraphy, mineralogy, climatology, meteorology, botany, zoology and fauna and flora.

When it was first published in the 1840s the *JRAS* was perhaps the only journal that regularly carried the fruits of serious research that was undertaken largely by the expatriate officials and academics in Sri Lanka. Its contributors have included the most prestigious writers and research workers who have lived in this country during the last hundred years. The main characteristics of the research studies published in this Journal have been their very close links with contemporary society, culture, traditions and the history of Sri Lanka. Most of the scholars who wrote to the Journal have been serious students of their respective areas of specialisation and they have laboured hard to carefully collect, sift and analyse materials on topics on which very little systematic information had been available up to that time. However, the kind of article which today has become more and more important in the political context did not find a place in the *JRAS*.

4. 1900 - 1947

Journals became a more popular medium of publication of research work in the social sciences and humanities in Sri Lanka after the turn of this century. The *JRAS* apart, the other journals which carried social and historical research during the period

before 1920 included the *Orientalist* and the *Ceylon Literary Register* which was first published in 1880 and at the outset mostly contained articles of literary value. But the *Ceylon Antiquary* and the *Ceylon Register* which was published in three different series from the year 1915 onwards were somewhat in the tradition of the *JRAS* although their coverage of subject areas was far more limited. These two journals published research pertaining to Sri Lanka's history, culture and other allied subjects. The *Ceylon Economic Journal* (*CEJ*) which briefly emerged soon after the depression in the 1930s continued to be in publication for a relatively short period under the editorship of Dr B. B. Das Gupta. It is presumably the first journal published in Sri Lanka exclusively on economic topics. The subjects covered in the *CEJ* were quite removed from the historical and sociological context of most of the earlier journals. Many of the articles in the *CEJ* were based on the economic background of Sri Lanka and the studies pertained to banking, commerce, trade, and financial affairs of the island.

While the first quarter of the 20th century was very fruitful where cultural and intellectual activities were concerned, the period from around 1925 to about 1950 could be looked upon once again as an era of vacuum in social research in the island. During this period, however, the government issued a large volume of statistical, social and economic information through the regular Blue Books, Almanacs, Sessional Papers and other publications which were put out from time to time. But the volume of research publications in the form of articles or in the form of books was very limited. Most of the writings in this period, especially after 1920, had a distinct bias towards the emerging political issues of Sri Lanka. This was the time when the nationalist movement had gathered momentum as an aftermath of the riots of 1915 which made the Ceylonese public aware of the rigors of British rule and its damaging effects. This was also a period when constitutional change took place, though very slowly, and the Ceylonese were progressively gaining political power into their hands. Other than pamphlets and small booklets written on the constitutional progress which the country had achieved, no major works of consequence even on politics appeared during this period. Being still under British domination it was not easy for people to write freely on the political situation and also to make evaluations with a sense of detachment.

5. Post-Independence Period

After the country gained Independence in 1948 the environment for research changed significantly in many ways and several factors contributed to this. Firstly, by this time, the country had its own university and there were many senior academics who made use of the vast body of material available on the social sciences to write on their individual fields of specialisation. The pioneering efforts were made by two categories of research workers. First, the academics to whom reference has already been made and second, those who were associated with the movement to gain Independence and contributed to the national and social awakening in the island.

At the same time, after Independence, several new organisations emerged and they became progressively equipped to undertake social research and to collect primary socio-economic data which would be of great use to other research workers. Other data gathering

government departments and institutions also stepped up their efforts to reorient their horizons and activities to national needs. The leadership in this direction was given by the Central Bank of Ceylon where the statute made specific provision for a Department of Economic Research, the first of its kind in the country. With a new interest in economic and social studies endeavours were made by independent groups of persons to bring out periodicals. One of the first attempts to do so was the publication of two important journals which had no official links. The first was the *Ceylon Economist* which continued to bring out volumes for a period of 7-8 years commencing in 1950 and then went out of publication. At that time, it was the only independent journal which contained economic writings. In 1952, the *Ceylon Historical Journal (CHJ)* also came into publication. It was sponsored by academics within and outside university circles. The *CHJ* carried articles mostly by university academics on history and related subjects. A great many of the articles in the journal touched on contemporary political issues and also historical factors that had conditioned current political problems. The journal continues to be published though infrequently. This may be due to the paucity of articles and also the multiplication of other journals with the same approach and background. In more recent years, especially the last ten the *CHJ* has begun to publish old works on Sri Lanka as a part of the series.

The University of Ceylon Review (UCR) although not exclusively concerned with social science research was also a vehicle for occasional articles on history, geography, economics and other disciplines in the social sciences. But its main bias seems to have been on studies pertaining to oriental studies, language, the arts and literature. After having been in publication for more than twenty years the *Review* is no longer being issued. One does not know whether this is a reflection of the paucity of research done at the universities or the lack of initiative on the part of the university authorities. It is now time that all the universities in Sri Lanka join together to revive the *Review* as a common vehicle for publishing research of whatever kind undertaken by the universities.² Its demise though gradual is also an indication of the general decline of research done by the academic community in the universities. University academics have from time to time published their research in book form but most of this represents the research that they have undertaken for their higher degrees, mainly doctorates.

Although the *UCR* which was an official journal of the University went out of publication, it seems to have been replaced by the *Ceylon Journal of Historical and Social Studies (CJHSS)* which is not a university publication but which has been brought out by a publications board which consists very largely of senior academics who have undertaken research for quite a long time and who have mainly been members of the university community at Peradeniya. The *CJHSS* appeared for the first time in 1958 and after ten years of publication it has brought out a new series starting in 1968. This journal has been the principal vehicle for transmitting social science research that has been done mainly by academics at Peradeniya to the public of Sri Lanka. The articles that have been published in this journal typically reflect the growing significance of the social and economic context

2 The University of Colombo has just brought out (in 1982) a *Review* on the same lines as the *University of Ceylon Review*.

in social science research. Perhaps, without exception the studies in this journal in the fields of history, law, politics, constitutional affairs and economics are related closely to significant social, economic and political issues of the country. It is also apparent that a fair amount of the research published in this journal has emanated from social and economic questions, not only because such issues have directly interested the researcher in the present context, but also because social research with a distinctly political flavour would be of interest to the reader and, therefore, the journal would have a much wider market.

Following in the same tradition another journal the *Modern Ceylon Studies (MCS)* has come out in publication from 1969 onwards. This, again, has been a product of the University of Peradeniya and the guiding lights have been mostly historians and economists who have had a lasting interest in social science research. The articles published in the *MCS* relate specifically to the entire field of social sciences including areas such as anthropology and psychology. Some of the material published in this Journal have been research specifically done for the *Ceylon Studies Seminar* workshops which have been frequently held in Peradeniya and whose proceedings and resulting papers have been published independently as well.

Another journal of importance has been the *Staff Studies* published by the Central Bank since 1970. The articles in this have been almost exclusively in the fields of economics and statistics and the papers have been written almost entirely by members of the Central Bank staff. The writers have been free to critically examine economic and social policy and to be independent and detached in their analysis. Since 1979 the *Staff Studies* has not been coming out regularly. The Marga Institute has also brought out a periodical entitled *Marga* which again has been a vehicle for scholars mostly in the non-government sector to publish their research. A new Journal has been just put out by the Agrarian Research and Training Institute (ARTI) entitled *The Ceylon Journal of Agrarian Studies*. The articles in this have been mostly written by the officers of the ARTI. In 1978 the Social Science Research Centre of the National Science Council of Sri Lanka began to publish the *Sri Lanka Journal of Social Sciences*. This journal is a biannual and it publishes articles covering the entire range of social science relating mainly, but not exclusively, to Sri Lanka.

The output of socio-economic research covering both the micro and macro levels increased substantially from the beginning of 1950. As already indicated social science research secured a new status by the establishment of the University of Ceylon and, moreover, weightage in the University in the fifties and sixties has been towards social science subjects. The science faculties were less developed and the largest body of students did subjects such as history, geography, economics and sociology. Furthermore, the largest number of faculty members also belonged to those departments where social science subjects were taught. Quite apart from this, a large number of scholars and expatriates who were undertaking research for institutions overseas, particularly universities in the U. K. and U.S.A., began to visit the country in large numbers. Many of them took a renewed interest in the political situation and one factor that spurred them on to research, especially in the field of politics and sociology, was the importance

that communal issues played in politics together with religion and caste. In most of the studies on politics and economics the main theme has invariably got linked to one of these three areas and the number of studies with such links have, in recent years, increased considerably. This is evident not only in the books embodying substantial research that have come out in the last two decades, but also in the articles and papers that are being published in the journals issued in this country and in journals concerned with Sri Lanka and South East Asia published abroad, particularly in the United States.

Although the writings on politics and sociology have today virtually inundated the documentation in the field of social science, substantial works dealing largely with economics have been few and far between. The first work on the economy of Sri Lanka which was more descriptive than analytical was the *Economy of Ceylon* by Ivor Jennings which was written when he was the Vice Chancellor of the University of Ceylon in the forties. Next, after a long spell, in 1966 D. Snodgrass attached to Yale University brought out his in-depth study entitled *Ceylon: An Export Economy in Transition*. In fact, of the macro analytical works on the economy of Sri Lanka Snodgrass' work stands out mainly because it makes a systematic fresh analysis of data that had been published over a long period of time. The analysis itself is devoid of any political undertones or policy prescriptions which normally become part and parcel of writings on economic subjects that embrace the economy as a whole. One of the few books published in the seventies on the economy of Sri Lanka was *The Economic Development of Ceylon* by H. N. S. Karunatilake which tends to review critically the development policies of successive governments since Independence.

However, the majority of publications, both articles and books, have been primarily in the areas of government, politics, constitutional change and sociology. With the exception of works in the field of history and archeology, strangely enough, in the other areas, research has been undertaken mostly by visiting scholars or by Sri Lankan scholars who have been living abroad for a considerable period of time and who have cut themselves away from the social milieu here. In the field of history a large volume of publications both books and papers have appeared in the last thirty years. Most of the substantial works, especially the two volumes of the *History of Ceylon* brought out by the University of Ceylon, have been objective studies devoid of any political or social prescriptions. Historians and the university academics have also produced a large number of individual studies which have covered the Portuguese, Dutch and British periods. Likewise, there have also been a large number of articles on history which have appeared in the *CJHSS* and the *MCS*.

Historians have also brought out general studies on Sri Lanka but these often tend to present an individual point of view. One such study is *Ceylon* by S. A. Pakeman published in 1964 which is really a broad analysis of Ceylon and the historical factors that have been most relevant to its understanding. Presumably this book has been written for the benefit of the reader overseas. Similarly, E.F.C. Ludowyk in 1964 wrote *Story of Ceylon* which is not really a substantial piece of research but a general study which links up Sri Lanka's history with the present. In 1964, S. Arasaratnam brought out a small book entitled *Ceylon* which is primarily a survey of political problems and unrest in modern Sri Lanka within a historical perspective. This book touches heavily on a common theme

of political and sociological research today which is the communal problem in the island or the conflict between different races. Essentially the focus in this book is on the three major communal groups the Sinhalese, Tamils and Muslims and a discussion of the 2,000 year old process of national development in the island.

Another historical study of significance is the *Modern History of Ceylon* also written by E. F. C. Ludowyk in 1966 without any political undertones. This is a comprehensive treatment of the British period in Sri Lanka's history. Special emphasis in the analysis has been given to the impact of British rule on the social and economic structure and the political and economic problems that have plagued Sri Lanka from 1931 to 1948. More recently K. M. de Silva has published *A History of Sri Lanka* which is a comprehensive survey of Sri Lanka's history from the earliest times to the present.

One of the earliest anthropological works on Sri Lanka was the *Veddas* by C.G. and B.Z. Seligmann which came out in 1911. In recent years studies in anthropology have been published by M. D. Raghavan, N. D. Wijesekera, Gananath Obeyesekere and a few others.

Among the early important socio-economic and geographical works was *Pioneer Peasant Colonization in Ceylon* by B. H. Farmer. This publication came out in 1957 and it is primarily concerned with the efforts of the Sri Lanka administration both prior to and just after Independence in the settlement of people in the Dry Zone. The book evaluates the success of these efforts and also the problems that have confronted the administration in doing so. A work that falls broadly into the same category but with an anthropological bias has been written by E. R. Leach entitled *Pul Eliya*. Here again, the focus of the analysis is on the problems associated with villages in the Dry Zone. The problems of development, settlement and the confrontation of the settler with the environment and other difficulties including shortcomings of the administration have been examined here. Books that fall into this category always tend to highlight the weakness of the political system and one could imply that a good part of the difficulties that pioneer peasant settlers have faced could be attributed to political and administrative deficiencies. G. Obeyesekere's *Land Tenure in Village Ceylon* is complementary to the work by Leach because kinship and land tenure feature in both studies. Obeyesekere has analysed tenurial problems in the context of Medagama, a village in the Dry Zone. The detailed analysis of land holdings with kinship charts constitutes an interesting example of modern anthropological techniques.

An even earlier sociological study by a Ceylonese has been *Sinhala Social Organization* by Ralph Pieris published in 1956. This is one of the author's very early works and represents a comprehensive account of the Sinhala society in the Kandyan kingdom. It analyses the social order in which the village community, village council, caste and other sociological factors have been living institutions. One of the pioneering sociological studies on a subject which has been of great importance but not much talked about and about which nothing substantial had been written for centuries has been the one brought out by Bryce Ryan in 1953. The book entitled *Caste in Modern Ceylon* has been a pioneering and monumental work and such a book at that juncture was most relevant because

it shows how the caste system operates amidst influences which contradict its basic premises. Sri Lanka has continued with the caste system although changes in the behaviour of Sinhalese have been brought about by western attitudes and increasing urbanization but these factors have not altered their sentiments. Bryce Ryan says that caste dominates in the fields of marriage and personal loyalties. This was a subject which was for a long time considered taboo for research by the people of this country and work in this field has nearly always fallen within the purview of visiting scholars. In a similar study Nur Yalman in his book entitled *Under the Bo Tree* examines the inter-relationship between caste, kinship, marriage and life in typical Kandyan villages.

More recently on the same theme, Janice Jiggins has brought out a comprehensive work entitled *Caste and Family in the Politics of Sri Lanka* showing the significance of caste as an important factor in politics in Sri Lanka and also how this has acted as a significant force in party politics and in successive elections that have been held in the country since Independence. This is the only study of its kind which has an analysis based on carefully collected and checked data.

The link between religion and politics has also been a focus of attention of many visiting research scholars. While religion has played an important part in Sri Lankan history, the role of religion in politics and in the present social context has been studied only recently. One of the first works in this field is by Francois Houtart entitled *Religion and Politics*. The study deals both historically and in the current context with the important role that Buddhism has played in leading the political trends and the political forces that have emerged at various times in Sri Lanka. However, a more important work which has an immediate bearing on the significance of religion in modern politics is the study by Urmila Phadnis on *Religion and Politics in Sri Lanka*. In this book she attempts a broad survey that extends over a period of 2,500 years but focuses attention on the structure and the role of the sangha in the formulation and implementation of cultural, economic and even foreign policy. She has also highlighted the changes that have taken place in the religion itself due to the involvement of the priesthood in secular affairs. The book was published in 1976 and perhaps, it is still the most useful book to understand the importance that religion tends to play in politics in the country at the present time.

Communal problems have been a favourite theme of researchers, not only because there is a vast fund of material on which they can draw upon, but there is also the fact that a lot of material representing one side or the other of a communal issue could always be assembled. Of course the quality of the writing would tend to depend on the bias or the point of view expressed by a researcher. One of the earliest books on this subject was *Communalism and Language in the Politics of Ceylon* published in 1967 by an American Robert N. Kearney. Although friction between the Sinhalese and the Tamil communities has existed for a long time, and was manifested in the outbreak of violence in 1958, yet it became a subject of analysis by scholars very much later. The only book that emerged from the communal troubles of 1958 was *Emergency '58* by Tarzie Vittachi. This was not really a serious political and sociological study but rather a description of the events that took place in 1958. Although there have been a plethora of works on the communal problem in the shape of articles and booklets brought out by various

organisations, more serious analysis of these problems have been still quite few in number. Nevertheless, the theme of communal conflict pervades a lot of other books on politics and government written by reputed researchers.

The most comprehensive account, although rather outdated in the present context, on the main political developments in Sri Lanka has been *Ceylon: Dilemmas of a New Nation* by Howard Wriggins. This book makes a broad survey of postwar political conditions but the narrative written in 1960 is not directly relevant to the present political and social context. Other studies with a wide spectrum of analysis have been two books by A. J. Wilson. One is *Politics in Sri Lanka 1947-1973* published in 1974 which is probably one of the more comprehensive accounts of political developments since the country gained Independence. The other study entitled *Electoral Politics in an Emergent State* deals with the general elections of 1970. Here again, the emphasis is on the problems emerging from the multi-ethnic society in the country and the issues that have stemmed from a basically rural society and how these have influenced the general political issues of the island. Another book which has recently been published by the same author entitled *The Gaullist System in Asia* is specifically a study of the new constitution that Sri Lanka adopted in 1978 and the role and powers of the Executive President.

Although in the field of economic research substantial individual works have been relatively few in number, monographs, articles and studies issued by organisations have increased to such an extent that the lack of individual research has been more than compensated for by the joint works of research groups or by studies from organisations. In this field with the establishment of its Economic Research Department the Central Bank, came to the forefront and it has over the last thirty years been a fountain of information and the source of a number of analytical works on the Sri Lankan economy. The Department itself has been primarily concerned with the collection, processing and publication of economic data. However, a considerable amount of time has also been spent on organising socio-economic surveys for the purpose of providing researchers with basic and up-to-date data which will contribute to the understanding of economic problems of Sri Lanka.

General research studies on specific micro subjects on the Sri Lankan economy have been published by the Bank. Every year, however, the Annual Report could be looked upon as a fairly serious piece of economic analysis and there is no doubt that the analysis, to some extent, has also been influenced by the contemporary social and political situation. The Bank has very often made constructive criticisms and looked meaningfully at Sri Lanka's economic problems in the hope that these observations would influence the decision-makers at the political level. To this extent, one cannot say that the research undertaken by institutions like the Central Bank has been without relevance to the prevailing socio-economic context. The criticisms and evaluations have often been made with the object of bringing about economic and social change which is desirable in the national interest.

More recently, a major source of research, particularly on problems pertaining to agriculture and the agrarian situation, has been the Agrarian Research and Training Institute (ARTI) which was set up in 1972. The output of work in the form of studies by individuals and joint efforts has been considerable. All these studies have been largely

based on data that have been collected in the field by research workers of the Institute. In this respect, the work of the ARTI in a broad perspective follows the discipline that has been established by the Economic Research Department of the Central Bank since 1950. However, the socio economic studies by the ARTI have tended to be too much pre-occupied with micro aspects and have lacked depth. This is because the Institute does not have adequate facilities for gathering macro data which embrace the economy as a whole and are relevant to policy formulation.

However, the data that have been collected by the ARTI and the analysis of problems in relation to the agrarian situation are of significance and are very closely linked to the present social context. Being basically an independent body the ARTI has steered clear of making political prescriptions although it has not always looked at problems related to agriculture and agrarian issues with a strict degree of detachment and objectivity. To this extent, it has not endeavoured to criticize the policies of the government and the Ministry of Agriculture which oversees its operations. On the other hand, however, the Central Bank has not been subject to the same limitations because it has had a tradition of doing independent work and there have been times when the Bank publications and reports have made very specific criticisms of government policy.

Another independent social and economic research organisation totally unconnected with the government and, perhaps, the only one of its kind in Sri Lanka, is the Marga Institute which has been functioning for a period of more than ten years. The Institute although it has done a fair amount of work has been guided in the choice of areas of social research by the agency that funds the organisation. It does not seem to have much independence in this respect because it has undertaken mainly funded research. This factor seems to have affected not only the quality of research, but often the approach taken seems to be conditioned by the criteria laid down by the funding agency and its outlook.

Social Science Research in Sri Lanka: A Contemporary Perspective

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1. Introduction

I do not wish to go into any historical aspects of social science research in Sri Lanka, but would like to confine myself to the post-independence period. I would like to start with the positive aspects of social sciences research in Sri Lanka in recent times. What I describe as the positive aspects must be looked at not only in the context of socio-political factors, but also in the context of other aspects that have a vital bearing on the nature, quality and quantity, of research. Of course it is difficult to separate these other aspects from the socio-political aspects because they are very closely interwoven. Nevertheless, I will start by dealing with certain aspects that have a bearing on social science research in Sri Lanka as a background to my identification of the positive aspects.

2. Personnel

When viewing the present state of social science research in Sri Lanka one has to first look at the research personnel available to do research. Obviously those serving in the universities in the disciplines relating to the social sciences would fall into this category and probably form a numerical majority among the researchers in the social sciences. Besides them are those attached to specialised research institutes such as the Agrarian Research and Training Institute (ARTI,) the Marga and certain other institutions such as the Central Bank where a part of the functions relate to research. If one were to take a census of the research personnel or potential research personnel, it would be found that the number is fairly large. However, if one were to look at the availability of personnel with formal experience and training in research it would be found that there is an acute dearth of personnel for social science research in Sri Lanka.

For example, in the universities, some of the departments that occupy key positions among the social sciences like sociology and anthropology suffer greatly from an inadequacy of people with research training and experience. This applies to other disciplines like economics and geography also. Now it is a debatable point whether one needs all that experience and training to undertake useful research. In this context, however, it is useful to note that those countries which have been very productive in social science research, are invariably fairly rich in experienced personnel. This is perhaps due to the fact that a certain amount of academic in-breeding is inevitable and desirable for any kind of research.

3. Facilities

Secondly, we must consider the opportunity and facilities that exist for research in the social sciences. Now these are serious constraints to the social science researcher in Sri Lanka, although they are not so formidable as often made out to be. But, at the same time, one could make the observation that, generally, opportunities and facilities tend to seek out those who are successful researchers, so that by themselves they are not very serious problems. However, for the young social scientist embarking on research the inadequacy of facilities, the lack of opportunity can in fact be a very serious problem. I can illustrate this point with a very brief example; the total research budget for what is one of the potentially largest research establishments in Sri Lanka, the Arts Faculty of the University of Peradeniya is less than the research budget available for a medium-sized research project at the ARTI. This situation has prevailed over a long period of time without any improvement. While on this I must add that organizations like the National Science Council are doing their best with limited resources to rectify the situation. However, here again, I identify a particular attitude of mind among the decision makers towards social science research which entertains the concept that somehow social science research is less important than research in the so called 'hard' sciences. This is illustrated by the relative ease with which funding could be obtained for research projects in the biological and physical sciences, but not in the social sciences.

4. Incentives

Thirdly, when it comes to incentives, in my opinion, this is one of the principal problem areas for the social science researcher in Sri Lanka the absence or the inadequacy of incentives. For some people incentives are no doubt there. Some people seek immortality out of research as their names enter publications. Some gain a certain amount of psychological satisfaction by publishing papers. There are others who find sabbatical leave, a very important incentive for research because unless you publish, the chances of going abroad on sabbatical leave become very remote. That is a very important and a very justifiable incentive. Some, of course, work for degrees and the rewards are the accompanying alphabetical ornamentations before and after one's name. All these are very good and important incentives, but when it comes to career incentives for the researcher, they are extremely limited. Very few take a researcher seriously when it comes to career prospects, promotional prospects and so on.

5. Freedom

There is, however, one major advantage which the social science researcher in Sri Lanka enjoys. That is, at least overtly, there is no political restriction on what he could research on, what he could write about and what he could speak on. This is an important advantage for the reason that not many other developing countries allow that freedom to their researchers. In many other countries with our level of development there is considerable political restriction on what one could research on and on what one could write about. It is against such a background that I would wish to look at the positive aspects of Sri Lankan social science research.

6. Volume of Research

In broad terms a considerable amount of research work in the social sciences is being done in Sri Lanka today. Each year, about 4 or 5 issues of research journals containing about 4 or 5 research articles each, come out. *The Journal of Historical and Social Studies* is the oldest and most regular among them, but, there are other journals, though less regular in appearance. Apart from the research journals, there are other research publications. Some of these are called occasional publications, some are called research study series publications and so on. Apart from that there are monographs and books and we also find that roughly about two or three Ph.D and M.Sc. dissertations are published every year. Thus taken in the context of the restrictive factors that I referred to earlier, it is a situation about which one could be fairly happy.

7. Types of Research

Next, I would like to deal with type of research that is being done in Sri Lanka. To avoid going into great detail, I would identify the research that is being done in terms of a three-fold typology. There is considerable overlap between the different types that I identify. They are not mutually exclusive types. One type of research is what I would like to call 'ideographic'. Ideographic research refers basically to research concerned with fact finding. This category includes a very wide range of writing. And at one extreme is found the census type of writing - population census, agricultural census and so on. In the same category but at the other extreme, one finds the fact finding type of research undertaken by individual scholars and institutions. They usually cover very narrow fields. These can be evaluation studies like the ones being occasionally done by the Central Bank or the ARTI. The purpose of some of these studies may be to fill gaps in available country-wide census. The methodology followed in these studies is very broadly similar. They involve sample surveys based on a questionnaire, and the tabulation and description of the data thus collected. That is roughly what is being done in a very great deal of research that comes out in Sri Lanka today.

The second type of research, in my typology is nomothetic research. Nomothetic research writings also encompass a very wide field. To describe rather than define nomothetic research, I would say this type of research includes the testing of hypotheses. You first formulate your hypothesis and then go to the field and verify whether the hypothesis is true or false. The elaboration of concepts through research also falls into this category. Then certain researchers try to work within a particular conceptual framework, the research writings of people who call themselves neo-Marxists being a good example. You enter into the research problem with a particular conceptual framework and deal with the problem from the perspectives of your concepts.

The third type of research, which has a great deal of overlap with the one I just identified, is generalised reviews, commentaries, and works of synthesis. Here the researcher does not bother very much to go into the field and collect original data. Instead, he takes as his raw material the facts found by others and attempts an overall synthesized review.

8. Empiricism

One of the foremost criticisms made against a great deal of research that has been done in Sri Lanka during the recent past is that there is a bias towards ideographic research. Observers use different terms to articulate this criticism; some people say that we are over-concerned with empirical data, others that there is an empiricism that pervades a great deal of social science research that has been done in Sri Lanka and so forth.

People who hold this opinion that we are far too much guided by an ideographic approach point to certain reasons for this. One of the reasons advanced is that this type of research requires very little effort and, even more importantly, it requires very little intelligence. It does not tax your mind very much to work out a questionnaire, go out and interview 100 informants, tabulate the data, analyse the data using some elementary statistical methods and describe what your statistics show. However, certain others have gone to the extent of asserting that the bias towards empiricism that pervades our research is due to our subservient mentality towards the academic world in the western countries. They have gone so far as to say that in being over-concerned with these empirical ideographic kind of research, we are in fact being only research assistants to our peers in the developed countries, particularly those in the Anglo-Saxon countries. Those who level this criticism against the social sciences claim that we have to breakaway from this tradition of being subservient to scholarship in the western world. This obviously is a controversial issue. All I would like to state is that there are arguments on both sides of this particular problem. My personal opinion is that on balance this is not a very serious problem. Empiricism or the concern about detailed data is an essential part of research and in this respect I feel that research in the social sciences done in Sri Lanka is not substantially different from research that is being done elsewhere in the world. Now, while I believe that this is not a serious problem, I would like to conclude my comments by identifying what I think are some serious shortcomings and problems in the type of research that is being done in Sri Lanka.

9. Shortcomings

The first shortcoming is that although the social scientists in Sri Lanka have not been inactive, their total contribution has been woefully inadequate. It is of relevance to note that there has been hardly any published research during the past 5 years by scholars of less than 30 years of age. I would like to add to this point the fact that there is not a single research journal in Sinhala.

The second concerns the quality of the data base in social science research. While a certain amount of empiricism in research is highly desirable, I often find that there is a lack of precision in the empirical data that form the basis of such research. Frequently, in describing their methodology the authors themselves very freely admit that their data are inaccurate. However, that admission is often forgotten in the main text of the discussion. However, in this context, I would like to make a contrast between a lot of research that is being done by local researchers and some research that has

been done by foreign scholars who come here. In my limited experience, generally, I find that the latter tend to concern themselves a great deal more than the former on getting accurate statistical data. So what seems to be the problem is not so much that we are over-concerned with statistical data, but that the statistical data which most research generates are of low quality.

The third problem which I would like to identify is that very little reading tends to go into research publications. For example, research studies are often published displaying total ignorance of related publications by others. Another way in which this problem manifests itself is that very often people come and ask you for research problems, which reflects the inadequacy of reading that forms the basis of research.

Finally, the fourth problem, which I would like to refer to is that much of our research is oriented towards a foreign readership and a readership that consists entirely of other researchers. We do not seem to care very much about the 'layman'.

10. Conclusion

In conclusion I would like to raise two issues which can be the subject of discussion and thought, 'What do you expect from a social science researcher in Sri Lanka' and 'What contribution has the social science researcher made to life in this country?'. Obviously one would not expect an immediate revolutionary impact from anyone's research. That kind of research is very rare indeed. However, this question is not entirely without relevance. If one were to look at the last 30 years one could probably think of Das Gupta's early studies on the villages that I think has had some general impact on policy. I would also probably include in this category B. H. Farmer's work on dry zone colonizations which I think has had some impact. There may be a few others but, by and large, social science research does not seem to have contributed very much to policy formulation and therefore to life in this country.

The Value and the Reorientation of Legal Research in the Modern Context of Sri Lanka

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1. Introduction

My topic revolves round the techniques of legal research and their re-orientation in the sociological context which obtains in Sri Lanka today. The techniques of legal research in Sri Lanka are largely conditioned by the nature of the legal system, and the special problems connected with its evolution. I will try to introduce you to some of the basic features of the legal system which prevails in this country and to indicate to you, how problems connected with the legal system would have a profound influence on the types of research which would prove useful in this country today.

I shall begin with some general remarks on the value of legal research and the manner in which it could contribute to the formulation of national policies. The major features of a legal system in a country should concern not only the legal profession and others directly involved in the study and the administration of law. All those with a sense of civic responsibility should take an intelligent interest in the problems, connected with the administration of the law. Law is indispensable to any social organization. The quest for justice and liberty has been among the most cherished ideals and deepest inspirations of mankind from the beginning of recorded history. No member of society who values freedom and justice as an essential foundation for his dealings with his fellow citizens and with the state can ignore the scope and the content of the laws by which he is governed. The legal system of a nation supplies the framework within which the spirit of freedom is preserved and justice done between man and man, and between man and state. In the final analysis the quality of the laws which represent the instrument of social control in any given society provides a reliable index to the quality of freedom and justice and, ultimately, to the quality of life itself within that society.

While there is a great deal that is of value in the legal system of Sri Lanka, it would be idle to deny that in many ways the form and substance of the rules comprising that system as it operates today, contain many defects. The defects which exist at present are due to a variety of reasons. Some of these are part and parcel of the legal heritage of the country. Others derive from the diversity and the complexity of modern legislation required to cater to the needs of the rapidly evolving society while others are inherent in sociological factors such as the multiplicity of ethnic and religious groups for the distinct needs of which the legal system of the land must provide. The causes underlying the present inadequacies of our legal system are very complex. But what needs to be emphasized is that there is one basic reason why improvement of the law and resuscitation of legal research has been so difficult to achieve. That reason is the inability to sustain the interest on the part of the

community as a whole, but particularly that of the intelligentsia in the relevant problems and their possible solutions. The inarticulate assumption easily made is that law is the business of lawyers, and that law allows little scope for a perceptive and sympathetic appraisal of its problems by laymen. Nothing is so conducive to the prevailing lethargy in matters connected with the re-orientation of legal research and the legal system as this indifference of the overwhelming majority of our people to issues which are fundamental to their daily lives. Certainly, the details and intricacies of the law are the pre-occupation of the lawyers. But few notions are so false as the belief that the broad principles on which the law is based and the general direction which the course of reform and research should take in the future, are all matters which could be left in the hands of the legal profession. If problems vital to the future development of the nation are to receive the attention that they deserve, and if constructive solutions are to emerge, the discussion must involve as large and as representative a section of public opinion as possible. It is proposed in this paper first to isolate some of the demerits of the present system and to formulate appropriate areas of research and proposals for reform.

2. Common Law

The first problem that I would like to deal with is the common law of the country, how it has come to develop and its present condition. It is an aspect of the legal legacy bequeathed to Sri Lanka by its colonial rulers that the Roman-Dutch law is still the basis of the general or the so-called common law of the Island. It was in force in the colony at the time of cession to the British Crown and it has continued to be applicable since then, subject to certain minor modifications and refinements. When the maritime provinces became subject to British sovereignty in 1796, the entire body of British Law was not imposed on those provinces. Instead, the British rulers continued to apply Roman-Dutch law purged of some of its obsolete features, and English law was introduced only piecemeal, either by express legislative provision or by tacit judicial acceptance as and when occasion demanded. The curious result of this policy was that at the end of a century and half of British rule, the Roman-Dutch law, an alien legal system in the eyes of the British, had become securely established as the basis of the common law of the country. The practical effect of this status conferred on the Roman-Dutch law is that in any matter not specifically provided for by statute, or by the provisions of a personal law applicable to particular sections of the people, Roman-Dutch law becomes applicable. Thus modern Roman-Dutch law is in vogue and is applied by the courts of Sri Lanka as a system which determines the rights and liabilities of our people in vital sectors of their life and experience. It embraces for the great majority of the people of this country such matters as the security of family relationships, liabilities for civil wrongs and breach of contract, the exercise of rights in respect of property and matters in relation to inheritance and succession. The application of Roman-Dutch law in Sri Lanka was a result of an historical accident. However, it is an accident which has had crucial repercussions for our society.

The primacy accorded to the Roman-Dutch law as a basis of the residuary common law of the Island has brought in its wake advantages as well as disadvantages. The main advantage of the Roman-Dutch law as it applies today is that it is flexible. It can be

changed to suit any situation which could arise but its disadvantages are equally serious. It is not found in any comprehensive form in any one place. It is difficult to ascertain the content of the law. This poses serious problems particularly in the present context of Sri Lanka, so far as the translation of the law is concerned, since its sources derive from early texts and from reported judgements not only in Sri Lanka but in so many different jurisdictions, including South Africa where the judgements are reported not even in English but in Afrikaans. Thus the task of translation becomes a very challenging one. That is perhaps the chief difficulty connected with the retaining of Roman-Dutch law as the common law of the country because it is difficult to translate even its basic postulates into the Sinhala and Tamil languages to make the provisions of the law understood by the vast majority of the people. That is one of the main problems with which legal research in the country would have to be concerned at the present time.

Then there are certain other practical difficulties which also arise from the nature of the sources of the Roman-Dutch law. The sources of the law are such that inevitably they give rise to difficult problems, especially in the context of an Asian legal system such as ours. The fundamental difficulty which permeates the whole system is the relative inaccessibility of its sources. The principles of the Roman-Dutch law on any given topic cannot be ascertained by the perusal of a single work or document or even by the scrutiny of a collection of works or documents which may be easily procured in any one place. The sources of the Roman-Dutch law are characterised by extreme diversity. They consist of Dutch statutory provisions known as *placaats* and glosses prepared by Dutch commentators on texts of the Roman law, an exposition by writers from different provinces of the Netherlands as to the prevailing legal practices and customs of their day. The complexity of the sources is enhanced by the consideration that on some points of law differences of opinion are expressed by different institutional writers. All these sources cannot be found outside a comprehensive law library and even when they are accessible they require study and analysis with considerable discrimination and legal acumen before the propositions they embody can be adopted as the basis of an argument or a conclusion. It is needless to point out that a complete understanding of a legal system which derives from so many sources presupposes linguistic expertise and sophistication at a level which is obviously impracticable in a country like Sri Lanka. Few laymen have any conception of the magnitude of the task which confronts a conscientious judge, a practising lawyer or a teacher of law in the context of the Roman-Dutch system when he is called upon to ascertain the content of the law on any given matter.

The difficulty is complicated by a further factor, namely that the people of the country are not all governed by any one system of law. You have the Roman-Dutch law as the residuary common law but that is resorted to only in situations where a personal law does not govern a particular section of the people. In the legal system of the country as a whole there is a series of personal laws. For instance there is the Kandyan law which applies to the Sinhalese of the up-country area, then there is the *Tesavalamai* which applies to Jaffna Tamils. There used to be the *Mukkuwa* law which was applicable in the province of Batticaloa, but which has now been abolished and there is, even today, the Muslim law which governs all Muslims in regard to matters of succession, inheritance, property rights,

marriage and so on. So there is this interplay of different systems within the framework of a single country and that inevitably enhances the difficulties which are attendant on the study of the law and on the undertaking of any serious legal research.

There are also problems arising from the fact that so many of our statutes which are applicable today have been enacted very long ago. For instance the criminal law of the country is contained in the Penal Code of 1889 which has not been up-dated or revised or improved in any important way for almost a hundred years. So it is only inevitable that some of the notions which it embodies are archaic. One illustrative example is the definition of insanity or disease of mind which is contained in the penal code formulated hundred years ago. Naturally, since then, there have been important developments in the fields of medicine and psychiatry. But those developments have not affected the content of the criminal law which is administered in the country today. The result of this is that the law has tended to lag behind advances in other disciplines and this is generally true of the laws of this country which impinge on science and technology. So there is a very vital need to up-date the law to make it consonant with present-day realities and needs and this, of course, requires a great deal of preliminary work.

3. Codification

In the recent past in this country a start has been made in the revision of the law by the revival of the Law Commission. A primary task of the Law Commission is to keep the laws of the country constantly under review, to suggest changes which are beneficial, and to present to the Minister of Justice proposals for the reform of legal education. There is in the country today a body of thought which feels that the best approach to legal reform is by way of a preparation of a code. As you probably know, the main examples of codification of the law are in France and Germany where very complicated systems were reduced to relatively simple provisions in a comprehensive code. That will not be a complete solution because the provisions of a code themselves have to be interpreted. There may be questions of doubt, questions of ambiguity and, from time to time, the provisions of the code may have to be elucidated and elaborated upon by the courts. But it would still constitute a significant improvement on the present structure of the law where judges of the courts, lawyers advising litigants, and the general public, have to inform themselves of the content of the law without the assistance of any such code. But if the preparation of a code is adopted as the solution suited to the needs of our society, then of course something has to be done before the code is thought of. That is, it would be necessary to understand the law as it exists today and identify its deficiencies. Before you can decide how it is to be improved you will have to be quite clear in your mind about the conditions of the law as it prevails at the present time. This requires painstaking research. It is possible. It has been done in other countries – for instance, in Scotland during the last ten years. The Scottish system is almost as complicated as ours. It goes back to Roman times. It has Roman origins. But in almost all branches of the law of Scotland, it has been possible for Scottish universities to produce a comprehensive exposition of the law which has served as the foundation of an ambitious programme for codification. A similar project has been undertaken with outstanding success in the U.S.A. where the American

estatement has been prepared with the assistance of academics, and the American restatement has also provided a basis for a codification programme. In this country, certainly, such a programme of restatement will be an essential preliminary. It is an indispensable prerequisite to any codification which may be done within the next few years.

4. Legal Publications

There are in the country today many constraints in regard to legal publications. The primary constraint is, of course, finance. Printing is prohibitively expensive today and legal publications have a limited market. This means that legal publications are usually priced at a level which effectively puts them beyond the reach of members of the public who may be interested in the broader issues such publications deal with, not the technicalities of the procedural law, but matters which are of concern to people in their everyday life. Fundamental rights are a good example. The 1978 Constitution of the Second Republic of Sri Lanka embodies a chapter on fundamental rights. We have been guided by the experience of other countries like India, the United States and some African countries like Nigeria. We have tried to incorporate in the Constitution a body of rights which are totally entrenched in the sense that they cannot be interfered with by governmental or executive action. There was a leading case in August 1980 when a student who had sat for the G.C.E. (A/L) examination went before the Supreme Courts and asked for an order that the University Grants Commission had violated the rights of that candidate by adopting a system of ratios as between two examinations for University admission. The argument of the student was there has been a denial of the criterion of merit, that the student had been deprived of the opportunity of being admitted to the Faculty of Medicine in the University of Colombo and that the process of selection resorted to by the University Grants Commission was inconsistent with the principles of equality before the law enshrined in the Constitution. In a judgement which can be described as a land mark decision with regard to fundamental rights in the country, the Supreme Court upheld the contention of the student and ordered the University Grants Commission to modify their system and to have a common merit list from which candidates selected to the different faculties would have to be drawn. These certainly are matters of momentous concern to all members of the public and those are aspects of the law which are far from technical. In fact all those who value democracy and the rights which go with the democratic system would have to be keenly conscious of these provisions of the law and they would have to strive to ensure their survival and their further development. Publications which are concerned with those areas of law are of interest to the public.

Another constraint on the publication of legal research in this country arises from the lack of personnel. We have very few people in the country who are qualified to undertake research of this kind and the problems are likely to be aggravated by the fact that now the University of Colombo has limited opportunities of training its younger lecturers abroad. Even in the case of the few available scholarships the awarding authorities have identified priority areas and the weightage naturally is for the sciences, particularly the applied sciences and medicine, so that the University in recent years has had difficulty in ensuring an adequate training for their assistant lecturers abroad and the Faculty of Law is beginning to feel that difficulty at the present time.

A third constraint with regard to publications which one would be able to identify, is the question of access to the law. Primary and the secondary sources of the law continue to be entirely in English. But since 1973 we have been teaching legal courses in the University in three media, English, Sinhala and Tamil. Thus every lecture is delivered in three parallel media. However, when it comes to research at the higher levels it is very important to make use of judgements in other countries, articles in journals, and this kind of material, unfortunately, is available only in English. Therefore, as a possible corrective, the University has embarked on an intensive programme for the teaching of English as a second language. But there again the University has been hampered by the lack of resources, and by the lack of teachers who are qualified to teach English as a second language to students in Sri Lanka. The problems connected with lack of linguistic expertise on the part of lawyers, who would otherwise have been equipped to undertake legal research, significantly hinders the development of legal research.

5. Law and Freedom

Any sophisticated legal system must necessarily accommodate conflicting interests. That happens in any branch of the law. For example, one of the fundamental rights ensured by the 1978 Constitution of Sri Lanka is the freedom from arbitrary detention and arbitrary arrest. All citizens in the country are also assured of freedom in regard to their persons, freedom of movement, and the freedom to decide without interference from any authority including the administration how they are going to lead their lives. If a person's rights are to be curtailed, to be abridged, or to be restricted, for instance by being taken into custody the procedural laws of the country define the situation in which it can be done and the modes by which an arrest can be made. Not every one can make an arrest. Police officers can do so in certain situations. In exceptional situations, members of the public can also avail themselves of that right. On an arrest being made, there is a certain procedure to be followed. For instance, if the person is in police custody he has to be produced before a magistrate within twenty four hours. So a judicial officer will have opportunity of addressing his mind to the question, whether there are adequate reasons to deprive the person concerned of his liberty, whether further remand is justified or whether the person arrested can be released on a personal bond or on bail. Thus the laws of the country ensure that the freedom of a person can be interfered with only in restricted situations and those situations are spelt out in considerable detail and with great clarity by the procedural laws which govern arrest and detention in Sri Lanka.

However, this is only one side of the picture. No legal system can ensure absolute protection of individual rights in that way and stop there. There may be a time of grave national emergency, for instance the insurrection of 1971, or there could be other situations in which the government may have to take extraordinary measures in order to ensure the security of the democratic system and, in those exceptional situations, it may no longer be possible to uphold in their entirety the procedural rights which are guaranteed by the ordinary laws of the land. For example, if the chapter on fundamental rights incorporated in the 1978 Constitution of Sri Lanka is examined it will be found that every person is declared to have those rights, but that there are qualifying clauses and provisos which set out that those rights can be interfered with. They can be detracted from on various

grounds, such as national security, danger to public health, danger to public morals or in the interest of the national economy. So the entire legal system assumes the character of a compromise between conflicting objectives. On the one hand there is the right to protect the freedom of the individual in all legitimate areas of activities, political, social, cultural and so on. On the other hand, there are situations in which the collective interests of the community have to be protected by conferring additional powers on the state to deal with exceptional emergencies.

The Constitution maps out a *via media* between these competing goals. Consider, for instance, the right of publication. A private citizen of the country should enjoy the right to criticize the politicians. If he thinks that a politician is corrupt, or dishonest, he should have the right to publish the facts which he knows and to make the criticisms which he thinks are legitimate. When self-criticism is suppressed, the culmination of such a process has been the emergence of dictatorship. This is generally true in most situations in world history. So the right of publication must be there and is guaranteed in a democracy. For instance, the very first amendment to the Constitution of the United States is concerned with the right of publication. It is one of the cherished freedoms which are respected and upheld consistently by the courts of the United States of America. In Britain and in Sri Lanka, it has not been spelt out in that way. But certainly, it is one of the most fundamental freedoms enshrined in the legal system of a country. Here again it will be realised that it is not an unrestricted right. It cannot exist in an unqualified form. There has to be some restriction, some check has to be placed on such a right. People cannot defame others with impunity. Just as you have a right to express your views, the person criticised has a right to protect his reputation. So there are two conflicting objectives. There again, the law has to take both these into account and to evolve a solution which is fair to both parties the man who has a view to express and the man who has a reputation to defend and to vindicate. These are all considerations which have to be taken into account in determining the content and the scope of a right-to what extent you should be allowed to publish your views, if harm is done to others and what are the steps which a legal system should take to protect the others who anticipate that harm will be caused. Various remedies are conferred by the law. One is the provision to claim damages. If somebody defames you, you are entitled to monetary compensation. If you feel that the defamation is such that no amount of money will compensate you for the loss that you have suffered, then there is the remedy known as the injunction. For instance, if something is going to appear in tomorrow's newspaper which is going to cause irretrievable damage to your reputation, the law gives you a remedy known as the injunction. You can go before the courts and you can ask that publication be restrained, that the court prevent that publication from being made. Thus while it is certainly desirable that research in the Universities and other institutions should not be curtailed, that uninhibited freedom of expression in matters legitimately connected with academic activities must exist, there may be situations in which the government may consider it necessary to curtail those rights in the larger public interest. That is inevitable in the present context.

6. Conclusions

I have outlined above some of the major difficulties confronting legal research in Sri Lanka at the present time. The research that has been done in the country during the last ten years, has been mainly individual contributions, contributions by individual teachers of law, individual judges and so on. I believe that a much more corporate endeavour is essential. The magnitude of the task requires a corporate effort involving collaboration among several persons and that requires organization and personnel. As I mentioned earlier a start has been made with the revival of the Law Commission and it is now a question of improving the machinery and of ensuring that the opportunities are properly utilized. If the major constraints on legal research in Sri Lanka with regard to finance, personnel, language and organization can be overcome I think a considerable amount can be achieved in this field in the near future.

PART III

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The Use of Models in Research

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1. What is a Model ?

The word 'Model' is used very often and yet many students have a fear for this word. Such fear is understandable as they have at their back of the mind only mathematical models. There are, of course, very complicated models but many of the mathematical models are very simple ones.

Models, broadly defined, are of interest not only to econometricians or biometricians but also to artists, architects, historians, sociologists, economists, philosophers, geographers and educationalists, not to mention the physical and biological scientists. However, models take different forms in different disciplines.

Science is generally identified with subjects where one does experiments in laboratories. In reality, however, beyond a certain level of research the methodology for all branches of science is the same. The specification of a model, testing the model and making inferences from the model are the common features. In science the model only reflects how one visualises the way in which the laws of nature or behaviour operate. Thus in simple language we could describe a model as a set of assumptions or hypotheses.

'Truth' is not known to anyone. It may appear different to different people. Everyone, therefore, visualises truth in a specific manner depending on how he is brought up, circumstances under which he lives, the types of books he reads, the concepts which he has preconceived and so forth. Thus in any research project hypotheses are stated in terms of an explicit or implicit model and attempts are made to establish their validity. How one tests the hypotheses and how valid these tests are will be discussed later.

2. Model Formulation

Anyone is free to formulate his own model. But this model should not be in conflict with the laws already established. This does not mean that laws already established cannot be disproved. They can be disproved but the steps that should be taken to disprove must be scientific. We may, on the contrary, find that the theory may be valid generally but may not hold good under certain circumstances. Take for example a model to find the supply pattern for a particular commodity. One may specify the model in the usual way and estimate the parameters. We expect the supply equation to have a positive slope but empirical testing may reveal that the slope is negative. Do we say that the result is inconsistent with the established theory or do we conclude that this is an exceptional circumstance ?

* In this paper I am confining myself mostly to the use of models in Economics but the reasoning could be extended to other disciplines.

We study in economic theory about the existence of backward bending supply curves. Can we therefore suddenly come to the conclusion that the supply curve is backward bending? One must first seek evidence to prove that the specification of the model and the method of estimation are reasonably acceptable, and second, prove with direct evidence that there is a possibility for the commodity concerned to have backward bending supply property.

One may like to know how one could conceive a model. Generally a research worker does not operate in a vacuum. He observes nature, how people appear to behave, what the laws of nature are, what theories that are established, research done in other countries and on the basis of this knowledge he visualises the probable behavioural patterns. Today several phenomena look obvious to us but for the pioneers they were a real challenge. For Adam Smith it was a real worry that water though useful was free but in contrast diamonds with no use fetched very high prices "Nothing is more useful than water, but it will purchase scarce anything, scarce anything can be had in exchange for it; A diamond on the contrary, has scarce any value in use, but a very great quantity of other goods may frequently be had in exchange for it".

3. Mathematical Models

In economics our main concern today is why prices are rising, why certain outputs are falling, why the rate of growth of population has shot up after 1945 and so on. We would like to find the reasons for them and isolate the effects of the various factors so that we may find remedial measures. These inquiries will need appropriate models.

Isolation of the causes may be very simple in most cases. However, in certain cases we may need complicated models. When several forces interact these interactions cannot be isolated by simple arithmetic. Therefore, from our observations and using the theoretical knowledge we have acquired, we spell out our hypothesis in mathematical equations, which is what is called a 'mathematical model'. In a mathematical model we have on the left hand side the variable to be explained (dependent variable) and on the right explanatory variables (independent variables) and an error term. The objective is to explain the variations in the dependent variable through the variations in the explanatory variables.

Because of the interaction of several factors which bring about changes in economic variables we cannot in all cases use a single equation model. Therefore, we need a system of equations. Some variables are called endogenous and others exogenous. It is difficult to define what is endogenous and what is exogenous. According to Klein, "the endogenous variables are those variables which are determined within the system of economic forces in a narrow sense, and they include such familiar magnitudes as output, employment, prices, profits, rents, interest. The exogenous variables are those which represent forces outside the confines of the economic system. They are determined by natural, technological, sociological, political or institutional forces which are assumed here to be non-economic".

The purpose of the model, therefore, is to describe the manner in which a particular system operates. It is the researcher's aspiration that he could discover to the best of his ability the actual operation of the laws of nature or behaviour. He cannot claim that only his model reflects the laws of nature or behaviour. Several alternative specifications can be made. The test of reliability of model depends on its capability to interpret historical facts and to make reliable forecasts. These forecasts are made with a specified level of probability. To quote Klein again "In the course of the search for models which are suitable for our purpose of forecasting and making policy recommendations we shall inevitably have to consider several alternative economic theories as admissible hypothesis. The acceptance or rejection of the hypothesis in the course of our search for truth will be our contribution to the problem". Mathematical models not only have the advantage of making forecasts about output, employment, foreign exchange earnings, etc. under the influence of various alternative economic policies but they can help the researcher to understand why his forecast did not come true and what further modifications are necessary to improve the efficiency of the model.

It is not possible to specify mathematical models in all branches of social sciences. But the process of formulation or testing of the models would be similar in that the researcher will have to collect information and find logical reasoning to substantiate his model. The reasoning is simpler if the information is quantifiable. Lord Kelvin explains the virtues of quantification in the following manner "when you can measure what you are speaking about and express in numbers you know something about it; when you cannot measure it, when you cannot express in numbers, your knowledge is of a meagre and unsatisfactory kind, it may be the beginning of knowledge but you have scarcely in your thoughts advanced to the stage of science".

4. Problems in Model Building

Economic variables are random variables in the same manner as variables in experimental sciences. The stochastic nature of the observed data is to a large extent the result of stochastic non-observable variables (random errors). The error component in models arises due to various factors. Among them are errors of measurement of dependent variables, approximation of one structure by another, omitted variables, and aggregation. The experimenter in the physical sciences can avoid this problem to some extent by replacing the natural conditions by laboratory conditions hereby freeing all variables other than the one to be explained from influences of error and shocks. In this respect, the problems facing social scientists are unique.

We are aware that the forces acting on the economic system are numerous. It is not possible for the researcher to take account of all such forces that determine the economic structure. Even if the collection of data in respect of all variables is possible and electronic computing facilities are available, there are various other constraints (especially degrees of freedom) which stand in our way. It is often sought to develop complex econometric models and estimating techniques to eliminate such difficulties but complicated models are not necessarily the most efficient ones. It is easier to understand and gain insight into problems through simple models.

Simplification of models without losing the characteristics of problems needs skill and dexterity on the part of the research worker. He should possess a sense of imagination and an inside knowledge of the subject in choosing the most crucial and appropriate variables to be introduced into the model. Thus different models are bound to produce different results. The efficiency of the model will have to be judged in terms of how it interprets history and its ability to make forecasts about the future.

Econometric models have in general three sub-sets of structural relations — behavioural (statistical equations), identities (definitions) and technical equations. The variables used in these models may be classified under endogenous, exogenous or endogenous predetermined. As we know the behavioural equations are not exact. These behavioural relations are made into equations by adding what we call random variables. The introduction of these random variables results in our seeking necessary econometric tools to handle them.

One aim of the whole exercise in econometrics is to determine the structure of the economy by estimating structural parameters, often referred to as population parameters. In physical sciences controlled experiments are possible and therefore the population parameters can be estimated with ease. But in economics and other social sciences, controlled experiments are not possible and we have to rely on the data that have been generated by society in the past. The economist's objectives may be similar to those of an engineer but his data are like those of a meteorologist.

The data generated with such shortcomings would inevitably cause bias and in some cases the estimates do not turn out to be efficient. Some of the shortcomings are errors of measurement, autocorrelation, multicollinearity, omitted variables, and non-quantifiability of variables (such as war and peace). The most crucial shortcoming in econometric models is the problem of estimation of single stochastic relations ignoring other relationships as though they have no part in determining the size of the variable to be explained. This is one of the important aspects to which much attention is paid in econometric theory. We are still not fully equipped to overcome these shortcomings.

In econometric analysis, subjects such as economic history, economic theory, mathematical economics, statistics and mathematics each has a part to play. Economic history helps in making objective observations, mathematical economics with the help of economic theory and mathematics helps to formulate the hypothesis and specify the model to be evaluated. Econometrics (as a specialized field of statistics) helps in estimating the structural parameters, testing them for reliability, making inference and hence in predicting economic variables. The economic structure so obtained can be used to formulate policies to achieve the desired targets. No parameters are accepted if they do not approximate theoretical values or values obtained from other sources. If the discrepancies are too large or are systematic and do not interpret history reasonably well the hypotheses are revised and retested. The model is tested further in other ways. One important test is to determine the extent to which the explanatory variables are able to explain the variation of the dependent variable. Another test is to make projections and to study the extent to which the projected values differ from the actual. Usually

the last few years data are left out in estimating the parameters in the first round. If the predicted values approximate the observed data, the left-out observations are pooled and reused in re-estimating the structural parameters.

No econometrician, however reputed, can say that his model is the appropriate model. He could only say that the particular model is best (in terms of fit, sign and size of co-efficients etc.) among all the alternative specifications. It may be best to build models on research undertaken by a team of competent men rather than by an individual if the model is to be used for practical purposes. They should discuss their assumptions, methodologies and results widely before the models are used for policy decision. Econometric models will have to be put forward in a scientific spirit, because these models if fully developed and properly used would eventually lead all investigators to the same conclusions irrespective of their personal whims and could therefore be suitable for decision making.

To quote Klein again "Econometricians do not operate in a vacuum, their methods are not purely mechanical in the sense that they do nothing but substitute in formulae. Any information of a qualitative nature that is available should be used by the econometrician in drawing inferences about the real world from his models. The non-statistical economist has only qualitative information from which to make judgements. The statistical economist has the same quantitative information plus a thorough knowledge of historically developed behaviour patterns, hence it may be said that the latter is better equipped".

Design of Models for Economic Planning

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1. Introduction

The major contribution of econometrics—that is the empirical study of economic behaviour with the aid of statistical and mathematical techniques—has been to provide the means to identify and measure the important relationships between economic variables. The object of this paper is to survey, in the broadest terms, procedures for the specification of a model of the economy of interest. In a second step that specification will be given numerical form by the estimation of its various parameters from data on its variables, collected from the performance of the economy over the recent past. The model is then no more than an equation system which describes the laws of motion of the economy together with the interdependencies which exist between the major variables.

Notice, it is a mathematical *model* of the economy which is the aim—not a perfect reflection of the economy itself. Inevitably there must be approximations where the mechanisms of economic behaviour are as yet imperfectly understood, in particular the speed and form of dynamic responses, where the required data are lacking; where relevant variables are not quantifiable (e.g. “confidence” influences investment behaviour; expectations influence stock building, etc.); and because there is necessarily a finite limit to the detail of the description possible—some variables and their determination have to be aggregated with a consequent loss of description and information. Finally, and this is perhaps the most important, the model’s parameters must be estimated on a restricted sample of recent data. They cannot be perfect estimates, i.e. complete in the sense that they describe the characteristics of the linkages between the variables valid for all circumstances—they are only valid for the kind of average behaviour of this sample of recent history. Thus, one can only expect the model to mirror the (approximate and aggregate) economic behaviour of circumstances similar to those of the recent economic environment. It cannot be valid for circumstances radically different from that. Whereas one may well consider that there should be one *ideal* model of the economy, i.e. the economy itself (although this is doubtful since different people will have different assessments of the initial position, the values of the unquantifiables, etc.) there will *never* in practice be *one correct* model wanting to be specified. Different approximations, different aggregations, different representations of the linkages will prove most suitable in different circumstances and for different intended uses of the models. All these approximations, and all the surrounding uncertainties as to how exactly the economy will react to new events (or has to past events), and the inherent uncertainties in the reactions of economic agents, all make the “best” specification very hard to find; and they make it essential that very considerable experience in handling the model must be available before it is used. Considerable experimentation may be necessary. It is at least as important that you know what your

model cannot do as knowing what it can do – and this is, evidently, intimately connected with the problem of picking the most appropriate model design. The process of building a model must introduce a full understanding of its shortcomings, and that in turn means the process of building a model is inextricably entwined with the using of that model. One learns by doing specification and uses are an interactive process which leads iteratively to a final estimated version which, while not perfect, is at least an adequate performer for the purposes for which it was designed and whose shortcomings are well understood.

I am not concerned here with the specification of any particular model. That specification must be done using all the appropriate economic theory and any supplementary information at hand, such as the institutional and observed behaviour pertaining to the economy under consideration. But by way of example, the likely steps a model builder would take in constructing various models are given. Nor am I directly concerned with techniques for the estimation or testing of the model, nor with a description of its statistical properties in any given area. That is a huge subject and, being technical, it is most conveniently summarised in standard textbooks on econometric theory. For the most part here we consider a model as given, but where it is not known with certainty we attach estimated probability functions to the uncertain parts. These probability functions summarise the likely distribution of errors which surround the three sorts of errors which a model, if used as if it were fixed, would make in forecasting—

- (a) *information errors*—uncertainty in the values that variables determined outside the system would take (including a summary of the uncertainty inherent in the behavioural reactions modelled);
- (b) *data errors*—uncertainty over the estimated model due to inaccuracy in the data used to derive it (including the debate over “what are the true facts”);
- (c) *model errors*—uncertainty in the estimated model due to a restricted and specialized sample of data having been used to derive the appropriate specification and the estimates.

Despite the attention given to scientific method, one may correctly have the feeling that the building of models is an art rather than a science. Economics has been described as a “would-be, may-be science”, and in view of the problems discussed below it inevitably must remain as such. In common with all techniques which rely on experience and also in this case an extremely intimate “feel” for the economy being measured, this is an art which cannot be taught; it can only be gained from extensive experience in the field. It is also not at all a simple matter - one cannot just specify relations from logic and/or observation as in natural sciences and fit them to facts experimentally because (a) there is no possibility of manipulating the economic system under repeatable identical experimental conditions (indeed there is no possibility of conducting experiments at all, let alone experimental design) (b) there is an inherent randomness in human behavioural reactions not found in physical systems, (c) there are observation problems (and measurement problems) which can never fully be overcome, (d) we must use restricted samples for study.

2. The Background

Interrelationships of economic variables have been displayed in a wide variety of econometric models, measuring the size and significance of the dependence of variables on one another from a set of historical data. The best known examples are those of national macro-econometric models. The earliest were those by Tinbergen for the Netherlands, the UK and USA at the time of the second world war. The success of these models, together with considerable advances in economic theory following the "Keynesian Revolution" and with the realization of the complexity and interdependence of economic processes, has inspired the construction of a whole range of models. The second major reason for the development of these models is the increasing commitment by governments, over the same period, to the achievement of certain social and economic goals.

Formally, a model specifies the set of constraints on the economic variables which a government must take into account in achieving those desired goals. Informally, the government may use a model to sketch and compare the consequences of various possible policy packages, or sets of likely circumstances, over its whole planning horizon, in order to choose its preferred strategy. At its simplest this may merely involve forecasting the variables of interest but it could also involve the optimisation of an objective function with respect to policy variables.

An important sufficient condition for the development and use of econometric planning models has been the introduction of large high speed computing facilities over the last 20 years. It will be observed that a typical feature of the models, and of the purposes to which they are put, is the very large quantity of information which must be treated.¹ Generally we wish to construct and then analyse the performance of a large number of, probably nonlinear, simultaneous difference equations (seldom of a low order) under a wide range of circumstances each over a number of time periods. Involved are nonlinear estimation methods, repeated solution of nonlinear equations and methods of mathematical programming. Re-estimation and re-specification of the models is then common practice, as more is learned of the properties and performance of the models as specified so far, for example in comparison with the actual outcomes of the true economy in real or hypothetical history. It will therefore be improved by considerable experimentation with various forms of the equations and adapted to match the actual performance of an evolving economy. Naturally to this we must add the second requirement of a comprehensive and reliable compilation of consistent national income statistics. These models place a considerable burden on the availability of a long time series, especially for quarterly observations, of a very large number of economic variables.

I stress these two sufficient conditions because they are the most difficult to satisfy with the third one of knowing how to use the model — in specifying a model. They are often forgotten in favour of the necessary conditions of knowing the estimation techniques which are a good deal easier to handle. Provided these sufficient conditions are satisfied, we may proceed to specification.

1. Often several hundred variables with 50 observations on each,, leading to several hundred equations with three or four times as many estimated coefficients.

3. Past Efforts

In the U.S. macro-models proliferate. Very simple macro-economic models first estimated by Klein led to the medium sized models of Klein-Goldberger (25 equations and annual data) and Michigan University (47 equations and quarterly data); both of which have been updated and expanded in several versions. More recently there has been a clear tendency for the size and detail of models to grow, enabling econometricians to explain separately many detailed components of the economy which otherwise would remain exogenous or be lost to sight in aggregation. The scope of the models has therefore markedly increased. In particular, nowadays, they are often designed for specific jobs; and consequently are often disappointing if used for purposes for which they were not intended. In the class of large general purpose models is the Brookings model with several hundred equations and exogenous variables requiring the estimation of several thousand coefficients; the well known Wharton model in its various versions of between 70 and 200 equations; more recently the Hickman-Cohen model has become available. Specific models are the Data Resources Inc. Model for a description in details of the components of demand (expenditure) and supply (production); the OBE (Office of Business Economics) model for government policy details; the FRB-MIT-Penn for detail on the monetary sector. All comprise a few hundred equations. Thus the disaggregation of models has proceeded over time, by sector detail, and in purpose.

In the U.K. the range is more restricted. An early small model was constructed at Oxford; a descendant of that is the forecasting and policy analysis quarterly model of the London Business School comprising about 300 equations plus a very detailed fiscal sector and recently expanded monetary policy sector. The Treasury has a very large (800 equations) but somewhat unproven model and there is a medium model in use at the NIESR (National Institute of Economic and Social Research). Those are all short run forecasting models. For long run projections and policy purposes, quite a different approach is taken by the growth model maintained at Cambridge University which is based on Input, Output interindustry accounting identities and a similarly specified linear expenditure system.

Models of this kind exist, but are used to varying extents in many other countries of the developed world. Most notable are the models in the Netherlands, also Canada, Australia and Japan. Similarly Sweden, Germany, France, Belgium, Israel, Taiwan, Greece, etc. have successful models. Some comments on the use of these models beyond academic purposes are made in the last section of this paper. Models of alternative systems (e.g. Russia) are also available. The final step of linking various national models to give an explanation of world trade flows has been undertaken and is operative in project LINK which has been extensively used in the past by the IMF in its work of assessing the trends of international trade.

Models have also been constructed for developing economies with a specific representation of their aid, investment and supply constraints, and particular goods and labour market problems. Examples are the models of India or Columbia and now one being developed for Sri Lanka by myself for the Ministry of Finance. Generally these have

concentrated exclusively on interindustry accounting identities but are gradually becoming more sophisticated in representing the main actors' behavioural reactions to constraints. Models also exist for dependent economies highlighting their special problems ; for example Puerto Rich (neo colonialism) Michigan State (automobile industry) or Massachusetts (industrial location and emigration). Extensions have also been undertaken in the form of economic area planning models and urban planning models.

The models cited above are not the only examples of simultaneous equation models in popular use. Commodity models are widely used to explain movements in a given market although perhaps they attract less attention and discussion. Quite often they are world market models and involve considerable institutional details and specialised knowledge of the particular market but they can be used by individual agents for planning: e.g. for the consequences for exchange rate policy, for foreign trade flows, or for stock control and price stabilization problems. These models have detailed explanations of the supply and demand of the given commodity and perhaps its immediate competitive and complementary goods. Such diverse products as tea, coffee, cocoa, jute, watermelons, meat, sugar and onions have been treated. Metals such as copper², tin, zinc, tungsten have also been considered.

It is a small step to construct these kinds of models within one economy – some examples are car industry, rail transport, or textile industry models. Really we are then considering models of particular sectors of the given economy. Many examples could be quoted in this context. The best known are perhaps those of the energy and agricultural sectors, housing, financial, complete demand systems, or even the wage-price sector.

4. The Interaction of the Use and Design of a Model

It should now be obvious that there will never be one model – or even one best model generally speaking – for any economic process; also that any model must be frequently revised and updated. But that apart, the crucial point is that the specification must vary according to the use to which the model will be put. The specification of the mode must first and foremost be dictated by the intended use for the model. Models designed for one purpose cannot be expected to be effective for some other; and if some particular model is effective for a particular purpose then a general model is probably less effective for any such purpose. In principle this results from size constraint on our problem, from differing constraints on data availability and reliability, from differing reliability in the underlying economic theory and from different levels of disaggregation and detail which are required for the different tasks.

The popular uses of econometric models are:

- (i) to explain the working of the component economic processes;
- (ii) to test specific hypotheses on the working of an economic process;

2. e.g. the joint Oxford—Rotterdam project to measure the scope for, and to provide rules of operating, any potential market stabilisation agreement.

- (iii) to make forecasts of what is likely to happen in the near future;
- (iv) to examine the likely impacts of various possible unforeseen events not under your control (forewarned is forearmed);
- (v) to explore the likely consequences should various possible events occur - in particular the impact of various possible policies and policy packages introduced by the controlling authorities, or the upshot of the set of policies introduced where more than one authority has a degree of control;
- (vi) to select suitable policies to achieve certain desired goals now and at points in the future (given expectations for exogenous events and the behaviour of other economic factors);
- (vii) to assess which of several policies are more effective for some target;
- (viii) to compute the best policies for (vi) for a given set of preferences; including the resolution of conflicting objectives and policy instruments which may be put forward;
- (ix) to analyse and assess the effects of past policies and events (with implications for future plans).

The idea that a government should accept specific responsibility for the management of the economy has been admitted only since the war. Then low unemployment was taken as a target. Now low inflation, reasonable rates of growth, a foreign trade balance, specific credit policies and perhaps a money supply regulation, currency stability, certain industrial structures, a fair income distribution over people and regions and certain expenditure patterns probably centered on investment policies - all of these, conflicting or not, are typical targets of economic policy. The main policy instruments include various types of direct and indirect taxation, taxes on imports and/or exports, interest rates, hire purchase conditions and other forms of credit availability, government debt management, investment incentives, the exchange rate, import restrictions, many components of government expenditure both current and capital - including the phasing of public investment programmes - and perhaps manipulation of nationalised industries, or a wages-prices policy. Typically unforeseen shocks to the economy come from world trade conditions, materials and other import prices or supplies, or events in a dominating commodity or market upon which that economy may depend.

In the Sri Lankan context the targets might be—

- (a) employment - with a derived consumption target;
- (b) to constrain the effects of the public investment programme on the balance of payments and external financing;
- (c) public and private savings;
- (d) sectoral rates of growth;

- (e) inflation;
- (f) urban-rural income distribution.

The principal instruments in use appear to be—

- (a) Taxes (corporate, personal, on exports, on imports, on turnover);
- (b) Public Expenditure (subsidies and transfers on food, replanting, fertilizers, investment concessions);
- (c) Public Investment Programme (size and phasing);
- (d) Exchange Rate;
- (e) Interest Rate or Domestic Credit Policy.

The main external “shocks” would probably be those in oil and other raw material prices, the slowdown in aid disbursements, movement in world tea or rubber prices, and possibly the weather on certain crops.

5. Pre-specification Steps in Model Design

Now, concentrating on national planning models by way of example, almost any model built for any of the purposes mentioned must include explanations for each of those targets, and probably for the major components upon which the targets depend. Moreover, an accurate representation of how the instruments and other major variables affect the targets, and how the government will react to economic changes and attempt to adjust their instruments is required. Then the particular features characterising that economy must also be built in. There can be no general all – purpose specification to fit all economies. Some industrial economies are subject to demand management and require demand – driven models. Others, typically the less developed, are supply constrained. Some suffer from investment constraints, others from balance of payments constraints, others are dominated by a particular industry or product market, and still others have regional problems or sharply divided economic sectors, say urban and rural, and so on.

Having settled the basic features of the model, the next problem is to decide on the level of disaggregation. Disaggregation over time gives a finer description of the structure of lags in the economic processes and is more useful for analysing business cycle developments and other short run policy analysis, problems of policy *impact* as well as policy *timing*.

Disaggregation by sector depends heavily on what is required from the model and what is necessary for an accurate explanation of each variable. Thus consumption is split into durable, non-durable and services on the argument that the speeds of adjustment of these expenditures are usually different, as are quantitatively and qualitatively the determinants for each; yet they are much the same for each item within each member of that classification. Aggregation would cause much accuracy and precision to be lost in the

specification and performance. Similarly investment is split into residential, business, plant and machinery, and government components. Imports, exports and employment are also often split into the main commodities and its components respectively. There are many other examples of a model expanding to accommodate a suitably accurate specification: Lipsey argues for the addition of a price equation to improve the Philips curve wage equation: Teigen presents the conclusion that the assumption of an exogenous money supply is untenable. Goldberger argues that a tax yield is not a proper policy instrument but tax functions must be included to represent tax rates which are.

Further an aggregated model may successfully predict GNP but have nothing to say about its components, nor about the effects of likely external shocks or policy changes. One may want a disaggregated model to give information on quite detailed components of the economy, to enable it to reflect changes due to structural shifts, external shocks or any possible policy shifts (which themselves may imply considerable disaggregation). Many targets and instruments operate at a micro level to affect the economy in a spatial sense (e.g. Dorrington and Renton investigated the effects of tax structure changes on the U.K. economy. Balanced-budget GDP was found to change 26 per cent more for given equal changes in the surtax rate as compared to those in a single persons allowances. Even more marked changes followed from the same changes in family allowances. A very detailed model is required for such exercises). Disaggregation decisions may then also follow from the intended use of the model.

On the other hand, too much disaggregation may be counter productive because the quality and coverage of the data becomes inferior. Unreliable or inconsistent runs of data will produce poor results. Aggregation not only uses more reliable data but also benefits from cancellation of errors, so forecasts are generally better on the same conditioning information. There have been a number of studies of comparative forecasting performance of different models which show this. But what is the advantage of that if none of the information or shifts mentioned in the previous paragraph can be treated, and turning points in the forecasts are missed? Anyone can successfully guess the major component of any economy on a "no change" or "same change as last period" basis since the economy evolves rather slowly. But that is not informative. So criticisms of models as compared to "calculations done on the back of envelopes" can be extremely poor criticisms indeed.

All these considerations of disaggregation and special features, being subject to the purpose of the model should, in conjunction with economic theory, make the general specification failure obvious. However, the use of the model may have a further particular influence on the specification of individual relationships, and the importance and effort attached to specifying the dynamic properties of the model. For example, the World Bank uses a standard annual model format when assessing the economic performance of many developing countries. This standard model frame includes no sectoral breakdown and requires, as inputs, the outputs of the economic policy of the government in question. It provides a picture in some detail via accounting identities (which follow from that government's *intended* objectives) of the financing of the import-export gap. There is no discussion of the policy outcomes (their advisability, their feasibility, their probability

(realism), or the capability of enacted policies to reach them) nor of the effects on specific sectors some of which the government will be specifically encouraging in a development and diversification policy; nor of those sectors on which the economy chiefly depends. Obviously, while the model is deliberately specified to be very useful for the purposes of the World Bank staff, it is quite unsuited as specification for forecasting or planning on behalf of the government in question.

From this argument we conclude—

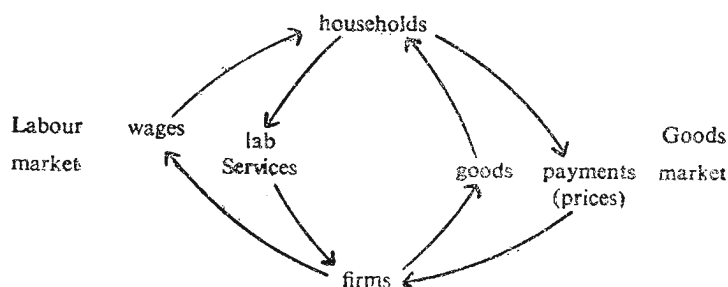
(a) A simple model concentrating on the really important influences on the targets and their lag structure will probably be quite adequate. The model should not be so simple as to preclude the necessary detail on the instruments and targets, or so simple as to be unable to reflect structural shifts and, more important, the dynamic responses.

(b) However, this simple model idea does not imply modelling by empirical linking “inputs and outputs” as in the merely accounting framework or black-box context. That would be modelling, without causal analysis, or without the application of any economic theory or institutional knowledge, in the reduced form. Since that cannot necessarily correspond with economic theory and observation, specification must follow economic theory and observation in the structural form.

(c) Disaggregation will then take place from the “top down” as dictated by the uses of the model. It is useful to start from a very simple aggregated prototype model.

6. The Flow of Funds, a Basic Model Structure, and Simultaneity

Traditional macro-economic texts start with a discussion of the circular flow of income:



physical goods and physical effort flow in one direction; for each unit of these there is a money counterpart flowing the opposite way. In either of those circuits, we can recognize potential leaks (of money, or goods) from the system and potential injections into it. If the leaks do not balance the injections, there must be a net loss or gain at that gap. The circuit would then be in disequilibrium because the result must be that changing quantities flow around the system. One is then interested in whether the laws of motion of the

system are such that the quantities adjust to close the gaps in time, or (as a special case of this) there is a controlling authority who will operate some controls so as to close the gaps, or whether there are conditions in the outside world which act so as to sustain the gaps.³

The potential gaps are :

- (i) Foreign trade: imports are money leaking out (goods in) and exports are injections in (goods out), so a balance of trade or resources gap is to be financed somehow by short or long run capital net flow in or out, or is to be closed by adjusting the flows and/or leaks and/or injections.
- (ii) Budget: taxes are money leaking out, government expenditures are money injections, leading to a budget deficit (surplus) to be financed by increases (decreases) in public debt, or to be closed by changes in government policy taking into account that the circular flows will also thereby change.
- (iii) Savings—investment gap: savings are a money leak, investment an injection, and any gap must be financed by credit expansion or reserves depletions; or be closed by altering conditions in the money (credit) markets and thereby the flows.

Evidently any remaining gap will ultimately be financed by the appropriate short or long term capital flows if adjustments in the goods or money markets have not fully closed the gaps. These capital flows can be generated within the domestic economy or by foreign loans (or aid programmes). Moreover the gaps may not be independent of each other. A large public investment programme in a low income/production country will entail a budget deficit and be supported by insufficient domestic savings and, if it has a large import content, imply a foreign trade deficit as well. Of course, the adjustment mechanisms which these gaps may set in motion can be a good deal more complex and wide ranging than those of the policy type cited above. There may be self-stabilising mechanisms in the economy itself, rather than those inserted by the authorities. Prices may adjust domestically in the goods market so that the values in the circular flow alter such that the gaps tend to close. They may alter likewise for foreign-traded goods. The budget and credit requirements will then be affected. Disequilibrium in the flow of funds will imply changes in labour demand and/or supply in the labour market since the general incomes are adjusting. Thus, we have three interdependent markets connected to three interdependent gaps. Adjustments in any one imply movements in all the others since the funds flowing around the system change; and that change itself then implies a further adjustment to the original gap or market (and then to the rest), and so on *ad infinitum* till a new equilibrium (or financing level) is reached. That is a *simultaneous* solution to the set of adjustments in all six components of this economy.

3. i. e. the system is dynamically stable in itself; or the system is not necessarily stable but the government acts as a stabilising force; or "foreigners" provided the means to plug the gaps.

The point for our purposes is that at the end of the day, making up the books will show that any outstanding gaps have been financed somehow — in an accounting sense. This is an economic equivalent of the conservation of matter: funds are neither gained nor lost to the economy's accounts although their ownership and form may change.

We must carefully distinguish this *ex post* view in which accounts necessarily balance, from the *ex ante* case (seen before adjustments or financing takes place) where the potential gaps, the forces of disequilibrium and, thus, movement appear. For it is the latter which are the key to the adjustments (i.e. type, size, speed, in which market, etc.) necessary, or the financing to be sought. For a successful planning or forecasting specification we must be able to model how much of each adjustment will take place in each interval, conditional on how much financing will be sought and obtained. To do that, it is necessary to have a (estimated) description of the behavioural reaction functions of the economic agents in each market; that is to say the impact that these disequilibrium gaps or financing have, via the agents' decisions on the economic variables concerned. The reactions will generally be distributed over time, so that we also capture the dynamic responses of the economy. In this way we can, in principle, determine the values arrived at by the economic variables of interest at different moments and in varying circumstances, rather than just suggesting an accounting framework to lie behind a particular scenario. The market adjustments made can be in either price or quantity form (e.g. as changes in price inflation, quantities produced, interest rates, money or credit supply, wage inflation, unemployment or labour supply). All the familiar concepts of economic theory appear in these reaction functions — propensities to consume and import, price and income elasticities of demand and of supply, cross-price elasticities (substitutes and complements), interest elasticities, derived demands for labour and capital services, wage-price-unemployment interactions, and so on. Adjustments in the leaks and injections beyond these induced by adjustments in the markets will be the result of policy reactions of the authorities — also a behavioural matter. As such they pose the policy problem conditional on a knowledge of how the markets work. Since the policy makers are not the only decision makers influencing the path of economic evolution (and here one cannot ignore the impact of foreign as well as domestic economic agents) a model which fails to explain decisions via behavioural reaction functions can hardly be a successful forecasting or planning device. This holds even when the policy authority assumes total control (in attempting to be a sole decision maker) unless the economy is closed, as the planners of East European countries have found to their cost. In short, it is essential that we have the explanatory power to show how and why the economy moves to each new position; in addition to an accounting system (both interindustry and financial) to picture that position when we get there. While the latter is interesting for assessing income and wealth, it is uninformative on the development of the economy and, thus, for forecasting and planning.

The flow of funds is given concrete form in the model via three possible definitions of GNP.

- (i) GNP = sum of value added in sectoral outputs (supply) ;
- (ii) GNP = sum of demand categories (consumption, investment, net foreign trade, net budget, etc.) ;
- (iii) GNP = sum of income types (wages, profits, dividends, rent, etc.).

Ex post they must be identical, but they will differ *ex ante* whenever gaps appear. Confronting one with another shows where adjustments are necessary—they may be in the demand or supply of goods, in the money used to support those demand and supply levels (money market), or in the incomes available to support demand and supply income (labour markets). Dissaggregation in each definition allows us to see which component is adjusting. Moreover, given that savings = income — consumption, each gap is represented in this three-way classification, so the closure or financing of them is represented. The way is now open for policy analysis. Our problem is to model the determinants of these various components, their interdependencies, and their adjustment mechanisms.

Sometimes simplifications are possible in this scheme because certain constraint exist which prevent the adjustment of one of the quantities. Then the economy must adjust to the level of the lowest constraint, and that is all that need to be modelled. For example, the western economies were demand constrained between 1930 and 1970⁴ and therefore subject to demand control. The Soviet type economies are supply constrained and subject to rationing, and others are income constrained (many developing economies). In the last category are economies which have found the means to finance their gaps⁵ rather than close them. Demand and supply controls are not themselves necessary although demand need not equal supply *ex ante* so that unintended inflation, shortages, unemployment may result in excess of that planned. In this context, one must recognize that these constraints which block adjustments can be administrative, e.g. where consumption is planned as a residual so rationing is achieved by queuing; or a release of the money supply so rationing by inflation follows; or import quotas are imposed; or indentured labour (such as the land army) is used. Some constraints are short run phenomena only.

Most economies have something of all three gaps from time to time. A model of them, and the three markets and their adjustment mechanisms or constraints, represent the basic characteristics of the economy and the likely future bottlenecks. In the case of Sri Lanka all the gaps are open at the time of writing and require considerable local and foreign financing. The gaps are largely derived from one source—the public investment programme. Constraints to be captured also are clear in the goods market because of heavy specialization on four agricultural crops (three for exports). In the money markets there is a domestic savings mobilization problem and massive aid and loan injections. In the labour market there is a clear skilled labour constraint (and unskilled labour surplus). That adjustments are taking place in the gaps is also obvious from policy provision, inflation and the shortages of certain materials and inputs leading to the under-utilization of capital. It is not obvious that any of these features had been analysed and anticipated by the planners.

7. Illustrative Models

As an example of a model and to the points above, consider the case of an industrial economy in which the government is interested in forecasting and policy analysis in a period when its principle concern is with the problems of demand management. A Keynesian demand-driven model is therefore appropriate, elaborated to consider full employment, inflation and foreign trade targets at least. We would start with.

4. Excepting the war years.

5. e. g. foreign grants & loans, labour, e. t.

- (1) $S = Y - C(Y)$ $I = I(r)$ and $S = I$ or financed gap (goods markets)
 (2) $M^D = m_1(Y) + m_2(r, p)$ and $M^S = M^D$ or financed gap (money markets)
 (3) $Y = Y(N)$ $w = Y'(N)$ $w = w_0 + W(N)$ (labour markets)

and $Y = wN$ or a financed income = full employment gap where S = savings, Y = aggregated demand, I = investment, r = rate of interest, M = demand for money, p = price level, M^S = supply of Money, N = labour force, W = wage rates sticky below w_0 ; and the bracket terms denote functionals with $Y'(\cdot)$ being the first derivative and $C(Y)$ being consumption expenditure. Such a model is no use. It is too aggregated, it contains no proper policy variables and no dynamics so there is no link over time periods such as in a variable capital stock, K . We also need a trade sector and some price determination. This might lead to the following

- (4) $C = a_0 + a_1 \frac{Y-T}{P} + a_2 C_{-1} + u_1$ (consumption)
 (5) $I = b_0 + b_1 \frac{Y}{P_{-1}} + b_2 K_{-1} + b_3 R_{-1} + u_s$ (investment)
 (6) $F = r_0 + C_1 \frac{Y}{P} - C_2 F_{-1} + C_3 P_F / P + u_3$ (imports)
 (7) $E = d_0 + d_1 T_s + d_2 P_e / P + u_4$ (exports)
 (8) $Y/P = C + I + G - F + E$ (real GDP)
 (9) $T = O_0 + o_1 Y + u_5$ (net tax yield)
 (10) $K = I + K_{-1}$ (capital stock)
 (11) $Y/P = f_0 + f_1 L + f_2 K + u_6$ (real output given labour demand),
 (12) $P = g_0 + g_1 \frac{WL}{Y/P} + g_2 P_F / P + u_7$ (prices)
 (13) $W/W_{-1} = h_0 + h_1 \frac{N-L}{N} + h_2 \frac{P}{P_{-1}} + u_8$ (wages)
 (14) $N = k_0 + k_1 (N-L) + k_2 W/P + u_9$ (labour supply)
 (15) $M/P = m_0 + m_1 Y/P + m_2 r + u_{10}$ (money demand)
 (16) $P_e = n_0 + n_1 P + u_{11}$ (export prices)

There are now 13 endogenous variables (determined within the system) jointly depending on 7 lagged dependent variables and 4 exogenous variables (determined outside the system). The lagged endogenous variables are subscripted by -1 to indicate a one period lag and are determined within the system at an earlier date, but are fixed if we consider the model at any given instant. The endogenous variables are on the left in each equation (of which only C , I , K , E , and F are in real terms). Targets might be Y , I , P , $N-L$, $E-F$ among others. The exogenous variables are P_F = price of imports; T_w = volume of world trade; G = real government expenditures, R = rate of interest. The latter two might be instruments along with o_1 , h_2 and possibly others. The lower case letters ($a_1, \dots, n_{11}$) are parameters that would have been estimated. u_i $i = 1, \dots, 11$ are stochastic random errors, following some probability law, to represent the errors of specification and the natural

variability or uncertainty in these behavioural relations. This model overcomes many of the difficulties mentioned for the model (1) — (3) but is still highly aggregated and could not handle some of the problems discussed in the previous sections. Therefore, disaggregation could now go ahead to tailor the model for the uses desired of it. The specification of (1) — (3) or (4) — (16) is an obvious, but highly simplified consequence of traditional economic theory. Its derivation was therefore a problem in economic theory. A more detailed development and criticisms of such specifications may be found in general texts, or in the discussion of any particular econometric mode, such as those mentioned in Section 3.

The equations of the model are of four kinds :

(a) Behavioural (stochastic) — testing empirically the behavioural theories of economic activity, e.g. (4) .

(b) Technical (stochastic) — testing relations with a scientific or physical rather than behavioural base, e.g. (II).

(c) Definitional (identities)— accounting relations in the flow of funds.

(d) Institutional — probability identities but with the property that in any event they may be changed at will by the economic management.

As an example of the finished product, an empirical model which has been used frequently is Klein's Model I of the U.S. :

$$C = 16.786 + .02 \Pi + .225 \Pi_{-1} + .8(W_1 + W_2) + u_1$$

$$I = 17.784 + .231 \Pi + .546 \Pi_{-1} - .146 K_{-1} + u_2$$

$$W_1 = 1.599 + .42(Y + T - W_2) + .164(Y + T - W)_{2-1} + .135t + u_3$$

$$Y = C + I + G - T$$

$$\Pi = Y - W_1 - W_2$$

$$K = K_{-1} + I$$

$$D = W_1 - 2\Pi \text{ where}$$

C = consumption, I = investment, W_1 = private wage bill, W_2 = govt, wage bill,

Y = national income, Π = profits, K = capital stock, D = income distribution,

T = tax bill, G = government expenditure, t = time (1931 = 1)

Here C (current welfare), I (future welfare), and D might be targets ; and T , G and W_2 the government's instruments.

8. Specification — Use Interactions

At this point one sees something of the position of economic and statistical theory in the model building process. Having settled the basic structure and a tentative specification of the economic relations by economic theory and observation, these specifications are confronted by data and the parameters estimated by statistical techniques (such as least squares). Then the results are assessed equation by equation. The standard diagnostics of statistical theory will be used (t-ratios on individual coefficients, F tests ($\bar{R}^2$) on

equations, Durbin-Watson tests of the stochastic specification (and omitted influences), that the sign and size of the estimated coefficients accord with prior knowledge or observation of such a relation). As a result respecification of that relation will be necessary, removing insignificant explanatory variables, introducing new ones, finding the exact form in which a variable actually influences the dependent variable. The specification/estimation phase will be repeated until a satisfactory equation is found. This can take quite a lot of experimenting especially where economic theory is weak, such as in specifying the dynamic lag structure of a causal influence.

It is useful to emphasize the distinction between causality and coincidence here. Statistical methodology and statistical tests cannot specify causality, they can only indicate where *in that particular sample* significant correlations have been found and estimate the degree of dependence of one variable on another. They cannot say that the same would be observed when different circumstances prevailed. In particular they cannot say which variable causes which, but just whether they are associated. Consider the wages-prices example. Some say wages cause prices to rise in order to cover costs; others say that prices cause wages to rise in order to preserve living standards. In fact if observations are taken at discrete intervals you cannot distinguish which is causing which, since both processes will appear to hold simultaneously. They are jointly determined variables, dependent on a group of third party variables (import costs, demand pressure, government policy, etc). Statistical theory cannot be used to specify the model it only provides checks on the significance of the estimated results from the given sample. Specification and re-specification must therefore agree with economic theory, and observation of the system.

We have argued that the estimated relations should appear suitable for the use for which they are intended. If they are for forecasting then they must produce forecasts which accord with common sense, observation, and in particular they must "forecast" known history correctly at least in terms of directions of movement, turning points, etc. A proper test is to forecast outside the sample, i.e. the "forecasting" of history before the sample, or between the sample and the present. Similarly they should simulate the observed responses of the true economy to various known stimuli. They should reproduce the same cyclical patterns and the same phasing between movements of different variables, which have been observed in the data. They should show the same patterns of uncertainty in the dependent variables and so on. They should show the same patterns of dynamic behaviour⁶ (signs and sizes of disturbances) in response to given shocks. As and when these characteristics fail to appear we must return to the specification stage, and try again. Those tests can be very stringent, and certainly will be extensive considering the number of variables and planning periods which will be of interest. That is why I stressed earlier that a knowledge of how to use the model was an extra and vitally important condition for successful model design.

Throughout we have talked as if the testing were only done equation by equation. Each equation will have explanatory variables which are "predetermined" in the use of that equation but are endogenous in that they are explained elsewhere in the model. Some

6. i.e. whether cyclical, or rise and fall, or any dynamic development to a new higher or lower level.

will be lagged endogenous. Therefore the hard work in this interaction starts when we test the model *as a whole* for its ability to forecast sensibly, “forecast” history, simulate real or hypothetical events, reproduce the correct dynamic responses to stimuli etc. It is quite possible to have well performing individual equations which collectively perform badly. The same use-respecification interaction here must be gone through again, but it is now considerably more difficult to trace the sources of unsuitable behaviour than in the single equation case. At this stage one should also check that the model suggests the expected outcomes from certain policy packages (and policy strategies) as a whole. The specification process is genuinely a “learning by doing” operation.

It will be noticed now that we are checking the consistency properties of the model as a dynamic simultaneous equation system. This is because the economy is in reality a set of constraints which force those consistencies, and which, in planning or forecasting, we must respect if we are to produce information with any connection to reality. Not to do so is to ensure failure in the short or medium term. With many targets, but policy instruments restricted both in number and variability, the planning of an economy becomes a very complex task if inconsistencies are to be avoided. Potentially there are target inconsistencies (the achievement of one implies the partial non achievement of another, e. g. the inflation-unemployment trade-off) sectoral inconsistencies (with finite resources the achievement of a target in one sector hinders the achievement of that in another; again there is a trade-off to be exploited), dynamic inconsistencies (when the natural dynamics of the economy serves to undo the achievement of a target — achieved in one period — in some later period), and policy inconsistencies (the policy introduced in order to achieve some target (partially) offsets, by way of side effects, the impact of another instrument designed to achieve another target). And none of these problems have anything to do with the planning methodology—or lack of it—employed. The difficulty of resolving all these conflicts and removing inconsistencies remains whether you try to plan formally in the sense of solving a set of simultaneous differential equations or informally in the sense of selecting broad policy measures aimed at steering a restricted number of targets towards some desired values. The latter policy measures are designed to induce certain operating conditions such that the behavioural responses by the economic agents tend to realize the required targets. The formal planning methodologies tend to be associated with centrally planned or command economies. The informal (or indicative planning as it was once called) tends to be associated with western liberal regimes. Apart from the fact that more loosely defined objectives are easier to achieve (or more difficult for critics to find failures to be denounced), the resolution of the inconsistency remains a problem in *any* planning exercise. It is a property of the system, not of the planning methodology ; it remains whatever the philosophies of planning techniques (and governments) may come and go.

9. The Model and the Administrative Planning Structure

A natural question to ask at this stage, is how much use in practice is made of these economic planning models by planning agencies. The answer to that question sheds light on how the information produced by the model may be used most efficiently. It is as important that the administrative structure surrounding the model should be

sound, as it is to have a good model. For the best of models will be valueless if its information is mishandled or not used. Thus, this structure is an integral part of model design. In addition, collecting together the points which planners "in the field" have found to be the important features of a planning system provides a summary of the points to be included in the system design.

In general the models used for planning purposes by the governments of the Soviet bloc have been of the (non-behavioural) "user and materials balances" in an inter-industry accounting framework type⁷, with a single centralized planning authority. In the developed Western Countries the models have been of the behavioural type (fitted to a national income accounting system) or decentralized indicative planning. The concern over the unsatisfactory treatment of the supply sectors has, in the latter case, led to some integration of the two approaches.

In less developed nations government economic planning is often in the form of solutions to a sequence of specific, (often viewed as unconnected) "one-off" problems such as urban unemployment, rural/urban income imbalances, encouragement of industrial investment, foreign exchange shortages, the dominance of particular products such as coffee, cocoa, tea, tin, tourism, etc. This situation manifests itself in the many plans which are a series of public investment projects neither linked nor integrated with the general development of the rest of the economy.

The question posed is extremely difficult to answer satisfactorily. It supposes considerable institutional knowledge of many governments — knowledge which is certain to become obsolete fairly rapidly. Of necessity the information of the exact institutional structure and procedures surrounding the model available to the outsider will be sketchy; and in some cases the secrecy which must naturally cover the planning discussions, is also found to cover the planning procedures. But nearly every country uses some form of forecasting model, simple or sophisticated.

In the Netherlands planning models are housed in the Central Planning Bureau. The models used are an annual one concentrating on supply functions, employment and foreign trade for planning long term developments, and a quarterly one for short run forecasts and policy adjustments. As a rule the short run model is used for problems of stabilization based on projections of exogenous events, and the long run model to study the possibilities for growth compatible with a moving equilibrium in demand and supply in the labour, capital and foreign trade markets. The Central Planning Bureau is independent of any political control and is a purely research organization with close connections with Dutch Universities. It therefore can, and does, publish its own analyses of economic problems. However, the government supports the Bureau and, particularly valuing the independence of its views, regularly consults the Bureau and its models to provide technical information on the likely consequences, and feasibility of a whole range of economic policy formulation problems. Through its directorate, the advice of the Bureau will be presented and argued at all levels up to, and directly into, the Cabinet. The initiative, and

7. as represented by Input - Output tables.

terms of reference, come from the government. Then in return advice will be presented in terms of various options and the likely outcomes. The final policy decisions lie entirely with the government but the methods of research to provide that advice are at the discretion of the Bureau. The Bureau does not handle problems of Central Banking policy; here the Central Bank's research staff are consulted instead.

In the U. K. the main points of the Treasury's planning procedures have been set out in the *Report of the Committee on Policy Optimisation* (HMSO, Council 7148, 1978). Again we see a deliberate split between the model builders (technicians) and the policy makers who must analyse and decide between the available policy options. The reason for this split is that the former group understands the model, its statistical basis and limitations very well, but the political and economic possibilities (i.e. what is acceptable and what is feasible) rather poorly. With the latter group it is the reverse. It is necessary to avoid misunderstandings and failures in communications. A policy coordinating committee consisting of all Deputy Secretaries (Departmental heads) of the Treasury and chaired by the Permanent Secretary, and a Macro-economic group consisting of the Undersecretaries⁸ concerned with Macro-economic issues, represent the policy makers. The technicians form a Forecast group with two components (the short term and model group; the medium term and policy group) up to undersecretary level. The two groups do not meet together but when each meets, the Economic Advisory Section attends as well to acts as liaison, interpreters and possibly referees.

Short term forecasts are made twice a year processed through the following system. The initial assumptions for the forecast are usually based on unchanged policies and assumed exogenous events (in consultation with the home and overseas specialists, the industrial group, etc., within the Treasury), which may be proposed by the forecasters but they must be approved by the Policy Coordinating Committee. A preliminary forecast is made from the model. It is then discussed, sector by sector, with specialists from other Treasury divisions and other Departments of government (e.g. Department of Trade, Energy, Bank of England, Ministry of Agriculture, etc.). The information, comments and criticisms are then used to produce a first draft forecast from the model with adjusted assumptions, corrections or even alterations in the model itself. This forecast generates further forecasts of foreign and domestic financing and industrial production detail, through sub-models which are linked to the main one and need the collaboration of specialist government departments. A two day seminar follows for reviewing these forecasts, attended by the technicians and the Economic Advisory Section. All decisions taken there are then reviewed again as a second draft forecast is made incorporating them. A report describing the forecast and the assessment of the uncertainties is made available to all Ministers, the Cabinet, Officials and some other departments. Although the forecast is the best single estimate, it is essential that the uncertainties and difficulties associated with it are also explained to the policy makers.

The forecast goes to the two committees of policy makers who discuss the policy implications (the macro-economic group is consulted first on more technical matters). The Secretariat of the Economic Advisory Section summarises the outcome of those

8. responsible for each division within a department.

discussions in terms of the policy implications. This passes to the policy Coordination Committee (now including the senior members of the forecasting group) who set the terms of reference for the examination of the policy options from the model. Some proposals will also come from earlier considerations of the forecast by those concerned with policy analysis. A systematic analysis of the policy options is then prepared from the simulated outcomes given by the model. Fully worked out variants in the effects of different policy packages are set out. This draft is considered again by the Policy Coordinating Committee, together with the original forecast and other comments from elsewhere in the Treasury. The Permanent Secretary may initiate further discussions to amend the picture and correct the advice presented to the Ministers in that draft. The final version is then sent to the Chancellor and through him to the Cabinet. The choice between options remains theirs.

This whole exercise is kept distinct from the medium terms strategy considerations. The latter follows very much the same pattern as the short term exercise in policy analysis. The Policy Coordinating Committee exercises more control in setting the assumptions and simulations to be considered. The results and further simulations are considered by the Economic Advisory Section before a draft report passes to the Policy Coordination Committee again for further discussion and amendment before going on again to the Ministers. There is therefore a split between short and medium term policy analysis, neither of which are properly integrated or necessarily mutually consistent. Throughout, the Central forecast is kept separate from any policy options about that forecast which may be analysed.

The weaknesses suggested by the planning systems described above are the lack of any mechanism to guarantee the integration and consistency of medium and short term plans and the lack of consultation or feedback from the political authorities over any desired modifications (either in proposing the terms of reference for policy analysis, or in discussing the results). It is desirable to avoid both, directives from above, and any possibility of a rationing determined by the civil service agencies involved, of the options investigated. In particular, there is no means of consultation with the major interest groups such as labour, business interests, regional authorities, etc., who although not part of the planning structure will have important advice and modifications to propose. Some of these points are reflected in the procedures adopted in other countries.

In the U.S.A. procedures are rather informal. The members of the Council of the Presidents Economic Advisors can, if they wish, make use of the projections provided by any of the models although they are unlikely to initiate specific exercises. With so many models, many of them specialized, it is even possible to take a consensus of model results, as well as a consensus of advisors' opinions, which is a luxury probably very valuable for the elimination of faulty information. The Federal Reserve Bank system also makes extensive use of its own rather sophisticated models for planning its strategy on monetary issues. These models are housed in its research division, and the policy and forecasting information is made available to the board of governors.

The Japanese economy, noted for its success in recent years, has made use of econometric models in planning since 1960. Their procedure is to set up a long run planning model and then try to fit short run stabilization, regional and industrial policies into

its presentations; policies which remain distinctly subservient to the long run strategy. Five main targets have been taken; social capital, manufacturing sector, rate of growth exports, investment in human resources, and income distribution. Then they experiment with several possible long run rates of growth (of a 10 year horizon) with a view to balancing the limiting factors of labour, energy, foreign exchange, savings, and key commodity markets. Next a larger short run model is used. It contains the national income and labour market sectors plus behavioural and policy relations. Instrument values are selected after experiments to show which are effective in achieving the targets set out at the previous stage—such as the share of government purchases and transfer payments in GNP and various tax rates. Finally the exogenous information is used in the model—most of it is derived as that consistent with the rate of growth obtained earlier. And that means the short run, regional and industry models can be used to give projections and help policy formulation. The results are consistent sectorally, dynamically and with respect to policies.

The French economy has a long history of centralised economic planning. Since 1971 a large nonlinear model has been used for extensive simulations on policy and non-policy variables. Again the policy maker may commission studies and he must choose his own policy. The modellers only present a range of options. Three alternative rates of growth in GNP are considered to give the long run framework. The model is then used to check the physical consistency in National Income. Outputs are broken down into agricultural, industrial and services outputs. These are further disaggregated into individual industrial outputs. Rather detailed single equation models give a fine disaggregation of demand components under the headings of consumption, investment, imports, exports and autonomous (committed) government expenditure. Intermediate industrial demands are obtained by input-output methods, leading to employment demands whereas labour supplies are estimated by demographic and other studies. Consistency of projections is obtained by iterating around the cycle of the projections of physical quantities. Finally policies on fiscal and monetary measures are set to make the financial model give consistent projections comparable with the physical balance just obtained. The plans are consistency and comparative static plans with no dynamics, and presumably difficult to revise.

The Belgium Economic Plan is a five-year plan but each year the corrections necessary to guarantee the realization of the Plan at the end of the five year period are made in the economic budget. The Plan is regionalised.

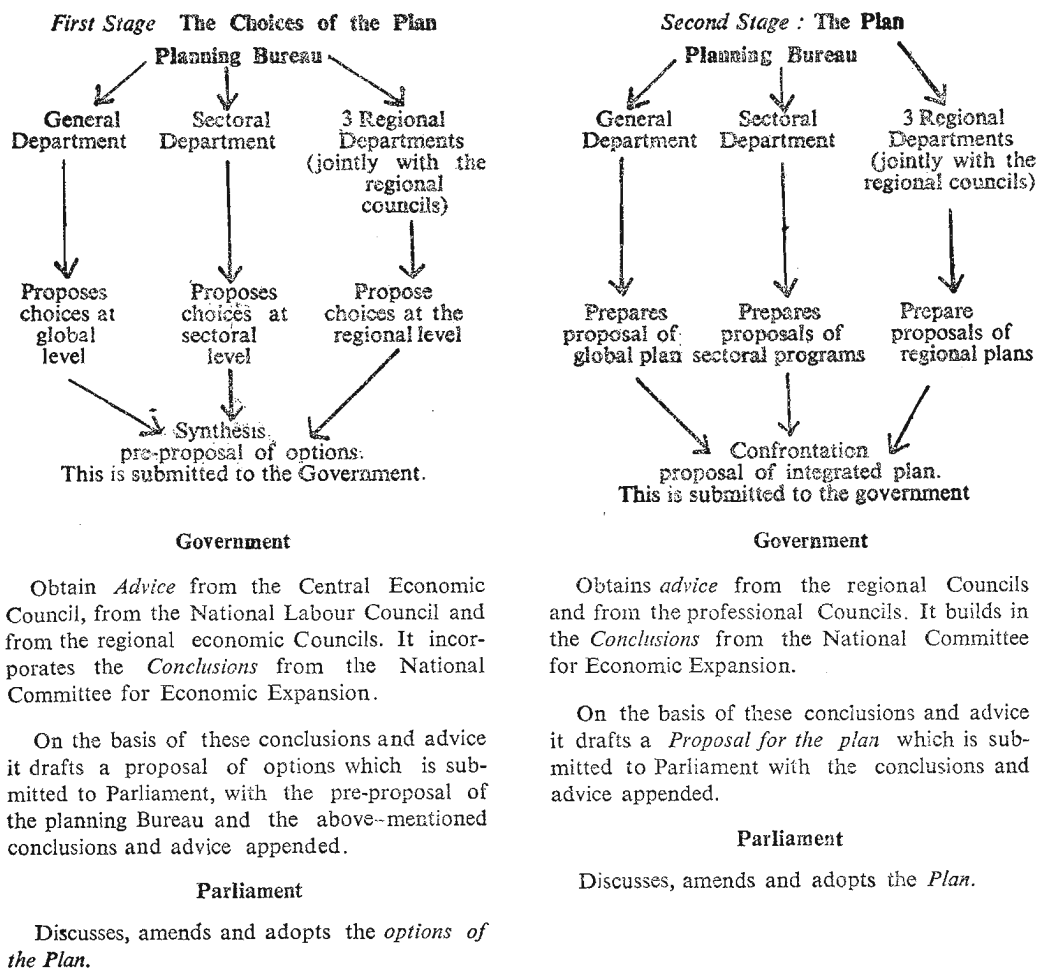
The Plan is : (i) binding for the Public Authorities only in as far as investment expenditures are concerned ; (ii) contractual to the extent that the state can get enterprises to agree to contracts which offer them benefits if they follow certain prescriptions provided in the Plan.

The Plan is built in two stages. At the first stage, the Planning Bureau evaluates and discusses the economic and social choices which are technically feasible with the social (Trade Unions and federations of Belgian enterprises) and regional (regional economic

councils) partners. This results in a proposal of options from which the government makes a selection which it then submits to Parliament. The latter amends and, eventually, votes the law determining the, options of the Plan.

The second stage consists in the drafting of the plan and in the determination of its concrete objectives in terms of the law on the options.

The following scheme summarizes the procedure :



The planning bureau generates Global macroeconomic projections by means of the RENA model. It is a regionalised, dynamic, non-linear macroeconomic model of the Belgian economy. The model has no sectoral dimensions. It is essentially used to test different variants of economic policy, by means of simulation techniques. Certain optimisation exercises have been conducted by the Planning Bureau.

From the global level, sectoral studies are obtained from input-output models, whose predictive versions are derived from the results of the RENA model. To guarantee consistency with the RENA model has caused problems of convergence and so the Planning Bureau is at present preparing a model integrating the sectoral and regional aspects.

Various other models are used or are being prepared to study specific aspects of economic policy, analysis of employment, demographic indicators, etc.

10. Conclusions

In conclusion, it is sometimes questioned how far governments should trust information generated by econometric models. In Britain, with a characteristic amateurism which has possibly been rather distinctive in recent history, it is often argued that better forecasts and policies will result from much simpler procedures,—“calculations done on the backs of envelopes”. This argument has effectively been answered by those requirements mentioned now placed by governments on their economic policies. Whereas it is relatively easy to understand a single relationship, the possible effects of several simultaneous relationships acting in concert on a variable, with feedback influences included and subject to several impulses over several consecutive planning periods, are next to impossible to grasp. In forecasting, the range of detail required, side effects, the dynamic effects and consistency of forecasts of different variables can only be handled by (simultaneous difference equation) econometric models. Only then is the simulation of many situations and policy packages in this detail possible. Another general point is that we need the means to rationally revise policies as changes and mistakes reveal themselves. And again it is an extremely valuable contribution of econometric modelling that it summarises the uncertainty in the forecasts and policy analysis ; where it is concentrated and what limitations it imposes. It is generally the non-model people who claim more for the models than is justified. And so it is instructive to read a pure economist on econometric modelling for confirmation on the most important comment that is made in this paper. That is the advice generated from econometric studies is no more than advice and guidance. It cannot supplant the function of the decision maker and his responsibility but can only be complementary to him. There will always therefore be room for ad hoc adjustments to any of the results we have discussed in the light of the judgement, experience, or extraneous information of the planner. Indeed judgemental forecasts are now common practice. That is small adjustments are made to the model's forecasts which reflect the planners assessment and perception of the uncertainties and inaccuracies involved. There is a considerable literature on the tortuous manipulations of constant adjustments which may be used to supplement or justify judgemental forecasts. The fact is that these studies show that the planners have lost none of their initiative, but know how to treat the model as a guide. It does not invalidate the model's information but it does recognise that the model is not perfect and the combination of planner and model is more powerful than either alone i.e. “Models are to be used but not necessarily believed”. The model will get variables into the right numerical area, ensure consistency of plans and forecasts, solve the issue of detail, and guide the planners thinking on likely consequences and the relative sizes of variable the planners then take over. The model has the function of concentrating the mind. It points out where the data are weakest, where our understanding of the economy is weakest

where the decision making machinery and/or plan implementation machinery is most in need of improvement or overhaul. The model makes systematic our understanding of the difficulties in making decisions and the interdependencies in the economy. All of this holds even when projections and policy making do not interest us *per se*. To quote Samuelson "I would no more dream of tackling the back of an envelope before I had looked at the Wharton, and Michigan and St. Louis models than I would dream of doing so on the basis of tea-leaves or reading Alfred Marshall's Principles. In other words, we dwarfs of judgement see as far as we do because we stand on the shoulders of computer giants".

Case Studies as a Method of Research

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Case studies focus attention not on the total population but on an individual unit in that population. It could be an individual, a family, an institution (e.g. school) or a group (e.g. class) within an institution. The intention is to study the unit in question at great depth and to seek to establish generalizations about the wider population from which it is drawn.

As a method of research case studies suffer from several limitations. Firstly, the selected unit may not be representative or typical in which case it is misleading to generalize. Secondly, the unique perspective of the researcher could enter into and distort the research. In case study there is a lot of opportunity for the biases of the researcher to be brought into the research. Thirdly, one has to ensure the confidentiality of the unit under study. What I mean is that if you study one person at depth, you have to win his confidence and respect his desire for privacy in order to obtain information from him which often is a difficult task. This of course means that if the findings are confidential (or the identity of the unit is confidential) nobody else can verify one's research findings.

However there are advantages in doing case studies. Firstly, as I described earlier, they provide indepth description. Secondly, case studies can generate hypotheses. Thirdly, it is possible to study a human being as a unique individual, which is especially useful in educational research.

Surveys as a Method of Research: A Socio-Economic Survey of the Mahaweli

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In empirical social research, you could either select a problem first and then subsequently select your geographical area of study or *vice versa*. For example, the problem could be the non-repayment of cultivation loans taken by farmers. After having selected the problem you select your area. In doing so, naturally you take into consideration certain scientific factors. However, non-scientific factors such as the availability of time, money and personnel also could be important. The second approach is to first select an area and then select a problem. That is precisely what happened to us,¹ because the Man and the Biosphere Programme is interested in the Mahaweli area, and in that sense the area was pre-selected for us. It was left to us to select a problem within this area. What we selected was 'what are the problems that arise when you settle people in a new area?'. It is a simple one and therefore the methodology we adopted was equally simple.

In answering this question we have to consider three basic issues which I think arise in any type of research. Firstly, 'from whom are we going to collect these data?' Secondly, 'how are we going to collect these data?' And thirdly, 'what type of data do we have to collect from these people to answer the question that we have raised?' So what I want to describe is how we attempted to answer these three questions, what problems we have had so far, and how we solved them.

The first question—'from whom are we going to collect these data?' As you know the Mahaweli area in the Kalawewa basin is divided into a series of blocks. You get larger blocks called H1, H2, H3 and H4, and each of these larger blocks have been subdivided into smaller blocks depending on factors such as topography and so on. The blocks that we selected were block 301, 302 and 303 and we selected these blocks for very good reasons. Firstly, they were very close to Galnewa township, secondly, we got a house very close to that area so that we did not have to walk long distances; and thirdly, this area had been settled about 3 seasons before we started this survey. After selecting these 3 blocks, we had to select a sampling frame. For this the Mahaweli Development Board gave us the list of allottees. In the Mahaweli Settlement area, people have been settled in clusters, like in earlier settlement schemes. In each cluster, an individual has been given a half an acre homestead. Also you get different types of villagers (settlers). First you get the Purana Villagers who have been residing in the area Prior to the new development. Secondly, the new settlers who have been brought from outside, and thirdly, there are the encroachers who have been living in this area for the last 10 or 15 years.

1. The research study which is described here is done in collaboration with Dr. Jayanthi Perera and Mr. Wilson of the University of Colombo.

We selected a sample from each group. Then we went to locate these individuals, and to our regret we found that some of these people have not occupied their homesteads. That is one mistake we did — to allow ourselves to be guided by the Mahaweli Board list. Having rectified the mistake a sample was chosen as follows: Purana villagers—100; New settlers—35 ; Encroachers—100. Thus we had a sample of 235 individuals.

Once we selected the sample the next problem was to collect the required information from the members of the sample. This was a difficult task especially since they were so widely distributed and we did not have any good transportation in the early stages. Thus we had to visit them on foot. At this stage, we had to consider two problems. One was, if we wanted to find out the problems that emerged in the area, we had to overcome the problem of recall. So there were certain alternatives open. One was to interview all these farmers through a one-shot survey. You could have got the data by this method but the data would not have been accurate. (There is not much point in going and asking a farmer about the fertilizer he applied 6 months ago.) To overcome the problem of recall, we divided the sample into two groups. One group we started interviewing once in two weeks. Because of the other constraints that we have had to face, we could not interview them more often. The second group we started to interview right through the cultivation calendar, in three stages; once soon after the sowing stage was over ; second, about 2 months after sowing; third, after the harvesting was over. We broke it up according to the paddy calendar. We interviewed the two groups both in *Maha* and *Yala*, one group was interviewed about 6 times and the other about 24 times.

In this way we got some good information. Firstly, the quality was good. Secondly, we were able to establish a rapport with the farmers, who anticipated our regular visits and appreciating our genuine interest in collecting good data were prepared to co-operate. Also we felt that we had overcome the problem of recall. Moreover because we interviewed them once in two weeks, we were able to get a continuous picture concerning the income and expenditure patterns, marketing problems, financial problems, social problems and so on over a period of about 18 months. That in brief is the methodology we adopted in collecting data.

What type of data should be collected from the farmer ? This was a very big problem. We divided the information we needed into several sections. For example, one section dealt with agricultural practices and under this we had a sheet for each practice—field preparation, sowing, fertilizer application, application of other agro-chemicals and so on. In this manner we had a wide range of topics and on each topic we had a small questionnaire. The questionnaire was about 30-40 pages long but this was no drawback because the farmers realised that we were genuinely interested in their information. In the case of the questionnaire, it was not completed in full by all the farmers. For example, if the farmer said that he could not apply the agro-chemicals, that sheet was not filled. Thus, on average only about 10-12 sheets were filled. Here there was one problem. We had to devise a method to find out whether the investigator had attempted to get answers to all the questions from the farmer. To overcome that, we had a check sheet with all these topics in single questions—“did you fall ill”? yes/no ; did you apply fertilizer? yes/no”, and so on and the investigators before starting the interview had to tick them off.

Based on these studies, we submitted about 3 or 4 reports, but at the end of it we had to ask some fundamental questions. We had assumed we could answer the question 'what are the agrarian problems that had arisen in this area?' by interviewing farmers. At the end of the survey, we realized, that we could not identify all the problems that emerge in an area by interviewing only the farmers. We also realized that it is difficult to understand the farmer's present behaviour unless you know his past. We had made that mistake of ignoring the past. Our survey said that some farmers were very good and some farmers were very poor, in so far as performances were concerned. And we had data-education and soon, which enabled us to arrive at certain conclusions, but some of these variables did not fully explain the differences. So we decided to go back into their past and after two seasons in blocks 301, 302, and 303 we went to 306, 6 miles away.

We thought a new block would be able to give us more meaningful answers which we were unable to find at the previous blocks. First, we decided not to accept the list given by the Mahaweli Board. Secondly, we did not want to take 3 blocks, because we felt that by spreading our resources too thinly we were failing to collect good information. Thus we concentrated on one block. The first thing we did was to send the investigators around to every house to fill a two-page basic schedule. It revealed that of the people who had been allocated land, about 85 people were not in residence. So we took as the sampling frame, those who had been given land in this area and were cultivating the land in this area only.

Then again we decided not to interview farmers on a once a month basis during the cultivating calendar because we realized that the information that we get from a farmer at intervals of 30 days was not very accurate. Therefore we decided to select a smaller sample of about 120, and interview each farmer once in two weeks. The methodology we adopted was the same as before but we modified the questionnaire slightly depending on the experience that we had gained.

In order to find out about the farmer's past we had a separate schedule by which we collected information on the pre-Mahaweli experience from all the farmers in the sample. This was a one-shot survey. In that sense, the information that we got on fertilizer use and use of agro-chemicals was not very accurate. However, on the other hand we were able to arrive at certain conclusions pertaining to the block, which I think were very important if one were to provide feed-back information to the Mahaweli Board. For example, we were able to say what proportion of the land remained uncultivated, how many people had not come into residence, how many people were migrating, how many people had marketing problems in the area and so on.

When we finished block 306, we decided to go to block 307, because this block had been recently settled and we had a nice bungalow to stay near block 307. Here we realised that there was not much point in doing a complete survey because the information which we have already had on block 306 was applicable to block 307 as well.

Before I wind up, I want to ask one or two questions. How useful is the survey method? What are we going to achieve by doing a survey? I am convinced that even if you do ten more socio-economic surveys in area H, you are not going to come up with any

more answers than what we already have. I am also convinced that if a few people who are knowledgeable on individual topics get together, they will come up with certain answers which will not be very different from the answers that come up by doing a detailed survey. In other words I am prepared to argue that in agrarian studies the survey stage of research is over in Sri Lanka. We have enough information now. Surveys are useful if they are going to be for a specific purpose (if you want to find out how much fertilizer you should order for area H for the next season you do a quick survey). But on the broader problems such as what is wrong with the extension system? What is wrong with our co-operative system? and so on, we have a good understanding. Therefore, I am convinced that we should do more case studies. That is, I would prefer to go into a block in Mahaweli area, spend a weekend, just walk around to get the feel of the area, select about 6 or 7 settlers and then study them in detail and ask them what their problems are. And based on that I will form a few hypotheses on these case studies and test those hypotheses over a larger area. I believe that in order to answer some of the questions that we are faced with, detailed case studies are absolutely necessary because of a variety of problems. Firstly, because the one-shot survey is not going to give you very valid information, and secondly, farmers are not on the same wave length as you when answering questionnaires.

In conclusion I would like to raise one last question concerning the role of case studies; how significant are they and how should we do it? In trying to collect information from a group of individuals, or to answer a particular problem, should we confine ourselves to that particular target group or should we go beyond these people and supplement this information, by doing other studies as well? Our Mahaweli studies have convinced us that in the next stage, we have to interview all the officers, all the shopkeepers and even people in Galgamuwa and Kekirawa. It is only then that we will be able to come up with answers to some of the problems that have emerged in the area.

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Types and Sources of Data for Social Science Research in Sri Lanka

R. MAHALINGASIVAM

Ministry of Finance and Planning

1. Introduction

For all areas of research, collection of information is vital. No inquiry on legal, medical, economic, sociological or any other problem is possible without information. In other words evidence will have to be collected and analysed before one could come to any conclusion. More than collection, reliability of the information is crucial. If reliable data are collected then the balance work is relatively simple. If a study takes 3 years the period devoted to collect statistical data and other evidence could be as long as nearly 2 years. In most cases the process of data collection will go on until the analysis is completed.

The researcher should know what information to collect, where to collect, how to collect and how to check the reliability. One should know, a priori, the data to be collected on the variables he proposes to use for his study. The causal factors will be known from what one observes, what theories one would have learnt about laws of behaviour, knowledge gathered from reading similar studies etc. Thus, invariably, it is possible to identify a large part of the variables that will have to be used. The others will become known to him as he proceeds with the research.

2. Types of Data

Available data are normally classified between primary and secondary sources of data.

Data are collected by government departments, ministries, public corporations, business firms, banks, research organisations such as ARTI* and Marga Institute, trade organizations like the Chamber of Commerce etc. There are also data collected through census and surveys and published by the institutions which collected them. Census of population, census of agriculture, census of industries, Socio-Economic Survey 1969-70, Consumer Finance Survey 1973 are a few such examples. Several survey results are also published by the ARTI and Marga Institute. In addition there are a number of institutions such as the Ministry of Finance and Planning, Ministry of Plan Implementation, Labour Department, Registrar General etc. where data are collected but all information collected is not published. All information collected and issued by these collecting organizations is called primary data.

* Agrarian Research and Training Institute.

Census data cover the entire population, but the sample surveys cover only a certain percentage of the population. Censuses are costly and take a lot of time for collection and processing. Because of this censuses are conducted once in ten years or so. But sample surveys can be conducted for specific purposes and are less costly.

In general research workers very often depend on surveys for data. Since surveys cover only a part of the population it does not mean that survey results are inferior to those obtained from censuses. Under some circumstances the survey results are more dependable than census data.

There are publications such as the Statistical Abstract, Central Bank Annual Review of the Economy, UN Year Books, International Financial Statistics etc. which compile information collected by other institutions. These are the secondary sources. Although it is more convenient to make use of secondary sources it is preferable to make use of primary sources.

The reasons why we prefer primary sources of data are as follows :

- (a) Secondary data may have errors in certain variables due to carelessness on the part of the compiler of data or due to printing errors.
- (b) Secondary data may not have the correct definition or indicate the method of collection or compilation.
- (c) If the information was obtained from a sample survey the user may not know the type of sample used, the size of the sample, the reliance he can place on the information collected and the adjustment he should effect to make the information suitable for his study.
- (d) The data may be aggregative and the researcher may not find details and breakdowns which may help him to choose the most appropriate variables.

The research worker has several options for collecting data :

- (i) Using published sources (see Appendix I for such sources) ;
- (ii) Using unpublished sources ;
- (iii) Collecting information by himself through sample surveys.

Of these the published data are the least expensive but in most cases they may not serve the purpose if sufficient care is not taken.

3. Shortcomings

The published and unpublished time series data are mostly not in forms which are readily usable for research. Therefore, sufficient attention must be paid to process the data before use. In contrast to time series data we have cross section (sample survey) data where this problem is less acute.

There is a great deal of information buried in the files of government departments and corporations. Even officers working in these departments do not realise the value of such information. Sometimes several departments collect information on the same area and invariably they are not the same. Such information is often quoted especially in public statements by different high officials on different occasions but it is very seldom that listeners as well as readers notice differences in the data quoted. Therefore, newspaper sources will not be the most appropriate ones for numerical informations.

Published data also have the shortcoming that they often do not supply the information needed for a particular research study. For example, the National Savings Bank may publish the amount of deposits collected each year but the researcher may be particularly anxious to know who the savers are - large entrepreneurs, middle-income wage earners, lower income wage earners etc. This information may not be even available in the records of the Bank as they may not have even collected this information from the depositors. To cite another example, when we wish to know separately the construction expenditure on new houses for owner-occupation and for renting, published information may not be available. In such cases one may have to check with the departments which collect these data. If this attempt fails the researcher will have to collect them himself by means of sample surveys.

Not all variables can be measured directly. In such instances proxies may be used in some cases to reflect the variable indirectly. In other cases other devices must be adopted. Some variables cannot be quantified at all. For example if one tries to explain with the help of a model the monthly earnings of agricultural labour, he will find that their earnings would depend on the season, say *Maha* and *Yala* cultivation seasons. In the model, seasons will have to be used as independent variables. How could one measure seasons? In such cases we use what are called 'Dummy variables'. Sometimes the researcher has to first define the concept in measurable terms. For instance, if one wishes to study the causes of poverty, the question arises as to how one should measure poverty. The term poverty itself depends on value judgement. Therefore, one has to first define what he means by the term poverty and then evolve a measure.

4. Need for Definition

In order to assist decision makers and other researchers, we should recognize the need to define variables. If they are not defined clearly, problems could crop up at various stages. This is more so because the same variable may mean different things to different agencies in a country, to different countries and at different times. For example, in the *Socio-Economic Survey of Ceylon 1969-70* the term 'Household' was defined as a group of two or more persons related or unrelated, who combine to occupy the whole or part of the housing unit and provide themselves with food and other essentials for living. Boarders were included if their number did not exceed three, but lodgers were excluded. Domestic servants who occupied the same premises and shared household meals were included. Persons who were temporarily away from their home were included as members of the household, while temporary guests were excluded. In contrast the Consumer Finance Survey 1973 dealt with spending units. Unless we understand the distinction between the two definitions and make suitable adjustments information in the two surveys is not

comparable and hence we are bound to make mistakes. Another example where simple unadjusted comparisons could be misleading concerns surveys on employment and unemployment where often the definitions used change from one survey to the next.

In forecasting the production of paddy several people make mistakes because they do not understand the meaning of asweddumized area and base their forecast on gross asweddumized area. Asweddumized land under paddy is defined as land which is ridged, bounded and prepared for the cultivation of paddy. Even here the output is calculated using net asweddumized area which is 85 per cent of the gross asweddumized area.

5. Need for Checks

If the research undertaken is to yield meaningful and useful results, as indicated earlier, the quality of the data is important. Therefore, the users of data must make sure of the suitability, reliability, accuracy and consistency of data. If wrong information is fed in, one should end up with wrong results. However if any one claims that he had obtained meaningful results after using inaccurate data, the decision maker should be extremely suspicious of the findings. The consequences of using inaccurate results for policy decision could be grave.

Thus a person who collects the data must also check the reliability of the data. For instance if someone observes some sudden jumps in a statistical data series he should make sure that such jumps had not taken place due to some change in definition, or method of computation. If the sudden change is due to a change in computation methodology one should ensure that the two sets of data are linked (splicing by averaging overlapping values) through the data which overlap. If this is not done any findings of your research using published data will be misleading. For example, the data given below would indicate how people can be misled by published data.

Table showing the Import Price - Index for Investment Goods

Year	(1) Index No * as given in the 1968 Report 1958—100	(2) Index No ** as given in the 1969 Report 1967—100	(3) Index No as given in the 1969 Report but converted to 1958—100
1958	100	49	100
1959	111	54	110
1960	120	59	120
1961	112	55	112
1962	92	45	92
1963	98	48	98
1964	96	94	192
1965	132	92	188
1966	185	90	189
1967	204	100	204

Source : Columns (1) & (2) Central Bank, Annual Reports

* All indices are worked with fixed weights based on the experience of the 5 years 1964—1958

* * Indices from 1964 onwards are based on the experiences of 1965-67 and are not strictly comparable with figures prior to 1964. Figures prior to 1964 which had been calculated on the experience of the 5 years 1954—58 (base year 1958) have been spliced to the new index (base 1967=100)

When the index published in the 1968 Report (Column 1) is compared with the index published in the 1969 Report converted with 1958 as base (column 3) it will be noticed that the changes in the indices over the two year period 1964 and 1965 are significantly different. In the first, import prices of investment goods have slightly fallen in 1964 but in the other they have almost doubled. In 1965 and 1966 it is the opposite, column 1 records a rise. In the first, import prices of investment goods have slightly fallen in 1964 but in the other they have almost doubled. In 1965 and 1966 it is the opposite, column 1 records a rise but column 2 records a fall, the rise being of significance during 1965 in Column I.III. When the figures in the 1969 Report (1967—100) are converted to the 1958—100 base (column 3) this discrepancy is considerably reduced except for the years 1964 and 1965.

When different institutions publish different statistics for the same variable, reconciliation becomes very necessary. For example, the Customs Department publishes data on imports of rice, flour, sugar, textiles, dried fish etc. During one period the first three commodities were monopoly imports of the Food Commissioner, the fourth that of the Salu Sala and fifth of the Ceylon Wholesale Establishment (C.W.E.). There used to be vast differences between Customs statistics and the statistics maintained by the importing institutions. There was a committee set up to investigate the causes for differences. The Committee after a detailed study identified the various reasons why the importing departments' data were more reliable than customs data. On a research undertaken earlier on per capita consumption of rice we found that meaningful results were obtained when customs data were used, and not when data of importing departments were used. However, in the light of the findings of the above Committee researchers were careful when they used Customs data. Because of the above limitation we abandoned our findings. Recently, the customs statistician had again tried to reconcile his figures with those of the Food Commissioner's. His report gives reasons why the Food Commissioner's statistics on imports of flour is an underestimate of the country's total imports. Now I feel that we should not have abandoned our earlier results.

To cite another example, the national income data and gross domestic capital in formation data published by the Central Bank are different from those published by the Department of Census and Statistics. Although some attempts were made to reconcile these differences they did not go very far. Researchers almost always use Central Bank data because they are available early. One does not know whether other sources are more dependable. For example, production data on state corporations are published by the Central Bank very early but they differ from those made available subsequently by the corporations themselves. Therefore, a lot of reconciliatory measures are required to make the data more reliable.

Most of the research publications carry a section on the sources of data. This helps one to familiarize oneself with similar work which had already been undertaken earlier. When a researcher reads articles in his field of research he may get some notion about where the information could be obtained from. Further, such reading will also give references to other studies already made in the area. Similar references to sources of data could also be had in administration reports, Royal Commissions or Presidential Commission reports and so forth.

In some studies the data required may be in respect of foreign countries. The most common sources for such data are the UN and IMF publications. In addition there may be international associations which publish data on specific areas. For instance, the International Tea Bulletin published by the International Tea Council provides information about tea. Similar sources exist for rubber, sugar, coffee etc. Since these data may also have the shortcomings enumerated above, checks will be meaningful here too.

Some data are now being stored in computer data banks. Such data can also be used. Such data I believe, will be continuously revised so that the data may be dependable and could be used conveniently by researchers.

Appendix I

The schedule below gives some idea about the types and sources of primary data in Sri Lanka (with methodology followed in some areas).

- (1) Land Area—Survey Department
- (2) Climate —Meteorology Department
- (3) Population—Various censuses of population or estimates by the Census & Statistics Department based on Registrar General Department data.
(Population by race, religion, literacy, age and marital condition, urban and rural population, gainfully employed population by industry and occupation group are available in Census data).
- (4) Vital Statistics (births, deaths, marriages, divorces etc.)—Registrar General.
- (5) Labour and Employment (Trade Unions, strikes, index numbers of earnings, monthly earnings by trade, employment)—Department of Labour.
- (6) Agriculture :—
 - (a) Paddy—Crop cutting surveys on a sample basis to estimate paddy yields (stratified multi-stage random sampling with D.R.O. division as basic strata, D.R.O. Division sub-stratified into major irrigated, minor irrigated and rainfed area. Each plot selected for sample survey is of size (33'X16½'). Paddy acreages collected each season on a parcel-wise basis on P1 Forms (a parcel is defined as a plot cultivated by one or more persons and surrounded by paddy land cultivated by other persons or by land which is not paddy). Ancillary data on crop damage etc. are collected at village level on Form P II.
 - (b) Tea, Rubber & Coconut—Acreage, production etc.—Tea Board, Rubber Controller and Coconut Development Authority, Census of Agricultural data.
Costs of production of Tea, Rubber and Coconut are estimated on the basis of information collected from a questionnaire sent out by Dept. of Census & Statistics.

- (c) Highland crops & Livestock statistics—Collected on H forms and L form primary data collected through *Grama Sevaka* by the Dept. of Census & Statistics.
- (d) Food Balance Sheet—availability of food and nutrition per capita per day computed by Dept. of Census & Statistics with data from Govt. Departments, State Corporations, Customs.
- (e) Forest area—Forest Department, Dept. of Census & Statistics, Forest Inventory Survey.
- (f) Timber—State Timber Corporation.
- (g) Fisheries—Department of Fisheries (Census and Sample survey).
- (7) Industrial production—Industries Ministry, Central Bank, Dept. of Census & Statistics, Industrial Development Board, Ministry of Textile Industries, Ministry of Rural Industrial Development, Greater Colombo Economic Commission.
- (8) Buildings—Department of Census and Statistics, Ministry of Local Government, Housing and Construction.
- (9) Energy—Ceylon Electricity Board, Ceylon Petroleum Corporation.
- (10) Transport—Buildings Dept, Motor Traffic, Police, Ceylon Transport Board, Railway, Ceylon Shipping Corporation, Customs Department, Air Lanka, Immigration and Emigration.
- (11) Communications—Posts & Telecommunications.
- (12) Prices—Colombo Consumer Price Index—Dept. of Census & Statistics (Based on Family Budget Survey of Colombo, Urban Working Class Families in 1949—50).

Wholesale prices (Colombo Town)—Dept. of Census & Statistics and Central Bank.

Retail prices (Colombo Town)—Dept. of Census & Statistics and Central Bank.
Fish prices—Fisheries Dept. Dept. of Census & Statistics and Central Bank.
Share prices—Brokerage firms.
- (13) Trade (Imports & Exports) — Customs Department.
- (14) Balance of Trade and Balance of Payments—Central Bank.
- (15) National Income—Central Bank & Dept. of Census & Statistics.
- (16) Public Finance—General Treasury.
- (17) Foreign Aid—General Treasury.

- (18) Banking, Insurance etc. (Money Supply, reserve position, rates of interest, savings deposits)—Central Bank.
- (19) Mortality and Morbidity—Department of Health Services
- (20) Crime—Police.
- (21) Status of prisoners—Prisons.
- (22) Education (Schools, students, teachers etc)—Ministry of Education, Ministry of Higher Education, University Grants Commission.
- (23) Tourism (arrivals, nationality, average duration of stay etc.)—Ceylon Tourist Board.

Main Published Sources

- (1) Registrar General's Annual Report
- (2) Customs Returns—Dept. of Customs
- (3) Statistical Abstract of Sri Lanka (Annual)—Dept. of Census & Statistics
- (4) Central Bank Annual Report—Central Bank
- (5) Administration Reports of government departments and state boards and corporations
- (6) Royal or Presidential Commission Reports
- (7) Accounts of the Island
- (8) Auditor General's Reports

Use of Archival Data

K. D. G. WIMALARATNE

National Archives

1. Introduction

The judicious selection and use of source material is an important factor in the field of research pertaining to any discipline. Even the application of any research technique will depend on the source material handled by a researcher, especially in the field of social sciences, where data are recorded on material either handwritten, typed, printed or taped, accumulated or accessioned from various sources authentic or otherwise.

Among the various source material used by the research students in the field of social sciences, archival sources are important for two reasons : (1) Archival records are accrued under certain national archival laws and not purchased, collected or accessioned as other source material. (2) They are sometimes unique and primary and also contain the archival quality or the integrity and authenticity as they are created unconsciously and accumulated by the various state institutions in their normal administration and transferred to the archives under national archives law for permanent preservation. They are preserved under the best possible conditions in the archives for the use of administrators and also constitute an indispensable national resource for research in all branches of learning including the humanities, the social sciences and the physical sciences.

There is one criticism which could be levelled against a major percentage of the records preserved in the National Archives, viz. that they necessarily reflect only the official viewpoint of the administrators of a given period as they contain documentation of policies, programmes and operations i.e. the reliable official memory of governments. Nevertheless, this official aspect of the source material could be supplemented to some extent by other source material which is in private possession. Many such privately-owned manuscripts have either been copied or documented by the National Archives and the Historical Manuscripts Commission through surveys of private manuscripts in the country. Moreover, information contained in the official archives could be checked with the material reported in the contemporary newspapers of the period the researcher is interested in, especially the newspapers critical or opposed to the government of that period. Even the oral history archives could shed light on a particular subject of a given period.

2. The Archival Collection

A research worker will be interested to know what types of records accrue to the Archives under the *National Archives Law* and other legal enactments implemented by the Archives. They could broadly be itemized in the following manner.

- (1) Inactive records of Government and semi-Government institutions which have an enduring value and selected for permanent preservation are transferred to the Archives 25 years after their creation. These include records of Ministries, Departments, Local Bodies, courts, corporations and statutory bodies.
- (2) Records of Public Offices which are to be closed down or wound up.
- (3) Records of Commissions of Inquiry, Committees of Inquiry and Presidential Commissions of Inquiry to be transferred within three months of the rendering of the final report of such commission or committee.
- (4) Copies of every annual report, statement of accounts and any other publication issued by any public office acquired within thirty days of issue.
- (5) Specimen of each new postage stamp, first-day cover, postal order form, money order form, aerogramme and post card issued by the Postmaster-General acquired within thirty days of issue.
- (6) Cancelled specimens of every new denomination of currency note and every new coin issued by the Central Bank acquired within thirty days of issue.
- (7) A copy of every map, plan, chart or other publication issued by the Surveyor-General for sale to the Public acquired within thirty days of issue.
- (8) A Candidate of any election or by-election for parliament or any local authority should transmit a copy of any election literature within thirty days of issue.

Under Legislative Enactments—

(a) Under Chapter 179 of the *Printer's and Publisher's Ordinance* a copy of any book published in the Island is preserved as the legal deposit copy.

(b) Under Chapter 180 of the *Newspapers Ordinance* a copy of every newspaper published in the Island is preserved as the legal deposit copy.

3. Arrangement of Archival Material

It is appropriate here to discuss in brief the arrangement of source material in the Archives as this would indicate to the researcher how to use the source material one is interested in.

All the archival records are arranged according to the "Principle of Provenance" i.e. arrangement according to the source of origin, where all records originating with any given institution are grouped together to form "Archive groups" or "Record Groups" of that particular institution. Thereafter, records within the group are arranged following the original pattern in which they stood under the agency which created them. Accordingly archival or record groups are the largest physical units which indicate the structure of the original administration that gave them birth. Once the main archival group is determined the sub-groups or the records of various branches created by an institution are identified and within the sub-groups record series or classes and sub-series or classes and individual files and items are determined. Items or record files may be arranged as circumstances dictate, either chronologically, geographically or alphabetically. This arrangement is followed to preserve the integrity and the originality of the archival records.

4. Use of Primary Archival Data

The use of primary archival data in a research study would enable the research student to prove his thesis or contention in a much more conclusive and authoritative manner than using secondary source material which may be contested or disproved easily. The value and quality of a research will also depend on the usage of primary and contemporary archival material which will help the researcher to understand and interpret past events rationally minimizing the distortions.

In an attempt to study the various aspects of the Portuguese period of Sri Lanka, (1505—1640 A.D.) a research worker will be disappointed as primary archival data are not available. The Portuguese who ruled the Island created valuable records relating to the maritime districts of this country. However, none of the Portuguese Archives have survived as bulk of the records were destroyed by the Portuguese themselves before their capitulation to the Dutch. The only documents which were saved from the siege of Colombo were also accidentally destroyed by the Dutch in 1700 A.D.

However, a student interested in the administration of lands by the Portuguese could use the copies of their *Thombos* and Quit Rent-Registers for the years 1614 and 1618 which are obtained from Lisbon. Accordingly, for a study of Portuguese activities in Sri Lanka one has to use and rely on the archival source material preserved in Portugal.

A student working on the Dutch period of Sri Lanka is in a much more advantageous position as the Dutch archives have survived. They consist of a continuous series beginning with the minutes of the military council held on a warship in Galle Harbour in March 1640 a little while before the fortress was attacked.

There are approximately 8000 primary records of which 5000 belong to the Central Dutch Government which operated from Colombo and the rest to the provincial unit—The Galle Commandant. In both groups the records are represented from 1640 to 1796 which cover the whole administrative set-up during the Dutch Period. The Dutch land *Thombos* pertaining to the maritime districts of Sri Lanka are an invaluable primary source material for the study of their land administration, movement and settlement of population, caste, service tenure and other related subjects. This source material is unique in the sense that it is not available even with the Colonial master the Dutch. It must be pointed out that so far no research student has made a serious attempt to use these data in an indepth study. The Head and School *Thombos* of the Dutch could be considered as records containing a wealth of material to be used in genealogical studies of the 17th and 18th centuries.

The "Political Council" chaired by the Governor was the highest administrative body under the Dutch. All the ordinary (1640-1796) and the secret (1665-1796) minutes of this body which contain the policy decisions of the Dutch Administration are available. Memoirs left by the Dutch Governors from 1650-1794, which elaborate in many cases the personality of the author, give us the best insight into the civil administration of the Dutch Period. A memoir offered any high official an excellent opportunity for explaining the

measures taken during his tenure of office and the state of affairs in general. Moreover, correspondence of the Governor in Sri Lanka with Patria (Holland) and Batavia is also a rich source material to study every aspect of their rule in the fields of trade, education, agriculture, laws and customs of the people and the relations of the Dutch with the independent Kandyan Kingdom.

Like any other well organized administration, the Dutch too issued proclamations, publications and orders, which had to be observed by the general public. Dutch publications are called "Plakkaten" or "Plakkats" which means "affixed notices". These plakkats throw light on their administration and the problems they encountered when ruling an alien country. The implementation and the impact of these plakkats on the Sri Lankan society would form an interesting piece of research. For example, one plakkat issued on 1st November 1780 abolished the Poya or the Full-Moon day as a holiday for the first time, which was enjoyed by the people of Sri Lanka since the introduction of Buddhism in the 5th century B.C.

The archival data for the study of the British administration (1796-1947) form the largest and the richest collection in the archives. This primary archival source material was formed as a result of the accrual of records from the Colonial Secretary's office which was the hub of the administration during the British period and various departments created during that time.

A research student using the primary archival data available for the British period could commence with the records of the policy making institutions which operated during that time. Firstly, the records which represent the two most important administrative bodies, i.e. the Executive and Legislative Councils. The proceedings and the decisions of these two councils consist of a continuous series from 1802—1931 & 1833—1931, respectively. However, the proceedings are also available in the printed form from 1870 in Hansards and in the newspapers from 1832.

Archive Groups which are related to the inward and outward correspondence (Despatches) between the Secretary of State for Colonies and the Governor of Sri Lanka contain a continuous series from 1798 to 1948. These include the enclosures sent with the despatches on various aspects of administration of the colony. One problem encountered by a research student using these despatches is the absence of confidential correspondence of the Governor on important issues. In order to supplement this, one would have to seek copies of these confidential despatches in microfilm from London. Moreover, the observations made by the officers of the Secretary of State for colonies regarding the despatches sent by the Governor of Sri Lanka could only be obtained in London. When using the despatches one should guard against the partisan viewpoints or reports of the Governors, who based their correspondence on the information and material supplied by the British officials and natives who supported the British. Nevertheless, the inward and outward despatches throw light on the administration of the policy makers at the highest level.

There are two very important record groups but rarely used by the research students which consist of the inward and outward correspondence of the heads of various government departments and institutions with the Colonial Secretary (Governor) on various

aspects and problems of administration. These two archival groups contain source material at the grass-root level where the thinking of the British civil servants, the impact on the colony and the reaction of the natives are recorded.

The rest of the archive groups under this period relate to the provincial, local and judicial administration of the Island. In particular the records on provincial and local administration throw useful light as these reflect the impact of the ruler on the ruled. Indeed the study of British colonial policy and its impact on Sri Lanka cannot be considered complete without utilizing and referring to this source of primary archival material preserved in the archives.

The archival material available since the gaining of independence on 4th February 1948, consists of the records of the public institutions and bodies which were established after Independence. Moreover, the creation of state corporations and statutory bodies since 1957 added a different kind of archival source material as the objectives and ventures of these corporations were much more broad based than the government departments. In addition minutes of evidence, proceedings and other material generated by official commissions and committees are also deposited in the Archives.

The establishment of the Presidential archives in 1978 introduced a new feature to our archival system where future scholars will gain access to the official, semi-official and even private records of the executive presidents of Sri Lanka.

5. Use of Secondary Archival Data

The use of the available secondary archival data for a research project could sometimes usefully supplement and complement the primary archival data he is making use of. Although one could identify certain archival data as secondary because they are in print, it does not mean that they are not valuable material for research. One reason is that the data contained in these secondary sources would be contemporary in spite of the fact that they are in print.

The Gazettes (1802 to-date), Proclamations, Orders, Regulations, Minutes of Governors, Ceylon Almanac (1815—1862) continued as Civil List from 1863, Hansards (1870 to-date) Blue Books (1821—1938), Legislative Enactments, Parliamentary Acts and Laws, Sessional Papers (1860 to-date) Administration Reports (1867 to-date), Census Reports (1814-1971), Civil Service Manuals (19th and 20th centuries), Gazetteers (19th century), which are government publications, could be utilized as valuable source material.

Ferguson's Directories (1863 to-date), and newspapers-Sinhala (1860 to-date), English (1832 to-date), Tamil (1864 to-date) and Malay (1925-1952) and publications received for legal deposit (1885 to-date) although considered as secondary source material, contain important information for research. For example it is always better to cross-check with other available sources whether the information contained in the newspapers was reliable.

Field Data Collection

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1. Introduction

Field data collection as the title connotes is the collection of data in the field as opposed to abstraction of information from published documents. Field data could be any of the following four main types; socio-economic data, agricultural data, industrial data or commercial data. The collection of each type has different techniques as well as its own problems. In this paper only socio-economic data collected through household surveys will be discussed.

2. Definition of Household

What is meant by a 'Household'? Some of us have the general impression that it is a biological unit, i.e. a group of blood-relatives living together and sharing meals in a given housing unit. However, for socio-economic surveys we do not use a biological definition of household. Instead we use a much broader *de facto* definition to include all those who live together and cook together. In Sri Lanka, in this definition of household we include servants and boarders who share meals with the rest of the household.

3. Frame for the Survey

Here the term 'Frame' refers to a list of households from which the sample is taken. In Sri Lanka usually the household list prepared at the last census is used to select the households for official surveys. The list generally suffers from defects such as omission, duplication, obsolescence and other inaccuracies. Hence the list has to be either revised or an entirely new list prepared before the sample is selected.

The revision of an existing list or the preparation of a new list is described as a 'Listing Operation'. Like in all aspects of field surveys, in listing operations also there are many practical problems that must be overcome. In particular the enumerators employed for the job must be properly instructed and supervised. Experience indicates that some enumerators resort to deception and supply either incomplete or fictitious household lists.

4. Enumerators

Enumerators can belong to two categories: those who belong to the permanent field staff of the organization conducting the survey or those who have been selected for the particular survey on a temporary basis. Experience in this country suggests that of the permanent field staff about 10 per cent are useless and therefore, we should select an extra

10 per cent to do the field work. If we select people temporarily, often they leave halfway through the survey when they get another job or do slipshod work as they are not going to lose in the long run. They know that they will be discontinued after the field work is over. Hence one should exercise great care in the selection of enumerators.

5. Deployment of Enumerators

When we deploy enumerators, the general practice is to give the enumerators areas in close proximity to their homes. Although this has some advantage as far as cost is concerned there are a lot of disadvantages. The enumerator being a person known to the respondent, the latter will be reluctant to disclose certain information on income, demographic characteristics and family planning. Also the enumerator being a local person can bias the result to suit his interests.

In order to eliminate possible errors due to faulty enumeration, statisticians use a technique known as an Inter-penetrating network of sub-samples (IPNS). Suppose in a given area there are 1000 households to be surveyed by 10 enumerators. The 1000 households are divided at random into 100 units, each consisting of 10 households. These units are allocated to each enumerator again at random. Thus, the sample covered by each enumerator will be spread throughout the area at random. Then, when the results are tabulated using statistical techniques such as the analysis of variance and fractile graphical analysis it is relatively easy to isolate any enumerator who has failed to perform his job satisfactorily. Assuming that such cases are proportionately few, say 10 or 20 per cent, we are still left with an adequate sample to complete the analysis.

6. Method of Data Collection in the Field

Data could be collected by either (a) direct observation or measurement or (b) inquiry. Only a certain type of data can be collected by direct observation or measurement. Most of the information has to be obtained by inquiry. The respondents do not always give truthful or correct answers. Sometimes they are ignorant, or cannot recall, or make a deliberate attempt to suppress information.

To get better results, the questionnaire approach rather than the schedule approach should be used. In the former case, the questions are so designed as to get the correct information. In the latter case it is left to the ingenuity of the enumerator to elicit accurate information.

7. Commencement of Field Work

It is absolutely necessary to have good rapport with the respondent. This will help to obtain accurate and reliable data. A brochure explaining the purpose of the survey, the organization conducting it, with a guarantee that personal information will not be divulged but statistical averages only will be published, should be distributed in advance to the respondent. This should be in the language he is most fluent in. The enumerator should carry out the work at the time and day convenient to the respondent. He should be humble in his approach and win the goodwill and confidence of the respondent.

8. Persons Interviewed

As far as possible the chief occupant of the household should be interviewed. If the chief occupant is ignorant or not available some other knowledgeable member of the household can be interviewed instead. It is best to conduct the interview in private. If embarrassing questions have to be asked, it is best done discreetly.

9. Pilot Survey

A pilot survey is generally done to test the questionnaire, train enumerators and determine the probable cost and size of the sample required. In short, in a pilot survey, field conditions are simulated.

10. Supervision

No field survey should ever be undertaken without proper supervision. The supervisor should accompany the enumerators to the first few houses to ensure that the enumerator interviews the respondent according to instructions. He must go afterwards to determine whether the enumerator actually visited the house during the survey. Also, he must do consistency checks pre-planned by the survey organization. It is also his function to ensure complete coverage, completeness and consistency of information as far as possible.

11. Non-Response

In no field survey do we get a one hundred per cent response. Therefore action should be taken to eliminate or reduce non-response as far as possible. The crudest method of handling non-response is to simply ignore the non-respondents. However, this can introduce errors into the survey because it almost invariably happens that the pattern of the people who respond is different from those who do not respond. Another solution to the problem is to substitute new households equal in number to the non-respondents. This will help to reduce but not necessarily eliminate the non-response errors. A still better method is to reach the non-respondents by a second or third visit. For example, if nobody was available in a particular household when it was visited by the enumerator, a second visit is made. The period earmarked to conduct the survey can be extended, and a sub-sample of non-responding units can be taken and enumerated. This technique cannot be used for data dependent on time factor (e.g. Census).

12. Post-enumeration Survey

Wherever a complete enumeration such as a census is undertaken, it is necessary to determine the extent of under-enumeration. For this purpose a sample of census households is taken and the sample information is matched with the information obtained at the full census. This will help to determine the extent of under-enumeration.

Questionnaires

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When social scientists require data which must be reported by individuals out of their own experience, direct communication becomes necessary. The instrument which is most frequently used for measuring characteristics, attitudes, expectations, perceptions and anticipated behaviour of a respondent is the questionnaire. The best method of obtaining responses to a questionnaire is the personal interview, particularly where some of the respondents may be illiterate. Some of the more important guidelines in formulating questionnaires are summarized below.

A question may be asked or read as written, or it may be a form to be filled in, accompanied by instructions. Questions may be open, i.e. to be answered in the words of the respondent, or they may be closed questions, with answers in categories specified by the researcher. The latter is easier to process but the possibility of misinterpretation by the respondent is greater. Closed questions may take many forms, ranging from dichotomies to multiple-choice and rankings.

A questionnaire must be pilot-tested in order to remove ambiguities in questions, to make questions comprehensible to both respondents and interviewers and to make the questions fit all respondents.

It is rarely that a question does not receive an answer. Care should be taken to make sure that the respondent has the required knowledge, because respondents may not like to admit ignorance. Answers to questions involving memory-recall become less accurate the greater the time that has elapsed since the event.

Direct questions do not always yield accurate information on items such as age, income, social class, inside information about job or institutions or the respondent's own shortcomings. Indirect questions often become necessary in such instances. Ranges or categories may have to be introduced in place of actual values.

Questions which lead to socially desirable responses should be avoided because they do not yield correct information. A respondent's true attitude has been found to be revealed when he is asked to put himself in another's position and answer the question concerned.

Questions that take one side of an issue should be avoided, e.g. asking about advantages without disadvantages may lead to biased responses.

In asking some questions the reason has to be kept in mind, e.g. questions on employment during a season of unemployment may evoke biased responses.

Words and expressions which are not familiar to the respondent lead to erroneous or biased answers, because the respondent may not admit that he has not understood the question. Technical words and terms should be defined. This becomes necessary even

in a simple question such as "What is the distance to your co-operative store?" In this case the real distance may be very different from that along a short-cut used by the respondent. A further problem arises here in that an individual's perception of distance may not agree with actual distance.

A question should be limited to one idea, and should be as short as possible.

Leading questions, i.e. questions that suggest answers, should be avoided. A question that begins with "Do you sometimes" has greater chances of eliciting a positive answer, while one that begins with "Do you always" is more likely to draw a negative response. Words such as "all, every, sometimes, never, and not" should be avoided as far as possible.

An open question does not lead the respondent and therefore may suggest new lines of investigation that have not occurred to the investigator, but, by not leading, it may elicit a superficial answer, or answers which may be irrelevant to the survey. A closed question, while overcoming the disadvantages of the open question, enables the respondent to conceal the lack of understanding, or to avoid giving the correct answer if it is not in the check-list. Some respondents may consider several answers relevant, but may be prevented from stating them if asked to select one answer. Asking for the most important answer or for a ranking of answers sometimes gives a better picture of the correct situation.

Questions should be arranged in such a way that they follow each other in a connected manner. Questions of a personal nature should be asked towards the end, after some rapport has been established between investigator and respondent. A questionnaire that takes a long time to fill, say more than an hour, may not be a success.

Today survey data gathered through questionnaires are often processed with the help of a computer. Experience suggests that wherever possible it is highly desirable for the persons chosen for programming and data processing to have a social science background. It can avoid a great deal of confusion and mistakes that otherwise could occur due to the unfamiliarity of the persons concerned with concepts and terminology in the social sciences. However, if such persons cannot be found — and this is often true of computer programmers who tend to have non-social science backgrounds — the non-social scientists chosen for the job should be associated with the project at least from the questionnaire formulating stage. This will ensure an interchange of ideas which will be of mutual benefit to the programmers and investigators as well as the researchers.

In survey-based team research projects sometimes the principal researcher tends to keep aloof and hand over the task of the survey and data analysis to colleagues or subordinates and he only wants the results. But this is an unwise practice. The principal researcher should participate in the project at all stages including the questionnaire formulation and pilot test stages. The researcher who knows the theory and wants to test a hypothesis has to be present to define concepts when the questionnaire is formulated. The pilot test stage is also important because most of the errors in the questionnaire would be revealed at that stage.

The Interview Method

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1. Introduction

In any branch of knowledge where human behaviour is the subject of study, one has to elicit most of the information from human beings themselves. One method of eliciting such information consists of disciplined and organized conversation designed to achieve a specific purpose. It is such conversation that I define as the interview method.

The interview method is employed in the collection of data and information by conducting field surveys. There are several reasons as to why researchers have to collect data by means of field surveys. Firstly, the available data may not be up-to date. Secondly, they may not be sufficiently reliable. Thirdly, they may not be in a form that is suitable for the planned study.

There are other reasons for the need to collect data by means of field surveys, especially in the developing countries. Over the past few decades interest in planning and development in the developing countries has been growing. This has necessitated the collection of a mass of new information and data on various types of variables without which practical planning is found to be almost impossible. Moreover, the most recent trend in some of these developing countries has been to lay emphasis on regional development. In Sri Lanka, for example, we have a regional development programme going on under the name of District Integrated Development. A great deal of factual information is required to formulate such regional level plans, but unfortunately very little of it is available. Hence the need for collection of fresh data.

2. Methods of Collecting Field Data

There are at least six methods used commonly to collect field data. The first is the survey method. In surveys one goes to the field with a questionnaire and collects the necessary information after interviewing the selected respondents. The enumerator or researcher may make one or several visits, the number depending on the requirements of a particular survey.

The second is the 'cost route' method. Under this the enumerator might have to visit the respondents several times, again depending on the requirements. The difference between the first method and this is that in the first method one does not take into account the changes that take place in the field over time. Under the second method, in addition to recording the data we get from the respondents an attempt is also made to incorporate into the study certain observations relating to the changes that go on in the field.

The third, which is normally employed in classical anthropological studies, is called the participant-observation method. In this method the enumerator or researcher while collecting data and information makes an attempt to gain insights relevant to the study by participating in the activities in which the respondents are engaged. By this means the researcher is able to closely observe the underlying behavioural patterns which remain elusive to the mere interview method.

The fourth is the non-participant observation method. In this method the enumerator or interviewer does not actually participate in the activities of the respondents. He observes them and their activities from a distance and without direct involvement.

The fifth is the direct measurement method. One might wonder whether there is any need for direct measurement in social sciences. There are instances where, even in the field of social sciences, the enumerator or researcher has to collect data by means of direct measurements in the field. For example, in agriculture, data relating to field size, output and yield may have to be collected by means of such measurements.

The sixth and the last is the group interview. The group interview consists of getting a number of persons together rather than isolating one member from the group and then discussing the relevant issues with the group. The purpose is to verify whether there is a consensus regarding the issues under consideration.

From the above it is seen that the interview method is used in three — the first two and the last — of the six methods of field data collection.

3. Preparatory Work

A considerable amount of preparatory work has to be done if we are to conduct fruitful interviewing. It has to be well-organized and well-disciplined as the main objective is to elicit selected information in a reliable manner.

I have been able to identify several major steps that have to be taken in preparation for conducting interviews. The first of these consists of selecting the area of research both geographically and subject-wise. Next, the people residing in the selected survey area have to be kept informed of the intended field investigation. This is very important as the success of interviews depends on the degree of co-operation one gets from respondents. Unless the correct relationship is established and the information needed for that is provided this co-operation is not likely to be forthcoming. This aspect should receive particular attention as people in general and villagers in particular are cautious of unknown outsiders who probe into their affairs.

Several methods can be employed to gain the confidence of prospective respondents. If a vast area has to be covered press notices or announcements over the radio can be used. Otherwise it is possible to make use of government employees functioning at the village level. In our country *Grama Sevakas*, Cultivation Officers and Agricultural Extension

Workers (*Krushikarma Viyapthi Sevakas*) are the village level government officers often used for this purpose. Making use of influential people in the selected survey area also becomes necessary. There are both advantages and disadvantages in these methods.

If we use either press notices or announcements over the radio, we might not be able to reach some of the illiterate or the poorer groups of people and hence they would be unaware of the intended survey. If one enlists the help of village level officials there is the advantage of their being known to the people of the selected area. When introduced by them, the enumerator or researcher is likely to be taken more seriously by the people. At the same time there are certain disadvantages because when village level officials accompany the researcher there is a likelihood for the expectations of the interviewees to rise. They would suspect the researcher to be a high government official coming to identify and solve their problems. An expectation of this nature in the respondents inhibits the flow of accurate information we are looking for. Placed in this situation respondents normally overstate their problems and understate their wealth, income, consumption, savings and so forth. There is another danger. Since the village-level officials are familiar with the villagers the former may even try to dominate the interview by not allowing the villages to express their free opinions. Moreover, the official accompanying the researcher might try to attend to some of his official matters with the selected respondents and thereby use some of the time that otherwise might have been available for the interview.

It is important to remember that no ready-made formula could be given as to which method is most suitable. This depends on the situation and the context. Good judgement has to be based on one's experience in the field. However, it is useful to bear in mind the points discussed above so that one is, at least, aware of the problems that have to be avoided.

4. Administrative Arrangements in the Field

Not many administrative arrangements may be needed in the field if the researcher himself is going to conduct interviews with selected respondents. However, very often the researcher may not be able to conduct such interviews by himself. Then enumerators have to be employed, and one has to look into their comforts and needs. Unless they are kept happy by attending to their problems, there cannot be much hope of getting the desired results. As regards the enumerators' problems arrangements have to be made for transport and accommodation. Sometimes, there may be other kinds of problems that develop as a result of the loneliness and the monotony of work they are made to go through. Due to these, if enumerators give a useless set of data, the resources and time spent become a wastage. Therefore, at the stage of selection, it is advisable to pay attention to the enumerators' personal and physical condition. When these considerations are taken into account it is preferable if the researcher is able to have full command of all the resources available—personnel, financial etc.—in making the necessary administrative arrangements. However, sometimes in collaborative research (e.g. Universities and Government) there could be dual control. Indeed there are occasions when enumerators are chosen and paid for by one and are expected to work for another.

When the researcher is not the paymaster he might find it difficult to discipline the enumerators and this could affect the quality of work. Therefore, if the researcher has no command over the resources, it is always advisable, as far as possible, to convince the persons who have got the resources of the importance of making proper arrangements for the field staff to function in keeping with the survey requirements.

5. Interview Programme

A well planned interview programme is essential for a successful field survey. Selection of the sample of respondents and giving the enumerators a set of questionnaires alone are not sufficient. A timetable must be laid down. In the programme provision must be made for the following items : (a) interviewing of respondents on fixed dates ; (b) procedure to be followed in solving problems encountered by the enumerators without much loss of time and money ; and (c) intermittent meetings between the researcher and the interviewers.

6. Selection and Training of Enumerators

The selection and training of enumerators is an important aspect of any survey as the success of data collection depends on the persons who are selected for the job and the training given to them. In the selection of enumerators, age, sex, education and experience are some of the important aspects that must be taken into consideration. Due to some constraints if interviewers with lower qualifications have to be selected, then in compensation they have to be given a longer period of training. The attitude of interviewer is also important. All persons are neither fit nor willing to do this kind of job because it needs patience and hard work. Without patience, the interviewer may not be able to get the necessary information. In addition to the correct type of attitude the cultural background of the enumerator also becomes relevant. For example, a man who has been brought up in an urban environment might fail to function satisfactorily as an interviewer in a rural area.

It is advisable to select initially a few more than the required number of interviewers to allow for dropouts during and after training. The period of training depends on the educational level of the interviewers and the type of work they are expected to do in the field. The latter depends on the complexity of the research project and the type of respondents who are to be interviewed.

The training has to be conducted in the classroom as well as in the field. The available time may have to be allocated between the two according to the situation and to suit the particular needs. In the classroom firstly, a general idea can be given of the area where the survey is going to be conducted. The interviewers must be made familiar with the beliefs, customs and the ways of behaviour of the people who are to be interviewed. There could also be other aspects of life peculiar to the area. For example, weights and measures used in the area may be different from those that are in general use. If the interviewers go to the field without getting a knowledge of these, they are likely to face difficulties in both getting the information and also filling questionnaires.

Secondly, questionnaires have to be explained in great detail. Unless sufficient time is devoted to this there is the risk of the questions being understood in different ways by different persons, including interviewers. Definitions have to be worked out according to the variables chosen and these have to be clearly explained to the interviewers.

Thirdly, the interviewers need proper guidance and even some training in the technique of interviewing.

Filling questionnaires by the interviewers must be an essential part of field training and this must be done under the direct supervision of the researcher so that any mistakes can be pointed out and corrected as and when they are made.

At the end of the training class, a detailed instruction manual for the use of interviewers in the field should be prepared and a copy given to each. This helps them clarify any doubts that may occur when they go to the field after their training.

7. Meeting Respondents

In meeting respondents for interviewing several aspects have to be taken into consideration: (a) locating respondents, (b) introducing interviewer to respondents and, (c) introducing the research study and its purpose to respondents. In all this an assistant recruited from the survey area itself can be helpful. Respondents in certain instances would want to talk first and come out with their own problems. In such instances the interviewer should be prepared to listen to them. Respondents must also be given the assurance that whatever information collected would be used only for the study purpose and kept confidential. Establishing the correct relationship with the respondent in this manner is important. Becoming too familiar with the respondent is undesirable as he would tend to feel embarrassed to divulge some of the information. The importance of the need to meet the respondent at a time convenient to him should not be overlooked.

8. How to ask Questions ?

There are at least 10 points that an interviewer must bear in mind when asking questions from respondents.

1. The language the interviewer uses must be understood by the respondents.
2. A teaching style should not be adopted in talking to respondents.
3. In explaining the questions given in the questionnaire care should be taken not to distort their meaning.
4. The interviewer also should refrain from asking leading questions which suggest a certain answer and introduce a bias.
5. Unreasonable or embarrassing questions should not be asked.
6. Sensitive topics must be either avoided or handled discreetly.
7. Probing is necessary.

8. Care must be exercised to note down any discrepancies in the answers given and to elicit the most accurate information as far as possible without giving the impression of disbelief to respondents.
9. Even though respondents may give inaccurate answers or behave in a resentful manner interviewers should not get involved in any arguments with them.
10. The interviewer has to be very skillful and cautious in getting correct information on the following aspects:
 - (a) output and income generally underestimated;
 - (b) cost generally overestimated;
 - (c) Labour inputs: farmers are usually unable to give them to meet the survey requirements;
 - (d) savings and assets not readily divulged to an outsider;
 - (e) Land sometimes given in local units and measures and the nature of tenure is not readily disclosed;
 - (f) qualitative variables pertaining to knowledge, attitudes and opinions—careful recording is necessary to guard against possible misrepresentation.
 - (g) The distinction between opinions and facts—questions designed to elicit facts must be separated from those designed to elicit opinions.

9. Mechanics of Recording

Recording must be done as far as possible when the interview is in progress. Whenever necessary explanatory notes should be included in the questionnaire itself. Doubtful points must be verified and rechecked. The completed questionnaires must be rechecked and corrected before despatching to the researcher as instructed.

10. Problems in the Field

In conclusion, brief mention should be made of a few problems one has to face in carrying out a field survey by using the interview method :

1. Cheating by interviewers ;
2. Lack of response from respondents ;
3. Offending influential persons in the local community—this could make data gathering a very difficult and unpleasant task ;
4. Difficulty of locating and meeting respondents ;
5. Determining the head of a household—i.e. the person who makes the managerial decisions of the household ;
6. Identifying the family unit in a household.

It is only by means of good planning and thorough preparation before a field survey is carried out that these problems can be satisfactorily overcome.

Data Collection in the Social Sciences with Special Reference to the Open Interview Method

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This study consists of three parts. Part 1 provides a brief account of an array of data collection methods adopted by the social scientists. Part 2 is devoted to an examination of the open interview method and its relative advantages in data collection. In this section the open interview method is compared only with the direct questionnaire method which is perhaps the most commonly used method of field data collection. Finally, the strategies that the investigator should adopt in conducting an open interview are set out in Part 3.

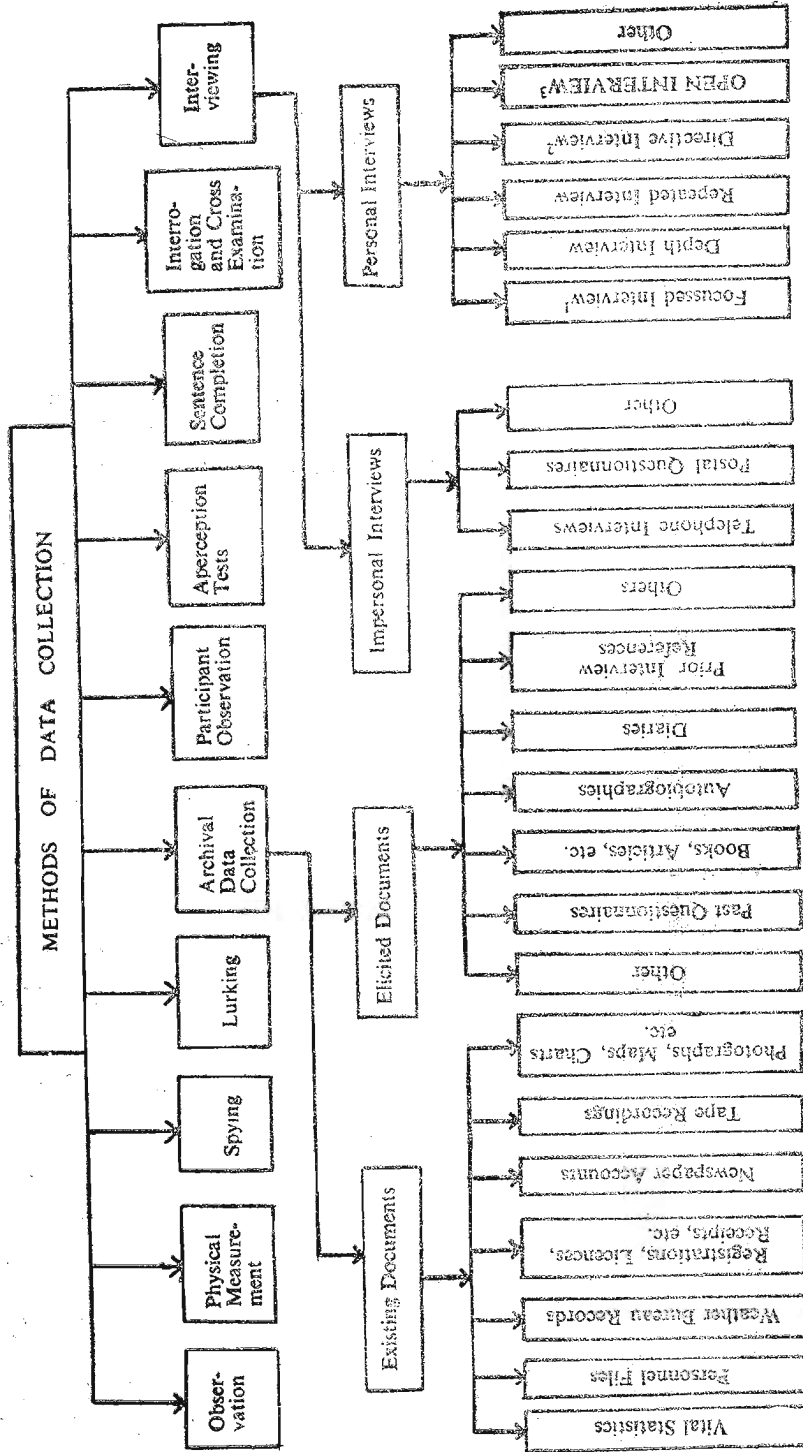
1. Data Collection Methods

Social scientists adopt various devices to collect raw data and the selection of a particular method depends on a number of factors. They include :

- (a) the objective of the research study ;
- (b) the resources such as finance, equipment, material and man-power available ;
- (c) the time available design a research project, plan and execute field work, process data and write the research study; and
- (d) the preference of a particular method by the researcher and the skills that he has acquired in the use of that particular method.

The existing data collection methods are being constantly improved in their application to collect field data and new methods are evolved from time to time. *Thematic perception tests* and *lurking* are two such new methods in use. A brief survey of the available literature on data collection devices adopted both in the developed and the developing countries enables us to identify a number of methods. They are presented in Fig. 1.

Observations—It is perhaps the simplest and the oldest method of data collection. The researcher makes observations to familiarize, experience or understand a place, object, person, situation or phenomenon.



Note: 1. Focused interview is also called semi-structured interview or semi-standardized interview.
 2. The other names used to denote directive interview are: direct interview, standardized interview, active interview and controlled interview.
 3. Unstandardized interview, unstructured interview, passive interview and guided interviews—all refer to Open Interview.

FIGURE 1

Physical Measurement—A researcher sometimes makes a physical measurement of observed phenomena. If a researcher observes that an omnibus is overcrowded he may count the number of passengers to determine the degree of overcrowding in that bus. In this situation, the physical measurement (or count) which follows the observation assists him to refine or give precision to his original observation. Still, in another situation, a physical measurement may precede a concrete observation or determination. For instance, only if a bushel of paddy is physically weighed is the investigator able to determine or observe the exact weight (in pounds) of that bushel of paddy.

Spying—This method is employed to familiarize, assess and determine specific positions in advance. Spying is common in world power politics. It prevails at international levels (Russians spying on Americans & *vice versa*), national levels (Watergate bugging) and at local levels (in political campaigns). The police uses its intelligence service (spy service) to assess in advance the likely strength of street riots and strikes. In spying, the investigator remains unobtrusive and often he uses equipment ranging from the most sophisticated to the simplest. Spying involves a very high element of risk. If exposed the investigator may even face death, torture or imprisonment.

Lurking—Lurking may be defined as a process of observing a particular thing by loafing about stealthily during a very short period of time. A researcher may lurk to get some sort of evidence to either accept or reject a particular suspicion or doubt in his mind. Unlike in spying, it will have no continuous flow of action. It is done on the sly and the lurker moves quickly out of the scene. Like spying, lurking is risky but to a lesser extent. At the most a lurker may be heckled, blamed, ridiculed, or threatened if found lurking.

Archival Data Collection—It is the examination of documents in search of necessary information. This method is particularly useful to the historians and other social scientists to study a subject in a historical context. Archival data could be collected from two types of sources. They are the *existing records* and *elicited documents*. Existing records generally contain recorded statements with very little or no interpretation of the facts recorded. Vital statistics, weather bureau records, registrations, licenses, receipts, newspaper accounts, films, tape recordings, photographs, and maps fall into this category. The elicited documents contain interpretations of facts collected or known in advance. They include past questionnaires of surveys, text books, journal articles, feature articles in newspapers, diaries, autobiographical records, prior interview references etc.

Participant Observation.—In this method, the investigator participates in the activities of his informants in so far as circumstances allow. Often it is necessary for the researcher to live and sometimes work with his informants, conforming to their life styles and, where necessary, to learn the language of the community. The most important thing is that the investigator has to gain admission to the society in which he plans to work, observe and collect data. Hence very often the traditions and customs of that society have to be adhered to by the investigator to get him accepted by his informants. Only when the investigator is acceptable to the society and no longer a total stranger is the 'social distance' sufficiently reduced, facilitating close observation. It is usually the anthropologists who use this method to collect necessary data.

Perception Test.—The use of thematic perceptions test is a relatively recent technique developed in the United States. It is simply the use of pictorial aids to elicit inner feelings of a respondent's past experiences and interpretations of those experiences. For instance, if the researcher needs to get interpretations of the past experiences of cyclone victims, a photograph indicating a person or a group of persons marooned in a cyclone is shown to them. Then they are able to recall their past experience of cyclones and describe them effectively to the investigator. In studying the farmers' perception of drought in the 'dust bowl' of the United States Saarinen (1966) employed this method very successfully. When a photograph of a person standing on a sun-baked, cracked land, looking downwards rather dejected, against a background of a dust storm, was shown to the informants, they gave their own experiences of past droughts and what they felt about droughts that frequented their homeland, without any difficulty in recalling or describing drought. This method has become increasingly popular in the 1970s particularly among those who are engaged in natural hazard perception studies.

Sentence Completion.—Like the perception test, the sentence completion device could be used effectively to collect raw data needed in attitude measurements. Suppose the researcher needs to know the nature of the psychological stresses and material losses of the victims of a recent cyclone, this method could be used effectively. Rather than directly asking a cyclone victim, "What are the losses that you incurred during the recent cyclone?", it would be best to inquire in the form of an incomplete sentence such as 'During the recent devastating cyclone among others we lost. ' and allow the informant to continue the statement. He will very willingly and frankly continue to say all what he lost during the cyclone in question. However, a sentence completion device may not be able to be used successfully among illiterate informants. If an informant is illiterate the sentence completion method boils down to the directive interview method because the investigator has to read out the sentence and wait for an answer which is more or less the same as asking a direct question.

Cross-examination and/or Interrogation—This method is used to collect guided information from a respondent. If the investigator decides in advance that the respondent is likely to evade the provision of correct information, then, a certain amount of psychological stress is brought on him. In a court of law a witness is required to swear before the judge that he "tells the truth, the whole truth and nothing but the truth". The lawyer, in the course of a cross-examination often asks "rapid-fire" questions and makes constant cross checks of the evidence furnished. Such devices bring psychological stress on the respondent and he is kept strictly to a guided tract in providing information. To understand the implications of the case before the courts and collect sufficient evidence to pass a fair judgement, such a device is indeed appropriate even though the respondent's freedom of expression is limited and strictly guided. A police officer interrogating an accused also often brings psychological stress on the respondent in order to gather sufficient evidence to pursue legal action in respect of the case in which the accused is involved. Instances are not rare where even physical force is brought on the accused in interrogation.

Interview.—When historically viewed, it is to be observed that this method was first used to diagnose ailments and recommend therapy or prescribe medicine. With the passage of time it was adopted as a criterion to select physically fit and reasonably intelligent persons for employment.

Interviewing is the process in which two parties conduct a face-to-face cordial verbal exchange of ideas in which the investigator attempts to elicit information and expressions of opinions or beliefs from the informant. Such a dialogue is intended to yield some sort of *measurement* or evaluation of the opinions or beliefs expressed at an interview however rudimentary. The ultimate objective is to relate the variables measured to one another at the interview itself or shortly afterwards or to possess required information to make an evaluation at a later date.

Interview techniques are vast and varied. Next to the archival data collection method interviewing remains the most popular method adopted by the social scientists to collect upto date and reliable data. Unlike in cross-examination and interrogation the investigator should not try to dominate an interview. An interview turns out to be an interrogation or cross-examination no sooner than the investigator attempts to dominate, control, demand or ridicule the respondent. Unlike in an interrogation or cross-examination, at a interview the respondent has the liberty to refuse participation.

All interviews could be broadly divided into *impersonal interviews* and *personal interviews*. Impersonal interviews are used to collect information without the investigator meeting the respondent in a face-to-face situation. Telephone interviews and the use of postal questionnaires are two commonly used impersonal interview techniques. Personal interviews are cordial verbal exchanges between two parties in a face-to-face situation. The two parties involved could be of varying numerical strength: one investigator and an informant; one investigator and several informants; two investigators and several informants or several investigators and several informants. The situation where several investigators question a single informant becomes more an interrogation than an interview.

There are several types of personal interviews. Often the same process of interviewing is given different names by different social scientists (Fig 1) which is a problem of taxonomy. A brief introduction to some of the major interview types is provided in the few paragraphs below.

Focussed Interview— A focussed interview is used to gather more information about a concrete situation which is already known to both the investigator and the informant. The informant is interviewed by the investigator to know exactly what the former thinks about the subject in question. Thus, the selection of informants for a focussed interview is strictly determined by the fact that the particular situation under reference is known to the investigator and the informant. It is often focussed on the subjective experience, attitude, emotional responses and definite mental association in respect of the particular concrete situation under study. If the investigator wants to know the views of those who have seen a particular film that the investigator himself has seen, the informants have to be selected

only from among those who have seen the same film and the questions have to be based on the subject matter of that film. The interview is focussed on a particular subject matter and a particular group of informants.

Although the whole situation is carefully structured and the major areas of inquiry are mapped out in advance, the informant once selected is given the freedom to express his definition and views of the situation that are presented to him. This type of interview is, sometimes regarded as *semi-structured* or *semi-standardized* interview.

Depth Interview — It aims to elicit information especially related to personality dynamics and motivations. This type of interview can effectively reveal psycho-social situations which are not otherwise readily known and yet may be crucial for understanding observed behaviour and repeated operations and attitudes. However, unless the researcher has a highly specialized training in this method of interviewing for collection of information on specific areas of mental situations such as calamity, it is best not to adopt it because it needs psychoanalytic penetration. Sometimes an allowance of sufficient time is necessary for the emergence of genuine feelings of the informant. In certain situations the investigator must have a lot of patience in extracting information from the respondent. Sometimes effective consoling of the informant is necessary. Yet in another situation, the adoption of aggressive strategies such as "rapid-fire" questioning to elicit information quickly and rather forcibly from an emotionally distorted informant becomes a necessity. In such varied situations an amateur can do more harm than good to a depth interview. Above all, an amateur investigator could do lasting damage to the mental situation of an informant. Hence amateurs, particularly on their own, should not employ this method to collect raw data.

Repeated Interview — It is sometimes argued that a repeated interview is not a method by itself but only an aspect of the *directive interview*. Surveys such as Sri Lanka's *Consumer Finance Survey* could be cited as examples in support of this argument. In Sri Lanka's *Consumer Finance Survey*, certain information is required to be collected repeatedly over a specific period of time. In such a survey if one of the objectives is to determine the average household expenditure on the consumption of food, the selected households have to be visited daily or once in every two or three days for a week or two, to collect the necessary information as accurately as possible. Repeated visits are necessary because it is difficult for the informants to keep in mind all the expenses incurred on food items over an extended period of time.

The repeated interview under reference here is closer to the focussed interview which also refers to situations which have been at least partially known and/or analysed prior to the interview, rather than to the above cited example of repetitive collection of consumer data. If the investigator wishes to know how the voters make up their minds as the election day draws nearer and nearer, repeated interview is the best method. It is common knowledge that voters change their minds as the election day draws nearer and nearer. But what is essential to know is how it takes place and what ratio of voters are in favour of which candidate. Hence, the voters have to be repeatedly interviewed at

certain specific time intervals of from time to time as the need arises to update the knowledge about the constant change of minds of the informants. It is difficult to know this from a single focussed interview.

2. Open Interview

An open interview is simply a group discussion. The group should be formed with a manageable number of informants, preferably 6 to 10 persons. It is essential that a restricted number of informants is selected so that the discussion is kept well under the control of the investigator (s). The investigator needs to be skilful in selecting suitable participants to take part in the discussion. A prior familiarization with the people in the community would be of immense use to the investigator to select suitable participants.

The attempt here is to show where the open interview method can be best employed to collect data necessary for a research project. It seems that this could best be achieved by comparing the open interview method and the directive interview method with each other.

- (i) In an open interview, it is necessary to have some pre-thinking to formulate at least some major questions necessary to collect the required data. For the investigator's convenience, it is useful to have a list of questions by his side so that at the end of the interview he can make sure that no major questions remain unanswered. However, if the researcher himself is the investigator and the objectives of the research very clear to him, then he need not necessarily have a rigid questionnaire by his side. He can develop the questions as the interview proceeds. Thus, there is much flexibility in developing the questions in an open interview. It is certainly an advantage in that the informant could be encouraged to state his concrete view on the subject matter of the question put to him. The informant has the full liberty to describe whatever event or point that seems important to him. In the directive interview, the questions are pre-planned and listed in a document with a sequence that the researcher thinks is the best to assist the informant in providing the required information. Even the wording of the questions is pre-determined. The investigator generally has no freedom to change the questions, wording of the questions, or the order of the questions in the questionnaire and the informant must answer only the questions put to him.
- (ii) In the directive interview method the fact that no freedom is given to the investigator to re-cast, reword or change the order of the questions after doing them in a pilot survey has a distinct advantage—i.e. it minimizes the investigator's bias particularly if he is a novice. Whereas in the flexible open interview method, such provisions could lead the investigator's as well as the informant's bias to creep into the data collected particularly if the investigator is not vigilant. However, these faults could be averted if the researcher himself is the investigator or the researcher can employ experienced investigators to conduct an open interview. If circumstances force to use inexperienced amateur investigators it would be safer to use the directive interview method than the open interview method.

- (iii) In the case of the directive interview method, it is encouraged to conduct the interview on a person-to-person basis to avoid disturbances from others while the interview is in progress and to enable the informant to provide information privately and even strictly confidentially where necessary. These norms appear to have come to stay in the directive interview method which was evolved and popularized in the highly individualistic urbanized western societies.

The physical distance between two neighbours in a western society may be as short as few yards but the 'social distance' that they maintain could be immense. Hence, individualism is so significant that an informant may not mind an outside official or a research worker knowing his (informant's) whereabouts, assets, behaviour, attitudes, etc. But as he generally believes that everybody in his community should mind his or her own business and not those of others he would be unwilling to see that the people in his community come to know about his affairs or lend ear to what he is telling another. Hence, the directive interview method has been found to be one of the best methods of data collection from those in the western societies. However, the directive interview method would not be the best method of data collection everywhere. In community-conscious rural communities such as those in Sri Lanka, experience shows that people are unwilling on their own to keep on answering direct questions from a stranger. The informants prefer to answer questions along with the other members of the community. This tendency needs the special attention of the researcher in adopting the interview methods to suit two different environments—rural and urban.

The informant in a rural community often needs a dialogue. He wants to talk about an issue raised by the investigator and to impress his viewpoint. He often does not mind the members of his community knowing about at least most of the things that he has to say, if not all. He is in fact hesitant to divulge information to a total stranger and as such he prefers his community members witnessing most of the things that he communicates to a stranger. This is why in an open interview the informants feel free, relaxed and get articulated when necessary, in discussing with each other rather than in answering questions put to him by a stranger in an isolated situation.

The friendly atmosphere created in an open interview enables even the correction of mistakes by fellow participants in a good spirit. Verifications are also made by informants themselves from the fellow informants where necessary. Experiments show that most non-responsive informants at direct interviews often turn very good informants at open interviews because amidst other informants a vulnerable informant becomes very responsible as fellow informants attempt to correct and guide him.

However, there is one danger in adopting the open interview method. That is, the possibility of informants going out of point and even getting out of control in the course of discussion. In such a situation the investigator must be careful and direct the informants in the proper direction.

In summing up the argument, it is necessary to emphasize the point that while the directive interview method is best suited to elicit information from the informants in highly individualistic urban societies both in the West and in the Orient, the open interview method could often prove satisfactory to elicit information from those informants in community conscious rural Sri Lanka.

- (iv) The directive interview method incorporates the basic principles of measurement and it makes information comparable from case to case. It is undoubtedly the best method to gather an array of personal data as accurate as possible for statistical comparison. For instance, to know the informants' age, marital status, level of education attained, employment particulars, income and consumption data the directive interview would be the best. The directive interview method is also ideally suited where it is required to maintain consistency in information collected from a large number of individual informants scattered over a wide area or over the whole country. However, where interpretations and attitudes are to be determined about matters such as causes of street riots, general strikes, social effects of technical changes, adoption of improved practices in agriculture, reactions to rising cost of living, psychological consequences of students living in a university hostel etc., the directive interview often fails and the open interview becomes the most suitable method.
- (v) The directive interview method is the best suited to minimize errors which are likely to be made by the investigators and informants of different levels of literacy and intelligence in the course of an interview seeking quantifiable personal data. This is because the rigidly pre-planned questionnaire for a directive interview strictly guides the investigator in the interviewing procedure however inexperienced he is. In contrast a high percentage of error may remain in data collected in an open interview conducted by an inexperienced investigator.
- (vi) When novices are employed as investigators the timing of an interview becomes easier under the directive interview method than under the open interview method because in the former the specific questions are laid down in a pre-planned and often pretested questionnaire and each question normally takes a limited period of time to complete. An experienced investigator may time the discussion of each question in an open interview minimizing the informant's inclination to describe irrelevant matters and thereby save time to explore the relevant information. Such an investigator may also be able to assist informants to recall matters of importance offering appropriate words

and phrases when the informants get stuck for words. Careful guidance aids the informant's stream of thought to flow smoothly, making the whole exercise interesting and worthwhile. However, the inexperienced and unskilled investigator often fails to achieve them in open interviews. In the hands of unskilled investigators, the informants not only go out of point but also attempt to fabricate the information in an open interview.

- (vii) In the structured questions of directive interviews sometimes the questions are asked with a multiple choice. However, the researcher may not be able to give a very wide range of answers for the informant to choose from. The informant may have completely different answers to the question asked. For instance consider for a moment that the investigator is asking the informant the reason (s) for non-payment of short-term cultivation loans and provides the following possible answers to the informant to choose from ;

- (a) Low income ;
- (b) Crop failure ;
- (c) Heavy indebtedness ;
- (d) Excessive family consumption expenditure ;

For non-repayment of past cultivation loans the informant may have a reason or reasons other than those from (a) to (d) above. He may have a totally different reason or reasons such as:

- (e) no inclination to repay cultivation loans as others do not repay their loans ;
- (f) lending agencies are not keen on recovering loans ;
- (g) the co-operative employees misappropriate the loans repaid; and
- (h) the belief that the government would eventually write-off the loans in default.

In a structured questionnaire prepared to use in a directive interview there is no provision to gather certain unexpected but very valid reasons for loan default. If an open interview is conducted to ascertain the reasons for non-payment of loans, there is a strong possibility of some informants stating one or more of those set out in (e) to (h) as the actual reason (s) for non repayment.

- (viii) In certain instances the open interview is very economical and less time consuming. If the researcher wants to determine the average tractor charges in a village, it could be obtained in an open interview by asking the informants to indicate the average figure rather than asking in a directive questionnaire from each individual or a sample of informants selected from the village and processing those data. Our experience is that (Table I) the average per acre yield in different field zones in a village could be obtained easily in an

open interview with a tolerable degree of error rather than attempting to get the same information by interviewing all or a sample of farmers using a directive questionnaire. The latter would prove extremely cumbersome and sometimes impossible because the number of holdings in different field zones could be far too many to consider during a limited period of time. Besides, some land owners may not reside in the same village and as such even if a sample of farmers is selected, many of them will not be available to collect the necessary information.

Table 1
Villagers' Generalized Yield Per Acre in Different Field Zones

Name of Village	'Old Field' Zone			'Field Blocks' Zone			'Parkland' Zone			'Forest' Zone		
	At first interview	At second interview	Average	At first interview	At second interview	Average	At first interview	At second interview	Average	At first interview	At second interview	Average
Galkiriyagama	18	25	21.5	40	40	40.0	10	15	12.5	15	20	17.5
Galewewa	25	20	22.5	50	55	52.5	12	10	11.0	20	20	20.0
Katupatwewa	20	20	20.0	45	55	50.0	12	15	13.5	25	25	25.0
Kapirigama	25	30	27.5	50	60	55.0	18	20	18.0	20	30	25.0
Thodamaduwa	35	40	37.5	40	45	47.5	30	25	27.2	30	35	32.5

Note —These estimates were made by farmers themselves who took part in discussions held in each village. The yields that they indicated for the different ones during the two interviews held were averaged (shown under the column 'Average' so as to avoid extremes of estimates)

Source —M. U. A. Tennakoon, *Rural Settlement and Land Use in North Central Sri Lanka*, M. A. Thesis (unpublished, Syracuse University, N Y 1974, p 170 : Table 23)

Some may consider that the collectively agreed upon figures of average yield per acre at an open interview are unreliable because the informants are likely to make irresponsible or dishonest statements. It could be safely assumed that once a lie is uttered, it cannot be repeated in the same way after a lapse of a period of time whereas, a truth told is very likely to be repeated exactly in the same way even after a lapse of a long period of time. Based on this assumption, the average per acre yield of different field zones mentioned above obtained by the farmers in four traditional rural settlements *purana* villages were recorded during early 1972 and the same villages were revisited after three months. The same farmers were interviewed to obtain the same yield data on the pretext that the information collected earlier was lost. On completion of the interview for the second time, it was found that the differences in average per acre yields obtained for the different field zones at the two interviews were negligible (Table 1). Thus, the quick and less costly open interviews could be effectively used to cross check data and to clear doubts about previous data collection if any.

- (ix) The administrators as well as the researchers particularly in the developing countries are under constant pressure to submit fact-finding reports, feasibility reports, project reports, work plans, etc., within very short periods of time. Most of these assignments are expected to be completed within few weeks or within a month or two. If the necessary information is not available and the time allocated is insufficient to administer a directive questionnaire, an open interview would be the most suitable device to collect urgently required field data.
- (x) The open interview is useful to formulate hypotheses before collecting data in the field. A researcher having a clear hypothesis will know exactly what type of data he needs well in advance of field work. Hence, he is in a position to collect only the relevant data. Even to formulate a hypothesis some background knowledge of the subject is necessary and a kind of fact-finding mission with a few open interviews would be of immense use. If, for instance, the intuitive knowledge of the researcher prompts him that *the adoption of HYVs has not increased the net farm income of small farmers*, it could well form a working hypothesis. But it would be best to find support for this suspicion or the "hunch" by talking to a group of persons in open interviews. Such a discussion would provide additional confidence to the researcher if the informants express views similar to what the researcher holds and sometimes he would still be able to reformulate and strengthen his hypothesis.

From the foregoing discussion it would appear that it is not possible to make a generalization and say that one method is always superior to the other in collecting field data. Both interview methods—the directive interview method and the open interview method — have advantages and disadvantages like any other data collection method.

The method best suited to collect raw data necessary for a research project or for a particular section of a research project may not be equally suited for another research project or some other section of the same research project. For instance, if the sole objective of the research project is to determine the average milk consumption by age groups in a particular settlement there is no choice but to conduct a directive interview because that is best suited to get personal consumption data. But if the sole objective of a research project is to find out the prevailing tractor charges in different settlements an open interview in each village would suffice to get that information because tractor charges are fairly well known.

However, in an islandwide survey such as the *Consumer Finance Survey* where information on both these areas (milk consumption and tractor charges) are necessary the two types of field data collection—directive questionnaire method and the open interview method — could be harmoniously employed. Sometimes the data collected in one method could be cross-checked using the other method. For instance, if there are doubts about the cost of inputs, labour wage rates, and yield data obtained in a directive interview in rural areas, the accuracy of such data could be cross-checked by collecting the same information in the same localities by conducting open interviews. In these cross-checks a perfect

agreement may not be possible. But if the difference detected is negligible it would give a very high degree of confidence to the researcher to accept the information collected in the first interview. Where the differences are of great magnitude re-investigation to secure more reliable information would be necessary and that must be done for the sake of accuracy.

What method is to be selected to collect information for a particular study is entirely the researcher's choice. It is he who knows best what the purpose of the research is and what information he needs.

3. How to Conduct an Open Interview

The open interview being more flexible than the rigidly structured directive interview the investigator requires a very high degree of skill in conducting an open interview successfully. He is required to change strategy to suit the informants of varying levels of literacy and interests. In this situation, it is difficult to lay down a code of conduct as such. However, it would be useful to provide some guidelines as follows :

- (i) The investigator is required to have clearly in mind the objective(s) of the research project.
- (ii) He must remember that the success of a research project depends heavily on the accuracy and consistency of data collection in the field.
- (iii) He must properly introduce himself and spend sometime in the community (at least a day in advance) talking to as many people as possible and skilfully select a small group of (6-10) informants who are capable of discussing relevant problems clearly. (It is necessary to restrict the number of informants to have an effective control over the discussion).
- (iv) He must request the selected informants to meet at a place and time convenient to the informants and not to the investigator.
- (v) He must be confident that he has won the full confidence of the informants before the commencement of the interview.
- (vi) If there is more than one investigator in an open interview, making gestures among the investigators and talking in a language that informants cannot understand have to be avoided unless there is an unavoidable reason to do so. Too much cross-conversation among investigators and conversations in a language alien to the informants can arouse suspicion in the minds of the informants which could prove highly injurious to the interview.
- (vii) It is very essential to avoid conversation in an open interview in any manner unappealing to the informants. If possible, the local style of talking and local phrases and terms should be employed in conversation.

(viii) In the conversation it is necessary to prevent the discussion from breaking down. To keep the conversation flowing, where appropriate, careful probing may be attempted by :

- (a) repeating the question that is being discussed ;
- (b) making an expectant pause ;
- (c) repeating the respondent's reply sometimes deliberately wrongly so that the informants are enthused to rectify it and elaborate it further ; and
- (d) injecting neutral questions such as—
 Anything else ?
 Could you tell more about your thinking on this ?
 Could you tell me about what you have in mind ;?
 Why do you feel that way ?
 Am I correct if I say? etc. etc.

Also the investigator may encourage the informants' expression of views with comments such as ;

I see ! ;
 That is interesting,
 Yes, I now understand ;
 It is incredible!
 It is amazing !,
 Is that so ? etc. etc.

- (ix) The investigator must show a keenness to listen and understand the problems of the informants even if all what informants utter seems irrelevant, because the informants like the investigator to listen to them. Once the informants are convinced that the investigator is willing listen to them, they are willing to provide meaningful and true information.
- (x) In an open interview if the investigator is not alert a leadership among the informants may emerge and that leader might try to override the others' views. In such situations the investigator has to be very diplomatic and make provision for others to speak, minimizing the chances of the one who is dominating the others in conversation.
- (xi) If an informant in the open interview is in the habit of providing distorted information, the other informants should be encouraged to discuss his points of view and come to a collective agreement.
- (xii) In situations where the informants attempt to give divided opinions the investigator must quickly move into the conversation as the moderator and a compromise has to be made to bring the whole group together.

- (xiii) It is necessary to record the information in brief form and to write an expanded note on the outcome of the survey afterwards. Recording of most of the information provided would be very much easier if there are two investigators. More than two investigators would lead to too much duplication of recording.
- (xiv) Throughout the investigation and during the stay in the community, the investigators total conduct has to be exemplary. He is even required to be in a plain attire. The informants as well as the other members of the community will be constantly observing the investigator. The impressions of the informants always have a profound influence on the information that the investigator receives. Hence, be good to get good information.

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Reliability of Data

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1. Introduction

Reliability of data can be discussed from two points of view. One is the accuracy of our observations in research relative to the actual situation which that situation is expected to reflect. The other is the concept of error in sampling which can be measured by means of statistical formulae. In this paper I shall restrict myself to the first which is concerned with problems in collecting field data and their interpretation. The rest of the paper is divided into four sections. In the first section I shall briefly touch on the need for reliability in research data. In the second factors affecting reliability will be discussed. In the third section I shall focus attention on the methods that can be employed to assess the reliability of data. The final section provides a few kinds as to how to achieve reliability in one's own research data.

2. Need for Reliability

Research, it is said, is an exercise in search of the truth. Thus the first and perhaps most important reason for trying to get reliable data lies in the intrinsic value of such data. Second, we do not normally collect data for their own sake but for some purpose. For example, government agencies and research institutions collect data to help formulate policy. Therefore reliable data are essential to formulate policies which can achieve pre-determined objectives. Third, we must critically examine the reliability of data that are collected because that is the only way in which we can improve the quality of data thus collected.

3. Factors Affecting Reliability

My concern here is with socio-economic data. In that context it is necessary to draw attention to the difference between natural science and the social sciences because some of the major factors affecting the reliability of data arise from the method of their collection. In the natural sciences we collect data generally under controlled conditions and we design experiments under controlled conditions to obtain various results. But this procedure is generally not available in the social sciences where data have to be collected in situations where many factors are not under control. Social scientists collect data about human behaviour by going to the field where a multitude of factors simultaneously affect the behaviour of the subject under study. Under such conditions it is generally difficult to collect accurate data.

Secondly, in the natural sciences, the person who generates the data and the person who uses the data are mostly one and the same person. In contrast, in the social sciences, they are produced not as a result of research studies but as a by-product of various routine activities of government departments and other state and private agencies. This method of collection is an important factor which makes for less reliability of socio-economic data.

Thirdly, even when data are collected for a specific research project the mechanics of collection can lead to a drop in the degree of reliability. The researcher is the person who knows best that he wants, what variables he is actually trying to measure and so on. However, due to practical reasons it is not always possible for the researcher to go to the field and a field investigator may be employed for the task. The investigator of course may not have the same degree of motivation and the level of knowledge and understanding of the project as the researcher himself, and therefore fail to collect data of a quality that the latter wants.

Fourthly, doubts about the reliability of data could also arise because the researcher might have access only to the tabulated final data but not to the disaggregated raw data. This is especially true when the researcher has to depend on data collected by institutional sources such as the Central Bank or the Department of Census and Statistics. Even when one conducts one's own survey, the scale of the survey may be such that it is practically impossible for the researcher to be intimately involved in all its various stages from the preparation of the questionnaire to collection, coding, processing and tabulation of data. If one were to rely on others for data collection and processing there is always possibility that inadequately trained or motivated personnel could produce unreliable data.

Fifthly, reliability of data could also vary depending on the nature of the data required. For example, in household surveys the data that are collected on demography and education are generally relatively reliable. In contrast, data on income, wealth, savings, tax payments and so on are generally less reliable, because often the respondents are reluctant to supply accurate information on such matters. Furthermore normally, there is no way of checking whether the respondents have spoken the truth or not.

Sixthly, the reliability of data can also be affected by the definitions and classifications one adopts in a survey. An obvious example is the measurement of "unemployment". There is no standard definition of unemployment used in surveys of unemployment conducted in countries such as Sri Lanka. Consequently there are wide margins of differences which cannot be explained by sampling errors alone, in the rates of unemployment estimated by the various surveys.

Seventh, the time that the researcher is willing to devote to the collection of data can also affect their reliability. This is especially true of field data collection. For example, it is generally difficult to obtain reliable data on farm inputs by means of a single interview with the farmer. Usually the respondent is unable to recall accurately such information from memory. Therefore, it may be necessary to visit the farmer several times during the cultivation season to gather reliable data.

The time factor can affect the reliability of data in another way as well. In the social sciences we are often interested in time series data stretching back several years and sometimes decades or even centuries into the past. Generally, there is no means of checking the accuracy and reliability of such data collected in the past. Furthermore, in the case of time series data there is a tendency for the quality of the data on a given subject to improve and the coverage to widen as time goes by so that changes indicated by time series become hard to interpret.

4. How to Assess Reliability

The assessment of reliability of data cannot be separated from the interpretation of data. The first and most obvious test of reliability of data is to match the data against the original hypothesis with which the research study was begun. If the data do not support the hypothesis, this does not necessarily mean that the hypothesis is wrong but that the data may be unreliable. A simple rule of thumb in this is to rely on a commonsense interpretation of data. For example, in a farm study if it is found that fertilizer applications and yields are negatively related it is better to question the reliability of data rather than doubt the hypothesis that fertilizer applications have a positive impact on yields. In such an event it is better to review the data for possible errors in collection, processing or tabulation. Sometimes it is also useful to compare one's own results with those obtained by others in similar studies. Normally, a vast discrepancy cannot exist.

5. How to Achieve Reliability

The collection of data is an integral part of the research process. Thus the reliability of data will depend not only on the quality of the field survey but also on the formulation of the problem and the definition of variables. When a questionnaire is used to gather data, it should be pre-tested. The questionnaire should sharply focus on the variables on which data are required. It is also desirable to build-in consistency checks into the questionnaire. The researcher must have full control over the field work and exercise close supervision over the field staff. It is also essential to process and analyze at least a small sample of the data while the field work is in progress, so that any errors that may remain can be corrected. Finally, the researcher must exercise equally close supervision at the data processing and tabulation stages.

6. Conclusions

In conclusion I would like to draw attention to two points. One is that the researchers must honestly report the degree of reliability of his data so that others can evaluate the findings in proper perspective. The other is that we must always be conscious of the fact that it is generally not possible to achieve absolute reliability in data in the social sciences.

PART V

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Descriptive Statistics - An Introduction

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1. Use of Statistics

The term statistics is sometimes used to refer to a set of figures. But the formally accepted meaning of the word statistics is in reference to statistical methods or to the subject that deals with methods by which quantitative information can be summarised and interpreted. The use of statistics comes whenever you start counting and taking measurements. However, this does not necessarily mean that anything you count makes up statistics. Statistics arise when the measurements taken are subject to variability. For example, in counting the number of legs a dog has, statistics does not arise because a dog having four legs is a predetermined fact. Instead of counting the number of legs, if you start measuring the lengths of the dogs, which is a variable, then you are taking a statistical measurement.

Statistics are used when there is a real-world problem to solve. To solve the problem, you must have knowledge of the problem. You must define it carefully and then model it in some sense. After modelling on the basis of assumptions using probability theory it is possible to deduce from the model what the behaviour of an ideal set of data should be. Ideal data do not exist. But if the model is correct, then that would be the behaviour of the ideal data. To test whether the model is correct, data are collected from the real world and examined. If the data fit into the model, then you have answered your real world problem. But usually, this does not happen quite so easily. You have to argue from your sample data and make statistical inference regarding the real population under consideration.

Now a large volume of data is cumbersome to handle. Therefore the initial step is to summarise this information in some sensible fashion. This is the area referred to as Descriptive Statistics. It is very simple, but it does form a very large part of statistics. Normally the descriptive part accounts for about three-fourths of the statistical analysis.

2. Qualitative Data

In descriptive statistics it is useful to distinguish between two types of data. One is qualitative data and the other is quantitative data. Qualitative data refer to data which are not characterised by a numerical quantity. For example, if you measure preference—whether you like a certain brand of tea or cigarette—you are asking questions which do not have numerical values associated with them. Summarising qualitative data is very simple. All you have to do is to count the number of people who fall into the various categories. For example, in the sex-distribution of a population, there are two categories and you count the number of males and the number of females separately. You can present it in a table in absolute numbers and if necessary in percentages as well. It is easier to interpret percentages than absolute numbers. In addition to presenting the information in the form of a table, it is often suitable to be able also to present it in the form of a graph or a chart because pictures have a stronger impact on the eye.

3. Quantitative Data

In the case of quantitative data, it is difficult to get sensible information by simply looking at raw numbers. For example assume that there is a set of 50 households and information is available on the number of occupants in each household. Now just looking at these data will not convey very much to you. You have to summarise them as an initial step in the analysis. Though at a glance you can say that most of the households have say, 4 occupants, you would perhaps like to condense your data a little more. The simplest method is to group the data, and be able to say something like, there are 8 households with 1 occupant, 21 with either 2 or 4 occupants, 11 with 5 to 7 occupants and so forth. This information also could be presented by means of a graph, chart or picture. However, these latter forms of data presentation should be used with care because sometimes they can convey a misleading impression to the user.

4. Average

The average is one of the most common tools used to give a representative figure for a collection of numerical information. There are three types of averages, the mean, median and mode. The use of each depends on the question to be answered. For example, (1) What is the average income of a household in Sri Lanka? (2) What type of rice does the average person prefer to eat? (3) What is the average height of an adult Sri Lanka male? To answer the first question the best is the median because according to its definition, half the values of the population lie above it and half below it.

Thus if the median household income in Sri Lanka is say, Rs. 400/- per month what it means is that half of the population receive an income of above Rs. 400/- per month, while the other half have an income below it. The mean is not appropriate to measure average income because the income of a few very rich people can lead to a very large value.

As regards the second question, "What type of rice does the average person prefer to eat?" the best average is the mode, which is the value which occurs most frequently. For example, if there are a few different kinds of rice, red rice, white rice, par-boiled, raw and so forth, and you count the number of people who fall into each of these categories, the mode gives you the type of rice eaten by the most number of people.

As regards the third question, i.e. the average height of an adult Sri Lankan male, the procedure is to take a representative sample, count each person's height, divide by the total number of observations. This would give a representative average for the population. Thus the mean, median and mode should be used depending on the nature of the question to be answered.

5. Dispersion

If you have two sets of data and you want to compare them, just quoting the means of these two sets of data is not enough. Usually it is necessary to have a measure of the spread of your observations. For example, say, you have two sets of students, four each, who are given a particular test. Suppose the mean mark of each group is 50, but the spread

is very different. For instance, the spread in group I may be from 45 to 56, while it is 25 to 90 in group II. To select a student of average ability, it is better to use group I because with group II, it is likely that your selection will result in a candidate who is either very weak or very clever. It is thus necessary to consider also the spread or dispersion of the measurements. We normally use either the variance or the standard deviation as a measure of dispersion of a collection of statistical data.

Some Statistical Techniques Applicable to Social Science Research

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Data in social science research are often gathered in the form of frequencies in categories or as ranks. Even if interval scales are used for measurement, it is seldom that they satisfy the requirements for interval scale measurement. Moreover, we are often in doubt as to whether the assumptions needed for parametric tests such as the *t* test and the *F* test are satisfied. It is therefore, appropriate and reasonable to use tests that are suitable for categorized data or ranked data.

In this presentation we will consider some parametric and non-parametric tests that can be applied to categorized or ranked data. In each case, we will take a problem and illustrate the application of a statistical technique appropriate for the situation.

Problem I—To test whether data relating to a question of interest obtained from a sample indicate a significant trend in the population.

Data —Frequencies ; i.e. the number of persons or events that belong to a designated category (e.g. answer “Yes”) and those who do not.

An investigator finds that 60 out of a random sample of 100 housewives from a certain district answer “yes” to a particular question. He wants to know whether these frequencies could have come from a population in which the opinion is evenly divided on this particular question.

When we have frequencies in two alternative, mutually exclusive categories from a single sample not smaller than 10, the Chi square test can be applied to test the null hypothesis that the split in the population is a 50-50 one.

In this situation, chi square can be calculated by the formula :

$$X^2 = \frac{(f_1 - f_2)^2}{N}$$

where f_1 and f_2 are the frequencies in the two categories and N is the size of the sample. In our example, $f_1 = 60$, $f_2 = 40$ and $N = 100$. Thus,

$$X^2 = (60-40)^2/100 = 400/100 = 4.00$$

The df to enter the X^2 table is 1. For 1 df, the obtained X^2 value is significant at the 0.05 level, So, we can reject the H_0 at the 0.05 level of significance.

Public opinion poll results or survey results are often reported as percentages. Although significance tests can be made on percentages or proportions using the normal distribution table, it is more convenient to convert percentages or proportions to frequencies and do a Chi square test. A percentage, when multiplied by $\frac{N}{100}$ or a proportion by N , is converted to a frequency.

The general formula for Chi square is

$$X^2 = \sum \left(\frac{(f_o - f_e)^2}{f_e} \right)$$

where f_o is the observed frequency and f_e is the expected or hypothesized frequency. Thus when we hypothesize a 50 - 50 split in the population, f_e for both categories is 50. In our example above, we observed a 60 - 40 split and we hypothesized a 50 - 50 split. Hence

$$\begin{aligned} \text{our } X^2 &= \frac{(60 - 50)^2}{50} + \frac{(40 - 50)^2}{50} \\ &= 2.00 + 2.00 = 4.00 \end{aligned}$$

If we hypothesized a 75-25 split in the population,

$$\begin{aligned} X^2 &= \frac{(60 - 75)^2}{75} + \frac{(40 - 25)^2}{25} \\ &= \frac{(-15)^2}{75} + \frac{(15)^2}{25} \\ &= 3.00 + 9.00 \\ &= 12.00 \end{aligned}$$

according to which X^2 value, we can confidently reject the null hypothesis that there is a 75 - 25 split in the population.

It is important to note that in both categories in the split, the expected frequency must be not less than 5 before we apply the X^2 test. This will not be a problem if we use large samples.

Problem 2—To test whether two independent samples differ significantly with respect to an attribute.

Data —Frequencies in two categories for each sample.

Suppose an investigator conducts a survey regarding the settlement of bank loans by farmers in two districts. He observes that, out of a sample of 30 farmers in District X 20 have not settled the bank loans while in District Y, only 8 out of 26 have not done so. Do the two districts differ in this matter ?

These data can be entered in a fourfold contingency table as follows :

	<i>Did not settle</i>	<i>Settled</i>	<i>Total</i>
X	20 A	10 B	30 A + B
Y	8 C	18 D	26 C + D
Total	28 A + C	28 B + D	56 N

The four cells in the table are coded A, B, C and D as shown. Chi square is calculated by the formula :

$$\begin{aligned}
 X^2 &= \frac{N(AD - BC)^2}{(A+B)(C+D)(A+C)(B+D)} \\
 \text{.....Applied to the data in our problem} \\
 X^2 &= \frac{56(20 \times 18 - 10 \times 8)^2}{(30)(26)(28)(28)} \\
 &= \frac{56(360 - 80)^2}{(30)(26)(28)(28)} \\
 &= \frac{56(280)^2}{30 \times 26 \times 28 \times 28} \\
 &= 5.82
 \end{aligned}$$

The degrees of freedom for a fourfold table is also one.

Thus, for 1 df, the obtained X^2 value is significant at the 0.02 level. We can reject the null hypothesis of no difference with confidence.

Note that the expected frequency in any cell of a fourfold table must be not less than 5.

The above test is equivalent to a significance test for the difference between two independent proportions or two independent percentages. The identical probability statement will be made if we did a significance test for the difference between the two proportions or percentages, but doing the X^2 test is more convenient than doing either of those two tests.

Problem 3—To test whether a change that has taken place in regard to an attribute in a sample is significant.

Data —Frequencies in two categories for a sample on two different occasions as before and after undergoing an experience.

Suppose an investigator wants to determine whether a farmer-education programme has had the desired effect. He conducts the survey before the introduction of the education programme and judges that 15 out of 40 farmers were efficient. He repeats the survey after the education programme and judges that 28 out of the same 40 farmers were efficient.

The Chi square test can be employed to determine whether the education programme had the desired effect.

The data can be entered in a four-fold contingency table as follows :

		<i>BEFORE</i>	
		<i>Inefficient</i>	<i>Efficient</i>
<i>AFTER</i>	<i>Efficient</i>	16 A	12 B
		9 C	3 D
	<i>Inefficient</i>	25	15
			40

The four cells in the table are coded A, B, C, and D as before. Since the data relate to the same group of persons, they are correlated. This fact has to be taken into consideration when the significance of change is tested. The following formula makes allowance for this.

$$X^2 = \frac{(/D-D/-1)^2}{A+D}$$

Applied to the data in the four-fold table given above,

$$\begin{aligned} X^2 &= \frac{(/16-3/-1)^2}{16+3} \\ &= \frac{12^2}{19} \\ &= 7.58 \end{aligned}$$

For 1 df, this is significant at the .01 level. The null hypothesis of no difference can be rejected. The education programme has been very effective in bringing about the desired change.

Problem 4—To test whether two independent samples have come from the same population.

Data —Scores in an interval scale or ratings or ranks when both samples have been combined and ranked. If scores or ratings are available, the two samples are combined and ranked in ascending order, having regard to ties.

Suppose an investigator obtained the following data for two independent samples. Columns 1 and 2 give the original scores for samples 1 and 2. Columns 3 and 4 give the same scores arranged in ascending order. Columns 5 and 6 show the ranks assigned to the scores in the two samples when the two samples are combined. If the data were ranks when the two samples were combined, the ranks of the two samples are simply listed separately as in columns 5 and 6.

1	2	3	4	5	6
38	47	34	40	1	7.5
35	45	35	40	2	7.5
37	42	36	42	3	11
40	43	37	43	4	12.5
40	45	38	45	5	15.5
45	47	40	45	7.5	15.5
34	40	40	45	7.5	15.5
36	45	41	47	10	18.5
43	40	43	47	12.5	18.5
41	48	45	48	15.5	20
389	442			$R_1=68$	$R_2=142$

The Mann-Whitney U Test is an excellent test to be used in situations like this, particularly when we are not sure of meeting the assumptions of normality and of homoscedasticity (equal variances) needed for the parametric t test, or when the measures are not in at least an interval scale.

When both N_1 and N_2 are 8 or greater,

$$Z = \frac{[2R_1 - N_1(N+1)] - 1}{\sqrt{N_1 N_2 (N+1)/3}}$$

expresses the difference between the two groups as a unit normal deviate by which the significance of the difference can be evaluated.

R_1 and R_2 , the sum of ranks of the two groups are obtained, and the smaller sum is substituted in the formula. If the smaller sum happens to be R_2 , the R_1 and N_1 in the numerator of the formula are altered to R_2 and N_2 . $N = N_1 + N_2$

For the data in our example,

$$\begin{aligned}
 Z &= \frac{/(2) (68) - (10) (21) / -1}{\sqrt{(10) (10) + (20 + 1)/3}} \\
 &= \frac{/136 - 210 / -1}{\sqrt{700}} \\
 &= \frac{-73}{26.4575} \\
 &= -2.76 \\
 P &< 0.006
 \end{aligned}$$

The null hypothesis of no difference can be rejected.

The Mann-Whitney U test has about 95.5% power efficiency of the parametric t test applied to the same data if they were available in at least an interval scale, which is demonstrated below.

$$\begin{aligned}
 X_1 &= \frac{389}{10} = 38.9 \quad \Sigma x_1^2 = 113 \\
 X_2 &= \frac{442}{10} = 44.2 \quad \Sigma x_2^2 = 74 \\
 t &= \frac{38.9 - 44.2}{\sqrt{\frac{113 + 74}{18} \left(\frac{1}{10} + \frac{1}{10} \right)}} \\
 &= -3.68 \\
 \text{For } df = 18, \quad P &< .005
 \end{aligned}$$

A less efficient non-parametric test that can be applied to the data of this same example is the median test. To apply the median test, we split each sample at the common median for the two groups combined. For our data, the common median is 41.5. The split of the two samples at this point is shown in the fourfold table below :

	Sample 1	Sample 2	Total
Above Median	2	8	10
Below Median	8	2	10
	10	10	20

We then calculate a X^2 as we did in Problem 2 above. For the data in the fourfold table,

$$\begin{aligned}
 X^2 &= \frac{20 \left(\frac{1}{64} - 4 \frac{1}{20} \right)^2}{10 \times 10 \times 10 \times 10} \\
 &= \frac{20 (50)^2}{10,000} \\
 &= 5.00
 \end{aligned}$$

For $df = 1$, $0.02 < P < 0.05$

Problem 5—To test whether two correlated samples have come from the same population.

Data —Original scores for several matched pairs of persons or several persons measured twice. The unit of measurement need not be equal as in an interval scale.

An investigator obtains measures for two related samples or for one sample on two different occasions.

Suppose he obtains the following data for 22 matched pairs of persons :

X	Y	$D = X - Y$	Rank of $ D $	Rank of D 's with less frequent sign.
37	23	+ 14	14.5	
44	34	+ 10	10	
55	59	— 4	3.5	3.5
70	25	+ 45	19	
26	16	+ 10	10	
39	12	+ 27	18	
26	16	+ 10	10	
30	25	+ 5	5	
85	60	+ 25	17	
83	69	+ 14	14.5	
74	74	0	—	
36	36	0	—	
59	70	—11	12.5	12.5
59	61	— 2	1	1
36	29	+ 7	8	
81	70	+ 11	12.5	
58	52	+ 6	6.5	
19	34	—15	16	16
11	7	+ 4	3.5	
45	42	+ 3	2	
14	14	0	—	
19	13	+ 6	6.5	
			190.0	33.0

The Wilcoxon Signed-Ranks of Difference Test is appropriate for analysing data of this type. The difference between the two scores of each matched pair is entered with the sign + or —. These differences, leaving out the zero differences, are then ranked, disregarding the sign. The ranks of differences with the less frequent sign are then entered in a separate column and their sum is obtained.

When the number of non-zero differences is 8 or more,

$$Z = \frac{[2T - N(N+1)/2] - 1}{\sqrt{N(N+1)(2N+1)/6}}$$

expresses the difference between the two samples as a unit normal deviate which can be evaluated by reference to the table of the normal curve function. T is the sum of + or — ranks, whichever is the smaller sum and N is the number of non-zero differences.

For the data in our example,

$$\begin{aligned} Z &= \frac{[(2)(33) - (19)(19+1)/2] - 1}{\sqrt{(19)(19+1)(2 \times 19 + 1)/6}} \\ &= \frac{[66 - 190] - 1}{\sqrt{(380)(39)/6}} \\ &= \frac{-123}{\sqrt{2470}} \\ &= -2.47 \end{aligned}$$

For a two-tailed test, $P < 0.014$. We reject the null hypothesis of no difference between the two populations.

This test also has a power efficiency approaching 95% of that of the parametric t test. If we did a t test with the same data, we would have

$$\begin{aligned} \underline{t} &= \frac{165/22}{\sqrt{\frac{(22)(4729) - (165)^2}{(22)^2(21)}}} \\ &= 2.72 \end{aligned}$$

For $df = 21$, $0.01 < P < 0.02$

Problem 6—To test whether C correlated samples have come from populations with equal means.

Data —Original scores or ranks 1 to C for each of R matched groups.

An investigator assigns at random one subject to each of C experimental conditions from each of R matched groups. Each matched group is ranked 1 to C. If scores or ratings are obtained, the C subjects in each matched group are assigned ranks from 1 to C.

Suppose he obtains the data (each matched group ranked 1-5) as given in the table below :

Group	Experimental Condition				
	1	2	3	4	5
1	2	1	4	3	5
2	1	2	4	3	5
3	3	2	1	5	4
4	1	2	3	5	4
5	4	3	5	2	1
T_c	11	10	17	18	19
T_c^2	121	100	289	324	361

The Friedman two-way analysis of variance by ranks is appropriate for testing the null hypothesis that the several samples came from the same population.

Procedure : T_c , the sum of ranks for each column, is obtained.

When $C > 3$ and $R > 9$ or $C > 4$ and $R > 4$,

X_r^2 follows approximately the X^2 distribution df being equal to $C-1$
df being equal to $C-1$

X_r^2 is calculated as follows :

$$\begin{aligned}
 X_r^2 &= \frac{12}{RC(C+1)} \left(\sum T_c^2 - 3R(C+1) \right) \\
 &= \frac{12}{5 \times 5 (5+1)} (1195) - 3 \times 5 (5+1) \\
 &= \frac{2}{25} (1195) - 90 \\
 &= 95.6 - 90 \\
 &= 5.6
 \end{aligned}$$

For df = 4, $P > 0.10$

Null hypothesis cannot be rejected.

Tied ranks within rows do not disturb the Friedman test. Power efficiency agrees very closely with F test applied to original scores (not given in the above table).

Problem 7—To test whether G independent samples have come from the same population.

Data —Scores in an interval scale or ratings or ranks when all G samples have been thrown together and ranked. Scores or ratings are also ranked, having regard to ties.

An investigator wants to compare four independent groups, each consisting of 5 persons. Suppose he obtains the data of the table given below :

Group 1		Group 2		Group 3		Group 4	
Score	Rank	Score	Rank	Score	Rank	Score	Rank
23	4	19	2	28	7	41	16
20	3	29	8	40	15	48	20
30	9	38	14	44	18	45	19
18	1	32	10	37	13	35	12
27	6	24	5	33	11	43	17

$$R_1 = 23 \quad R_2 = 39 \quad R_3 = 64 \quad R_4 = 84$$

$$R_1^2 = 529 \quad R_2^2 = 1521 \quad R_3^2 = 4096 \quad R_4^2 = 7056$$

The Kruskal-Wallis one-way analysis of variance by ranks is an appropriate test to test the null hypothesis that the G independent samples have come from the same population.

Procedure : R , the sum of ranks for each group is obtained. The H statistic is calculated by the following formula :

$$H = \frac{12}{N(N+1)} \sum \frac{R_g^2}{M_g} - 3(N+1)$$

If all M_g are greater than 5, H follows approximately the X^2 distribution with $df = G - 1$

$$\begin{aligned}
 H &= \frac{12}{20(20+1)} = \left[\frac{23^2}{5} + \frac{39^2}{5} + \frac{64^2}{5} + \frac{84^2}{5} - 3(20+1) \right] \\
 &= \frac{12}{420} \left[\frac{529}{5} + \frac{1521}{5} + \frac{4096}{5} + \frac{7056}{5} \right] - 63 \\
 &= \frac{12}{420} (2640.4) - 63 \\
 &= 75.44 - 63 \\
 &= 12.44
 \end{aligned}$$

For $df = 3$, $P < 0.01$

The H_0 that the G samples came from one population is rejected at the 0.01 level.

If there are tied ranks and the obtained H fails to reach the tabled value in the X^2 table, a correction may be made.

For this, we calculate the quantity given by

$$1 - \frac{\left(\sum t_s^3 - \sum t_s \right)}{N^3 - N}$$

t_s being the number of ties at any rank. Then we divide H by this quantity to obtain the corrected H . If the obtained H is large enough to reject the null hypothesis, the correction is not necessary.

That is a test that may be used when homogeneity of variances is suspected. It has a power efficiency of 95.5%.

Problem 8—To estimate the degree of association or correlation that exists between two attributes one or both of which have yielded data in more than two categories.

Data —Cross-tabulated data in the form of frequencies in a contingency table, where each attribute is divided into more than two broad classes. Even when measures on a continuous scale are available, they can be reduced to a few categories if the other attribute yields information in a nominal scale.

Suppose an investigator has information relating to two attributes (say, Parental Occupation and University Course selected for) of a group of persons. Parental occupation is differentiated into three broad classes and University courses are also differentiated into three broad categories. Fictitious data are given in the table below.

				Parental Occupation			Total
				I	II	III	
University Course	A	..	100	..	60	..	200
	B	..	130	..	160	..	400
	C	..	160	..	240	..	600
Total				390	460	350	1,200

Pearson's Contingency Coefficient gives a statistical index to the degree of correlation that exists between the two attributes. It is given by the formula.

$$C = \sqrt{\frac{X^2}{N + X^2}}$$

when x^2 is calculated by the usual method. For the data in the table above,

$$\begin{aligned}
 X^2 &= 1200 \left[\left(\frac{(100)^2}{390} + \frac{(60)^2}{460} + \frac{(40)^2}{350} \right) / 200 + \left(\frac{(130)^2}{390} + \frac{(160)^2}{460} \right. \right. \\
 &\quad \left. \left. + \frac{(110)^2}{350} \right) / 400 + \left(\frac{(160)^2}{390} + \frac{(240)^2}{460} + \frac{(200)^2}{350} \right) / 600 - 1 \right] \\
 &= 1200 (0.19019 + 0.33389 + 0.50857 - 1.00) \\
 &= 1200 (0.03265) \\
 &= 39.18 \\
 C &= \frac{39.18}{\sqrt{1200 + 39.18}} = 0.178
 \end{aligned}$$

To test the null hypothesis that there is no relationship between the two variables, we test the significance of the obtained x^2 value. For $df = 4$, $p < 0.001$. We decide to reject the null hypothesis of no relationship.

C cannot be compared with a product moment r or an estimate of it unless a correction is made. Contingency coefficients themselves are not comparable unless they are derived from tables of the same size. The upper limit for C derived from a 2×2 table is 0.707; for a 3×3 table, it is 0.816; for a 10×10 table, it is 0.949. Also, C can never be negative.

Despite these limitations, C is a very useful statistic for the social scientist. No assumptions regarding the nature of the variable need to be met. There is no better measure of relationship to be used when nominal scale data are available in more than two categories.

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Statistical Methods for Social Science Research

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The growing use of qualitative as well as quantitative statistical information in social science research has resulted in an ever increasing utilisation of statistical methods. A cursory inspection of current international journals on social sciences and allied disciplines amply demonstrates this. It, therefore, highlights the necessity for the social scientists to familiarize himself with and acquire some knowledge of statistical methods.

1. Analysis of Cross-Classified Data

Survey data are presented in many different ways. A very common way is that of classification. When the members in a sample have been doubly classified, that is, classified according to two characteristics or *attributes*, the results can be presented in a rectangular table (see for example, Table 1.1). Such a table is known as a *contingency table*. The size of a contingency table is generally indicated by the number of rows and columns it contains. For example, Table 1.1 is of size 3 x 3. Table 1.1 is symbolically presented in Table 1.2. The figures such as n_{11} , n_{12} , ..., n_{33} in the body of the Table 1.2 are called the *cell frequencies*. Instead of two attributes, several may be used in classification of the members.

Table 1.1

Distribution of Sample of Head of Households According to Educational Ability and Occupational Achievement

Educational ability	Occupational Achievement			Row total
	Low	Medium	High	
Low	16 (12.0)	51 (40.8)	53 (67.2)	120
Medium	14 (14.0)	62 (47.6)	64 (78.4)	140
High	20 (24.0)	57 (81.6)	163 (134.4)	240
Column Total	50	170	280	500

Note: Figures within parentheses are explained in section 1.1

Table 1.2

Symbolic presentation of observed frequencies and margin totals in Table 1.1

	C ₁	C ₂	C ₃	Total
R ₁	n ₁₁	n ₁₂	n ₁₃	n ₁₊
R ₂	n ₂₁	n ₂₂	n ₂₃	n ₂₊
R ₃	n ₃₁	n ₃₂	n ₃₃	n ₃₊
Total	n ₊₁	n ₊₂	n ₊₃	n

Table 1.3

Further symbolization of frequencies in a contingency table (for use in sec. 1.2)

	. . . C _i . . .	Total
R _i	A (n _{ij})	B (n _{i+})
Total	B (n _{+j})	A (n)

1.1 Test for Independence in Contingency Tables

When a sample of people or things has been classified as in Table 1.1, it is reasonable to enquire whether the two classifications are independent. What is meant by independent is that the magnitudes of the all frequencies are in conformity with the proportions indicated by the margin total, that is, the row totals and the column totals. For example, suppose the two classifications in Table 1.1 are independent then we expect the upper-left corner cell frequency to be $(n_{1+}) \times (n_{+1})/n = (120) \times (50)/500 = 12.0$. Similarly, we expect the lower-right corner cell frequency to be $(n_{3+}) (n_{+3})/n = (240)(280)/500 = 134.4$. The cell frequencies expected under independency of the two classifications are given within parentheses in Table 1.1.

The observed frequencies differ considerably from the frequencies to be expected had the two classifications of the individuals in the sample been independent of each other. The question now is whether these discrepancies between the corresponding entries in the table are such as could have arisen from random sampling errors alone or whether they are indicative of a real difference between categories in the two classifications. To answer this question we usually calculate what is called the *Chi square statistic* using,

$$X^2 = \sum_{ij} \frac{n_{ij} - \frac{(n_{i+})(n_{+j})}{n}}{\frac{(n_{i+})(n_{+j})}{n}} = \sum_{\text{all cells}} \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected frequency}} \quad (1.1)$$

Thus, for Table 1.1 we have,

$$\begin{aligned} X^2 &= \frac{(16 - 12.0)^2}{12.0} + \frac{(51 - 40.8)^2}{40.8} + \dots + \frac{(163 - 134.4)^2}{134.4} \\ &= 1.33 + 2.55 + \dots + 6.09 = 28.06 \end{aligned}$$

However, formula (1.1) gives only an approximate value for the required statistic. The exact value of the Chi-Square statistic is given by,

$$X^2 = 2 \sum_{ij} n_{ij} \log \left\{ n_{ij} + \frac{(n_{i+})(n_{+j})}{n} \right\}$$

$$= 2 \left\{ n_{ij} \log (n_{ij}) - n_{i+} \log (n_{i+}) - n_{+j} \log (n_{+j}) + n \log (n) \right\} \quad (1.2)$$

where log refers to natural logarithm (and not logarithm to base 10). We shall use formula (1.2) in place of (1.1) to calculate the Chi-square statistic in contingency tables.

For Table 1.1, formula (1.2) gives,

$$X^2 = 2 [16(2.77) + \dots + 163(5.09) - (120(4.79) + \dots - 280(5.63) + 500(6.21)]$$

$$= 28.30$$

Any Chi-square statistic is characterised by a number associated with it, which is called the *degrees of freedom* (d. f.). If any of the four cell frequencies in Table 1.1 are known to us, then other cell frequencies in it can be obtained with the help of margin totals. Therefore, Table 1.1 is said to possess 4 degrees of freedom. Generally, a contingency table of "r" rows and "c" columns has (r-1) (c-1) degrees of freedom. Thus, for Table 1.1, (3-1) (3-1) = 4 d.f.

We may restate our problem as follows. Test,

Null Hypothesis, H_0 = The occupational achievement of an individual is independent of his educational ability

against, Alternative Hypothesis, H_1 = The occupational achievement of an individual depends on his educational ability.

If we test at 5% level of significance (that is, we are 95% sure that we take the correct decision) using Chi-Square Table, we have,

$$X^2_4 (=28.30) > X^2_{4, 0.05} (=9.49)$$

Hence, we reject H_0 , and conclude that educational ability significantly affects the occupational achievement.

In situations where we reject the null hypothesis which postulated that there is independence between the classifications, we may say that there is association between the classifications. In such situations, it is useful to examine the direction of the association too. It can be accomplished by comparing the observed and expected frequencies in the

cells at the opposite corners of the contingency table. In the above example we see that by comparing the observed and expected frequencies at the upper-right and the lower-left cell of Table 1.1 $53 < 67.2$ and $20 < 24.0$. Thus, the direction of the association is that lower educational ability is a hindrance to higher occupational achievement.

1.2 Decomposing Contingency Tables

Once the Chi-square statistic is computed for a contingency table, sometimes it is useful to decompose the original table into several sub-tables. The purpose of such a decomposition is to partition the original Chi-square into several components which will provide a better understanding of the relationship between the characteristics under study than what is available from the overall Chi-square alone. By knowing the sub-tables of the original table that give significant Chi-square we can find specifically where the relationship is located within subsets of that categories of the two characteristics.

To illustrate the technique, let us consider the data in Table 1.4 which presents the distribution of sample of Grade I students according to the number of years of pre-school training they had and their progress in Grade I.

Table 1.4

Distribution of Sample of Grade 1 Students According to the Number of Years of Pre-Schooling and Progress in Grade I

No. of years of pre-school training	Progress in grade 1			Total
	Weak	Medium	Good	
0	2	23	7	32
1	14	31	12	57
2	12	25	6	43
More than 2	6	12	0	18
Total	34	91	25	150

In an attempt to see whether there is any association between the number of years of pre-schooling the Grade 1 students have had and their progress in Grade 1, we may proceed as in Sec. 1.1. Thus, we have (at the 5% level of significance)

$$X^2_{6, 0.05} (=15 \cdot 16) X^2_{6, 0.05} (=12 \cdot 59)$$

from which it can be inferred that there is a significant association between the pre-school training a child has had and the progress he/she has made in Grade 1.

Let us now decompose Table 1.4 into two sub-tables as in Table 1.5. Again on proceeding as in Sec. 1.1 we have (at the 5% level of significance),

$$\text{For Table 1.5 (a) : } X^2_{2, 0.05} (=7.40) > X^2_{2, 0.05} (=5.99)$$

$$\text{For Table 1.5 (b) : } X^2_{4, 0.05} (=7.76) > X^2_{4, 0.05} (=9.40)$$

Table 1.5

A Decomposition of Table 1.4

(a)					(b)				
Pre-school training (years)	Progress in Gr. I			Total	Pre-school training (years)	Progress in Gr. I			Total
	Low	Medium	High			Low	Medium	High	
0	2	23	7	32	1	14	31	12	57
1 or more	32	68	18	118	2	12	25	6	43
					2+	6	12	0	18
Total	34	91	25	150	Total	32	68	18	118

Thus, Table 1.5(a) reveals that there is a significant association between the progress of children in Grade 1 and the amount of pre-school training they have had. The direction of association is such that (since 7.53 and 3226.7, where 5.3 and 26.7 are the respective expected frequencies) children without pre-school training tend to show "high" progress than the rest. Table 1.5(b) reveals that progress in Grade 1 is independent of the number of years of pre-school training.

It is possible to summarise the various Chi-squares we have calculated in order to see more clearly how the overall Chi-square breaks down. Such a summary is in Table 1.6. without decomposing the overall Chi-square it would have been difficult to arrive at the above detailed understanding of the data.

Table 1.6

Decomposition of overall Chi-square of Table 1.4

Source	d f	X ²	Significant
With & without pre-schooling Vs Progress	2	7.40	Yes
With varying no. of years of pre-schooling Vs Progress	4	7.76	No
Total	6	15.16	Yes

For a given contingency table there are many ways to decompose the overall Chi-square. Therefore, it is useful if we can have some rules to follow when decomposing contingency tables. The rules are simpler to express if the frequencies in a contingency table are defined as being of two types as shown in Table 1.3. One type (A) consists of the cell frequencies (n_{ij}) and the table total (n). The other type (B) consists of row totals and column totals (n_{i+} and n_{+j}).

The two rules for decomposing contingency tables are :—

- (1) Each frequency in the original table must appear once and only once as a frequency of the *same* type in one of the component tables.
- (2) Each frequency which is in a component table but not in the original table must appear in another component table as a frequency of the *other* type.

Note the manner in which we have fulfilled these two rules in decomposing Table 1.4 into Tables 1.5 (a) and 1.5 (b).

2. Association and Correlation in Social Data

Much of the effort in analysis of social data is directed towards evaluating and interpreting *associations* among variables. One way of defining association is as follows. Two variables are associated when the distribution of values of one differs for different values of the other. When working with ordinal or metric data, we often speak of “correlation” than of “association”. Correlation suggests two factors increasing or decreasing together, while association suggests two factors occurring together. The level of association (or correlation) is usually indicated by a suitable measure constructed for the purpose. Out of the many measures of association available in the literature only a few will be presented here.

The choice of a measure of association for a given problem depends, among other factors, on the scale of measurement used in measuring the characteristics. The measures outlined in Sec. 2.1, namely χ^2/χ and χ are suitable for nominal level data. The index in Sec. 2.2 is for ordinal level data. Finally, correlation coefficient in Sec. 2.3 is for metric data.

2.1 Goodman and Kruskal's Index of Proportional Reduction of Probably Error.

Consider the data of Table 2.1 which deal with the relationship between the level of mass media exposure and knowledge of fertilizer recommendation of a sample of farmers. Suppose we select a farmer from the area from which this sample has been taken. Should we guess that his knowledge about fertilizer recommendations is good or bad ?

Table 2.1

Distribution of a Sample of Farmers According to the Mass Media Exposure and Knowledge of Fertilizer Recommendations

Level Mass Media exposure	Knowledge of Fertilizer Recommendation		Total
	Good	Poor	
Low	25	55	80
High	20	10	30
Total	45	65	110

Note: $\chi^2_1 (=5.64) > \chi^2_{1, 0.05} (=3.84)$

Since, out of 110 farmers in the sample majority have a poor knowledge of fertilizer use we will be better off, although not by much, in guessing that his knowledge is poor. Suppose, however, that we are told that he has high mass media exposure. Then a better guess is that his knowledge of fertilizer use is good, because out of 30 with high mass media exposure majority have a good knowledge. The additional information about the farmer's background helps us to make a better guess about his knowledge of fertilizer use.

How much better will be our guess, if the extent of mass media exposure of the individual is known to us? Without this information we should be mistaken 45/110 of the times. With this information, we shall be mistaken in 10 of the 30 cases and in 25 of the 80 cases : a total of 35 of the 110 cases. Our error is reduced from 45 out of 110 cases to 35 out of 110 ; a reduction of probable error of 10 cases from the original 45. We shall take the proportional reduction of probability error as the measure of association in the table, and denote by (knowledge/media exposure).

The formulae for $\lambda_{y/x}$ when the row variable (x) is given and predicting the column variable (y) is

$$\lambda_{y/x} = \frac{\sum_{\text{over all rows}} \left\{ \begin{array}{l} \text{(largest cell frequency)} \\ \text{in row} \end{array} \right\} - \left\{ \begin{array}{l} \text{largest column} \\ \text{total} \end{array} \right\}}{n - \text{largest column total}} \quad (2.1)$$

For the example discussed above,

$$\lambda_{\text{(knowledge/media exposure)}} = \frac{(55 + 20) - 65}{110 - 65} = \frac{10}{45} = 0.22$$

The above value of $\lambda_{y/x}$ is interpreted as follows : There is a 22% reduction in the probable error in predicting the knowledge on fertilizer when we are told about the farmer's level of media exposure.

The index lies between 0 and 1. It is zero if the knowledge of the x classification is of no help in predicting the y classification and then we may say that there is no predictive association. It is 1 if the knowledge of an individual's x class completely specifies his y class and then we say that there is complete predictive association. It needs to be emphasised that this idea is not completely equivalent to statistical independences and association as referred to by Chi-square statistics.

The above index is an asymmetric measure since, in general $\lambda(y/x)$ and $\lambda(x/y)$ will not be identical. It is possible, however, to develop a symmetric measure of mutual association by assuming that half the time we are predicting in one direction and half the time in the other. The formula that results is,

$$\lambda = \frac{\sum \left\{ \begin{array}{c} \text{largest frequency} \\ \text{in row} \end{array} \right\} + \sum \left\{ \begin{array}{c} \text{largest frequency} \\ \text{in column} \end{array} \right\} - \frac{\text{largest row}}{\text{total}} - \frac{\text{largest column}}{\text{total}}}{2n - \text{largest row total} - \text{largest column total}}$$

For the data of Table 2.1,

$$\lambda = \frac{55 + 20 + 25 + 55 + 80 - 65}{2(110) - 80 - 65} = \frac{10}{75} = 0.13$$

This may be interpreted as follows: there is a 13% reduction in the probable error of prediction when we are given information about media exposure half the time and information about knowledge of fertilizer use half the time.

2.2 Goodman and Kruskal's Index of Predictive Association λ , in Ordered Classes

This index depends on the number of pairs in which attributes are positively associated and the number of pairs in which attributes are negatively associated. Let us first see how positive and negative pairs are counted.

Suppose we have the following rankings of three undergraduates called Alwis, Basil and Charlie, on both ability in mathematics and ability in chess playing.

	Alwis	Basil	Charlie
Ranking in Maths	1	2	3
Ranking in Chess	2	1	3

We can now examine the three pairs of the three undergraduates and see whether mathematical and chess playing abilities are associated in each pair. The results are as in Table 2.2.

Table 2.2

Pairing of 3 undergraduates ranked on two qualities

Pair	Rank in Maths	Rank in Chess	Direction of Relationship
(1) Alwis	1	2	Opposite (—)
Basil	2	1	
(2) Alwis	1	2	Same (+)
Charlie	3	3	
(3) Basil	2	1	Same (+)
Charlie	3	3	

Let us denote by P the number of positive pairs where there is a direct relationship and by Q the number of negative pairs where there is an opposite relationship. Then for Table 2.2, $P = 2$ and $Q = 1$.

Suppose now we have 30 undergraduates classified according to both mathematical ability and chess-playing ability as in Table 2.3. To calculate the number of positive and negative pairs for such a table.

Table 2.3

Thirty Undergraduates Classified According to Mathematical and Chess-playing Abilities

Mathematical ability	Chess - playing ability			Total
	High	Medium	Low	
High	6	3	1	10
Medium	4	5	1	10
Low	0	2	8	10
Total	10	10	10	30

We have the following rules :

- (i) The number of positive pairs, P , is the sum obtained by multiplying each frequency by the sum of all the frequencies that are both *below* and to the *right* of it, and
- (ii) The number of negative pairs, Q , is the sum obtained by multiplying each frequency by the sum of all frequencies that are both *below* and to the *left* of it.

It needs to mention that before applying the above rules, we must arrange the rows and column of the table so that they are similarly ordered from top to bottom and from left to right, as in Table 2.3.

Applying the above rules to Table 2.3, we have

$$\begin{aligned}
 P &= 6(5 + 1 + 2 + 8) + 3(1 + 8) + 4(2 + 8) + 5(8) \\
 &= 96 + 27 + 40 + 40 = 203
 \end{aligned}$$

$$\begin{aligned}
 Q &= 1(4 + 5 + 0 + 2) + 3(4 + 0) + 1(2 + 0) + 5(0) \\
 &= 11 + 12 + 2 + 0 = 25
 \end{aligned}$$

The formula for δ , the Goodman & Kruskal's Index of Predictive Association in terms of P and Q is,

$$\delta = \frac{P - Q}{P + Q} \quad (2.3)$$

For the data of Table 2.3,

$$\delta = \frac{203 - 25}{203 + 25} = \frac{178}{228} = 0.78$$

This indicates that among pairs where there was difference in both abilities, the proportion in which high mathematical ability went with high chess-playing ability was 78% greater than the proportion in which high mathematical ability went with low chess-playing ability.

The index lies between -1 and +1. It is +1 if the data are concentrated in the upper -left to lower -right diagonal of the table and is -1 if the data are concentrated in upper -right to lower -left diagonal of the table. δ is a symmetric measure.

2.3 Pearson's Product - Moment Correlation Coefficient

When we work with data in interval or ratio scale generally we want to know the extent to which there is a *linear relationship* between the variables, a situation in which a change of a certain number of units in one variable results in a proportionate change in the other variable. A measure that indicates the strength of the linear association between two variables is the well known *correlation coefficient* r . If x and y denote the two variables, the correlation coefficient is defined as follows :

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2} \sqrt{\sum (y - \bar{y})^2}} \quad (2.4)$$

In calculating r , it is easier to use the following formula :

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}} \quad (2.5)$$

To use (2.5), we need first to calculate the five quantities $\sum x$, $\sum y$, $\sum xy$, $\sum x^2$ and $\sum y^2$.

The correlation coefficient lies between -1 and +1. It is +1 if there is perfect positive relationship between the variables (i.e. when the graph of the points lie on a straight line sloping upwards). It is -1 if there is a perfect negative relationship between the variables (i.e. when the points lie on a straight line sloping downwards), r is a symmetric measure. While r can be interpreted as a measure of the closeness of the data to a straight line,

r^2 can be interpreted as the proportion of variation in one variable that is explained by the other. Note that $r=0$ indicates only the absence of a linear relationship ; in such a situation it is possible a curvilinear relationship that exists.

As an example consider the data of Table 2.4 which are from the *Sri Lanka Fertility Survey—1975*.

Table 2.4

Percentage of women who want no more children or have been sterilized,
by the number of children living

No. of children living (x)	=	0	1	2	3	4	5	or more
Percentage of women who want no more children (y)	=	2	14	50	73	87	93	

Taking "5 or more" as "5" for Table 2.4, we have, $\sum x = 15$, $\sum y = 319$,
 $\sum xy = 1146$, $\sum x^2 = 55$, $\sum y^2 = 24247$. Now substituting in (2.5),

$$r = \frac{6(1146) - (15)(319)}{\sqrt{6(55) - (15)^2} \sqrt{6(24247) - (319)^2}} = \frac{2091}{\sqrt{105} \sqrt{43721}} = 0.976$$

This value, since it is very close to +1, indicates strong linear relationship between the two variables under study. Further we observe that $r^2 = (0.976)^2 = 0.952$.

This may be interpreted as 95.2% of the variation in data on percentage of women who want no more children is explained by the number of living children they have.

Table 2.5

Variation in cost of production per copy of a school text book according to
the number of copies printed

No. of copies (Thousand, x)	1	2	3	5	10	20	30
Production cost per copy (Rs. y)	10.2	5.5	4.1	2.8	2.1	1.6	1.4

As an another example consider the data of Table 2.5. Let us calculate the correlation coefficients (a) between x and y and (b) between $1/x$ and y. For that we need,

$$\sum x = 71, \sum y = 27.7, \sum xy = 142.5, \sum x^2 = 1439, \sum y^2 = 167.87$$

$$\sum (1/x) = 2.2167, \sum (y/x) = 15.2133, \sum (1/x)^2 = 1.1447$$

Then using (2.5) we have,

$$(a) r_{x,y} = -0.6766$$

$$(b) r_{1/x,y} = 0.9996$$

While (a) indicates an inverse moderate relationship between x and y , (b) indicates that there is a perfect linear relationship between $1/x$ and y . Thus the transformation of the variable x to $1/x$ has provided us with an "improved" relationship.

The correlation coefficient is one of the measures in statistics that is more frequently misused than used correctly.

3. Relationships in Social Data: Regression Analysis

Sometimes it is desired to know how well several independent variables taken together explain the variation in the dependent variable. The criterion used is how closely a function of the independent variables—having a specified form with unspecified parameters—could predict the dependent variable. Regression analysis is an important and general statistical technique in drawing such inferences.

3.1 Simple Regression Model

A simple regression model has two variables, one called the independent variable and the other called the dependent variable, which are usually denoted by x and y respectively. In symbolic form, a simple regression equation can be written as :

$$Y = \alpha + \beta X + e \quad (3.1)$$

where α and β are called *parameters* which need to be calculated and e is called the *error*. The parameters are determined using the *principle of least squares*. For testing hypotheses concerning the parameter, we assume that errors (e 's) are independently normally distributed with zero mean and same variance².

To present the result in a convenient form define the following "corrected sum of squares".

$$\begin{aligned} CS(x^2) &= \sum x^2 - n(\bar{x})^2 \\ CS(xy) &= \sum xy - n(\bar{x})(\bar{y}) \\ CS(y^2) &= \sum y^2 - n(\bar{y})^2 \end{aligned}$$

where $\bar{x}$ and $\bar{y}$ are the means of n observations of x and y respectively. The following are well known results.

$$\text{Estimate of } \beta = b = \frac{CS(xy)}{CS(x^2)} \quad (3.2)$$

$$\text{Estimate of } \alpha = a = \bar{y} - b\bar{x} \quad (3.3)$$

$$\text{Estimate of } \sigma^2 = s^2 = \frac{1}{n-2} [CS(y^2) - b^2 CS(x^2)] \quad (3.4)$$

$$\text{Standard error of } b = s_b = s \sqrt{\frac{1}{CS(x^2)}} \quad (3.5)$$

$$\text{Standard error of } a = s_a = s \sqrt{\frac{1}{n} + \frac{(\bar{x})^2}{CS(x^2)}} \quad (3.6)$$

To test whether each parameter is significantly different from zero, we use the appropriate "t—statistics,"

$$t = \frac{a}{s_a}; \quad t = \frac{b}{s_b} \quad (3.7)$$

Here "n-2" indicates the degrees of freedom. A measure of goodness-of-fit of the fitted regression equation to the data is given by the coefficient of determination R^2 where

$$R^2 = \frac{[CS(xy)]^2}{CS(x^2) CS(y^2)} \quad (3.8)$$

By multiplying by 100, R^2 is usually expressed as a percentage. Then $100R^2$ lies between 0 and 100 ; figures closer to the upper limit indicate a better fit.

As an example let us fit a simple regression equation (3.1) to the data of Table 2.4. We see that it is appropriate to consider the number of children living as the independent variable (x) and the percentage of women who want no more children or have been sterilized as the dependent variable (y) . Then we have,

$$\begin{aligned} CS(x^2) &= 17.50 & CS(xy) &= 348.5 & CS(y^2) &= 7286.83 \\ b &= 19.91 & a &= 3.38 & s^2 &= 86.68 \\ s_b &= 2.23 & s_a &= 6.74 & R^2 &= 0.952 \end{aligned}$$

The fitted regression model is usually presented as,

$$\begin{array}{rcl}
 y & = & 3.38 + 19.91 x \\
 \text{Standard error} & & 6.74 \quad 2.23 \\
 t\text{-value (d.f. = 4)} & & 0.50 \quad 8.93
 \end{array}
 \quad R^2 = 95.2\% \quad (3.9)$$

Since $t_4 (=0.50) < t_{4, 0.025} (=2.776)$ we observe that the constant term is not significant at the 5% level. This points out that a better model for the data in Table 2.4 is,

$$Y = \beta X + e$$

which indicates a straight line through the origin. Here we use the following results.

$$\begin{aligned}
 b &= \frac{\sum xy}{\sum x^2}, s^2 = \frac{1}{n-1} [\sum y^2 - b^2 \sum x^2], \quad b = s \sqrt{\frac{1}{\sum x^2}} \\
 R^2 &= \frac{[xy]^2}{(x^2)(y^2)}
 \end{aligned}$$

Now the fitted regression model is,

$$\begin{array}{rcl}
 y & = & 20.84 x \\
 \text{standard error} & & 1.16 \\
 t\text{-statistics (d.f. = 5)} & & 17.97
 \end{array}
 \quad R^2 = 98.5\% \quad (3.10)$$

We observe that (3.10) is a better model than (3.9) for data in Table 2.4. Equation (3.10) tells that for every additional child a family receives about 1 in 5 families decides to have no more children.

3.2 Multiple Regression Model

The concept developed in Section 3.1 can be easily extended to situations with more than one independent variable. Then in place of the simple regression model, we have the *multiple regression model* which can be written as,

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + e \quad (3.11)$$

We do not intend to present the formulas for the estimation of parameters of (3.11) and the other quantities, but the reader is referred to a standard text like N.R. Draper and R. Smith (1966) *Applied Regression Analysis*.

During the application of regression analysis to social data where some of the variables are in nominal or ordinal scale, special treatment is necessary. Suppose we have the three variables, monthly income (y) age (x_1) and education which is in ordinal scale with three categories primary, secondary and tertiary. Then we may define the dummy variables x_2 and x_3 to represent education as follows :

	X_2	X_3
Primary	0	0
Secondary	1	0
Tertiary	1	1

We then use the regression model defined as,

$$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$$

which provides us with the following interpretations :

For given X_2, X_3 , $\alpha + \beta_1 X_1$ represents the mean income for those with primary education

For given X_1, X_3 , $\alpha + \beta_1 X_1 + \beta_2 X_2$ represents the mean income for those with secondary education

For given X_1, X_2 , $\alpha + \beta_1 X_1 + \beta_3 X_3$ represents the mean income for those with tertiary education

3.3 An Overview of Regression Analysis

In a regression model there several assumptions that need to be satisfied by the variables and the errors. One of the assumptions is that the independent variables are not strongly correlated among themselves. This assumption is usually invalid in socio-economic variables. This is known as the problem of *multicollinearity*. The best way to minimise the effect of multicollinearity is to select the variables carefully. Sometimes it may be possible to replace the independent variables by one or two uncorrelated "new variables" which are defined as linear combinations of the original variables, using the *principal component analysis*.

Another assumption is that variance σ^2 is constant and independent of the values of x_i 's. When σ^2 is correlated with x_i 's the problem is known as *heteroscedasticity*. This may be overcome using *weighted regression analysis*.

Another problem with the residual errors may be that the errors are *autocorrelated* instead of being independent. This problem is more important in the analysis of time series data. Survey data being cross-sectional, the problem may not arise. The *Durbin-Watson test statistic* can be used to detect autocorrelation in the residuals. If autocorrelation is present it will be advisable to make appropriate transformation of the variables which will make the residuals independent.

Formal conditions which the variables and residuals should satisfy for the valid application of a regression model are rarely satisfied by socio-economic data. However, it is encouraging to observe that a regression model is fairly robust unless the departures from standard assumptions are serious.

All mini-computers have package programmes for regression analysis. So the actual computational work has been simplified a lot. However, it is always advisable and instructive to tabulate the data in simple contingency tables and present the data in various graphical forms before going in for a large regression model.

4. Analysis of Variance

The analysis of variance (ANOVA) is a statistical procedure which makes it possible to compare the effects of the variables being studied, first independently of the effects of all other variables, and second in all possible combinations with one another. In ANOVA

all the standard general theories of statistics such as point and interval estimation and hypothesis testing come into play. Although the ANOVA was originally developed in the analysis and interpretation of data collected from agricultural experiments, in recent years, the technique is being extensively used in disciplines in which experimental designs are not always possible, such as in social sciences. Assumptions made in the ANOVA are—

- (a) The populations from which the samples are drawn are normally distributed (or at least similar in distribution).
- (b) Samples are randomly drawn.
- (c) The observations in each sample are independent (hence the test is not appropriate for paired observations).
- (d) Common variance exists among the populations from which the samples are drawn (i.e. the so called heteroscedasticity is absent).

For some models of ANOVA the assumption (a) may be violated if the samples are large, and also assumption (d), if the number of cases in each sample is the same. But, in general, if the assumptions are not clearly met, the ANOVA will yield false results. The purpose of the analysis is to partition the variance of the dependent variable into components attributable to each of the influencing variable.

4.1 Replicated Two-way Classification

Consider the data in Table 4.1 which presents the yields of four varieties of paddy in three locations in each of the three districts Kalutara, Kandy and Anuradhapura. By analysis of variance of these data we will be able to answer the following questions :

- (i) Is there a significant difference between the yields of the four varieties of paddy, or between any group of paddy varieties?
- (ii) What is the additional yield (above the overall average) due to each paddy variety?
- (iii) Is there a significant difference between the yields in the three districts?
- (iv) What is the additional yield (above the overall average) from each district?
- (v) Is there a significant “interaction” between paddy varieties and districts?
- (vi) Which of the paddy varieties can be recommended for each district?
- (vii) What is the expected average yield in each district with the recommended paddy variety?

Table 4.1

Yields of 4 varieties of paddy in 3 locations in each of 3 districts

(bushels per acre)

Paddy variety	DISTRICTS		
	Kalutara (D_1)	Kandy (D_2)	Anuradhapura(D_3)
P_1	71, 75, 72	79, 81, 78	75, 73, 79
P_2	66, 70, 65	69, 68, 66	68, 70, 72
P_3	61, 63, 62	68, 66, 68	71, 74, 68
P_4	64, 62, 65	69, 70, 73	79, 81, 77

The computations during the analysis becomes simpler if we code the data by subtracting a construct number from each of the observation. We proceed with the coded data in Table 4.2.

Table 4.2

Coded data obtained by subtracting 70 from each observation of Table 4.1

	D_1	D_2	D_3	T_{i++}	$\bar{y}_{i++}$
P_1	1, 5, 2	9, 11, 8	5, 3, 9	53	5.89
P_2	-4, 0, -5	-1, -2, -4	-2, 0, 2	-16	-1.78
P_3	-9, -7, -8	-2, -4, -2	1, 4, -2	-29	-3.22
P_4	-6, -8, -5	-1, 0, 3	9, 11, 7	10	1.11
T_{+j+}	-44	15	47	18 = G	—
$\bar{y}_{+j+}$	-3.67	1.25	3.92	—	0.5 = $\bar{y}$

We assume the following Model :

$$(i = 1, \dots, 4, j = 1, 2, 3 \text{ and } k = 1, 2, 3)$$

where

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + e_{ijk}$$

Y_{ijk} = Observed yield,

μ = Grand mean,

α_i = Additional yield due to i^{th} paddy variety,

β_j = Additional yield due to j^{th} district,

γ_{ij} = Additional yield due to ij^{th} interaction effect,

e_{ijk} = Error assumed to be $N(0, \sigma^2)$

We calculate the following “sums of squares” :

$$CSS_{\text{Total}} = \sum_{ijk} y^2 - \frac{G^2}{abc} = (1^2 + \dots + 7^2) - \frac{18^2}{(4)(3)(3)} = 1097$$

$$SS_{\text{Paddy}} = \frac{1}{bc} \sum_i T_i^2 - \frac{G^2}{abc} = \frac{1}{9} (53^2 + \dots + 10^2) - 9 = 436.11$$

$$SS_{\text{District}} = \frac{1}{ac} \sum_j T_j^2 - \frac{G^2}{abc} = \frac{1}{12} (44^2 + \dots + 47^2) - 9 = 355.17$$

$$SS_{\text{Error}} = \sum_{ijk} y^2 - \frac{1}{c} \sum_{ij} T_{ij}^2 = 1109 - \frac{1}{3} (8^2 + \dots + 27^2) = 702.6$$

$$SS_{\text{Interaction}} = CSS_T - SS_P - SS_D - SS_E = 203.05$$

The results are usually presented as in Table 4.3 which is known as ANOVA Table.

Table 4.3

ANOVA Table for data in Table 4.1

Sourde	d.f.	s.s.	Mean ss Square = $\frac{ss}{df}$	F value	F 0.05 (from F— table)
Between paddy	a—1 = 3	436.11	145.37	33.96	3.01
Between districts	b—1 = 2	355.17	177.58	41.49	3.40
Interaction	(a—1)(b—1)=6	203.05	33.84	7.91	2.51
Error	ab(c—1) = 24	102.67	4.28 = s^2	—	—
Total (corrected)	abc—1 = 35	1097.00	—	—	—

On comparing the last two columns in Table 4.3, it can be inferred that,

- (a) There is a significant difference between the yields of paddy varieties.
- (b) There is a significant difference between the yields in the three districts.
- (c) There is a significant “interaction” between the paddy varieties and districts.

The additional yields due to each factor are calculated as follows :

Due to paddy, $\hat{\alpha}_i = \bar{y}_i + + - \bar{y}$

Due to districts, $\hat{\beta}_j = \bar{y} + j + - \bar{y}$

Due to interaction, $\hat{\gamma}_{ij} = \bar{y}_{ij} + - \bar{y}_i + + - \bar{y}_{+j} + + \bar{y}$

Thus we have the following results,

P_3	P_2	P_4	P_1
-3.72	-2.28	0.61	5.39
D_1	D_2	D_3	
-4.17	0.75	3.42	

$\hat{\gamma}_{ij}$ Values

$i \backslash j$	D_1	D_2	D_3
P_1	0.94	2.69	-3.64
P_2	2.94	-1.31	-1.64
P_3	-0.61	-0.19	0.18
P_4	-3.28	-1.19	4.47

Finally, we have the following recommendations with the respective expected average yields

District :	Kalutara (D_1)	Kandy (D_2)	A'pura (D_3)
Paddy variety :	P_1	P_1	P_4
Expected Average yield,			

$$\bar{y}_{ij} = \mu + \alpha_i + \beta_j + \gamma_{ij} : \bar{y}_{11} = 72.7 \quad \bar{y}_{12} = 79.7 \quad \bar{y}_{43} = 79.0$$

5. Non-Parametric Statistical Methods

Non-parametric statistical methods are based on explicitly weaker assumptions than such classical parametric procedures as Student's t — tests, regression analysis and analysis of variance. The underlying motivation for the use of non-parametric methods is the reluctance to make the traditional parametric assumptions, in particular (but not only) the assumption of normality. An advantage of some, but by no means all, non-parametric methods is that they are easy and quick to apply.

5.1 The W Test for Two Independent Samples

The Wilcoxon - Mann - Whitney (W-M-W or W) test is used for two independent samples. The objective is to detect whether the two underlying populations are centered differently.

Consider the data in Table 5.1 which presents annual incomes of independent random samples of households from two villages.

Suppose we want to test the null hypothesis that the underlying populations are identical. Suppose the alternative hypothesis is that village "X" is poor, so that one-sided test is appropriate.

Table 5.1

Annual Incomes of Samples of households
from two villages

Village "X"	Village "Y"
3000	3500
4000	5000
5500	7000
8000	7500
	8500
	9000
	10000
	12000
No. of m-4 observations	n=8

Table 5.2

Combined ranking of data of Table 5.1
and W Statistics

Village "X"	Village "Y"
3000(1)	3500(2)
4000(3)	5000(4)
5500(5)	7000(6)
	7500(7)
8000(8)	8500(9)
	9000(10)
	10000(11)
	12000(12)
Sum W=17 of ranks	

We combine the observations X and Y and rank them as in Table 5.2. The actual income levels have now been replaced by ranks providing a test that is not affected by skewness of the data—thus a distribution-free test. The test statistic W is the sum of all the X ranks. Thus,

$$W = 1 + 3 + 5 + 8 = 17 \quad (5.1)$$

In large samples, when $n > 7$, W is approximately normally distributed with,

$$\text{Mean, } \mu = \frac{1}{2} m(m+n+1) \quad (5.2)$$

$$\text{Variance } \sigma^2 = \frac{1}{12} mn(m+n+1) \quad (5.3)$$

when m and n are the number of observations in each sample. Thus, we can use the normal tables for significant tests.

In our example, $m = 4$ and $n = 8$ and thus,

$$\mu = \frac{1}{2}(4)(13) = 26, \quad \sigma^2 = \frac{1}{12}(4)(8)(13) = 34.7$$

To test the null hypothesis we calculate the value of "z" and compare it with the value of z from the normal table at a given level of significance. Now,

$$z = \frac{W - \mu}{\sigma} = \frac{17 - 26}{\sqrt{34.7}} = -1.53$$

Since at the 5% level of significance $z = -1.64$, the above value of z does not fall into the critical region. Hence, we accept the null hypothesis that the underlying populations are identical.

5.2 The Kruskal-Wallis Test : One - way Analysis of Variance by Ranks

The Wilcoxon-Mann-Whitney test for two independent samples, presented in Section 5.1, may be extended to the situation of k independent samples, where $k > 2$.

Consider the data of Table 5.3 in which four teaching methods are compared for effectiveness with four groups of students in grade 2. Suppose we want to test the null hypothesis that the four teaching methods are equally effective against the alternative hypothesis that certain teaching methods are more effective than others.

Table 5.3

Scores obtained by grade 2 students under each teaching method and the computation of the test statistic.

Teaching Method			
A	B	C	D
70(13.5)	65(9.5)	70(13.5)	80(21)
89(25)	65(9.5)	68(12)	81(22)
86(23)	60(3)	58(2)	75(19)
73(16)	72(15)	61(4)	74(17.5)
63(6.5)	57(1)	74(17.5)	63(6.5)
64(8)	62(5)		78(20)
67(11)			88(24)
Totals $R_i = 103$	43	49	130
No. of observations $n_i = 7$	6	5	7

To apply the Kruskal-Wallis test, we first rank the observations from the lowest value to the highest value, taking care to assign the average rank in the case of tied observations. The test statistic is as defined below and it has a chi-square distribution with $(k-1)$ d.f. when $k \geq 3$ and smallest $n_i > 5$.

$$T = \frac{12}{n(n+1)} \sum_{i=1}^K \frac{R_i^2}{n_i} - 3(n+1) \quad (5.4)$$

where $n = n_1 + \dots + n_k$, total number of observations

R_i = total of ranks for i^{th} sample

n_i = no. of observations in i^{th} sample

k = no. of samples.

For data of Table 5.3

$$T = \frac{12}{25(25+1)} \left[\frac{103^2}{7} + \frac{43^2}{6} + \frac{49^2}{5} + \frac{130^2}{7} \right] - 3(25+1)$$

$$= 9.11$$

since $T (=9.11) > x_{3, 0.05}^2 (= 7.81)$, we can reject the null hypothesis at the 5% level of significance and conclude that there is a significant difference between the effectiveness of the four teaching methods.

5.3 Runs test for Testing Randomness

One of the most crucial assumptions (even more important than the normality assumption) we frequently make in statistical methods is that our observations constitute a random sample. Let us see how we can test a given sequence of observations for randomness.

Consider a coin tossing experiment which has resulted in the following sequence of heads (H's) and tails (T's) :

$$\begin{array}{cccccccccccccccccccc} \text{T} & \text{T} & \text{T} & \text{T} & \text{T} & \text{H} & \text{H} & \text{T} & \text{T} & \text{H} & \text{T} & \text{T} & \text{T} & \text{H} & \text{H} & \text{T} & \text{H} & \text{H} & \text{T} \\ \text{H} & \text{T} & \text{H} & \text{H} & \text{T} & \text{H} & \text{T} & \text{T} & \text{H} & \text{H} & \text{H} & \text{H} & \text{T} & \text{T} & \text{T} & \text{H} & \text{H} & \text{T} \end{array}$$

Suppose we want to test the null hypothesis that occurrence of heads and tails is random (In other words, we are testing that the coin is unbiased).

The test procedure is based on the number of *runs* in the set of observations. Any sequence of like observations, bounded by observations of a different type, is called a *run*. Thus, in the above set of observations, first 5 T's constitutes one run, next 2 H's another run and so on. It is convenient to indicate each run by drawing a line under each sequence of like observations, as in the example above. If we denote the total number of runs by U , then we have $U = 21$. Further, denote the number of H's and number of T's by m and n respectively. When both m and n are large, U has approximately a normal distribution with,

$$\text{Mean, } \mu_u = \frac{2mn}{m+n} + 1$$

$$\text{variance, } \sigma_u^2 = \frac{2mn(2mn-m-n)}{(m+n)^2(m+n-1)}$$

The approximation is usually good enough for practical purposes when m or n exceeds 20. The null hypothesis is tested using a two-tail test ; if U is either too small or too large we suspect non-randomness.

In our example; $m = 18$, $n = 22$ and we had $u = 21$. Thus,

$$\mu_u = \frac{2(18)(22)}{18+22} + 1 = 20.8$$

$$\sigma_u^2 = \frac{2(18)(22)(792-18-22)}{(18+22)^2(18+22-1)} = 9.54$$

The two-tail test for the null hypothesis at the 5% level of significance is given by the following rule :

Reject the hypothesis if

$$Z = \frac{u-20.8}{\sqrt{9.54}} \geq 1.96$$

Accept the hypothesis otherwise.

In this example, $z = 0.06$ and so we accept the null hypothesis and conclude that the occurrence of heads and tails is random.

Measurement and Scaling of Scores

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1. Introduction

Measurement consists of assigning numbers according to rules to objects or persons to represent quantities of attributes. Procedures for assigning numbers have to be carefully formulated so that the scale of measurement that is used will faithfully reflect the attribute being measured.

Data obtained by measurement are subjected to various manipulations before we derive meaning from them. The nature of the scale of measurement sometimes restricts the kinds of statistical manipulations which can be made with the data. It is therefore useful to become familiar with the different kinds of measurement scales. When these scales are classified according to certain properties, they are also referred to as levels of measurement. The properties relevant to the question are magnitude, equal intervals, and absolute zero point.

When a scale has magnitude, a datum obtained by using the scale can be judged as greater than, equal to, or less than another datum obtained from it. A temperature of 29° is greater than that of 28° and less than 31° . If the measured temperature of two towns is each 29° , we say that they have an equal temperature.

Equal intervals relate to the property of the unit of measurement being the same at whatever point on the scale it occurs. The difference between 28° and 31° represents the same difference in temperature as between 35° and 38° .

A scale has an absolute zero point if it can indicate that nothing at all of the attribute being measured exists. When the number of children in the family is recorded, absence of any children is denoted by a zero.

A scale of measurement that has magnitude, equal intervals and an absolute zero point is a ratio scale. If a child weighs 28 kg. and his father weighs 56 kg., we can say that the father weighs twice as much as his son.

An interval scale possesses magnitude and equal intervals, but not an absolute zero point. A temperature of 30° is not twice the temperature of 15° .

A scale that reflects magnitude but does not possess equal intervals or an absolute zero is called an ordinal scale. A teacher ranks 10 students in a class according to their height. We know that the student ranked 2nd is taller than the one whose rank is 3, and he in turn is taller than the one ranked 4th, but we do not know what difference in height exists between the 2nd and the 3rd as well as between the 3rd and the 4th.

When all that a scale can do is to classify objects or persons into discrete groups or categories without any relation to magnitude, it is called a nominal scale. Classifying persons according to their religions or geographical location is an example of the use of a nominal scale. Although numbers can be used as labels for different categories, any kind of magnitude is not implied in their use.

2. Derived Score Scales

Obtained or raw scores are sometimes transformed to derive scores having desirable scale properties. The main purpose of such transformations is (1) to make scores from different tests comparable and (2) to change the shape of the distribution.

Measurements of human characteristics can rarely be obtained with reference to an absolute zero point. Nor can it be maintained that equal differences between raw scores represent equal differences in the trait being measured. Because of these limitations, the distribution of scores of a representative group is often taken as a frame of reference for transforming raw scores to make them comparable.

2.1 Percentile Ranks

The percentile ranks of a score is the percentage of persons in the reference group who obtain scores lower than or equal to that score. If in a distribution of scores, 72% of the group scored 61 or less, the score 61 is said to have a percentile rank of 72. Percentile ranking of scores assigns a rank to each score on a scale of 100.

The easiest way of computing percentile ranks is through the cumulative percentage distribution. Consider the distribution of scores in the following table :

<u>Raw Score</u>	<u>f.</u>	<u>Of to the mid point</u>	<u>Percentile Rank</u>
63	4	48	96
62	6	43.0	86
61	8	36.0	72
60	8	28.0	56
59	10	19.0	38
58	4	12.0	24
57	4	8.0	16
56	3	4.5	9
55	2	2.0	4
54	1	3.5	1
<u>N = 50</u>			

Column 3 of the table gives the cumulative frequency to the mid-point of each score. This is obtained by counting the number of persons below the score and adding one half of the number of persons getting that score. The percentile rank in column 4 is obtained by multiplying the value in column 3 by $\frac{100}{N}$.

When the data obtained are in the form of ranks, percentile ranks are best obtained by using the formula

$$PR_{(R)} = 100 \frac{(N - R + .5)}{N}$$

Where R is the rank to be converted to the percentile rank (PR) and N is the number of persons in the group. Suppose X has been rated 4th in a group of 10. His percentile rank will be

$$PR_{(R)} = 100 \frac{(10 - 4 + 0.5)}{10} = 65$$

The figure below explains this.

1	1	1	1	1	1	$\frac{1}{2}$	$\frac{1}{2}$	1	1	1
10	9	8	7	6	5	4	3	2	1	

3. Rank Order

When raw scores or ranks are converted to percentile ranks, a person's performance in different tests can be compared or different persons can be compared with one another.

It is not legitimate to sum percentile ranks to obtain composite scores. The percentile rank scale is an ordinal scale. Thus it does not possess equal points or an absolute zero point.

3.1 Standard Scores

Conversion of raw scores to standard scores yields a set of scores which are comparable and are of equal units. Here again, the group becomes the frame of reference. Standard scores are obtained by a linear transformation.

The first step in computing standard scores is the calculation of the mean and the standard deviation of the distribution. Each obtained score is expressed as a deviation from the mean and this deviation is divided by the standard deviation. The result is called a standard measure or a z score. The mean of the z score scale is 0 and the standard deviation is 1. As the scores below the mean will be negative and all except a few scored will have decimal fractions, it is customary to carry the linear transformation a step further by multiplying the z score by 10 or some such convenient number and adding a constant such as 50 or 100. The multiplier will be the new standard deviation and the constant will be the new mean.

Suppose the mean and the standard deviation of a distribution of scores were 40 and 12, and a person's obtained score was 56. When this score is transformed to a standard score of a scale with 50 as mean and 10 as its standard deviation, we will have—

$$\begin{aligned}
 Z &= \frac{(X - M) S'}{S} + M' \\
 &= \frac{(56 - 40) 10}{12} + 50 \\
 &= 13.3 + 50 \\
 &= 63
 \end{aligned}$$

Different distributions of scores become comparable when they are transformed into a common scale of standard scores. Whatever the earlier unit of measurement was, the new unit of measurement is a common one. In the “50—10” scale used above, the unit of measurement will be $\frac{1}{10}$ th of the standard deviation.

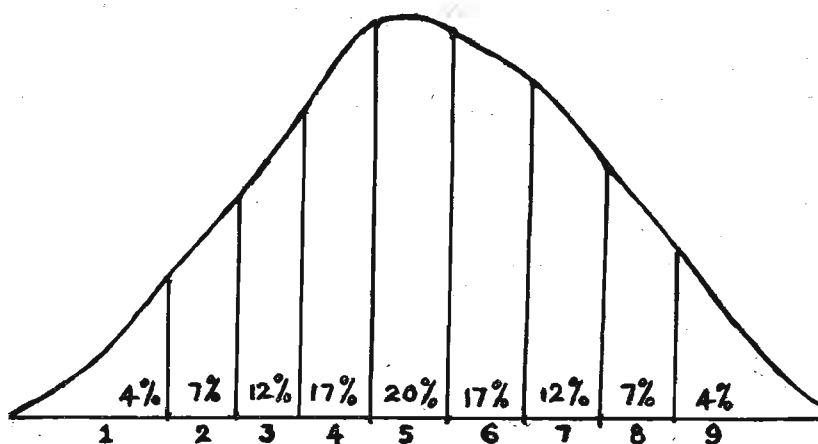
However, it should be noted that the comparability of standard scores does not hold for skewed distributions unless the distributions have the same degree and direction of skewness.

3.2 T Scaling

When the shapes of distribution differ, the procedure known as T scaling is adopted. This not only leads to comparable units, but also normalizes the distributions. The first step in converting a set of scores to T scores is to obtain the percentile ranks or the cumulative percentages corresponding to the scores. The next step is to enter a table of the normal curve function to find the corresponding z values. The z values are then multiplied by 10 and added to 50. For example, suppose a percentile ranks of 72. The z value obtained from the table of the normal curve function corresponding to an area of $0.72 - 0.50 = 0.22$ above the mean is $+0.6$. Multiplying this by 10 and adding 50, we obtain a T score of 56. The distribution of T scores will always conform to the normal curve.

3.3 Stanine Scaling

While the T scale has, by definition, a mean of 50 and a standard deviation of 10, the Stanine scale has a mean of 5 and a standard deviation of 2. It has only 9 scores in the scale, i.e., from 1 to 9. The unit of the scale is one half of its standard deviation. Thus the middle score 5 occupies the middle area of the normal curve having as its lower boundary the perpendicular drawn at the z value of -0.25 and the perpendicular drawn at the z value of $+0.25$ as its upper boundary. This area is approximately 20% of the area under the normal curve. Hence, in a distribution of Stanine scores, the middle score of 5 is assigned to the middle 20% of the group. The 17% above the middle 20% get the score of 6, and the 17% below the middle 20% get the score of 4. The figure below shows how the 9 scores in the scale are assigned to the various sections of the distribution.



All that one has to do to convert a set of scores to Stanine scores is therefore to arrange them from the highest to the lowest and assign 9 to the highest 4%, 8 to the next 7%, 7 to the next 12% and so on until the lowest score is assigned to the lowest 4% of the group.

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Scaling Methods*

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1. Introduction

Scales that measure physical attributes and properties are precise and well established. There are well defined set rules of measurement. For example the length of a rod can be measured in centimetres thickness and (weight also can be measured) accurately. In a yard stick a 'Zero' indicates non existence of a property in an absolute sense. If one rod is twice as long as a second rod it is a meaningful comparison.

In sociological, psychological, educational and other similar disciplines such well established, precise scales of measurement are not available. When one says person 'A's height is 65 inches, weight is 120 lbs and IQ is 98, one can accept his height and weight with no doubt in mind, but doubt the IQ measure. If one remeasures the person A with the same scales used in measuring on the first occasion one will find that his height is 65 inches and weight is 120 lbs but may not record the same IQ (98) as was recorded on the first occasion. If one measured height and weight with different scales (centimetre and grams) still one will get exactly the same height and weight once one converts metres and grams into inches and pounds. However, in the measurement of intelligence, if i.e. a test other than the one used on the first occasion is employed, the chances of recording the same IQ (98) are rather remote. Despite such difficulties there is a need to find some procedure to construct scales to measure social and psychological variables.

A well established measuring scale requires two properties. One is the property of identifying a 'zero' point to indicate non-existence of the property being measured. The second is the property of *equal units of measurement* to measure different degrees of the property or attribute being measured.

These two necessary conditions of a satisfactory measuring scale can be further illustrated by drawing examples from physical scales-length weight. When you say that the length of a rod is one inch it indicates there is an inch unit from an absolute zero point. If the length is 'zero' it means there is no length. When one says length is 3 inches it indicates that there are 3 equal 'inch units' of length. An inch on any part of the standard foot-ruler will be equal in length.

In socio-psychological measurement when one says that person A's intelligence is 'zero' that does not indicate that he absolutely has no intelligence. Similarly, when one says A's IQ is 98 and B's IQ is 99 that does not say that B is definitely one IQ unit better than A. Therefore in using measurement scales in the Social Science one has to be rather cautious.

* The author is indebted to A. L. Edward, W. L. Hays and C. Selliti et al., and on some occasions have directly taken material from their books listed under reference.

Measures from a well established scale facilitates mathematical manipulations—addition, subtraction, multiplication and division. Measurement is assignment of numbers to objects and events. These numbers come from a set rule-scale. Usually numbers can be added, subtracted, multiplied and divided, though not always.

If a measuring scale has no absolute 'zero' value and equal units of measurement, mathematical functions are unwarranted with measures that are taken by such scales.

Example :

The length of rod one is 12 inches and rod two is 24 inches. Therefore, the two rods together will be 36 inches long—additive property – ($12 + 24 = 36$). Rod one is 12 inches shorter than rod two – ($24 - 12 = 12$ ”). Rod two is twice as long as rod one—($12 \times 2 = 24$). Rod one is only a half of rod two—($12/24 = 1/2$). All these statements are true.

However, if we state that person A's IQ is 75 and person B's IQ is 150 we cannot make similar statements. A's IQ plus B's IQ will not make an IQ of 225. Also B cannot be sighted as twice as intelligent as A. These statements have no logical meaning. The absence of an absolute 'zero' point on the IQ scale as well as the absence of equal IQ units as units of measurement do not warrant such applications.

Since variables such as IQ are measured by scales which have no 'absolute zero point' or 'equal units of measurement', these measures do not qualify for ordinary mathematical operations. However, psychometry, sociometry and econometry offer certain solutions to overcome these problems of measuring psycho-sociological dimensions. Techniques of scaling attempt to offer satisfactory solutions to these problems.

Physical measurement scales possess unambiguous equality of units because such equality has been operationally clearly defined for them. Two weights are said to be equal if they balance when placed on a suitable weighing device. If we are willing to accept the requisite operational definition to every psycho-sociological dimension these properties can also be measured on a scale that has the same properties as the scale of weights. Problems arise in psycho-sociological measurements because of two reasons.

- (1) Experts cannot agree on a clear operational definition of the attribute to be measured.
- (2) The attribute is defined in terms of operations for which the symbolic processes of mathematical manipulations can be given no useful operational meaning.

Angoff (1960) states that 'any set of measurements can be expressed in terms of a scale with equal units, in some sense, if only we can agree on a definition in operational terms of what is meant by equality. Torgerson (1958) compares social and behavioural sciences with physical sciences and illustrates that constructs and connections between /among constructs are not neat and clear social and behavioural disciplines as in physical sciences. As a result, it is difficult to have precise statements and operational definitions.

When operational definitions are not possible due to weaker connections between constructs, measurement procedure also becomes weaker. Measurement is assignment of numbers to objects or events. In assigning numbers one must have a scheme. The measurement rule tells how to go about putting each event into the proper category in the scheme. All branches of science, in fact, make use of sets of qualitative labels, classes or categories along with the measurement rules specifying how to assign events, objects or subjects into given categories.

2. Scale Construction

In selecting items for inclusion on a scale two criteria are commonly used. Firstly, the items *must elicit responses that are directly or indirectly related to the construct* being measured. The relationship does not necessarily have to be so evident. Depending on the psychological or sociological construct intended to be measured, at times, there is a considerable advantage in using indirect items.

Secondly, items *must differentiate among people* who are at different levels or points along the construct being measured. This is the discrimination power of the item. The item should have the capacity to discriminate respondents who possess varying degrees of an attribute. Differentiation not only depends on the scale but also on the method of scoring. An item may discriminate the respondents, say at five different points on the scale but if scoring was done, assigning the same score to the first three levels and a different score to the other two levels, discrimination will appear only at two points of the scale as a result of scoring.

Example : We must strive for loyalty to our country before we can afford to consider world brotherhood.

	<i>Strongly Approve</i>	<i>Approve</i>	<i>Undecided</i>	<i>Disapprove</i>	<i>Strongly Disapprove</i>
Score	1	2	3	4	5
	(Discriminates at five points on the Scale)				
Score	1	1	1	2	2
	(Discriminates only at two points on the Scale)				

Broadly speaking there are three types of scaling techniques—

1. Differential Scales –
2. Summated Scales –
3. Cumulative Scales –

2.1 Differential Scales

A differential scale consists of a number of items whose position on the scale has been determined by some kind of ranking or rating operation performed by judges. Differential scales can be constructed under different methods.

- (a) Method of paired comparison.
- (b) Method of equal appearing intervals.
- (c) Method of successive intervals.

are some of the better known methods of scaling. Only the first two (a) and (b) above, will be discussed here.

(a) *Paired Comparisons*—

In the 1920s Thurstone (1927a, 1927b) invented this technique. It is a method of ordering stimuli-objects/events—along a sociological or a psychological continuum. For instance, a consumer can rank order seven varieties of vegetables in terms of his utility. Utility is a psychological continuum.

In paired comparisons one stimulus is evaluated or valued against another in pairs. Say, beans as a vegetable can be compared with cabbage with carrot and so on. Similarly cabbage can be valued against beans, carrots and so on. If one vegetable can be valued against the other six vegetables in pairs, then, if you have N objects/events to judge, you will have $n^2-n/2$ pairs to be judged.

In paired comparison scaling we let a large sample of judges (sampling considerations are to be followed) to make their judgements taking a pair of stimuli at a time. By getting comparative judgements of the kind described above, we can obtain an empirical frequency corresponding to the number of times that one stimulus (i) is judged to be more favourable than the other stimuli (j). We let (1.0) $f_{ij} = i > j$ where f_{ij} is the frequency with which i is judged better than j . Once we divide the f_{ij} by the total number of judges (N), we can get a proportion of times that i is judged better than j .

$$(1.1) \quad P_{ij} = f_{ij} / N$$

Now we have two metrics, one having frequencies, the other with proportions. These can be denoted as F and P metrics respectively. These proportions can be transformed into unit normal deviates (Z_{ij}) by means of the normal distribution.

TABLE 1
F Matrix for 7 Vegetables Judged by 94 Judges

Vegetable	1	2	3	4	5	6	7
1	47	65	75	80	75	86	80
2	29	47	51	54	62	68	81
3	19	43	47	49	59	60	63
4	14	40	45	47	49	63	67
5	19	32	35	45	47	51	55
6	8	26	34	31	43	47	57
7	6	13	31	27	39	37	47

TABLE 2
P Matrix for 7 Vegetables Judged by 94 Judges

Vegetable	1	2	3	4	5	6	7
1	.500	.691	.798	.851	.798	.915	.936
2	.309	.500	.543	.574	.660	.723	.862
3	.202	.457	.500	.521	.628	.638	.670
4	.149	.4268s	.479	.500	.521	.670	.713
5	.202	.340	.372	.479	.500	.543	.585
6	.085	.277	.362	.330	.457	.500	.606
7	.064	.138	.330	.287	.415	.394	.500
Sum	1 1011	2 329	2 884	3 042	3 479	3 883	4 372

TABLE 3
Z Matrix for the 7 Vegetables Judged by 94 Judges

Vegetable	1	2	3	4	5	6	7
1	.000	.499	.834	1.041	.834	1.372	1.522
2	— .499	.000	.108	.187	.412	.592	1.089
3	— .834	— .108	.000	.053	.327	.353	.440
4	— 1.041	— .187	— .053	.000	.053	.440	.562
5	— .834	— .412	— .327	— .053	.000	.108	.215
6	— 1.372	— .592	— .353	— .440	— .108	.000	.265
7	— 1.522	1.089	— .440	— .562	— .215	— .269	.000
Sums	— 6.102	— 1.889	— .231	.226	1.303	.596	4.097
Means	— .872	— .271	— .033	.032	.186	.371	.585
Scale Value	.000	.603	.839	.904	1.058	1.243	1.457

For illustrative purposes assume that the seven vegetables were judged by 94 judges. The Tables 1, 2, 3 present the F, P and Z Matrices respectively derived from the judgements.

By Summing the Z_{ij} values column-wise, we get the $\sum Z_{ij}$ values. Once we divide the $\sum Z_{ij}$ by the number of stimuli, we can obtain the average scale value for each of the seven vegetables.

$$(1.2) \quad \bar{Z}_i = \sum Z_{ij}/n$$

Vegetables with negative scale values are those judged to be less favourable than the average of the scale values of all statements and those with positive scale values are judged to be more favourable than the average.

Since the scale values ($\bar{Z}_{ij}$) are with minus values, to avoid minus signs the absolute value of the largest negative scale value ($\bar{Z}_i$) was added to every Z_i . The last row in Table 3 presents the scale values assigned to indicate the utility value of the seven evaluated vegetables.

Similarly, attitudes, values, interests, aspirations and many other psycho-sociological constructs can be evaluated and scaled.

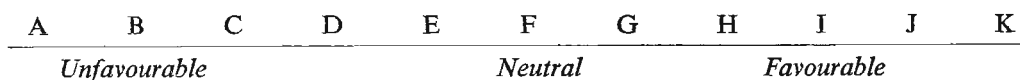
Though there is no absolute zero value in our scale, we have arrived at an arbitrarily fixed relatively meaningful zero point. Though it does not say absolute absence of a property, it indicates the absence of the property with respect to the other objects or events evaluated.

(b) *Equal Appearing Intervals*

Thurstone and Chave (1929) introduced this technique which is very commonly used today. The procedure followed in this method can be listed step-wise.

- (1) Gather a large amount of evaluative statements related to the construct/attribute to be measured and scaled.
- (2) Select a sample of judges (at least more than 50) to judge these statements.
- (3) Ask judges to classify these statements according to their judgements into eleven piles. Say the least favoured statement to pile one and second least favourable to the second pile and so on in respective order of preference. The eleventh pile will have the best favoured statements.

The following diagram illustrates this:-



Only the middle and the two extreme cords on which the statements were to be sorted are to be defined for the judges. The eleven point rating scale then becomes the psychological continuum on which the statements have been judged.

- (4) Once all the judges have made their judgements by sorting statements to the eleven piles, a frequency count (f) as well as the proportions (P) can be computed (see Table 4). In Table 4, an illustrative example is given, where 3 statements and a sample of 200 judges are used.

Once the proportions are computed, the cumulative proportions (cp) can be computed.

- (5) Compute the median value or pile to which it is assigned by the group of judges. The median is the point where the cumulative proportion (cp) will add up to 0.5. In the 1st statement of the Table 4, the median value lies between F and G (0.40 and 0.72).

Table 4
Judgements obtained by Equal Appearing Intervals

Statements		Sorting Categories											Scale Value
1	f	22	2	6	2	6	62	64	26	18	8	4	
	P	.01	.01	.03	.01	.03	.32	.32	.13	.09	.04	.02	6.8
	CP	.01	.02	.05	.06	.09	.40	.72	.85	.94	.98	1.00	Q—1.7
2	f	0	0	0	10	40	28	50	26	28	14	4	
	P	.00	.00	.00	.05	.20	.14	.25	.13	.14	.07	.02	6.9
	CP	.00	.00	.00	.05	.25	.39	.64	.77	.91	.98	1.00	Q—2.8
3	f	0	0	0	2	8	6	26	44	56	44	14	
	P	.00	.00	.00	.01	.04	.03	.13	.22	.28	.22	.07	8.7
	CP	.00	.00	.00	.01	.05	.08	.21	.43	.71	.93	1.00	2.0

Median value (scale value) can be computed with the help of the following formula :—

$$\text{Mdn} = 1 + \frac{(.50 - \sum P_b)i}{p_w} \quad \text{Medn} = 1 + \frac{(.50 - \sum P_b)i}{\left(\frac{p_w}{p} \right)}$$

where, Mdn = Median (scale value)

1 = The lower limit of the interval in which the median falls.

P_b = The sum of the proportions below the interval in which the median falls.

P_w = The proportion within the interval in which the median falls.

i = The width of the interval which is assumed to be equal to 1.0.

Using the above formula we can compute a scale value for the statement I on Table 4

$$\text{Mdn} = 6.5 + \frac{(.50 - .40)}{(.32)} 1.0 = 6.8$$

Similarly, for every statement we can compute the scale values.

Statements that have too broad a scatter are to be discarded because such items are ambiguous and irrelevant to the construct being measured. Therefore, another statistic is needed to indicate how big the spread is. Inter-Quantile Range (Q) is often used for this purpose.

$$Q = C_{75} - C_{25}$$

where,

$$C_{75} = 1 + \frac{(.75 - p_b)}{\left(\frac{p_w}{p} \right)} \quad \text{and}$$

$$C_{25} = 1 + \frac{(.25 - P_b)}{\left(\frac{p_w}{p} \right)}$$

where, l = Lower limit of the interval in which the C^{th} centile falls.
 $\sum p_b$ = The sum of the proportions below the interval in which C^{th} centile falls.
 p_w = The proportion within the interval in which the C^{th} centile falls.
 Substituting values from Table 4, we can compute the Q value—

$$C_{75} = 7.5 + \frac{(.75 - .72)}{(.13)} = 7.7 \quad \frac{(.7 - .72)}{(.13)} = 7.5$$

$$C_{25} = 5.5 + \frac{(.25 - .09)}{.31} = 6.0$$

$$Q = C_{75} - C_{25} = 7.7 - 6.0 = 1.7$$

Similarly Q values can be computed to investigate the spread (discriminant dispersion) looking at both scale value (median) and the Q items that will be selected for the scale.

Now the standardized equal appearing interval scale can be administered to measure the degree of presence of a particular construct in an individual.

These statements can be arranged in random order and presented to subjects with instructions to indicate those that they are willing to accept or agree with. Taking the agreed responses and the scale values assigned to those statements the attitude score can be obtained.

2.2 Summated Scales

The Summated Scale is better known in the literature as the Likert scale. Likert presented this method in 1932. In a summated scale, the subject is asked to react to a series of items. The subjects will respond to each item in terms of their own agreement or disagreement with the statements. The Likert scale is usually a five point scale—it often uses five categories ; Strongly agree, Agree, Undecided, Disagree, Strongly disagree. Each item will be scored. Very often unfavourable responses are indicated with a 'negative score' and a favourable responses with a 'positive score'. The total score is a summated score. However, rather than just scoring, by assigning an arbitrary scoring key such as 0, 1, 2, 3 and 4 one could also obtain *normal deviate weighting* of response categories. Table 5 presents the weighted normal deviates for the five response categories of an item.

TABLE 5

	Strongly Agree	Agree	Undecided	Disagree	Strong disagree
(1) p	.130	.430	.210	.130	.101
(2) cp	.130	.560	.770	.900	1.101
(3) mid point cp	.065	.345	.665	.835	.951
(4) z	-1.514	-.399	.426	.974	1.641
(5) z + 1.514	.000	-11.115	1.940	2.488	3.151
(6) z rounded	00	1	2	2	3

In Table 5, first the proportion of subjects responding to each of the five response categories is indicated. Row (2) *cp* indicates the cumulative proportion. Row (3) gives the cumulated proportions to the mid-point, that is, the proportions below a given category plus 1/2 the proportion within the category. Row (4) indicates the normal deviates for the corresponding mid-point cumulative proportions. Row (5) illustrates how the negative *Z* values were converted to positive values by adding the absolute value of the largest negative value. Row (6) presents the rounded *Z* value. Similarly, every item has to be weighted. The final score of a subject will be the total score obtained by summing scores for the individual items.

Selection of items for a summated scale is done after an item analysis. The steps to be followed in an item analysis are as follows :—

- (1) Administer a large number of items to a realistic sample.
- (2) Score the items either using the normal deviate score or with an arbitrarily fixed scoring key (this was discussed above).
- (3) Obtain the total summated score for each individual and rank order the individuals on total score.
- (4) Take the top 27% and the bottom 27% of the subjects in the rank ordered list. Those two groups—High and Low—are the criterion groups which are to be used in item evaluations.
- (5) Prepare a list with item responses of the subjects of the two groups. The following gives an idea of the procedure :—

TABLE 6

<i>High Group</i>		<i>Low Group</i>	
<i>Individual</i>	<i>Item Score</i>	<i>Individual</i>	<i>Item Score</i>
1	4	1	1
2	2	2	0
.	.	.	.
.	.	.	.
i	3	i	2
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
n _H	5	n _L	3
Sum	$\sum X_H$	Sum	$\sum X_{Li}$
	H		
Average $X_H = \frac{\sum X_H}{n_H}$		Average $X_L = \frac{\sum X_{Li}}{n_L}$	

Using the item scores, we can compute the average item score ($\bar{X}_i$) for the two groups.

- (6) To evaluate the items the average score of the High and Low groups can be compared by obtaining the following statistical ratio :—

$$t = \frac{X_{Hi} - X_{Li}}{\frac{\sum (X_{Hi} - \bar{X}_{Hi})^2 + \sum (X_{Li} - \bar{X}_{Li})^2}{n(n-1)}}$$

The value of t is a measure which indicates the extent to which the item discriminates the high and low groups. Edwards (1969) suggest items with a t ratio of 1.75 or higher, a better item to have on the scale.

The summated scale has certain advantages.

- (1) It permits the use of items that are not manifestly related to the attitude being measured. In Thurstone Scale judges limit the item pool.
- (2) Relatively easy to construct.
- (3) The Likert type permits the expression of several response levels (usually five) whereas the Thurstone scale offers only two alternatives (agree or disagree). As a result the summated scale is considered more reliable.

There are disadvantages as well.

- (1) The Likert scale is regarded as an ordinal scale where neither equal units of measurement nor an absolute zero point is present. On the other hand Thurstone's is considered as an interval scale.
- (2) The summated score of a Likert scale does not indicate clearly the pattern of individual behaviour. Several individuals can have the same score but obtained through different behavioural patterns.

2.3 Cumulative Scales

Louis Guttman originally introduced the cumulative scaling technique which is now better known as Guttman's Scalogram Analysis. Guttman's method emphasises internal consistency so that different items do represent different quantitative positions on the same basic dimension. Items are expected to be related to one another in such a way that, ideally, an individual who replies favourably to item Z will also reply favourably to item 1. Similarly one who agrees with item 3 will also agree with items 2 and 1. As a result, when once score is known his response pattern is obviously known.

For example, consider the following three items (extracted from Hays - page 70):-

- a. Students should have voice in University policy—(Agree/Disagree).
- b. Student should be consulted on matters such as curriculum changes (Agree/Disagree).
- c. Student representatives should sit with the Board of Regents in decisions affecting all University policy (Agree/Disagree).

If the above items were presented for response, it is logical to expect one who agrees to item "C" will also agree to items 2 and 1. An individual who does not agree to B cannot be expected to agree to item C.

The following table shows the response pattern expected by a Scalogram :

TABLE 7

<i>Individual</i>	<i>Items</i>				<i>Individuals' Total Score</i>
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	
1	X	O	O	O	1
2	X	X	O	O	2
3	X	X	X	O	3
4	X	X	X	X	4
Item Score	4	3	2	1	
Rank	1	2	3	4	

We do not know in advance that a given set of items necessarily falls along a single continuum from least to most favourable. It is the purpose of Scalogram analysis to set items to satisfy that condition or order.

There are different methods of Scalogram construction. Steps of one of the simpler method is listed below.

- (1) Guttman scale is strictly undimensional. Therefore, one has to collect/write statements which are strictly related to the dimension to be measured.
- (2) Collect a large number of undimensional items. Lots of items may have to be discarded if they do not fit in well with the rank order analysis.
- (3) As in the Thurstone's method, select a large group of judges and ask them to sort out the items to 11 piles, according to their judged favourableness or unfavourableness toward the issue. At this stage itself, items with great variability should be eliminated.

- (4) Selected items at step 3 above, will now be formed into Likert-type items with five response categories, and administer the likert-type scale to a large number of individuals. As in the Likert scale now looking at the total score, from a High and a Low group and compute the item discrimination indices. Items with the highest discriminatory coefficients will be selected and be placed in rank order.

Guttman's scale appears to be theoretically sound but it has its own disadvantages.

- (1) The scale is basically an Ordinal scale. Therefore, as a scale, it has its inherited weaknesses that are common to an ordinal scale.
- (2) It is difficult to stress on a unidimension because a statement which is thought to be unidimensional to one person may appear multidimensional to another person.
- (3) Such a scale may not serve the purpose when an object or an event is complex.
- (4) Construction procedure involves relatively more work than the ones discussed earlier.

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PART VI

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Computers in the Analysis of Data in the Social Sciences

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1. Introduction

Digital computers may be employed to handle a vast variety of tasks ; for the processing of scientific and commercial data and for the real time control of machinery and scientific equipment. Here we shall be concerned with the processing of data.

The use of a digital computer influences both the volume of data that can be analysed and the type of analysis that may be performed. The amount of data can be much greater than when purely manual processing is done. Also, with the aid of a computer, sophisticated analytical techniques may be applied. Although the use of computers is spreading, the existence of a technical 'jargon' tends to discourage the beginner. One of the objectives of this paper is to show that the jargon is in fact quite simple and that it need not act as a barrier between the computer and the research worker.

The technology of computing has undergone continuous change during the last few decades and is likely to do so in the foreseeable future. For instance, at the time of installation in 1970, the computer at the University of Peradeniya was considered a medium-sized one. Today it would be more appropriate to refer to it as a mini-computer. In the following paragraphs we shall consider a level of technology applicable to the computing installations that have been available in Sri Lanka for a decade or so. Where appropriate we shall refer to the more modern computers installed during the last three years.

In commercial data processing, large quantities of data are subjected to simple operations such as addition, sorting and ordering. On the other hand, in the physical sciences, very often, a small amount of initial data is subjected to sophisticated mathematical manipulations. The kind of applications that we are interested in—processing of data in the social sciences—usually fall somewhere in-between. That is, the number of observations lies somewhere between a few tens and a few thousands, while the mathematical techniques applied would be laborious but not impossibly so using manual devices.

2. Hardware

This refers to all the mechanical and electronic assemblies that do the processing. With modern installations the user need not familiarise himself with the hardware at all. The only aspect that is of importance would be the cost of using the hardware. However we shall describe below some of the common items of hardware.

The Central Processing Unit.—This is the single most expensive item of hardware and often governs the charges for using the computer. The CPU has three important properties that are of scientific interest. These are, the size of the main memory, the speed at which calculations may be performed and the repertoire of machine instructions.

The smallest unit of memory is the binary digit or bit. This is a piece of electrical circuitry which can exist in one of two states, e.g., current flowing or current not flowing, voltage present or voltage absent, clockwise magnetic field or counter clockwise magnetic field. For purpose of logic we can assign a bit to any variable which may exist in one of two states, e.g., 0 or 1, true or false, male or female. The science of information theory tells us that all information may be represented as an array of bits. Therefore all logical reasoning can be reduced to the processing of bits. Note that no claim is made for any possible equivalence between logical reasoning and human intelligence.

In practice the bit is far too small a unit for convenient processing. The 'byte' which consists of an array of eight bits is much more convenient. Since a byte consists of 8 bits it can hold one of 256 possible values. Most computers use one byte each to hold an alphabetic character and several bytes to hold a number.

In the jargon the size of the main memory is expressed in K's. The K stands for Kilo or 1024, which is approximately one thousand. Thus, e.g., the computer at Peradeniya has a main memory of 32K or 32 768 bytes. For the type of problems that we are interested in, a memory of 8K would almost always be sufficient.

The speed at which calculations can be done is governed largely by the speed at which information can be transferred to and from the main memory. The minimum time required to extract a unit of information from the memory is referred to as the access time. The access time of a modern computer is typically less than one micro-second. Most arithmetic operations take several units of access time. The repertoire of machine instructions varies widely from computer to computer. Basic operations such as addition, subtraction, test for equality are always available. Any operations that are not available may be synthesised using the available instructions. Modern programming languages are designed so that the user may be completely unconcerned about the repertoire of machine instructions.

Input Devices.—The computer must be supplied with information in a form which can be 'read' by a machine. This may be done by employing punched card, punched paper tape, flexible magnetic disk (called floppy disk or diskette), or through a keyboard connected to the computer.

Punched card (Hollerith card) is a popular medium for input. A card has 80 columns and 12 rows. Each decimal digit, letter, or symbol such as the decimal point, is represented by a unique arrangement of holes along a column. Thus a card may carry a maximum of eighty characters, initially the cards are prepared on a key-punch machine. This machine has a keyboard which resembles that of a typewriter but has no lowercase letters. It is not directly connected to the computer, i.e., it is 'off-line'. Several key-punch machines are required to keep a computer busy.

The punched cards are fed into an 'on-line' card read machine. This machine converts the pattern of holes along each column into an electrical signal which is transferred to the memory of the computer. The speeds of card reads vary from 200—1000 cards per minute, i.e., 16, 000—80,000 characters per minute.

Punched paper tape may be used as an input medium. Tape punching machines are cheaper than the key-punch machines used in the preparation of Hollerith cards. Also tape read machines are cheaper and often faster than card read machines. However, if during preparation, an error occurs, it is necessary to tear the tape and to splice it. For this reason and also because a deck of cards can be rearranged, Hollerith cards are more popular than paper tape.

With the more modern installation, the input data may be placed on a floppy disk via a key-board : the floppy disk is then loaded on a read machine wired to the computer.

An on-line electrical typewriter may be employed to input information to the computer. However, this is very wasteful of computer time except in the case of large computers with multiple terminals.

Output Devices.—The fastest and most common output device is the line printer. The maximum speeds of line printers vary from 80 to 1200 lines per minute. The standard line lengths are 120 and 144 characters. Lower case letters are usually not available on line printers.

A printed output may also be obtained from a typewriter. This is much slower than the line printer, a typical speed being 60 characters per minute.

The processed output may also be placed on card or tape. This is a very useful facility if the output data are to be processed further at a later date.

The processed output may be directly transmitted to a graph plotter. This is a slow but versatile machine. The results of the processing can be plotted on a graph saving considerable manual labour. The axes, scale factors and cardinal points can be drawn automatically under the control of the computer. The graphs may be annotated and titles inserted.

Back-up Storage.—Back-up or auxilliary storage usually takes the form of magnetic tape or magnetic disk. When the volume of data is too large for the main memory or when the data are to be analysed on several occasions it may be transferred from the input device onto tape, hard disk or floppy disk. This may be done directly or at some intermediate stage in the processing.

The capacities of disk packages vary from the equivalent of one million alphameric characters to that of 20 million. These capacities are greater than those of the largest main memories. The CPU can communicate with the disk unit(s) at speeds that are much higher than it can with the input/output devices described earlier. A typical speed is of the order of 200,000 characters per second.

Data kept in auxilliary storage are usually referred to as a 'file'. If the file is maintained on a disk, a relatively small block of information (record, sector, cylinder or bucket) may be accessed directly without having to go through the whole file as would be the case with a card file. The disk unit would get at the required block within a few thousands of a second.

Storage on magnetic tape is cheaper than that on disk. However communication between the CPU and the tape drive is slower because the tape has to be wound up to the point where the required data are recorded. A magnetic tape 1 inch wide and 2,500 feet long wound on a reel of $10\frac{1}{2}$ inch diameter can typically store the equivalent of 20 million characters.

A floppy disk stores 0.1—0.5 million characters.

Since the disk cartridge or the reel of tape can be removed from the drive mechanism they provide unlimited off-line storage. When carefully protected from heat and humidity, disk and tape files can be as reliable as punched card or hard copy.

3. System Software

In order to put the computer to use the CPU must be given detailed instructions. While the computer is running these instructions are in a form referred to as 'machine code'. Since the machine can handle only bits, a machine code program is a bewildering array of 1s and 0s. The system software usually provided by the manufacturer insulates the user from machine code and allows him to communicate with the computer using ordinary numbers and Latin characters.

The Operating System.—This is the most important part of the system software. Some part of it is always held in the main memory. The user provides certain control information, in order to set up the machine to handle the particular job. The control statements required vary widely among different installations. For scientific jobs, generally very few control statements are required and it takes very little effort to learn the sequence. Usually all that is required is to supply information that tells the computer what programming language is being used and what input/output devices are to be held on-line.

The Compilers.—Modern computers may be programmed in what are known as problem oriented or high level languages. Some examples of such languages are, FORTRAN (FORMula TRANslator) ALGOL (ALGORithmic Language), COBOL (COMmon Business Oriented Language), RPG (Report Program Generator), BASIC, APL and PASCAL. A program written in such a language consists of a sequence of statements. These statements resemble statements in English and mathematical notation. Of the languages referred to above, FORTRAN has been designed for scientific work while COBOL and RPG are used in commercial applications. For social science work, the scientific languages would be generally appropriate but RPG may be useful for some problems. Currently, the most widely accepted of the scientific programming languages is FORTRAN.

The source program is input to the computer through a medium such as punched card. It is then converted to machine language by the system software. The suite of programs that does this is referred to as the compiler. The compiled program may be stored in auxiliary storage or executed immediately. The data associated with the problem are provided at the time of running.

4. User Software

The term 'User Software' refers to programs written by the user or by a programmer under the direction of the user. Such programs are generally written in high level languages.

Communicating with a Programmer.—Modern high level languages are so convenient to use that there is no reason why a research worker who can presumably handle the mathematics required by his work cannot write the program himself. However, perhaps because of the lack of regular access to a computer, many research workers find it necessary to employ a programmer. In this case it is necessary that the research worker has some idea of the capabilities of the computer installation. On the other hand the programmer must be supplied with very comprehensive information regarding the type of data, the exact form in which it is to be presented and the mathematical procedures to be employed. The form of output required should be described in detail. The mathematical procedures may be explained with the aid of flow charts. The formats of the input and output can be described with the aid of 'coding sheets'.

Sub-programs—Most user programs consist of a main program together with a number of sub-programs. When the main program is run, the computer calls up the required sub-programs. A user may write a sub-program if he finds that the same procedure is to be repeated several times at different points in the main program.

Very often users call up sub-programs that are available as part of the program library maintained at the installation. The program library is maintained in auxiliary storage or in the form of punched card. Each sub-program has associated with it some literature which defines the function that it performs and the conditions under which it may be used. Particular care should be taken to see that such conditions are not violated by the nature of the data or by the main program.

5. When Does One Use a Computer?

The factors to be considered before deciding to use a computer : time cost, ease of access to a computer, availability of consumable items (card and printer paper) and the availability of the services of a programmer. Since the last three factors are clearly beyond the scope of this paper, only the first two will be considered here.

The actual computing time usually forms a negligible part of the total time taken for the project. Usually most of the time is taken in preparing the data, entry of data in a form suitable for key-punching, validation of the data and preparation of programs. The time taken for writing programs can be reduced if suitable library programs are available.

Often the mathematical procedures are simple but the volume of data is large. In such cases the cost of hiring the computer may be roughly estimated by calculating the time taken to read the cards and to print the results.

The fact that the volume of data is large does not necessarily justify the use of a computer. Let us consider a hypothetical example. Suppose that we have a large number of values of a parameter and we wish to calculate their mean. This could be done manually or with a hand calculator by passing over the data once only. Perhaps we may have to pass over it again to check the first calculation. If we were to do this job on a computer the punch operator must pass through the data at least once. If the data are checked on a card verifying machine the operator requires two passes. Similar reasoning applies for any other input medium. Clearly, using a computer for this job would add to the cost and delay the results.

Now let us suppose that we wish to calculate the standard deviation as well. With a simple calculator we should have to pass over the data twice and possibly twice more for checking. Therefore at this stage it may be worth considering the use of a computer.

If, say, the same data were to be arranged in ascending order, it can be shown that the number of passes required is approximately $N(N + 1)/2$, where N is the number of items. Clearly the use of a computer will save considerable time and labour if not money, provided N is large enough. Thus a simple rule is that the use of a computer is advantageous if the same data are to be passed over a large number of times in order to get the desired information.

6. Validation of Data

The importance of ensuring that the input data are error-free cannot be over-emphasised. In manual processing any absurdities in the data usually show up during the processing and can then be corrected. Unfortunately a computer has no discretion at all and the data are treated as legitimate. Therefore, before processing proper is started, as many checks as possible should be applied. For this purpose too the computer may be used. The checking procedures would depend very much on the nature of the data but we shall consider two general methods briefly.

If the limits of each item of data (numeric or alphabetic) can be established beforehand, the computer can be made to reject all records containing any item of data outside the limits allocated to that item. If the limits are not known beforehand, likely limits, erring on the narrow side, may be placed. The rejected records can be re-examined and the limits adjusted.

The computer can be programmed to check for known logical interrelationships between different items of data. For example, in a demographic survey, if the number of expectant women drops by one due to erroneous punching of a card the resulting error in the predicted may be insignificant. If however the missing punch has been transcribed into a man's record and further processing done some of the results may look rather odd. This type of situation can be avoided by subjecting the data to extensive validation using the computer itself.

Errors are frequently introduced when the raw data are transcribed into a format suitable for key punching. The best thing to do is to avoid this stage altogether by designing the forms on which the data are collected in such a manner that punching can proceed directly from the forms.

The extensive validation of data results in the rigid definition of their numerical and logical properties. This is a great help to the programmer when he is designing the programs and also in tracing program errors.

7. Validation of Programs

In principle the validation of programs is more difficult than that of data. There are no known general methods to 'prove' that a program will work the way it is intended to work. Therefore, if a programmer is employed, the research worker may have to accept the accuracy of the programs on faith. However, one simple and very effective although not 100% fool-proof method of program validation is to run every program or sub-program on a sample of the data. The test sample could be randomly picked or artificially created. Either way, the sample should be picked by the research worker and not the programmer. The computer results for the test sample can be compared with manually obtained results. Even the slightest discrepancy between the two sets of results should be traced to the point of origin.

The output can be formatted so as to facilitate simple checks such as row, column and grand totals in tables. Again any discrepancy must always be traced to the point of origin because although punch operators, programmers and even research workers often make mistakes, the probability of the computer making a mistake that cannot be detected is so small as to be completely negligible.

GLOSSARY OF COMPUTER JARGON

The following is a glossary of terms that occur often in computer "jargon". The explanations have been taken from some authoritative and popular English-English dictionaries. The meaning when used as a technical term is identical to, very close to, or derived from, the meaning in non-technical English.

Abbreviations : n. — noun, v. — verb, adj. — adjective

ABORT	v. to arrest in development at an early stage
ACCESS	n. opportunity of approach or entrance
ACCUMULATOR	n. a thing that can collect or amass
ALLOCATE	v. to place or locate
ALPHANUMERIC	n. relating to alphabetic and numeric representation
AMPERSAND	n. the character representing "and", &
ARRAY	n. order ; group of things arranged in some order
ASSEMBLE	v. to collect or put together parts of
ASSIGN	v. to specify, to allocate, say, a value
CARRIAGE	v. conveying, transport
	n. part of machinery for shifting position of other parts

CHARACTER	n. a letter, sign, figure, stamp or distinctive mark
COMPILE	v. to draw up, collect ; to put or bring together, in a meaningful manner
CONCATENATE	v. bring together or link as in a chain
CONFIGURATION	n. mode of arrangement
CONSECUTIVE	adj. following in regular order or one after another
CONSOLE	n. frame containing keyboards, stops, etc. eg. of organ
CURRENT	adj. belonging to the period of time now passing
DECK	n. a pile of things (cards) laid flat
DECREMENT	n. the quantity lost by decrease
	n. the act of decreasing
DETECTION	n. state of being found out or discovered
DIAGNOSIS	n. a formal determining deception or identification
DISTINCT	adj. different or well defined
DUMMY	n. a sham or counterfeit article taking the place of a real one
EVALUATE	v. to determine the value of
EXCESSIVE	adj. beyond what is usual or right
EXECUTE	v. to carry into effect
EXECUTABLE	adj. that which can be executed
EXPLICIT	n. not implied merely but distinctly and plainly stated
FACILITY	n. means or opportunity which gives ease in performance
FORMAT	n. the size, form or shape in which a book, page, line, or card is issued
HEXADECIMAL	n. a container through which grain (cards) passes in mills (cardreads)
IMPLICIT	adj. relying entirely on or implied though not plainly expressed.
INCREMENT	n. an amount or thing added, the act of adding
INVALID	adj. without validity, null, void
LINKAGE	n. an act or mode of linking or the fact of being linked
LITERAL	adj. expressed by letters of alphabet
LOOP	n. that which diverges from the main and joins it again
MANIPULATE	v. to handle or manage
MODE	n. way, manner or form in which a thing is done or happens or exists
NEST	n. an accumulation or set of things fitting one within another
ORIENTATE	v. to place or determine the position of, relatively to fixed or known directions
OVERFLOW	v. to flow or run over, or pass out in part as under pressure
	n. that which flows over
OVERRIDE	v. to pass over or to set aside,
PARAMETER	n. a line or quantity which serves to determine a point line, figure, property or quantity in a class of such things.
PARENTHESIS	n. a pair of round brackets(.....)
PERIPHERAL	adj. in a surrounding region
PRECISION	n. quality of being exact or accurate
PROCESS	n. a sequence of operations or changes undergone
PROTOCOL	n. rules of formal behaviour
RANDOM	adj. irregular, haphazard (i.e. without order)
RECORD	n. register or a book of writings of any facts or proceedings
	v. to set forth
REDUNDANT	adj. superfluous or excessive
SCAN	v. to examine critically and to mark out
SEQUENTIAL	adj. that which is in sequence i.e. a set of things following in order of some principle

SIMULATE	v. to have or assume a false appearance of
STACK	n. a large built up pile v. to pile into a stack
STATEMENT	n. that which is stated, expression in words etc.
SUBSCRIPT	adj. written beneath
SYMBOLIC	adj. that which by custom or convention is a representative of something else
SYNTAX	n. grammatical structure in sentences.
TERMINATE	v. bring or come to an end
TRANSFER	v. to convey or change over from one place to another
TRUNCATE	v. to cut short (top or end)
UPDATE	v. to bring up to date
UNDERFLOW	n. (current) following beneath surface
VALIDATE	v. to make legally or logically good

Data Presentation

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“When you can measure what you are
Speaking about and express it in numbers,
You know something about it, but when
You cannot express it in numbers, your knowledge
Is of a meagre and unsatisfactory kind”

LORD KELVIN

1. Introduction

Having gone through a series of lectures on the conceptualization of research, the designing of research projects and surveys, the designing of questionnaires, the collection of data and the analysis of data, you have come to the last stage of the process, the presentation of the data that have been collected. This is indeed a very important step because it relates to the communication of your research findings. If you do not communicate your research findings adequately and effectively much of the efforts and expenditures on developing and designing the research project and all the care in the collection and processing of the data would be of little benefit to the community. The way in which data are presented, discussed and interpreted is crucial to the effective communication of the research findings.

Yet, relatively little has been written on this area compared to the other aspects such as data collection and analysis. This is no doubt due to the fact that data presentation is an art. Experience is indeed the best means of acquiring the skills. Yet a few hints, guidelines and consideration could assist a beginner and what is attempted here is just that.

This lecture will deal with the following :—

1. Preliminary and Basic Considerations in Data Presentation
2. Formats of Reports
3. Textual Presentation of Data
4. Tabular Presentation of Data.

2. Preliminary and Basic Consideration in Data Presentation

First :—BE CLEAR ABOUT THE OBJECTIVES OF THE REPORT OR SURVEY OR RESEARCH

Without the writer being clear about the objectives of the survey he will be unable to sift the data, emphasise what should be emphasised and omit what is unnecessary. Without a clear idea of the objectives of the research, the report writer will tend to include all the data that have been collected and what is presented will lack purpose and clarity.

In fact the objectives of the data collection or survey should be clear at the design stage and the type of presentation of data decided upon at that stage. This would minimize the collection of unnecessary data as well as ensure that needed data are collected in a form that is useful and necessary for the final report.

Second :—BE CLEAR TO WHOM THE REPORT IS ADDRESSED : WHAT IS THE TARGET AUDIENCE

This is one of most difficult things in practice in social science research undertaken by public institutions. In the case of academic research like post-graduate thesis and journals the target audience is clear. It is academics with scientific training in the same field. One could use scientific words with precise meaning, use formulae, often skip steps in the logic or calculations and get the point across clearly and without ambiguity by the use of statistical measures such as regression coefficients, standard deviation, significance tests etc. The only difficulty in presentation of data for the academic community is the need to strictly adhere to acceptable standards and norms and styles of presentation required by the University or Journal.

A much more difficult task is the presenting of a report whose target audience ranges from the academic community to the general public and includes sponsors of research, other professionals administrators and politicians. The usual advice given is that one cannot write a successful report addressed to such a cross-section target audience. Therefore one should write separate reports for each target audience.

In practice this is not possible. One is able to write only a single report. Therefore what does one do?

Here are a few suggestions :

- (1) Write a chapter summarising the findings with cross references to the detailed chapters. The summary chapter could be fairly comprehensive in giving the findings and should be written simply and fairly briefly. This would be in non-technical language.
- (2) Each chapter's introduction and conclusions could be written in non-technical language.
- (3) Indicate that (1) & (2) have been done for the use and benefit of the non-technical reader and for the reader who has no time to read the entire report. Also asterisks may be used to indicate other sections in the report which are useful for this same audience.
- (4) In the report itself where technical jargon is used attempt also to state the salient features in simple language. If the writer is clear in his own mind about the scientific presentation, this task of simple expression in common language is not too difficult.

- (5) Remember that there are statistical measures which can be understood by laymen and use them. Examples are mean, range, percentages and other ratios. Even statistical measures like regression coefficient can be interpreted in simple language. Though a certain amount of precision may be lost in such interpretations the conclusion can be clearly conveyed.
- (6) Footnotes giving explanations and definitions of scientific and statistical terms is another useful device.

This discussion, I hope, makes two things clear. One is that writing to a mixed audience is difficult but not insuperable. The other is that it is a compromise which like all compromises does not yield the best results. However, given situations where there is no option, your ingenuity must find the means of presenting the best report to a mixed audience.

If you have the option of writing several reports certainly write separate reports for different target audiences.

Third :—ALWAYS DRAW UP AN OUTLINE BEFORE COMMENCING A REPORT

An outline clarifies your thinking. You can see whether there is a logic in your organization of the report. It is easier to change the outline than attempt to change the report once written. This is especially so because often reports have cross references.

Fourth :—DON'T MAKE YOUR REPORTS EXCESSIVELY LONG

A short concise report is likely to communicate the findings much better than a long one. Where useful but not directly relevant data have been collected, place these in an appendix rather than clutter the main report and thereby lose the attention of most readers.

Fifth :—USE AIDS LIKE DICTIONARIES, THESAURUSES, CONVERSION TABLES AND HAVE THEM WITH YOU WHEN WRITING

Dictionaries will minimize spelling errors, when in doubt always consult them. Thesauruses are books containing a host of similar words, synonyms and antonyms generally arranged and classified by ideas. They are very valuable in choosing a better word than the first one which comes to your mind. Conversion tables permit you to give the data in units other than those in the tables. This can be useful especially today when you may use the metric system but the readers are more used to other measures.

Sixth :—GET AT LEAST TWO PERSONS TO READ THE DRAFT REPORT

The report writer is not likely to see errors he has himself made. Therefore one person who knows the subject should be given to read and comment. Another person not connected with the subject matter of the report and representative of the target audience should be given the draft report. This latter person should be asked to comment on particularly whether the presentation is clear and asked to mark sections which are not clear. This should be followed by discussions.

If possible the writer himself should “keep off” the report for a length of time and do a final reading, forgetting that he was the writer.

3. Formats of Reports

The contents of a Report may be divided into four parts and consists usually of the following sequence :

Part I	1. Title Page
	2. Foreword/Preface
Pre-Report	3. Table of Contents
	4. List of Tables
Part II	5. Introduction
Introduction	6. Problem Formulation
	7. Methodology—
Methodology	(a) Research Design
	(b) Sampling Plan
	(c) Data Collection
	(d) Data Processing
	(e) Response of Survey
	(f) Adaptations made, if any.
Part III	8. Presentation of Data
Findings of Research	(Contents of Chapters would vary with nature of inquiry)
	9. Conclusion
	10. Summary
Part IV	11. Appendices (a) Questionnaire
	(b) Instructions to investigate
Additions	12. Appendix Tables
	13. References

Although usually the summary is placed as the last item in Part III, there are good reasons to make the Summary Chapter the first Chapter in this part. This is one means by which the summary could be conceived of as a self-contained report for a general audience. Another device that is now quite fashionable is to publish a separate report as a summary—it is often called an “Executive Summary” and is often published very attractively.

4. Textual Presentation

The preliminary and basic considerations in data presentation outlined earlier have a relevance here. But these further guidelines may be offered.

- (1) *The Textual Presentation should not be a verbal restatement of the tables.*

A verbal restatement of a table apart from being repetitions, is an uninteresting and boring exercise both to the writer and reader. Tables are a far more concise method of data presentation and the purpose of having the tables is defeated if every row and column is described.

The text should draw attention only to the important and significant aspects of the table.

- (2) *The text should attempt to interpret the tables in the light of the experience in the field.*

The interpretation of the tables include the modification of the figures and cautioning the reader from interpreting the figures too rigidly. This implies that those who were involved in the field work should do the writing of the report. If the writers of the report have themselves conducted the field work they would have a "feel" for the data. The figures in the table could then be modified in the text. Some illustrations would make the point clearer.

For example, consider the well known bias in the collection of income data. Several categories of respondents would not disclose their true incomes. Despite efforts to obtain correct figures and cross-checks in the questionnaire itself (as for example reconciliation with expenditure information) it may be realized that the income data presented in the tables have a downward bias. This may be especially so with respect to a particular occupational or income category. While there may be some categories whose information is fairly correct others may be purposely understated. By indicating these limitations in the data contained in the table in the textual presentation, the report will prevent exaggerated interpretations that are likely with the figures alone.

Another example is where the data collected and tabulated are correct but do not disclose the whole truth. An example of this type is where for instance in the distribution of interest rates it may be found that 25 per cent of the loans is without an interest charge. However, from your experience in the field you may be aware that those who do not charge an interest overtly do commit their borrowers to certain conditions which in fact amount to a hidden interest charge. Landlords who lend without an interest charge may require their tenants to pay higher rents or sell the produce at a lower price. Boutique keepers who lend without an interest charge may sell to their borrowers at higher prices. These facts which are not included in the table could be discussed in the text. Such discussion would enable a better understanding of the actual situation than disclosed by the figures in the table.

- (3) *The text should attempt to interest the data collected in the particular research project in the context of other studies and background knowledge of the subject.*

The experience and knowledge of the report writer is very important in interpreting the findings of the research project in a broader context of other studies and related knowledge. Such background knowledge could enrich the quality of the report greatly.

Let me again illustrate the types of contributions a writer could make. He could relate the data to previous research findings. The data could be related to the economic and social context of the time of research. Economic facts

and quantitative data generated by the research project could be related to sociological and cultural factors and realities. Policy implications of the research finding could also be discussed.

These discussions in the text would bring out the significance of the research far more than if only the data are presented. The intellectual quality and wide experience and perspectives of the writer would indeed be the most important factor determining the quality of the textual presentation.

5. Tabular Presentation

There are several advantages in the tabular presentation of data. The main advantages are :

- (a) Conciseness in presentation
- (b) Clarity and ease in reading
- (c) Comparability—the rows and columns enable easy comparison.

Basic Requirements of a Table

The tables should be constructed so as to bring out these advantages of the tabular form. The following basic requirements of a table must be kept in mind.

- (1) The table with its title should be self-explanatory. It should not be necessary to read the text to understand the contents of the table.
- (2) The title of the table should contain all the relevant dimensions contained in the table and yet be brief. Year or Period of Data should be stated. E.g: District-wise Distribution of Population by Sex, Sri Lanka 1980.

Not.—Distribution of Population or District-wise Distribution of Population or Sri Lanka Distribution of Population by sex.

- (3) Units of measurement must be indicated clearly, as for example whether figures are in Rupees or Dollars, Metric Tons or Long Tons or Cwts., whether figures are numbers or percentages.
- (4) Column and row headings should be concise, brief and unambiguous.
- (5) Figures in series should be in columns. Comparable data in rows.

E.g:

In thousands		
Year	Cars	Motor Cycles
1975	6,210	4,111
1976	6,315	4,711
1977	6,400	5,848
1978	6,501	7,111
1979	6,800	8,999
1980	7,645	10,801

The columns indicate the numbers of vehicles each year for six years, the rows permit comparison of Cars and Motor Cycles in each year.

- (6) Where figures in the table are from other sources or derived from other tables, the source should be indicated at the bottom.
- (7) When unfamiliar terms are used these should be defined in footnotes.
- (8) Extensive ruling should be avoided. Spacing of columns and rows should be planned so as to accommodate these in the available space. If possible there should be uniformity in the width of columns. Remember that printed tables are more flexible to accommodation in available space than typewritten tables.

Hints on Tabular Presentation

1. Figures which are to be compared must be placed in immediate juxtaposition. By such placement of figures the reader's attention is drawn to a particular comparison rather than another. Consider the following two tables with the same figures.

Table 1
Sex and Age Distribution of Population, Sri Lanka 1972 & 1979

Age Groups Years	In Thousands			
	Male		Female	
	1972	1979	1972	1979
0 — 4	857	964	830	936
5 — 14	1,691	1,900	1,634	1,841
15 — 49	3,197	3,594	3,057	3,443
50 — 60	578	650	472	532
65 and over	296	333	249	278
Total	6,619	7,441	6,242	7,030

Source : Registrar General's Dept.

Table 2
Sex and Age Distribution of Population, Sri Lanka 1972 & 1979

Age Groups	In thousands			
	1972		1979	
	Male	Female	Male	Female
0 — 4	857	830	964	936
5 — 14	1,591	1,634	1,900	1,841
15 — 49	3,197	3,057	3,594	3,443
50 — 64	578	472	650	532
65 and over	296	249	333	278
Total	6,619	6,242	7,441	7,030

Source : Registrar General's Dept.

In Table I the comparison is between males in 1972 and 1979 and females in 1972 and 1979. In Table II the comparison is between the sexes in each of the two years. Therefore the juxtaposition of the same figures in different ways highlight different issues. The comparison in Table I is an analysis of the changes in the population of each sex in each age group in the two years. Table II is useful for an analysis of the sex ratios in each year.

2. Several types of comparisons and analysis could be facilitated by the use of ratios (percentages being the most popular), averages, cumulative figures and other computed relationships. These could be incorporated in the tables themselves in additional columns.

3. Do not overload your tables. Too many figures in a table could distract the reader and not enable him to see the important figures. If there are too many variables, it is better to construct separate tables.

4. A common error that should be avoided is the ambiguity of end values in class intervals. The class intervals should be as in Tables I and II above and not 0-5, 5-15, 15-50, 50-65 and 65 and over where the values of 5, 15, 50 & 65 could be in either of two class intervals. Where comparisons are made it is better to have class intervals of the same size.

5. Where placing the percentages is useful but separate columns and rows would make it cumbersome, percentages could be placed in paranthesis or brackets. It is however important to be clear of what total the figure is a percentage.

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Maps, Diagrams and Graphs

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1. Introduction

The results of research have to be presented in a meaningful and readily understood manner. If a researcher manages to convey to the reader what the researcher himself understood from the study concerned it is a mark of good scholarship.

Several techniques can be used to present the produced data of research studies. One technique is literary description. Data can also be presented in the form of tables. The other technique is to present data diagrammatically, graphically or pictorially. The technique to be chosen depends on the nature of the information, the purpose of the presentation and the type of readership at whom the study is aimed. In the rest of this lecture I shall make some observations regarding the use of maps, diagrams and graphs as techniques of data presentation.

2. Objectives

Quantitative data are analysed with one or more of the following objectives in view. Sometimes the researcher is interested in observing the nature of fluctuations and the degree of variability in a given series of data. The purpose of the study may be to discover a possible secular trend in the variable. Attention may also be focussed on the relationship between two or more variables. The data can also be analysed to observe possible deviations from a norm, such as the mean, median or mode. The objective of the researcher may be to find out the concentration or scatter of the values pertaining to the particular observation. It is also possible to observe patterns of variation in space. A researcher may wish to ascertain the frequency of occurrence of a particular value. Having processed and tabulated the data it is sometimes possible to use maps, diagrams and graphs to present the information with a view to bringing out one or more of the features mentioned above.

3. Maps

A map consists of presenting data in a diagram which contains or represents a region, a country or an area with a definite boundary and an orientation. Any pictorial representation having these characteristics is a map.

The presentation of information by means of maps can be divided into two broad categories. One is a qualitative representation which is called, 'chrochromatic' map without precise quantitative data. For example information provided in land-use maps or maps showing the distribution of vegetation fall into this category. In these no exact measurements are given. For instance, in land-use maps the distribution of the different types of crops are just marked without reference to the actual acreage.

There are two types of maps used in the quantitative representation of data. One type is the 'isopleth' map and the other is the 'choropleth' map. In isopleth maps we identify the locations having the same value and join them with a line. Thus these maps show not only the pattern or the spatial distribution but also its spatial quantitative variation. Maps showing rainfall and temperature distribution are examples from physical studies. In socio-economic studies, for example, if we want to show homogeneous regions in relation to variables such as per capita income, employment, or the cost of production it is possible to mark the locations where the same value is obtained and by joining all such points with an iso-line it is possible to indicate the variations of values over space.

In choropleth maps the quantitative average values of a variable are given in relation to some given area, usually an administrative unit. For example, the average yield per acre for a crop or the density of population per square mile can be calculated for an administrative unit and shown on a map.

4. Diagrams

Diagrams are those representations which use certain geometrical shapes such as bars, circles and so forth. The most commonly used diagrams consist of bar diagrams, wheel diagrams and flow charts.

Bar diagrams can be of two types, vertical (column) bar diagrams and horizontal bar diagrams. Column bar diagrams are particularly popular in the presentation of weather and climatic data. In such instances the columns are usually drawn without allowing for an interval between two columns. Horizontal bar diagrams are mostly used to present socio-economic data. For easy comparison horizontal bars can be constructed either in a pyramidal arrangement or in pairs sitting side by side to each other. Data on demography, export-import trade and so on can be presented in this manner.

Wheel diagrams can be used either individually or in groups. They could be drawn in such a way that both the overall magnitude of the different variables as well as the constituent parts of a given variable could be compared simultaneously. For example, suppose one wants to show the asweddumized area of paddy under major irrigation, minor irrigation and rain-fed conditions in each of the twenty two districts in Sri Lanka. Then twenty two wheel diagrams can be drawn with the size of each wheel diagram varying according to the area under paddy in the district concerned and each diagram showing in proportionate terms the three types of paddy land in the district in question.

Flow charts can be used to indicate simultaneously direction of flow as well as the magnitude of flow. Direction is indicated by drawing a line with an arrowhead and by adjusting the length and/or the thickness of the line it is possible to show the relative magnitude of the quantity which flows in that direction. For example, if we want to show the migration pattern between Colombo and the surrounding area it is possible to show this by means of a flow chart.

Flow charts are also used to demonstrate intra-organization and inter-organization relationships. There are several advantages in this technique. The respective responsibilities or functions of groups and individuals and their inter-relationships can be specified.

The direction of authority can also be conveniently shown. Sometimes it is also possible to include some data (e.g. strength of individual units or organizations of various wage levels) and descriptive notes in the chart.

Before I end this section it should be mentioned that it is sometimes useful to represent data by incorporating diagrams into a map. For example monthly rainfall data in the different districts can be shown on a map where a bar diagram for each district is drawn within the district boundary.

5. Line Graphs

Line graphs can be sub-divided into three main categories. Simple line-graphs where only one line or curve is drawn to show the change in any given series of data constitute the first. Second, the polygraphs where a number of lines or curves are drawn to represent different variables. Thirdly, the land graphs where along with the change in the total quantity that is represented by the graph we also show its constituent elements on the same graphs.

Some line graphs represent time series data. In such instances the convention is to represent the time period on the horizontal axis and the values of the variable on the vertical axis, and plot the points on the graph.

Some line graphs are scatter graphs where we try to show the relationship between two variables. It makes no reference to a time period as such. Very often when the points are plotted it is found to be a scatter and not a line. Scatter graphs are especially useful as a means of preliminary verification of possible relationships between variables before a researcher attempts more sophisticated methods of analysis such as regressions.

Semi-log paper can be used for line graphs when it is necessary to compress the vertical scale to manageable proportions. Semi-log graphs are also useful to indicate the rate of growth of a variable.

6. Some Rules to Observe

When presenting data by means of maps, diagrams and graphs there are certain rules and conventions to which the user must adhere. Firstly, if it is a map, an orientation which indicates the north must be clearly shown on the map. Secondly, whether it is a map, diagram or a graph, the presentation should be given in a frame to make it visually striking. Thirdly, where necessary a scale must be indicated. A scale can be presented in three ways. It can be a statement such as, say, 'one inch on the map represents one mile'. Alternatively, it could be shown either as linear scale or a representative fraction. Fourthly, maps, diagrams and graphs must have definite and clear titles conveying what they attempt to show. Fifthly, a legend may be required to explain signs, symbols and letterings used. Sixthly, the source of data must be stated. Seventhly, the lettering and numbering must be clear. Letter and number sizes can be varied so that due attention can be focussed on more important captions by means of relatively bigger-sized letters and numbers. Finally, when colouring is used, as in maps, various shades of the same colour must be used to indicate the different gradations of the same variable, and different and contrasting colours to represent different variables.

Reference

Monkhouse, F. J. and Wilkinson, H. R. *Maps and Diagrams*, London, Methuen, 1963 (University Paperback).

PART VII

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Retrieval of Information: The Literature Search

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1. Introduction

The ability to use your own library and to exploit its resources to the full is an essential prerequisite for any meaningful research and if the library is a good one—like the library at the University of Peradeniya—it may go a long way in providing the researcher with a knowledge of the literature in the field. Still it is not enough to know merely how to use the library of the institution you are attached to, for the publishing world has grown so much today that no one library could possibly possess all the books written and published all over the world even in just one field of study.

Therefore researchers have to be able to find out what documents have already been published in his field of study in the form of books, articles in scholarly journals and the like—irrespective of whether they are available in his own library or not. This knowledge has to be periodically up-dated to keep in touch with literature being published while the research is going on. This is what is termed a literature search and there are a number of tools available for the purpose.

2. Bibliographies

One of the most important of the tools which may be used in the literature search is the bibliography. A bibliography is a list of books pertaining to a given topic or field of knowledge. Bibliographies are of many different types. Some are a simple listing of books arranged alphabetically according to the author. Except in a bibliography covering a very narrow area of study or a short time span this kind of bibliography is less useful than a classified bibliography which makes it easier for the user to find out the material he is interested in.

A bibliography may be comprehensive or select. A comprehensive bibliography includes all material published on a particular subject or field without excluding any items that the compiler may think would be of little use. This type of bibliography has its uses, for it presents the researcher with a complete list of publications and lets him decide what would be more useful from his point of view. On the other hand a select bibliography would present him with a much easier task of a smaller list of works already screened by a bibliographer. However, here the danger is that items which may be of value to the researcher might have been dismissed as unimportant by the compiler who had a different set of norms and objectives. Then again a bibliography may be annotated. An annotation is a note which gives information about the contents of an entry in the bibliography. Annotations may be descriptive or critical. Usually a critical annotation is more useful than a descriptive one but again it depends on the expertise and the point of view of the

compiler. Bibliographies may limit themselves to books published during a certain time span and may be designed for a certain kind of user. Therefore the proper utilization of bibliographies depends partly on some knowledge about the aims and standards of the compiler as well as of the scope of the bibliography.

3. Types of bibliographies

Bibliographies can be divided into—

1. National bibliographies
2. Country bibliographies
3. Subject bibliographies.

A national bibliography is a complete listing of books published in a country on any subject. A national bibliography has a number of advantages. They are reasonably comprehensive. Moreover, they are published regularly—e.g. *The British National Bibliography* (BNB). This is published weekly and classified by subject, with author and title indexes. There are monthly, quarterly, annual and five-yearly cumulations. Therefore researchers can find out what has been published in Britain on his subject for the last, say, 20 years, while also keeping a check on current publications since full descriptions are given, i.e. author, title, place of publication, publisher, date, pagination, price etc. It is possible to use the BNB to request librarians to order books as well.

However, national bibliographies are not usually annotated and are a mere uncritical listing of all publications. Other examples of national bibliographies are *Ceylon National Bibliography*, *Indian National Bibliography* and *National Union Catalogue of the USA*.

In contrast, a *country bibliography* is a comprehensive listing of all publications regarding a particular country irrespective of whether the works were published in that country or elsewhere. We have an excellent example of such a work for Sri Lanka in H.A.I. Goonetilleke's *A Bibliography of Ceylon* published by Inter Documentation Company, Zug, Switzerland. This is a comprehensive bibliography and has been developed as a continuing work with annotations, both descriptive and critical, attempting to guide the scholars to the more valuable publications. It is classified according to a scheme devised by the compiler but has numerous cross references and a good author index. It is an indispensable starting point for all research workers on Sri Lanka and the later volumes appear to be better annotated than the original two-volume work.

Finally there are the *subject bibliographies*. As the title indicates these bibliographies cover particular subject areas. Sometimes the area covered may be very wide, e.g. *International Bibliography of Social Science*, Tavistock Publications, prepared by the International Committee for Social Science Information and Documentation. This appears in four parts—Sociology (since 1951), Politics (since 1952), Economics (since 1952), and Social and Cultural Anthropology (since 1955). Entries for the volumes are obtained

from many countries and include articles selected from over 25,000 periodicals. Its continuous publication for 25-30 years has made it a good source of recent research publications but it is usually about 2 years behind time.

Some bibliographies are limited by area though they cover wide subject fields, e.g. *The Asian Social Science Bibliography*, Vikas Publication House Delhi edited by N. K. Goit. This is a classified and annotated bibliography but it takes a long time to appear in print (e.g. the volume for 1967 appeared in 1974). The annual bibliography appearing in the *Journal of Asian Studies* (Ann Arbor) is another example. Other subject bibliographies may be more limited or specific in the subject scope, e.g. *The Annual Review of Anthropology* published by the Stanford University Press provides a regular survey of the literature on anthropology classified by subject divisions.

Current Annotated Bibliography of Dutch Expansion Overseas edited by Gerard J. Telkamp in the *Itinerario* is a fine example of a classified, annotated subject-bibliography but it does not extend to cover material written from outside the Netherlands by non-Dutch sources. Single-volume or multi-volume bibliographies covering more specific fields can be found in plenty: e.g. A. Ajaeghu, *Africa Urbanization: A Bibliography*; H. A. I. Goonetilleke, *Coins and Currency*. Some subject bibliographies cover only a certain type of material, e.g. Joseph Schulman's *Doctoral Dissertations on Asia*.

Lists of theses are very important, for one of the nightmares of every research worker is the possibility that someone might work on exactly the same problem and produce his thesis before him. Works to consult in this respect are as follows.

(1) *Index to theses accepted for higher degrees by the Universities of Great Britain and Ireland* (London). This is arranged in broad subject category with a more detailed subject index and an alphabetical list of authors. It is usually published about two years after the theses are presented.

(2) *Dissertation Abstracts International (A)—Humanities and Social Sciences* : (University Microfilm, Ann Arbor) This has been published since 1938 and covers 350 academic institutions in North America and is better designed, for it provides not merely titles but abstracts of doctoral theses and is carefully cumulated. There is an invaluable cumulative index to the first 29 volumes of the series called *Retrospective Index* published in 1970 in 9 volumes, and almost all theses presented to Universities in the USA since 1861 are listed in the *Comprehensive Dissertation Index 1861-1972*. Ann Arbor, 1974.

Other bibliographical tools that cover current research : *The Asian Studies Association of Australia Review* gives a listing of theses in progress or completed in Australian Universities. The *Sri Lanka Research Bulletin* lists on-going research projects by scholars working in Sri Lanka. *The Progress Report of the Marga Institute* lists research work completed and in progress as well as projects formulated for the future.

4. Printed Catalogues

Another major tool which may be used in the literature search is the printed library catalogue. The difference between a bibliography and a catalogue is that while the former usually represents a listing of books irrespective of where they happen to be located—the catalogue represents a collection deposited in one or in a collection of libraries. The printed catalogues of some major libraries in the world are often used as instruments for finding out what books have been published in a particular area, e.g. *The General Catalogue of Printed Books to 1955 of the British Museum* published in 1965 runs into 263 volumes and is supplemented by 5 yearly cumulations. This is a very useful work because of the great comprehensiveness of the British Museum Library, but this is an author catalogue and is thus of limited value in locating books on subjects. This is only partly remedied by the *Subject Index of Modern Books acquired since 1881* published by the same institution.

Catalogue of the New York Public Library—Oriental Collection, G. K. Hall, 1960
16 Vols. First supplement 8 Vols.

Library of Congress Catalogue : (Books : Subjects) This appears in quarterly issues with annual and semi-annual cumulations and can be very useful as the accessions to the Library of Congress are extensive.

Trade Catalogues : These often provide the quickest way in providing information on current publications. Each publisher issues a list of books that are in publication or will be issued shortly. In addition *British Books in Print : A reference catalogue of current literature* (Whitaker) and *Books in Print* (Bowker) provide information on the publications in UK and the USA.

The Bookseller : The Organ of the Books Trade was first established in 1958 and is published by the Booksellers Association in London. This gives advanced information of books published in the U.K. This is a very useful guide for both selection for libraries and to the individual scholar.

Guides to Journals and Newspapers : Since journals and newspapers are a little different from monographs in that they may contain a variety of information on many unrelated topics in one issue, they need special guides. We will first deal with journals. In many areas of the social sciences one of the most important sources of information on recent research is the journal literature. There are a number of obstacles to the exploitation of journal literature. Of these I will mention three here. The first is the enormous size of the available literature. The second is the scattering of articles on a topic among a great many different journals. The third is the problem of locating a journal which is not available in one's own library.

There are over 5,500 Social Science journals available today. Therefore, it is extremely difficult to locate articles on a subject field of your choice among these journals and these will certainly not be discovered by browsing among a library's limited collection of journals.

On the existence of journals the standard reference work is *Ulrich International Periodicals Directory*. This publication lists over 55,000 periodicals in print (on both social science and sciences) by subject and title. There are other listings limited to a country, e.g. *Guide to current journals*. But periodicals appear and fail frequently, they change their titles often and change frequency of publication. The *International Social Science Journal* provides a way of keeping track of new journals in the social sciences. The list provided in this is selective, but includes all journals likely to be of interest to academics. This journal also lists the current and projected social sciences programmes of Unesco.

To find out the contents of journals there are various *bibliographical services* provided by libraries as well as commercial organisations. There are *indexing journals* which comprise lists of bibliographical references arranged by subject headings in alphabetical order. *Abstracting journals* also provide bibliographical references together with an abstract or summary of essential facts, theories or facts presented in the articles. Academic libraries now issue photo-copies of contents pages of periodicals. There is a very popular *Current Contents in Social and Behavioural Sciences* published commercially by the Inst. for Scientific Information, Philadelphia. *The Union Catalogue of Serials* and *The National Union Catalogue*, also provide information on periodicals.

The British Union Catalogue of Periodicals of the world, from the 17th century to the present day in British libraries arranged under title. For Sri Lanka we have the *Union List of Periodicals in Social Sciences and Humanities* published by the National Science Council.

Newspapers are a significant source of current and historical information for many social scientists. Unfortunately the newspapers do not take the trouble to compile subject indexes to their past contents. *The Times (London) Index* is an exception to this. This has been published since 1906. The American Association for the Advancement of Slavonic Studies publishes the index to *Pravda* on a monthly basis, with annual cumulations. This service started in 1975.

The lack of an index to newspapers is compensated by the publication of the *British Humanities Index* (Library Association, 1962 +). This indexes *The Times*, *Guardian*, *The Daily Telegraph*, and also such journals as the *Economist*, *Political Quarterly*, *Economic Journal*, *Sociological Review*, etc.

Events and issues which are recorded in newspapers are incorporated into digests; among these, the best known is *Keesings Contemporary Archives*, a weekly diary of important world events with index continually kept up-to-date (1931 +). *The African Record : a fortnightly digest of African events* (1962) and the *Asian Recorder : a weekly digest of Asian events* (1955 +), both published by the Recorder Press, New Delhi, are modelled on Keesings.

Finally, useful bibliographical information can also be had from the book reviews in *Times Literary Supplement*, *Sunday Times*, *Guardian*, *Daily Telegraph*, *New York Review of Books*, *London Review of Books*, *Times Higher Educational Supplement* and book reviews in learned journals.

Reporting, Interpretation and Generalization: A Historian's Perspective

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Research writing in the social sciences is not as simple as it sounds. If you look at the handbooks that introduce you to research techniques in the social sciences they will tell you to consult your sources, test them and satisfy yourself about their authenticity. Then once you are reasonably satisfied that your facts are accurate you have to assemble them and prepare your report giving at the same time clear references. This is sometimes called the 'historical method' (a method which has a remarkable antiquity.) But today historians are beginning to doubt whether there is anything called a 'historical method'. I need not go so far as to agree with that but there is a point in it because the method of the historian is rather different from, say, that of an accountant or even a lawyer. When an accountant or a lawyer sets about his task he proceeds on certain time-tested lines. They have a number of methods for a variety of purposes and each has a procedure. A systematic mode of proceeding from question to answer and of suggesting remedies for difficulties. What they have in common is the procedure can be repeated. But with the historical method you cannot repeat it. I do not think that two historians work alike. I would go so far as to say that there are as many methods as there are historians. In other words, in so far as the historian is concerned, method is only a metaphor to say that he is trying to be rational, resourceful, imaginative and conscientious. These are four qualities which are extremely difficult to acquire. But this is more or less what a person means when he says that he is adopting the historical method in tackling a particular problem.

Some American universities and schools, we are told, teach their pupils composition. In some of these schools, there is a practice which some people find rather deplorable but it has its advocates. You are simply told to get, say, a novel from Conrad and repeatedly copy, say, the first fifteen pages. The idea is that in this process you learn something of style, of technique of writing. But I think there are easier and less dreary methods of learning to write a report. The important thing I want to emphasise is that when you write prose you have to be simple as possible in your language and avoid jargon as far as possible. If this sounds very twentieth century, let me assure you that what I was giving you now was a summary of something written in the year one hundred and sixty A.D. by a Roman historian called Lucien in a treatise called *The Way to Write History*. The fact of the matter is that there is nothing remarkable in resorting to jargon. In fact, the clever person will do without jargon. The freer you are from jargon, the more effective you are in preparing a report because the purpose is to communicate your ideas to make people understand what you are saying and not to confuse them. If your purpose is to confuse others, then by all means resort to jargon.

I began my talk by more or less suggesting that there is not anything called a 'historical method'. Instead I would use the term 'a historian's approach' to a problem. Looking through all the guide books that I have been referring in the last few weeks to prepare this lecture, I found one in which a very well known historian, talking of the historian's approach to the social sciences, said that any decent report had to have four particular qualities. They are narrative, chronology, concreteness and memorability. In other words, in telling the historian how to prepare a report he insisted first of all that history is a narrative or a story. Interpretation is more often than not optional and there are some historians who have lived without interpretation. The story of course, is intended as the truth, and it gives particulars of change within time and space.

The second quality is concreteness. That is, you begin with events, incidents or with data. Indeed, in terms of most reports the whole question is 'what happened ?'

Memorability is rather more complicated, because it has two meanings. One is, 'it is worth remembering', the second is 'capable of being remembered'. Both these meanings are essential in preparing a report. There are no clear limits as to what one person or another will deem worth remembering. Yet it is also evident that no one would want all the facts even if it was possible to collect all. So the two meanings point to one, a certain selectivity and second, to an intelligible pattern in your writing. Quite often, especially as a social scientist, you will be confronted with a situation in which you have a mass of data and information, and you are called upon to give it a certain order and coherence. There is no point in taking a chaotic situation and trying to be as faithful as possible. You are expected to select facts and try to put your ideas together in some cohesive order.

As historians we know one thing. No one expects mathematical precision from us. But sometimes social scientists in allied fields believe that mathematics performs the same role today that religion performed a few centuries ago. There is no virtue in mathematics of that sort and, I would add for myself, no virtue in religion of that sort. But your purpose is to select and to matter, put it together. At this stage, I would like to remind you of a saying from Bernard Shaw, which is important to social scientists. He said 'chaos has no statistics, it has only statisticians'. Of course, I am not suggesting that you should not consider the bulk of the data before you. It is simply that this encyclopaedic ideal of all the facts is self-defeating. It is self-defeating for a historian or any other social scientist.

Next you come to the question of interpretation. Here, as all good scientists should, you need to have a look in the dictionary. The Concise Oxford Dictionary (New Edition) gives two meanings to the word 'interpretation'. One, stretched out at great length says "Expound the meaning of (abstruse or foreign words, writings, dreams etc.) make out the meaning of; bring out the meaning of; render, by artistic representation or performance ;" and so on. So you have a fair idea of what the word 'interpretation' means.

In practice what interpretation means is this. You have through the exercise of intelligence and diligent research collected a lot of facts. These facts by themselves will not amount to anything more than a certain amount of order imposed on chaos. It must include an interpretation of the facts, because a framework of facts is not enough in a report. To get a coherent story out of these disconnected pieces of separately recorded information, it requires critical and imaginative powers of a very high order. When that is done there will be a number of difficulties. You have to attribute causes and explain events.

If the meaning of an event is to be short, an attempt must be made to set out the possible pattern for a whole period. Now complications arise. For example, consider a historical analysis of the twentieth century. As you approach modern times the framework of facts will become closer knit and more massive. There will be a great body of corroborative history, more records will survive. But the fact is that there are large gaps in all this. Some documents will be invented. Some documents will be destroyed. Some decisions will be taken over the telephone. In this sort of situation interpretation becomes a much more difficult exercise. It should, on the face of it, rather be easier, because at least if you live in contemporary times, you know the reputation of the persons who prepared those documents. Nevertheless, it presents very awkward difficulties. There are whole areas which are neglected, despite the seeming immensity of the material that you have.

How would you fill these gaps? Fill them with myths or theory? The first of course is not available to a historian. It may be possible for a sociologist. But the second aspect of it is a rather more attractive proposition. But what I would say is that as apprentice social scientists, trying to make your way into research, you have to make absolutely certain that everything that passes for history, political science or any other social science should bear a close relationship to a provable fact. It is better to say in your essay or your paper that there is a gap and I would merely point to the existence of this gap than to say that this is what I think has happened, if you do not have evidence to back you.

The interpretation of history can never be a mere catalogue of facts alone. But any interpretation which makes use of facts is open to challenge and falsification. Those which rely on obviously dubious facts and do not take into account facts which are known and could be found out, are misleading and deceptive.

As you know historical research is going on most of the time and new facts are being constantly discovered which often makes old interpretations impossible to retain. Historians are constantly probing and re-interpreting what were once recognised to be accepted facts. Any historical concept which has not been adjusted to the most recent research will cease to be satisfactory. To put it differently, times change and with time, views change and outlooks change. The changed outlooks alter the appearance and therefore the meaning of some part of the past.

The appearance and meaning of a picture or a scene change according to the angle from which the picture or the scene is viewed. It is the same with history and allied subjects. As the angle of vision changes, the appearance and meaning of historical facts change. Accordingly a re-writing of history from a new point of view becomes necessary.

The problem of historical generalization is a slippery and evasive subject which has a great deal to do with things like philosophy, from which I normally flee. But in view of the fact that this has been introduced here, I will merely indicate why some historians now do not accept the term 'generalization' in the sense in which it was accepted thirty years ago. I will merely say that it is difficult to agree on what a generalization is. Nor is it particularly profitable to try to distinguish generalizations from other kinds of historical propositions. A generalization was ordinarily conceived to be a statement broader than some other statement. But the term 'broader' is relative. All statements are in a sense generalizations. But some which are commonly and as a matter of convenience, referred to by this designation are broader than others. Even the distinction between factual statements and generalizations becomes really a philosophical problem and among historians it is a matter of controversy whether general laws are really useful in historical study.

To show you how complicated the problem is, I will explain what happened, when I tried to get a definition of the word 'generalization'. The concise dictionary, I thought, was not good enough. So I went to the marvellous thirteen volume Oxford English Dictionary. It had about six pages on generalization. It had a definition which would have suited anybody. This I thought was not satisfactory when I had to speak only for thirty minutes. Therefore, I consulted the Shorter Oxford Dictionary which had almost one page on it. But the complication was still there. So I went back to the Concise Oxford Dictionary which sets out the meaning of 'generalize' in this form—"reduce to general laws ; form into a general notion ; give a general character to ; call by a general name. 2. infer (law, conclusion) by induction ; base general statements on (facts etc). 3. (Math and Philos) express in general form, extend application of and so on. What is really means is that even the compilers of the Oxford Dictionary have given up in despair. The result is that some historians have now shifted their focus away from generalization to generic statements. This may appear to be an exercise in semantics, but it is not.

A generic statement for purposes of this discussion is simply a statement about common characteristics of behaviour of individual people, events or things. It is an ugly word but from all points of view rather better than generalization. I will refer to two generic statements made use of by historians when they discuss the past and the present. The simple and the most obvious is one which divides history into periods. The conventional division used to be ancient, mediaeval and modern, which no historian now accepts in that form at least. But in historiography, periodisation is necessary and historians have evolved new divisions. In other words people have moved away from one set of generic statements to a new set of generic statements, which, hopefully will yield new insights.

The second area of generic statements is much more difficult. That is a statement which involves personality, be it a nation, race or class. For example, today Great Britain is a nation. But you cannot use the phrase to imply that certain things happen in Great Britain over several centuries, because Great Britain is, in terms of history, something of recent evolution. The use of the word generic term German in relation to the twentieth century can be even more confusing because it could mean either the Federal Republic of Germany or the German Democratic Republic or indeed Austria. These are illustrative of the problems caused by common seemingly innocent generic terms.

I wish to conclude my lecture with just one piece of advice. If you are trying to be a social scientist of any quality, the most important thing to do is to immerse yourself in the reading of the standard classical works on your subject. That will give you some idea of the way in which a work of scholarship should be approached and handled.

Technical Aspects of Writing

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1. Introduction

My lecture will start with some assumptions which have dictated its position at the tail end of this seminar. It will be assumed that the research topic has been chosen, that the research work has been done and that the major conclusions are already in the researcher's mind. It is also assumed that the researcher has obtained some facility in expressing his ideas. At this stage you come to the problem of acquiring some knowledge over the technical aspects of writing. By the technical aspects of writing I mean the rules for writing footnotes or making a bibliography and possibly even correcting proof copies of the publishers. These aspects and the details relating to them may seem very boring and tedious, after the excitement of formulating the hypothesis, conducting a survey and so forth. But a good piece of work in terms of research and conclusions can be marred by inattention to the technical details.

Since the whole exercise in proof reading is combination of information and of patience, what I will do is merely to circulate a copy of proof readers marks (see Annex 1) and hope that you will read the marks and develop patience. I will, however, deal at length with footnotes and with the preparation of a bibliography.

2. Footnotes

Let me first take the case of footnotes. There are two basic kinds of footnotes. Firstly there are source footnotes, which give the source from where you have obtained information or from where you have obtained a quotation. Source footnotes are also those which may refer the reader to a further source of information. This kind of footnote can be distinguished from the explanatory footnote, which gives additional information which though it may not be related to the main theme you are discussing, may still be of interest to the reader. I will give you an example of an explanatory footnote from a book called the *Facets of Ceylon History. The Letters of J. Peiris*, written by Michael Roberts. The name of C. Don Bastion is incidentally mentioned in the text. In a footnote, the author says Bastion (1852-1921) was a Sinhalese novelist and journalist. Born in The Pettah, he settled in Karagampitiya, Dehiwela and carried influence in the locality. He was the proprietor and editor of 'Dinapatha Pravurthy'. Now this has nothing to do with Roberts' main theme. But he has found this information and thought that it may be of interest to the reader. So it is mentioned in a footnote.

It is easier to talk about the format of a footnote, and types of footnotes rather than as to when to use them and the extent to which they should be used. Nevertheless I would prefer to centre the discussion on the latter aspects because it is useless to know how to construct a footnote, if you do not know when and how to use it and how it can

be misused. It is a little difficult to lay down a set of common rules for the use of footnotes for this depends on the kind of report, article, paper or book you are writing. But for people who want to write a report based on research, the source footnotes are indispensable. They are indispensable because you have to acknowledge the source from which you got the information in order that somebody can check on it and find out whether you have reported correctly or whether you have misinterpreted the evidence. But even here the use of source footnotes can be limited. There is no need, in my opinion, to sight footnotes for well known and accepted facts or information. For example, you may not have to give a footnote to prove that there was an election in 1956. This is accepted or generally known, at least in Sri Lanka. However, if you are working on a new theme which has not been written on before, you may need to substantiate many of the things you are stating because they may not be familiar to your readers. If you are writing something that has been explored before, then you might well be able to cite an authoritative source, a source which states certain conclusions which you accept, and thus dispense with a lot of footnotes which you might otherwise have to present.

There is much greater debate in the case of explanatory footnotes. One extreme argument is that if there is something which is not important enough to be put in the text, then it does not deserve to be entered at all and that excessive footnotes distract the reader from the main arguments in the text. At the other extreme certain scholars illustrate many things in the text with long explanatory footnotes so that often the space taken by footnotes in a page is much longer than the text. I do not think anybody can dictate to you which method to adopt or whether you should compromise between the two. There have been very good books written without any explanatory footnotes and there have been excellent books written with a lot of explanatory footnotes. Much would depend on the kind of topic you have chosen and the amount of information that you have obtained. I think that, by and large, explanatory footnotes do have a place in most studies. You can use them to define some of the terms used in the text, and to place some bits of information which cannot conveniently be woven into the narrative.

In the case of an article in a periodical, footnotes are normally numbered consecutively. In books footnotes are numbered separately in chapters. Some scholars have adopted the practice of having separate footnote numbers for each page. But that could cause problems because normally an article would go through many drafts and, in retyping, often there is a change in the way the text is arranged. Thus a lot of confusion can be created about the numbers of the footnotes.

Let us now look at the format in which a footnote should be arranged. There are many manuals available which discuss the format of footnotes. But the differences given in the manuals are actually very marginal and I think you can adopt a system of your own if you so wish, as long as the system gives the necessary information and as long as you consistently adopt the system. In Annex 2, I have given examples of footnotes. The first time a book is cited in a footnote, as you will find in example 1, you need to give full and complete information. The only exception is where you have a bibliography at the end when you might be able to shorten the reference in the footnote. But under normal circumstances when you are writing a paper, you have to give the author, the title of the

book, the publication data and the pages or chapter referred to. The abbreviation pp. is used to denote the word 'pages' (singular = p) and c. or ch. (plural = chs.) to denote a chapter. You should also note that in the footnote normally the author's name is given in its proper order unlike in the bibliography. In a bibliography, you would have, for example, MYRDAL, Gunnar whereas in the footnote (see footnote 1, you would have the normal order in the name. The second format is an example where a pseudonym is used. E. J. Thompson is a pseudonym as in example 3.

When a work is more important than the author, as in the case of an encyclopaedia or a dictionary, you would normally enter it under the title of the work as in example 4. If the title page does not give the author whose name is known to you then you can put the name of the author within brackets as in example 5. In the case of multiple authors, they should all be listed as in example 8, unless the number of authors or editors exceeds three, in which case, as in example 9, you say J. W. Winston and others, to keep the footnote short.

The name of the editor of a collection of essays is often given before the title as in example 6. But when a work written by one person is edited by another, as in example 7, you give the author's name first, then the title and then the editor's name. The same rule applies in the case of translations. There are a number of rules relating to the entry of a title. The complete title is given in the original spelling, even though the original title may have spelling mistakes. The words in the title are capitalised except the articles and propositions within it. That is 'in' 'a' and 'the' are not capitalised unless they are found at the beginning of the title. Often as a convention the last word of the title is capitalised.

Names of all books, monographs and journals are given in italics and therefore should be underlined in your typed script. When there is a sub-title, the sub-title is joined to the title by a colon, as you will find in example 1.

The place of publication must be given, and if it is not clear where the place is as in example 1, you can give the state in which the place of publication is located—New Haven, Connecticut. Normally the city is given in the anglicised form—for example you have Kandy and not Mahanuwara.

If some information is lacking, it is normally indicated. For example, in example 2, in example 2, you will find (n.d.). This means that the date of publication is not recorded. If you have (n.p.) as in the example 3 it would mean that the location of publisher is not known.

If there is a re-print or a new edition, this should be mentioned as in example 7. If a book is not yet published, you can always give the title of the book, the author and so on, and say forthcoming and refer to the pages, if the page numbers are known. If you want to refer to a number of pages following your reference, you can say *passim* (every here and there) as in example 8.

Sometimes you have out of print books re-printed photographically and in such cases scholars often cite the original edition as well as the second edition. When a book is published in hard back and paper back, you should always mention the kind of volume you have used because sometimes the pagination is different. In the case of multi-volume works normally the page reference is preceded by the volume number.

If a book has been cited once subsequent references in later footnotes can be shorter, as in the example 11—Myrdal *Beyond the Welfare State op.cit.* *Op. cit.* means that it has been cited before. If in the next footnote you want to refer to the same book, it is not necessary to write it all over again. But as in example 12, you can write '*ibid*' and give the page numbers. That means you are referring to the same book as above. However, you do not start with *ibid* at the beginning of a chapter in your book. If you wish to compare something you have said in the text with that of another work you can use, as in example 13, the abbreviation of which means (compare) (Latin=*confer*).

Now I would like to turn to articles in journals where you have the same format. For instance, in example 13, the author's name is given first, the title of the article next and then the name of the journal underlined, followed by the series, the volume number, the number of the part, then the data of the journal and the pages. In the case of popular magazines and newspapers, as in example 14, the title of the article is given first followed by the name of the publication underlined, the date of publication and the page number. Example 15 refers to an article published not in a journal but a collection of essays. Here the name of the author of the article is given first, followed by the title of the article, title of the book, editor's name and then the usual publication details.

Example 16, 17 and 18 illustrate references to unpublished manuscripts. All three indicate the author and nature of the manuscript, the date of production and the depository or library where the manuscript can be found.

3. Bibliographies

A bibliography generally reveals the author's knowledge of his chosen subject. A bibliography of a good research article or monograph must contain a representative sample of the latest works on the subject. The bibliography can be especially important in the case of dissertations where examiners usually scan them to assess the candidate's familiarity with the field of study.

In certain types of research writings such as seminar papers a separate bibliography is an optional, whereas in certain other types such as dissertations it is an essential. In general, most books, monographs and articles written on academic subjects carry a bibliography.

The normal practice is to include in the bibliography all the articles, books and other similar materials to which reference is made in the text. Sometimes a bibliography can contain titles which are not mentioned in the text but this is usually done only in instances where the author wishes to supply the reader with a comprehensive bibliography on the subject under discussion.

The format of a bibliography can vary considerably depending on the type of material that has to be included. The simplest case is a consolidated bibliography where all entries are listed in alphabetical order according to the names of the authors. However, a bibliography which is lengthy and includes a variety of sources can be usefully divided into appropriate sections. Published and unpublished sources can be listed separately and each in turn can be sub-divided depending on the material to be listed. For example, in the section containing publications, journal articles and books can be listed separately and in the section on unpublished sources, archival material and dissertations can be listed separately. When archival material from more than one depository is used it may be helpful to list the material from each depository separately.

Sometimes authors like to number the entries in the bibliography, and in the text refer to the sources by their respective numbers. Alternatively, the year of publication can be referred to in the text together with the name of the author. In such instances, if there is more than one entry from one author, the usual practice is to attach an alphabetical subscript (e.g. A.B. Perera, 1977a ; A. B. Perera, 1977b) to distinguish them from one another.

In 'literature survey' type of articles or monographs which attempt a comprehensive review of the existing knowledge on a given topic, sometimes the bibliography is annotated.

4. Conclusions

Finally, as young scholars who are about to embark on research careers you should bear in mind one important point. A piece of writing which pays proper attention to the preparation of footnotes, a bibliography and other technical details usually indicates a disciplined mind and dedicated scholarship.

References

Barzun, Jacques and Graff, Henry F. *The Modern Researcher*, Third Edition. New York, Harcourt Brace Jovanovich Inc., 1977.

Chang, Sidney H. Lloyd, Shavon F. and Yoshino, Ronald W. *Method and Form for Paper Writing : A Manual*, Revised Edition, Taipei, By the Authors, 1978.

ANNEX I

THE PROOFREADER'S MARKS AND THEIR USE

MESSAGE TO PRINTER	MARK INDICATION IN TEXT	CORRECTED TEXT
Remove letter or word.	He read the boook.	He read the book
Insert letter.	't She wrote a leter.	She wrote a letter.
Insert space.	# We wenttogether.	We went together.
Change to capital letter.	B Pam asked bill.	Pam asked Bill.
Change to lower-case.	lc Do You know him?	Do you know him?
Wrong font (type face)	uf He mixed them up	He mixed them up
Broken letter. Replace.	X Clean your type.	Clean your type.
Inverted letter. Turn.	9 It must be wrong.	It must be wrong.
Reset in italic type.	ital Don't do that!	Don't do that!
Reset in roman (regular).	rom What can it be?	What can it be?
Reset in bold-face (dark).	bf The word was nor.	The word was nor.
Reset in small capitals.	sc The sign said Stop!	The sign said STOP!
Transpose.	tr but enough world and	but world enough and
Insert period.	o Such is life.	Such is life.
Insert hyphen.	/=/ Mr. Wycliffe Jones	Mr. Wycliffe-Jones.
Insert comma.	/, That's all folks.	That's all, folks.
Insert apostrophe.	^v Dont look now.	Don't look now.
Insert quotation marks.	^v^v Eureka, he said.	"Eureka," he said.
Insert inferior figure.	^ Water is H ₂ O.	Water is H ₂ O.
Insert superior figure.	^v E=MC ²	E=MC ²
Insert question mark.	? What's going on here.	What's going on here?
Paragraph.	¶ done? [Now we must	done? Now we must
No paragraph.	n. ¶ decided. Then they	decided. Then they
One-em space.	□ □ Call me Ishmael.	Call me Ishmael
One-em dash.	/M/ had if only because	had--if only because
Move as indicated.	□ □ Move it to the left.	Move it to the left.
[move left move right]		
Close up space.	⊖ They had a break up	They had a breakup.
Let stand as is.	stet Which one did it?	Which one did it?
Straighten type.	= Type can shift a bit.	Type can shift a bit.
Query to author.	⊙ A word overlooked.	A word was overlooked.

ANNEX II

EXAMPLES OF FOOTNOTES

1. Gunnar Myrdal *Beyond the Welfare State : Economic Planning and its International Implications*. New Haven Conn., Yale University Press, 1960. pp. 47-50.
2. (Edward Morris) E. J. Thompson *The Economy of Johbra*. Kuala Lumpur, Academic Press. (n.d.) p. 81.
3. Sparataous (pseud.). *World Revolution*. (n.p.) Ziff-Davis, 1962. p. 36.
4. *The World Almanac and Book of Facts 1980* ed. by George E. Delury, New York, Newspaper Enterprise Association Inc., 1980. p. 87.
5. (W. Wiswan) *The Urge to Slander*. New Delhi, 1971 (p. 13).
6. K. Indrapala, ed., *The James Thevathasan Rutnam Felicitation Volume*. Jaffna, The Jaffna Archaeological Society, 1975. (Released 1980) p. 32.
7. Thomas Pires, *The Suma Oriental of Thome Pires*. . . . trans. & ed. by Armando Cortesao, London, Makluyt Society, 1944. Reprint edition. Oxford University Press, 1972, 2 Vols. Vol. I. p. 37.
8. Barrie M. Morrison, M.P. Moore and M. U. Ishak Lebbe (editors) *The Disintegrating Village : Social Change in Rural Sri Lanka*. Colombo, Lake House Investments, 1979. *passim*.
9. James W. Winston and others *The Economy of Zambia*. Revised Edition. London, C. Hurst, 1980. p. 86.
10. Fernao de Queyroz *The Temporal and Spiritual Conquest of Ceylon*. translated by S. G. Perera. Colombo, Ceylon Government Press. 1930. 2 vols.
11. Myrdal *Beyond the Welfare State op. cit.* p. 84.
12. *Ibid.*, p. 114.
13. cf. K. M. de Silva "A Tale of Three Constitutions, 1946-8, 1972 and 1978" *The Ceylon Journal of Historical and Social Studies, New Series*. Vol. II, No. 2, June-December 1977, pp. 1-17.
14. "Poland's Race Against Time" *Newsweek* 1 Sept. 1980. p. 18.

PART VIII

Field of Research	Page
1. Choice of Field of Research — <i>G. H. Peiris</i>	259

Choice of Field of Research

G. H. PEIRIS

University of Peradeniya

In this lecture if you expected me to suggest topics for research I am afraid you will be disappointed. Such an exercise, if undertaken, will be counter-productive for several reasons. First, the social sciences encompass a very wide range of disciplines. There may be some whose knowledge covers a relatively wide span in the spectrum of social sciences. Nevertheless no individual or no manageable group of individuals can or should pretend to be able to suggest topics of research to others.

My second reason is that there is considerable diversity among those who comprise the present audience. They vary from each other in academic training, talents and capabilities, interests, inclinations and objectives. To such a diverse audience it is not possible to generalise. What could be prescribed for one person may not be appropriate or relevant to another person.

My third and most important reason of all is that the idea of an individual prescribing or suggesting possible areas of research to a group of others or even to an individual runs counter to my perception of what research is and what research should be. The only exception to this rule would be those who are doing research in a particular area because their job demands it.

Selecting a subject for research is like selecting a spouse. There are many parallels. Undertaking the task of giving advice to another on the choice of a research subject would be like someone advising another whom to marry. Extending this analysis a little further, I would like to recognize four interrelated qualities, if the researcher is to be successful and productive.

The first of these is that the topic or the field of research must be capable of maintaining the sustained interest of the researcher. This depends both on the subject as well as on the perseverance of the researcher. Research in any branch of science, not only in social sciences, inevitably entails a great deal of routine, repetitive and painstaking work. Therefore it is desirable for the prospective researcher to consider whether his topic has the quality of being able to sustain his interest for a long period of time. There could be the counter-argument that the researcher might develop an interest in his subject as he goes on, just like in marriage, although at the start he would have little interest. Still I would maintain that when a person is adequately prepared to undertake research, he will be able to sense before he starts whether that topic is capable of sustaining his interest.

The second quality can be described by borrowing a term which is usually associated with my marriage analogy, namely 'compatibility'. A research topic must be compatible with the researcher's training and more importantly his talents and interests. For example, some may prefer long hours in libraries and archives, some may possess writing skills, and

others may be good at statistical work. The topic that you select for research, therefore, must be compatible with your talents, interests and inclinations. Here too, it is possible to say that these skills and talents can be acquired as you go on. But my opinion is that acquiring new skills is a time-consuming and a tedious process. More importantly, the scope for useful research in the social sciences is so vast that it is certainly easier to adjust the area of research to suit one's capabilities than to acquire capabilities to suit one's area of research. That is why I say that in the choice of a research topic, one must look for this characteristic of compatibility with one's own talents and interests.

The third important consideration that you must look for in your research topic is whether you can afford it in terms of facilities, funds, time and opportunity. The more obvious aspects of this require no further elaboration. But there is evidence in our own experience that the significance of affordability in the broadest sense of the term is not quite appreciated even by some experienced researchers. For example, in Sri Lanka there is the eternal complaint that not enough funds are made available for research or that official data are not accessible to local researchers. I am not suggesting that these are not serious constraints on research. But the point I wish to make is that even if we are to consider these problems as a part of a given and a unchangeable system, still there are enough areas of research to select from which are affordable.

Fourthly, the selected field of research must be capable of fulfilling the researcher's aspirations. This too is a quality that has parallels in my marriage analogy. To adopt a pragmatic approach, I would say that one of the questions that should be posed when selecting an area of research is, 'what can you expect from it?' This is a question which is rarely asked. Aspirations or expectations may vary from individual to individual, and in this, I do not see certain aspirations as being intrinsically superior to others. Your aim might be to get a Ph. D. or an M.Sc. or to satisfy your intellectual curiosity, or to make a contribution to solve a problem confronting the community. Obviously these aspirations are not mutually exclusive. With luck one may select a topic that fulfils all these aspirations but that would be unusual.

In conclusion I would like to recall the question that I raised at the beginning—"what topic of research should I select?". A researcher with good potential will be able to answer the question himself taking into account, among other things, the factors that I have discussed. One who is not capable of doing so should not aspire to a research career.

PART IX

Evaluation of the Training Seminar*Page*

1. Report of the Course Director — *S. W. R. de. A. Samarasinghe*

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Report of the Course Director

S. W. R. de A. SAMARASINGHE

University of Peradeniya

1. Background

The idea to hold a Training Seminar on Social Science Research Methodology was first mooted by the Unesco and it also offered to help the National Science Council (NSC) of Sri Lanka with funding and the procurement of resource persons from abroad if the latter were to implement the proposal. The NSC accepted the project and the Unesco's offer of assistance and entrusted the Statutory Working Committee on Social Science Research (SSRC) the task of implementing it.

The SSRC under its Chairman functioned as the organizing committee. The University of Peradeniya was selected as the venue, and a three-member co-ordinating committee in Peradeniya was entrusted with the task of local organisation.

The dates for the Seminar (25 th August to 13th September 1980) were chosen partly with a view to avoiding a clash with University sessions. Given the fact that the initial decision to hold the seminar was taken in late June, this left relatively little time to complete the preparatory work. Indeed, it is conceivable that the quality and final outcome of the Seminar could have been further improved if a little more time was available for its planning. This would have been particularly true of resource persons, several of whom were unable to participate because of the short notice given.

2. Objectives

Briefly stated, the objective of the Seminar was to improve and build upon the knowledge of social science research methodology that participants might have had acquired in the course of their undergraduate careers and post-graduate study and research.

3. Selection of Participants

The selection procedure adopted was to call for applications by means of a notice in the national press, process and short-list the applications submitted, and select a pre-determined number (about 40). Given the fact that time was short, this was a reasonable procedure to adopt and, indeed, it is likely that about three-fourths of those who were selected would have secured admission even if the SSRC had adopted a more elaborate method. However, it is worth stressing that on similar occasions in the future

- (a) a prescribed form should be provided for applications (this was not done when the initial press notice appeared) ;
- (b) adequate information should be provided to applicants concerning the course content (in answer to a questionnaire a fair number of participants indicated that more information at the application stage would have been helpful) and ;

- (c) the final selection should be made only after an interview (rather surprisingly, more than half of those who answered the questionnaire (36) would have preferred an interview before final selection—perhaps because it would have given them a chance to obtain more information about the Seminar). An interview would have almost certainly eliminated the few who were very weak in English and consequently found the proceedings hard to follow.

4. Composition of the Seminar

The 41 participants came from the following institutions :

Universities ..	..	19
Central Bank ..	..	4
Research Institutes ..	..	2
Ministry of Planning ..	..	4
Other Government Departments ..	..	5
Other State-sectors ..	..	6
Private sector ..	..	1

They either held junior staff rank positions (e.g. Research Officers, Planning Officers) or were Assistant Lecturers in Universities.

The bulk of the participants had a social science academic background. Most had graduated after 1973 and were under 30. Very few had post-graduate qualifications or any significant research contributions to their credit. However, almost all claimed to have research projects in progress, some in relation to post-graduate degrees for which they were registered with local universities.

5. Length of Seminar

The consensus of opinion among the participants was that the Seminar period of three-weeks was just about right. Given the course content most participants found it to be a tolerable period to be away from home and work. While a shorter Seminar would have reduced the quantity of the course content and probably lowered its quality as well, a longer Seminar would have almost certainly failed to sustain the interest and enthusiasm of participants.

6. Course Content

Broadly speaking the course content divides itself into :

- (i) General, philosophical and theoretical ;
- (ii) Statistical and quantitative methods ;
- (iii) Computing ; and
- (iv) Field work.

The answers provided by the participants to a questionnaire administered to them at the conclusion of the Seminar suggest that most of them found in the Seminar what they expected to find at the time applications were first made. The overwhelming majority of participants were also generally satisfied with the course content. However, on both counts there were a few exceptions. These were mainly either those who had an unusually narrow and specialist research interest and academic background (e.g. Mathematicians interested in Statistical Techniques only) or those who had entertained the misconception that the Seminar was a course in Statistical Techniques.

It is quite evident that those whose research interests were limited to a narrow field should have been left out. However, it must be stressed that the value of a Seminar of this nature lies partly in encouraging inter-disciplinary thinking and research. Thus, a more homogenous group though helpful from a practical point of view would not have been necessarily desirable when broader academic considerations are taken into account.

7. Course Structure

In planning the course structure (sequence of lectures) of a seminar that consists of over forty lectures one is necessarily constrained by practical problems such as lecturers not being free on a given date, or, worse still, not appearing on the appointed day and this Seminar had its fair share of these. However, given such problems, a logical and smooth course structure makes an important contribution towards the success of a seminar. Broadly speaking, the programme for the Seminar was satisfactory. However, there was room for improvement. For example, there were a few days when about five or even six full-length lectures were crammed into a six or seven hour period, a situation which denied the Seminar an opportunity to discuss subjects adequately and also over-taxed the mental absorptive capacities of the participants. It also became evident that tampering with the planned programme should be avoided as far as possible, however expedient it may be.

Finally, while dwelling on this subject there is one general—should I say philosophical—point to be considered. The logic of the situation apparently suggested that the Seminar should first deal with the general and theoretical aspects of methodology, and then move on to quantitative techniques. However, this apparently logical sequence was broken by having had to accommodate one lecture on a general theme in the middle of the course on Statistics. On reflection this appears to have had the beneficial effect of breaking the monotony of the Seminar and also reminding the participants of the essential unity of the Seminar theme.

8. Lectures on general, philosophical and theoretical themes

The answers to the questionnaire suggested that most participants thought that the time devoted to this aspect of the Seminar was reasonable and the quality of lectures good. However, almost none wanted most time devoted to these topics and indeed about one-third were of the opinion that too much time was devoted to them. In the point of view of one such participant, "The important point of the (sic) Research and Methodology is statistical methods. But you have given more attention to General, Philosophical and Theoretical Parts".

The failure on the part of a substantial minority of participants to grasp the fundamental importance of theory and conceptualization in social science research is unfortunate and, I dare say, to that extent the Seminar has failed to realize one of its objectives. The zeal to learn statistical techniques arises from the misconception that the hallmark of good social science research must be the inclusion of a few regression equations generated (preferably) with the help of a computer. This, as one lecturer (Dr. S. B. de Silva) emphasized is to sacrifice rigorous analysis for mere quantitative data generation. However, it is probably correct to assert that the Seminar succeeded in including a more balanced perspective of methodology in social science research in the minds of the majority of participants.

9. Statistical and quantitative techniques

Almost without exception participants lay great emphasis on the Seminar component on quantitative techniques. In general, those with a modest knowledge of mathematics and quantitative techniques found the course content useful and interesting. A few who had read mathematics and statistics for their degree found the course too elementary, and a fair number with a weak background in these subjects found it too advanced. Almost half the number who participated would have preferred to see more time devoted to Quantitative Techniques. Time and resources were not available for such an extension. Moreover, in a general seminar it would have imparted an imbalance to the course content. However, based on this experience one modification can be suggested for the future. In the case of technical subjects the participants should be graded in terms of their knowledge of the subject and, if necessary, several workshops must be conducted concurrently, one for each level or grade.

10. Computing

The participants were almost unanimous in acclaiming that the computing course was useful and that the lectures and instructions were of a high calibre. The lecturer concerned (Prof. J. A. Gunawardena) succeeded in making computer programming at an elementary level appear quite simple. Almost all participants also wished to see more time allocated to this part of the Seminar (only two days were made available). On reflection the programme would have been even more profitable if at least three or preferably four days had been allocated for computing.

11. Group Work in the field

The objective of Group Work was to introduce the participants to survey-type field work. The majority of participants found the experience useful. A few who had had some previous experience in field surveys did not find anything particularly novel. Many indicated that they would have preferred to spend more time on field work. However, here too the comments I made earlier with respect to availability of time, resources and balance in course content apply.

The Geography group under Professor G.H. Peiris (assisted by Prof. J.A. Gunawardena) which carried out a microsurvey of household firewood consumption deserves special mention. Without exception the participants (10) belonging to the group were

thoroughly satisfied with the work they did. Moreover, the survey concerned succeeded in collecting some data - crude as they may be - on household firewood consumption which have hitherto not been available in this country.

12. Resource persons

Almost all resource persons participated as scheduled in the sessions allotted. In the case of 6 lectures (out of a total of 48) the lecturers concerned made available a mimeographed copy of the full text to the participants before the lectures were delivered. Most other lectures were supported by handouts of varying length and coverage.

Although two foreign consultants were expected only one arrived. The uncertainty concerning Prof. S. C. Dube's participation - he eventually did not come - caused some disruption to the Seminar programme. It would have also been useful if the curriculum vitae of foreign consultants was made available by their sponsors at an early stage. However, the participants were highly appreciative of the contributions made by the foreign consultant who came, Prof. B. Ahmed.

13. Organization and Welfare

Almost all the participants indicated that they were happy with the general organization, seminar and accommodation facilities, and the food provided, at Peradeniya.

14. Free time

The majority felt that there was not enough free time. In retrospect it appears that it would have been better if the first week-end of the Seminar period, 30th and 31st August 1980, had also been left free.

15. Attendance

Attendance at sessions was very satisfactory averaging almost 90 per cent.

16. Overall evaluation

Almost all the seminar participants expressed that they benefitted considerably from the experience and that they felt more confident than before in undertaking a research project. Most indicated that they would strongly recommend a similar seminar to their colleagues.

17. Financial cost

Table 1 shows a 'full' cost budget estimate of the Seminar. A few salient points are worth emphasizing. First, the total local cost has been well within the original budget estimate and a substantial saving has been made on the estimated expenditure on foreign consultants. Second, a substantial saving has been made on the food budget (per capita expenditure on food per day was only Rs. 28.31 as opposed to Rs. 40/- provided for in the original budget). Moreover, the former figure does not take into account the extra meals - about 10 to 15 more in the case of lunch-supplied to Seminar personnel. Third, the free accommodation and seminar facilities (a relatively minor sum was spent on labour) provided

by the University of Peradeniya have made a major contribution towards keeping down costs. Fourth, mainly because of the close proximity of the seminar facilities, computer facilities, the Library and lodgings, to each other, we have succeeded in limiting transport cost at Peradeniya to a modest Rs. 3,000, half of which was incurred on the field trips. When field trips are excluded (and ignoring wages of the National Science Council driver) transport cost at Peradeniya amounts to Rs. 75.00 per day. (The relatively large number—19 out of 44—resource persons coming from the University of Peradeniya also helped to contain the transport bill ; see item 5(ii). Finally, the seminar cost per capita works out as follows :

Local— Rs. 1,585.00 per participant

Total (including expenses for foreign consultant) Rs. 2,154.00

18. Conclusions

The relatively minor shortcomings in the planning and execution of the project notwithstanding, the Seminar appears to have been a reasonable success in terms of the objectives it set for itself. Perhaps this seminar, being the first ever of its kind in Sri Lanka, will serve as a useful guide to the organization of similar seminars in the future.

It is too numerous to mention the names of all those who contributed in many ways towards making the seminar a success. To all of them I say a big 'thank you'.

TABLE I
TRAINING SEMINAR ON SOCIAL SCIENCE RESEARCH METHODOLOGY
A 'FULL' COST BUDGET ESTIMATE

<i>Local</i>	<i>Actual</i> Rs. cts.	<i>Estimated</i> Rs. cts.	<i>Imputed cost for services provided free</i>
1. Food	23,216.00	32,800.00	(Rs. 40 x 41x20)
2. Vice-Chancellor's dinner ..	2,018.00	2,000.00	(Rs. 20 x 100)
3. Accommodation	787.00		16,400 (Rs. 20 x 41 x 20)
4. Seminar (secretarial services & incidentals)	8,523.00	10,000.00	Seminar facilities
5. Transport		3,000.00	3 out of 4 vehicles by Peradeniya cost
(i) Peradeniya	2,686.00	3,600.00	only petrol & drivers wage Rs.800.00
(ii) Lecturers (Rs. 135x11xRs.270x6)	3,105.00	No provision	If hired (two days) cost would have to be at least Rs. 1,600.00
6. Trip to Sigiriya	1,567.00	do.	
7. Lecturers and Discussants ..	9,100.00	10,000.00	
8. Group Directors	3,500.00	5,000.00	
9. Honorarium for 3 Course Co-ordinators	6,000.00	6,000.00	
10. Others	5,000.00	No provision	
Expenses incurred by NSC (Administration, Organization, Transport Computer service etc.)			
11. TOTAL LOCAL COST	65,502.00	72,400.00 (70,000.00)	21,200.00
<i>Foreign Consultant</i>			
12. Travel	15,600.00	31,200.00	
13. Per diem (5 days)	3,680.00	14,720.00	
14. Honorarium (5 days)	3,520.00	14,080.00	
15. Total cost of consultants ..	22,800.00	60,000.00	
16. GRAND TOTAL (Local & Foreign)	88,302.00	130,000.00	21,200.00
<i>Sources of Funds</i>			
	Rs. cts.		
UNESCO	80,000.00		
NSC	10,000.00		
SSRC	40,000.00		
TOTAL	130,000.00		

Note—The total estimated local cost in the Budget Estimate circulated at the SSRC meeting on 01.08.80 was Rs. 70,000 . That estimate was changed in detail and also increased substantially at that meeting.

Costs of transcribing Seminar proceedings and other items of expenses connected with the planned publication are not included here.

source—Items 1 to 7 of actual expenditure from accounts submitted to the Accountant of the NSC by the Co-ordinating Committee. The others have been estimated.

The Nature of Science and Scientific Method

H. CRUSZ

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1. Introduction

The moment the scientist starts reflecting on the nature of science and scientific method, he is in the realm of philosophy. And, a scientist is not worth his salt if he cannot give some account of the outcome of such reflection. Moreover, as Richard has pointed out, “philosophy alone enables the man of science to acquire a notion either of the principles implicit in all experimental knowledge or the true foundations of the special sciences, and to understand the position and bearings of his special science in the sum-total of human knowledge”¹. Maritain (1930, p. 115) has even warned that if at any time philosophy is not allowed “her rightful suzerainty over the sciences”—as what Aquinas called the ‘scientia rectrix’², the leading or guiding science—that period in the history of human culture will inevitably end “in a condition of intellectual chaos and a general weakening of the reasoning faculty”. Indeed, one of the great drawbacks of modern science-education is the neglect of those cultural elements such as the history and philosophy of science, and many other things besides, that go to make the pursuit of science dynamic and meaningful, for which time can be found, if only an honest effort is made.

2. The Nature of Science

Science (from the Latin ‘scientia’) simply means knowledge. It has also been called ‘organised common sense’. There is an element of truth in this but it is too broad a description. Today, science has at least two specialised meanings, namely:—

- (i) Systematised and integrated knowledge, which not only provides *explanations for observed phenomena* but also *establishes generalisations that help us to predict* the relations between these and other phenomena. In this sense, we can speak of moral science, political science, natural science, social science, etc.
- (ii) Systematised and integrated knowledge about *material phenomena*, based mainly on observation, experiment, induction, and deduction, where *more definite and precise prediction is possible*, e.g. physics, chemistry, biology, sociobiology, etc. The word science, as generally used today, seems almost exclusively to mean this category of knowledge.

1. Richard, T. Philosophie du raisonnement dans la science d’après Saint Thomas, p. 14 (quoted by J. Maritain, 1930.)

2. Aquinas, S. Th. (1225—1274), In *Metaph.* (On Aristotle’s *Metaphysics*), Introduction.

The distinction, however, is arguable. Many a social scientist, for instance, will deny that their methodology does not involve 'experimentation'. The mathematicians too, if not positively shocked, will at least raise eye-brows, if we ask: Is mathematics a science? The mathematician Sylvester once took the zoologist Thomas Henry Huxley to task for thinking that "mathematics is the study which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation". "Such a description" says Turnbull (1951, p. 123) "completely misrepresents Mathematics, which in its making increasingly calls forth the highest efforts of imagination and invention. As for induction, there is no more wonderful instance of its use than that of Ramanujan". One can even admit that there are 'experiments' in mathematics. One need not labour this point further. Mathematics rightly claims departmental status in university science-faculties and even arts faculties. "Mathematics . . . standing as it does on the borderland of all that is wonderful in Science and all that is beautiful in Art" (Turnbull, 1951, p. 126); its relation to science is best expressed in the words of Mather (1953, p. 140): "while it would be foolish to deny the name of science to any branch of study merely because it makes little use of measurement, no science can reach its flowering until it becomes quantitative in both its observation and theory".

3. The Scientist and the Scientific Attitude

Science does not exist in a vacuum. There is no science without human beings. It is a human activity involving *an attitude of mind* and *a method of thought and action*. It is not simply an accumulated body of knowledge about the world around us. Indeed, according to Karl Popper (1959) it is 'tentative forever', and tentativeness can exist only in a mind. Science therefore is something dynamic. It is an on-going human process — one of the noblest of human activities.

The scientific attitude involves two important factors, namely (a) a fundamental scepticism towards authority, and (b) a questioning mind and an incessant search for answers.

3.1 Scientific Scepticism

Someone once urged our university students to "cultivate the irreverent mind". I would consider that a rather hazardous occupation for scientists. Questioning authority does not mean at all the abandoning of reverence for the mystery that is nature. The more questions we ask in science, the more answers we get, the deeper the problems become, and, once again, the more innumerable the questions. That alone should make us reverent. But we must treat authority with at least a dash of scepticism. With B. A. Clough we must say: "Thank you very much; but I always like to go and have a look for myself"³. Having said that, of course, we must make sure that we go and have a look for ourselves. We must not accept observations and hypotheses *merely* because someone has plausibly offered them to us. We must look for more and more confirmation of them, or stated more accurately perhaps, try our best to refute them. We must be basically sceptical about

3. Dictum quoted by M. W. Jepps (1956) in *The Protozoa Sarcodina*, Edinburgh & London, Oliver & Boyd.

everything, without being irreverent. Loss of reverence sounds the death-knell of all scientific endeavour. It is often (even conveniently) forgotten that the greatest of the medieval schoolmen, Thomas Aquinas, taught his students this fundamental attitude when he wrote "Never mind who said it, take in what is sanely said"⁴.

This does not mean that we must indulge in the dubious pastime of not proceeding with our scientific work until the work which went before us is confirmed by others in its various aspects related to our own work. It only means that we bear in mind the tentativeness of all scientific statements, whether they be facts, hypotheses, theories, or laws, and that we proceed with the task of furthering our approximations to the 'truth'. It is enough if, on the basis of such scientific findings, things work, even if only for the time being. A greater achievement would be if our work also generates more problems for future investigation.

3.2 *The Questioning Mind*

In science, it is generally not ordinary questions that are asked, and the answers are not ordinary answers. The questions are 'scientific' questions, that is, those prompted by observations and experiments. The answers also must be 'scientific' answers, that is, those that can be tested (or refuted, as Popper would say) by more observations and experiments. Although this seems to be true, a sort of serendipity (that word which came to the English language from Sri Lanka's ancient Arabian name Serendib) — chance observations — and the astonishment and questioning that accompany them — have led to many discoveries such as that of penicillin. No wonder Aristotle said that the beginning of science is in wonder.

This theme of the questioning mind is closely linked with the scientific method. There have been vital and fruitful contributions by philosophers of science within the last few decades, which I shall be briefly touching on towards the end of this paper.

4. *The Scientific Method*

Before discussing, in a final section, the great attempts at generalising about the exact nature of the scientific method, let us consider the several operations that go to make up what is usually known as scientific method. I do not propose to do more than classify them here, and deal very briefly, if need be, with a few that may call for special treatment.

A. GENERAL BASIC METHODS

- (i) *Observation* — facts — it must not be forgotten that even facts are 'judgements' — judgements of coincidence (e.g. fire burns; this is a sheet of paper).
- (ii) *Enumeration* — simple counting of facts.
- (iii) *Classification* — arrangement of facts.

4. Aquinas, S. Th. In a letter to students on how to study, *S. Th. Aquinatis Opera Omnia*, ed. Frere et Mare, Paris, 1872—80.

B. SPECIAL METHODS

(a) *Methods of Probability* (leading to inferences where from true premises we get conclusions that are true in most cases).

(i) *Sampling* — Samples should be large, and random i.e. free from bias.

(ii) *Statistics* — The value of calculating the standard deviation rather than the average, the estimation of probability, etc.

(b) *Methods of Causality* (after John Stuart Mill)⁵

(i) *Method of Agreement* — This only discovers some *common factor*, and *nothing more*. It can only lead to further investigation, e.g. scotch and soda intoxicate; arrack and soda intoxicate; bourbon and soda intoxicate. Therefore, soda intoxicates? If not, what is the common intoxicating factor?

(ii) *Method of Difference*—Here we keep every other factor the same, except that which we assume to be the cause, e.g. in the above instance, change the chaser (soda) in one case. What happens? If intoxication persists, drink them neat without a chaser. What happens? etc. etc. We are dealing here with *the controlled experiment*. I once bemoaned the omission of this method by a scientist whose script was sent to me for assessment: "It was required to test the effect of a certain substance on an organism. The substance was used as a solution in alcohol and the organism apparently registered a sharp reaction to it. But one was at a loss to know how the organism would have behaved under the influence of the alcohol alone, without the other substance. The whole idea of a control experiment missed the mind of the investigator"⁶.

(iii) *Joint Method of Agreement and Difference* — This is supplanted today by the method of statistics. For example :

Agreement (Positive instances) :—

1.	—	a	b	c	d	e	}	<i>a</i> is the common factor
2.	—	f	a	g	d	k		
3.	—	l	m	n	a	e		
4.	—	a	w	x	y	z		

Difference (Negative instances) :

1.	—	b	w	d	c	y	}	<i>a</i> is the missing factor
2.	—	m	f	d	k	e		
3.	—	z	e	n	y	c		
4.	—	l	b	g	f	d		

5. Mill, J.S. (1893) *A System of Logic*, Bk. III, London, Longmans, Green & Co.

6. Crusz, H. (1971) "Some trends in science education and scientific research in Ceylon", Presidential Address to Section D (Natural Sciences), *Proc. Twenty Sixth Annual Sessions (1970) Ceylon Association for the Advancement of Science*, Part II, p. 238.

Therefore, *a* is the cause of the phenomenon shown by the positive cases (say, in patients suffering from a disease, and those without the disease).

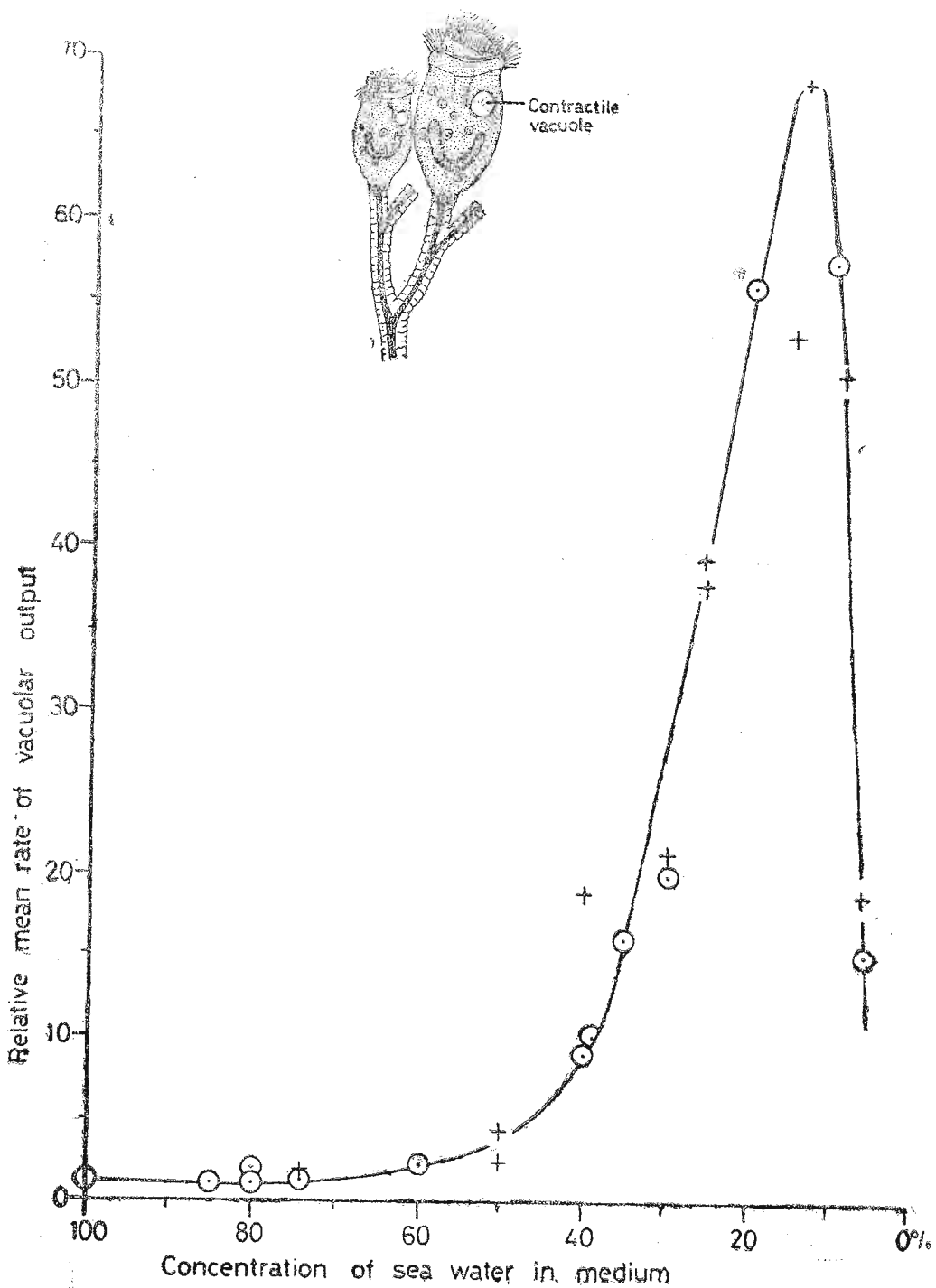
- (iv) *Method of Concomitant Variations*—A variation in the amount of a certain factor produces corresponding or parallel variation in the effect. The factor may be the cause, e.g. varying pulsation rates of the contractile vacuoles in marine protozoans on diluting the sea water medium with varying amounts of fresh water (see Fig. 1). These vacuoles, by accumulating water and regularly emptying it to the outside through a “gullet”, help the organisms to get rid of excess water, and prevent them from bursting.
- (v) *Method of Residues*—After certain causal connections are discovered there remain factors the causes of which are not yet known. The method of residues deals with such factors. The story of human malaria (in which I happened to play an infinitesimally small and modest role) when a residual factor was finally dealt with, is a good illustration of this⁷.

By nearly all the methods outlined above, the life cycle of the human malarial parasite came to be well known, but for one stage. Where are the parasites during the incubation or prepatent period, i.e. from the time of the bite of the parasite-carrying mosquito, to the first evident symptoms of the disease in the patient (high fever and presence of the parasite in the blood)? This missing stage was vividly indicated in an Isotype diagram in the Penguin book *New Biology* (Vol. I, 1945), which had appeared just in time for my teacher and predecessor in office, Dr. D. R. R. Burt, to produce it before the medical members of the Senate of the University of Ceylon when they pooh-poohed his insistence that the life-cycle of the human malarial parasite was not yet completely known. In 1948, as a Ph. D. student at the London School of Hygiene & Tropical Medicine, I cut the very first microtome sections of human liver, for Professor H. E. Shortt, which showed the ‘missing’ stage of the parasite. To be sure, this stage had already been discovered earlier by Shortt for monkey malaria, when the method of residues, after various other internal organs had been tried out unsuccessfully, suggested that the liver was the site of the ‘incubation period’. That did not prove it conclusively for human malaria. The proof was established when Shortt had malarial mosquitoes feed on a general-paralysis-of-the-insane patient (as a cure for this particular illness), did a biopsy after about a week, and obtained the piece of liver which finally settled the issue.

(c) *Methods of Explanation*

- (i) *Analogy* — Ronald Ross was led to the discovery in 1898 of the mosquito vector of human malaria on the analogy of Patrick Manson’s discovery in 1878 that the vector of the filaria parasite was a mosquito. When experiments (e.g. on hormones, cancer, etc) are done on laboratory animals,

⁷ Shortt, H. E. (1951) “History of recent researches on tissue phases of the malaria parasite at the London School of Hygiene and Tropical Medicine”, *Trans. Royal Soc. of Tropical Med. & Hyg.*, 45, p. 175—188.



Marine protozoans:

○ *Z. marinum* + *C. curvula*

Fig. 1—Concomitant variation in vacuolar output and concentration of sea water in two marine protozoans *Zoothamnium marinum* and *Cothurnia curvula*. (After J. A. Kitching, *Biological Reviews*, Vol. 13, p. 403, (1938). Note that after about 20 per cent concentration, i.e. 20 parts sea water and 80 parts fresh water, vacuole functioning breaks down.

before being tried out on humans, the underlying idea is analogical. Analogy is only a first stage in explanation and can only lead to a hypothesis. However, we must guard against false analogies.

- (ii) *Hypothesis* — This is crucial to the scientific method. It is the first significant act of intellection of the scientist in action. If a scientist stops short of formulating a hypothesis, after observing, classifying and experimenting, he fails as a scientist. Let it not be thought, however, that a formulation must be dazzling, in order to earn the name of hypothesis. Even when a taxonomist names a new species of organism, or discovers a pattern in its geographical distribution, he hypothesises. The way a hypothesis is formulated has been the subject of intensive philosophical research and will be dealt with in section 5. Suffice it here to say that one of the first to realise the true nature of the scientific hypothesis and its provisional character was Thomas Aquinas, who saw that the then-reigning hypothesis of the movement of the heavenly bodies could not be taken as certain truth, forasmuch as another hypothesis could well be propounded in the future offering a better explanation of the observed facts.⁸
- (iii) *Theory and Law* — Complete method of explanation, after repeated experimentation; i.e. until the hypothesis is 'fully' verified (this is a pre-Popperian view, to which I shall refer further on). It involves (a) collection and classification of data, (b) formulation of hypothesis, (c) designing and carrying out of experiments for testing the hypothesis (or refuting it, as Popper would say), and (d) continued verification (or continued attempts at refutation) by repeated experiments.
- (iv) *Historical Method*.—This is reconstructing the past on the evidence of the present. The formulation of the Theory of Evolution generally follows the historical method; although the Special Theory of Evolution by Natural Selection has lent itself now to strict experimental testing (attempts at refutation).

5. Philosophy of Science : From Aristotle to Kuhn

Modern science emerged from the marriage of two great ideas-forces: the *Empiricism and Rationalism of the Greeks* (especially represented by Aristotle, who brought down to earth, as it were, the 'ideas' of his master Plato, and thereby paved the way for the extensive exploration of sense data in science) and the *Experimentalism* of the thirteenth

8. Aquinas, S. Th. *De Caelo*, II, 17, & *Sum. Theol.*, I, 32, I.

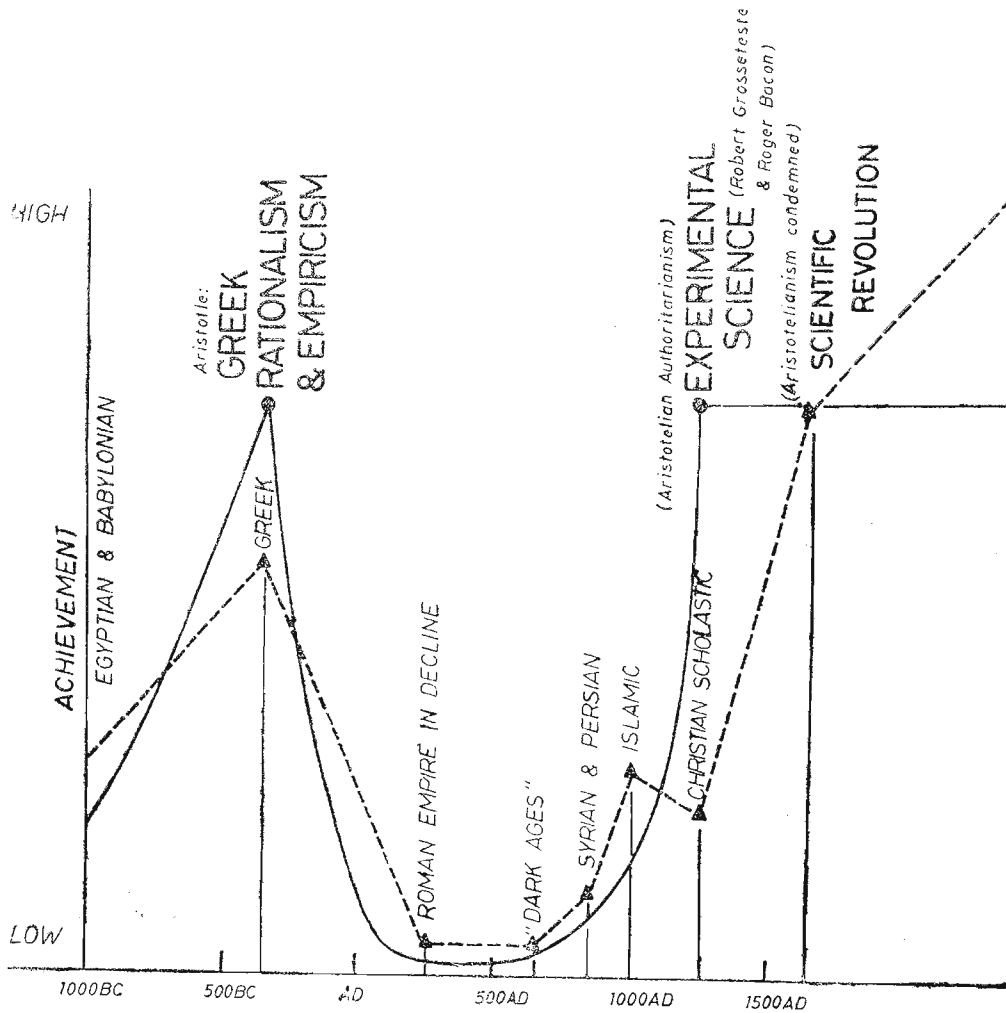


Fig. 2—Achievement in scientific philosophy and methodology (unbroken line) and science in action (research and discovery) (broken line) down the ages. The achievement axis has necessarily to be somewhat arbitrary since it is refractory to precise quantification.

century (especially fostered by the two Christian pioneers of experimental scientific methodology, Robert Grosseteste and Roger Bacon)⁹. When Empirico-Rationalism and Experimentalism met, the Scientific Revolution became possible (Fig. 2). With the rise also of Capitalism, there followed an unprecedented steep rise in scientific achievement, which continues unhindered even today.

5.1 *Deductive and Inductive Methods*

For long, on the basis of the work of Aristotle, who first expounded the deductive method and the importance of the syllogism as the indispensable tool of valid reasoning,¹⁰ and of the work of John Stuart Mill¹¹, who expounded more thoroughly than had Aristotle earlier, the nature and importance of the inductive method, we have become accustomed to think that science takes the well-worn path of observation, collection, and classification of facts, thinking out of hypotheses, and testing these hypotheses by repeated experimentation, until they graduate to the status of theories and laws. Experimentation is crucial to this process and we should not take even observations or facts for granted, for they too could have all the marks of hypotheses requiring to be tested.

In this way we have been led to believe that the findings or 'truths' of science are about the most reliable the human mind can come by, for has not science established its credentials in wonderful and manifold ways. That is not all. We have also been led to believe that the scientific paper is sacrosanct, at least as a true statement of the way a scientist has carried out his work and arrived at his conclusions, most of which at least were not known to him at the beginning of his effort — an open-ended experiment, in modern science-educational parlance.

5.2 *Hypothetico-Deductive Method*

The work of Ludwik Fleck (1935), Karl Popper (1959) and Thomas Kuhn (1962) has seriously affected, if not upset, this rather simple, if not simplistic, view of the scientific enterprise, to such an extent that Nobel laureate Peter Medawar (1963) could talk on "Is the Scientific Paper a Fraud?", and Ian Morris (1966) could write on "Is Science Really Scientific?" Medawar makes out that the conclusion is at least implicitly known to the researcher before he performs his experiments and writes up his research findings; that the usual sequence of Introduction, Materials & Methods, Observations & Experiments, Results & Conclusions, is, purely and simply, putting carts before horses — a sort of fraud — but one that has become an accepted, and even indispensable, convention for making scientific work publicly available to scientists, for repetition (replication) and refutation. What cannot be so repeated and made open to refutation, what is not falsifiable, is not scientific at all (*vide* the sharp criticism on these grounds of the work of the sexologists

9. Crombie, A.C. (1950) "Robert Grosseteste and the origins of English empiricism", *The Cambridge Journal*, 3, (6) pp. 356—367.

10. Aristotle (348—322 B.C.) *Organon* (Treatise on Logic).

11. Mill, J.S. *op.cit.*

Masters & Johnson, as reported in the *Time Magazine* of August 11, 1980). A scientific hypothesis is thus tentative forever. It need not even be a shattering one such as Einstein's $E=mc^2$. It can be as modest as a 'new species' of plant or animal, which could have long-term effects for man and his environment.

This is Karl Popper's teaching in a nutshell. Whether we realise it or not, we *think up our hypotheses* and then try refuting them by experimentation and all the other accompaniments of scientific activity. These methods are strictly logical and rigorous, and depend on deductive arguments. *We do not think out hypotheses* on the basis of observation, classification, etc. The process is therefore, in Popper's view, hypothetico-deductive, and not the other way about. The stress on 'falsifiability' and 'tentativeness forever' led Popper to meet the criticism of how far in that case could we ever have certain knowledge, and trust even the validity of his own theory, with his asserting that "only in our subjective experiences of conviction, in our subjective faith, can we be 'absolutely certain'"¹². The position for the scientist, therefore, is that while science never attains the goal of certain and ultimate truth, scientific discoveries especially when they stand up to repeated attempts at refutation are, at best, only approximations to our notion of what is true, for they are found to work, when wisely used, towards the happiness and progress of mankind.

5.3 *Scientific Revolutions*

In Thomas Kuhn's *The Structure of Scientific Revolutions* (1962)¹³ we see a shift of emphasis, and even an attempted critique of Popper, but the basic tenet that hypotheses are invented, not discovered, that there is an imaginative or inspirational element in hypothesising remains the same. Kuhn distinguishes, however, between '*the scientific revolutions*' which involve what he calls '*paradigm shifts*' ("occasional, discontinuous revolutionary changes, in tacitly shared points of view and preoccupations of science", e.g. the Darwinian revolution) and 'normal science', which is the continuous work of building on and refining these models of the past. He even observes that it is usually the young, or persons new to a discipline and relatively free of established preconceptions, who bring about such 'paradigm shifts'. These shifts occur only when a glaring anomaly, during the continued verification of a paradigm by 'normal scientists', is seen to blur its clarity. Even then, the scientific community is slow to let go the prevailing paradigm. Paradigms die hard. When scientists are forced to abandon them for new ones, we get what Kuhn calls scientific revolutions.

Kuhn counters Popper's view that there are no verification procedures at all, only falsification, which, if successful, results in the rejection of an established theory, with the observation that this is much like the role he himself assigns to 'anomalous experiences', which evoke crises leading to scientific revolutions. A further point of difference of the Popperian scheme from that of Kuhn seems to be the value Popper places on thinking up, and attempting to refute, even the humblest hypotheses in scientific work.

12. Popper (1959).

13. Chicago Univ. Press. Also see Daly, H.E. (Editor) (1973) *Towards A Steady State Economy*, San Francisco: Freeman; where Daly, in his Introduction, discusses Kuhn's insights.

5.4 *Sociology of Science*

Since this seminar deals with the social sciences, I cannot do better than refer finally to the work of Ludwik Fleck, the Polish-Jewish bacteriologist, who in 1935 published a book in German which has now been translated into English under the title *Genesis and Development of a Scientific Fact*¹⁴. Fleck had anticipated many of Kuhn's ideas, and Kuhn (1962) generously acknowledged this as an indebtedness "in more ways than I can now reconstruct or evaluate".

Fleck's importance for all science is such that he does the social scientist proud, although he himself was a practising natural scientist. Steven Shapin (1980) in a rewarding review of Fleck's book in translation, refers to his basic teachings. There are interconnected 'active' and 'passive' elements in human cognition (shades of the 'active' and 'passive' intellect of Aristotelian and Thomistic philosophy). Facts are invented, not discovered, but both inductivist and individualistic views of science are repudiated, for science has a 'holistic character'. That no active social processes are involved in the making of a scientific fact is an illusion. Each individual scientist has a 'thought style' and the scientific community, and indeed even the community at large, have a 'thought collective' (Kuhn's paradigm). The act of cognition is the most socially-conditioned activity of man, and knowledge, including scientific knowledge, is the paramount social creation. "The shape of answers is preformed in the nature of permissible questions" (e.g. questions and answers in ancient and modern times, in regard to syphilis). Fleck explores the illusion that scientific facts are not socially constructed by what Shapin calls "an intriguing analysis of the effect of history and communication in the thought collective".

It is not difficult to see from all this that there are firm grounds for believing that the scientific process, even as it obtains in the natural sciences, is not that simple after all. With Fleck's insistence on the whole man, as well as society, playing a part in it, followed by Popper's focus on the imaginative and inspirational aspects of thinking up its perennially tentative hypotheses (its only element of certainty being in the subjective conviction that it is true), and Kuhn's dramatic analysis of the structure of scientific revolutions, the stage has been set, I should say once again since the time of the ancients, for a more comprehensive and all-encompassing view of what is meant by science and the scientific method.

14. Fleck, L. (1979) *Genesis and Development of a Scientific Fact*, Translated from the German edition (Basel 1935) by F. Bradley and T. J. Trenn, Chicago, Chicago University Press. One might add here that unlike Fleck, Popper and Kuhn's works, Edward O. Wilson's *Sociobiology: The New Synthesis* (Cambridge, Mass., Harvard University Press, 1975) is not a contribution to scientific methodology as such. Sociobiology is a science, not a philosophy of scientific method.

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Patterns and Problems in the Methodology of Science

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1. Introduction

Science is said to begin with a problem and, in general, it is said to end with a hypothesis (a solution). One could question, which comes first; the problem or the hypothesis? I would suggest that science begins with a hypothesis and ends with a hypothesis and that the problem comes in between. The first hypothesis, nowadays, is more fashionably called a paradigm. Thus, the sequence in the method of science is: hypothesis (paradigm) — problem — hypothesis (solution).

According to Kuhn (1970), a pre-paradigm period is a period of pre-science. Science then, begins with a paradigm. Obviously here I am relying on what is called relativism in the philosophy of science — of which Kuhn is a key protagonist,¹ because it is convenient to do so in this exposition although I myself do not subscribe fully to the relativistic thesis.

What is a problem? We might not know what a problem is, but one has enough problems today not to have experienced them or spotted them. The problem of going to Kandy in time for the last *Perahera* night; the problem of being seated in a library when one feels that a cup of tea in the canteen would help better; the problem of inflation; the problem of big power confrontation in the Indian Ocean could be some of them. If one has to live today, (or perhaps at any time) one does not run short of problems. Life itself is a problem. It is a problem in two senses. First, it is a problem in the sense that it is a conglomeration of problems of the kind listed above. Next, let us say, to a philosopher or a theologian it would be a problem in the sense of 'exist what for and how' — 'the mystery of existence' — and may be 'why exist at all?' as well.

2. Paradigm

Problems can be raised in different ways and at different levels. That is where the paradigm becomes relevant. A problem is raised, or a question is asked, based on a paradigm. What is the constitution of water? But why ask this question? Why should water have a 'constitution'? In the good old days, water was an element. After all, was it not the great Thales, who said that all was water? Was it not common knowledge in the ancient world that apo, (water) was the first of the elements? Let me quote from Russell Hanson (1961):

1. One of the contentions of relativism is that a science is based on a paradigm—i.e. it is relative to the paradigm.

“ ‘What caused the clock to stop running ?’ is a request for news about the one thing responsible for the stoppage, the ‘link’ immediately preceding the cessation of movement. One less frequently asks ‘What makes the clock keep running?’ If one does, it is with an awareness that it is different from the former query (Medical students soon learn the difference between: 1. ‘What caused the baby to start breathing ?’ 2. ‘What caused the baby to stop breathing ?’ and 3. ‘What caused the the baby to continue to breathe?’).

Tangibles have become paradigms of what there is ;”

Thus at any stage of a scientific inquiry the problems are problems about nature or society and these problems are mostly dependent on man’s outlook in that sphere at the time in question.

The paradigm — the base hypothesis in a science at a particular time or in a particular school — largely determines the problems. An example can be had from psychology to illustrate the point. The development of psychology as an empirical science begins with Wundt in the last quarter of the last century. Psychology before Wundt and for sometime after him was mainly concerned with consciousness, and the method used in psychological research was introspection. By the second decade of this century, with the advent of behaviourism, the paradigm changed. Both consciousness as the field of investigation and introspection as the method were toppled over. ‘Not for an instant but for fifty years psychologists were blinded with the great hope that they could make psychology a genuine and successful science if only they would follow a number of clear-cut rules. Chief among these rules were elimination of consciousness as the subject matter of psychology on the one hand, and the rigorous use of scientific method on the other; the history of behaviourism is the history of the attempt to treat these two rules as one’ writes Brian D. Mackenzie in his book *Behaviourism and the Limits of Scientific Method* (1977, p. xi).

Behaviourism was influenced by the then current positivism, operationism and physicalism in the philosophy of science. The behaviourist wanted to reduce the complex to its elements. Physics had used this method (what are the forces acting on the billiard ball ?) and so did chemistry (what is the constitution of water?). It should, therefore, work for psychology. But, a little later, the behaviourist paradigm was rejected by the Gestalt psychologists. “The whole is more than the sum of its parts” the latter said. “Put down three dots, each about half an inch apart from the other two, but not in a straight line. What do you see? A triangle — not just three dots.”



Gestalt psychologists are not the best example of those who rejected the behaviourist paradigm. The psychoanalytical school, which originated in Austria at the beginning of this century, would serve us much better in this respect. The behaviourists very consciously wanted to do away with consciousness whereas psychoanalysts made consciousness big

business. The latter sold it in bulk. They sold it in variously flavoured cubes, with fascinating names — the Sub-conscious, the Unconscious, the Ego, the Super-ego and so on. In other words, the psychoanalysts adopted a different paradigm. Thus it can be seen that in the same science, at the same time, three paradigms — three schools — were operating. The problems investigated and the questions asked in each of these were dependent on these different paradigms.

I chose psychology partly because it is considered both a natural and a social science. For those in the social sciences, whether in sociology, economics, political science, history or any other, this type of example should ring very familiar: Marxian social theory vs. Weberian social theory, Marxian economics vs. — — — and so on.

I said that we can give examples of problems, although we may not know what a problem is. I have roughly indicated what could be a paradigm. I would find it difficult to *explain* what a paradigm is. Kuhn who advanced the “paradigm thesis” in very persuasive terms in his classic *The Structure of Scientific Revolutions*, would take, for example, the Copernican revolution, Galilean or Newtonian physics, the discovery of oxygen, etc. as events leading to new paradigms. But Kuhn himself uses the term paradigm in a number of senses, that is, very generally and vaguely. It was Margaret Maserterman (1970) who counted the senses in which Kuhn used this term in his book and found that it was quite a count! But that does not invalidate Kuhn’s position.

So, we begin with the paradigm. The paradigm and our experience make us see problems. A problem, then, is usually what is not seen to fit in with the pattern outlined by the paradigm. It is a puzzle (e.g. How and where does this piece fit in? How do the ‘canals’ on Mars fit in with the general scheme of things? Why do tides take place? Why do we dream?) We probe the problems and seek a solution. The solution is a hypothesis. Here one could ask the question, ‘how do we get at these hypotheses? How do we discover our laws and theories in science?’

3. The “Discovery” of Theories

The answer to that question is, “we do not know”. Rather, it has been fashionable for the contemporary methodologists to get out of this problem very briskly and pretentiously smartly by saying, “None of my business”. The methodologist places himself on a pedestal. His business is logic. There is no logic of discovery. There is no general pattern discernible in the great and small discoveries of the past. Did Newton see an apple fall and “realise” the fact of the law of gravitation? That would, at best, be only a half truth. In any case, the story itself is probably historically false. Gravitation was a thought that occurred to many a thinker for centuries before Newton and, in fact, what Newton did was to formulate the correct law of gravitation, rather than to produce *ex nihilo* the concept of gravitation. So it is with Darwin’s theory of evolution. It was not just the trip round the world on board the HMS Beagle that brought him the idea. Evolution was in the air. Darwin arrived at a more specific and acceptable theory. It is a good maxim for a researcher that he must be deeply “involved” with the problem, and do hard work. Massacre the guinea-pigs to find the causes of and cures for diseases.² But there is no

2. Cf. Paul de Kruif, *Microbe Hunters*, Pocket Book, p. 177.

guarantee of success. One is likely to be led up the blind alley more often than not. The *Sleepwalkers* is an apt title given by Koestler (1959) to his book which deals with discovery of Cosmic laws.

Involvement, hardwork, daring and insight may be the foundations of scientific discovery. However, the history of science shows that favourable circumstances, historical and social factors and what we may call chance or luck are equally instrumental in this venture. The time must be ripe; science is also a process in history. Sir Peter Medawar (1969) the noble laureate in Medicine, has attempted to examine the role of intuition in science in his interesting little book on scientific method. But genius does not flourish on barren soil. In 1665 Newton's draft of the Theory of Gravitation went into the drawer for twenty years, partly because predictions based on it did not tally with the observed motion of the Moon. The French estimated the size of the earth more accurately twenty years later and only then did Newton take out his sheets of paper again to gain immortality.³ The story of the theory of evolution is a fine example for this contention. Darwin was cogitating for years after the Beagle until Wallace dropped his bombshell.⁴ And then there is the "accidental" discovery of Penicillin.⁵

Thus there is no logic of discovery. Despite its title, Popper's book *The Logic of Scientific Discovery* does not discuss discovery in this sense.⁶ That discussion is a matter left to the historian and the psychologist.

4. The Deductive Method

In the first chapter of his book, Popper disposes of induction and inductivism, psychologism, and so on. The "Discovery" begins with the hypotheseis. It is the scientist's job to test the hypotheseis. Scientific method is a deductive method.

"A scientist, whether theorist or experimenter, puts forward statements, or systems of statements and tests them step by step. In the field of empirical sciences, more particularly, he constructs hypotheses . . . , and tests them against experience.

I suggest that it is the task of the logic of scientific discovery . . . , to give a logical analysis of this procedure; that is, to analyse the method of the empirical sciences".⁷

"The initial stage, the act of conceiving or inventing a theory, seems to me neither to call for logical analysis nor to be susceptible of it. The question how it happens that a new idea occurs to man . . . may be of great interest to empirical psychology; but it is irrelevant to the logical analysis of scientific knowledge. This latter is concerned not with *questions of fact* . . . , but only with *questions of justification or validity* Its questions

3. Cf. Mason (1953) p. 157.

4. Cf. Darwin (1958); especially the author's observation in his introduction. Also his historical sketch of the progress of opinion on the origin of species.

5. Cf. Bernal (1965) pp. 675-77.

6. Popper (1959).

7. Popper (1959) pp. 27ff..

are of the following kind. Can a statement be justified? And, if so, how? Is it testable? Is it logically dependent on certain other statements? Or does it perhaps contradict them? In order that a statement may be logically examined in this way, it must already have been presented to us. Someone must have formulated it, and submitted it to logical examination.

Accordingly I shall distinguish sharply between the process of conceiving a new idea and the methods and results of examining it logically”⁸

Thus we start with the (given) hypothesis. We study the logic of its justification. Logic, at least for Popper, is deductive logic. It is deductivism which dominated the methodology of science during the first half of this century. Battered though, it is still in vogue. No doubt Popper will go down in history as one of the leading methodologists of this century. However, Popper's is not the only deductivist school. Popper's is what I shall call here the deductivist falsificationist school. I shall begin the discussion of deductivism not with Popper, but with the deductivist verificationists.

The deductivist verificationist thesis is the view subscribed to by logical empiricists like Carl Hempel and Ernest Nagel. They are, in a sense, heirs to the long dethroned logical positivists of the Vienna circle and their successors. According to them the structure of the argument which justifies a scientific hypothesis could be given in the following terms.

A hypothesis is tested by testing the predictions derivable from it. Thus, the hypothesis implies a prediction:

The prediction is true (verification by empirical test)

Therefore, the hypothesis is true

If H stands for the hypothesis, p for the prediction and $\rightarrow$ as the sign of implication then, in symbols, the above reasoning will read as:

H $\rightarrow$ p
p

$\therefore$ H

What this suggests is that the truth of the prediction leads to the truth of the hypothesis. Now, this form does not give a deductively valid argument. The above argument is, in fact, invalid. It is a good example for the common fallacy of asserting the consequent of a hypothetical and then asserting its antecedent. We would thus be led to conclude that this form ultimately gives us only what could be called a piece of inductive reasoning.

8. Popper(1959) p. 31.

The reasoning would be:

$$\begin{array}{c} H \rightarrow p \\ p \\ \hline \therefore (\text{probably})H \end{array}$$

For, a correct inductive piece of reasoning will lead to a probable conclusion. And as more and more predictions given by a hypothesis agree with experience, the probability of the hypothesis increases. Now Popper does not believe in induction and hence he rejects this form. Instead, he maintains that the argument involved in the justification of a hypothesis could be reconstructed in the following form:

$$\begin{array}{c} H \rightarrow p \\ \neg p \quad (\text{by test}) \\ \hline \therefore \neg H \end{array}$$

This is to say that the strategy in science is: construct hypotheses, derive predictions from them, and attempt to falsify the hypotheses by showing that the predictions do not agree with experience.

The above is, of course, a valid deductive form by what is called in logic the rule of modus tollens. This rule says that from a hypothetical and the negation of its consequent, the negation of the antecedent could be validly inferred.

If one is familiar with Popper's Demarcation Principle which distinguishes between science and non-science our line of argument should be evident. For Popper, science is that which is falsifiable by test. The empirical nature of a hypothesis shines when it is actually found to be false.⁹ It is on this basis that, for example, he argues that the Marxist theory of history and Freudian psychoanalytic theory are non-scientific. For he considers that these theories, by their vagueness of formulation, have made it possible for them to be variously adjusted and interpreted, thus making it impossible to falsify them.

Some of us, when introduced to Popperian methodology, find it a little disturbing. For surely, the strategy in science is not to disprove theories but to prove them. Nevertheless, the strength of Popper's view as a reconstruction of the logic of science has been considered with much favour. It has been pointed out that science progresses by elimination. Moreover, it is our experience that even very general and established hypotheses like that of gravitation have been falsified.

5. Verification vs. Falsification

Both the verificationist and the falsificationist forms given above have to be made a little more complex to accommodate the actual situation. Predictions are, usually, predictions of particular facts. A hypothesis is a generalization. It is not possible to derive statements about particular facts from a general statement unless other particular statements are taken in conjunction with it. These particulars are called the initial conditions. Moreover, there are what are called the auxiliary hypotheses which join with the main hypothesis to give a prediction. The reasoning of the deductivist verificationist is

9. "Once a theory is refuted its empirical character is secure and shines without blemish". Popper (1969)

(The hypothesis + The initial conditions + The auxiliary hypotheses) imply the prediction
 The prediction is true (i.e. it seems to agree with experience by empirical test)

Therefore, probably, the hypothesis is true.

If we use $i_1, i_2, i_3 \dots$ to indicate the initial conditions and $a_1, a_2, a_3 \dots$ to indicate the auxiliary hypotheses and $\wedge$ as the symbol of conjunction then the form of the deductivist verificationist reasoning could be represented thus :

$$\frac{H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots \longrightarrow p}{p} \quad (1)$$

$\therefore$ (probably) H

The parallel Popperian formula will be

$$\frac{H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots \longrightarrow p}{\neg p} \quad (2)$$

$\therefore \neg (H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots)$

It will be noticed that in these last formulations there is a difference between what is asserted by the verificationist and what is denied by the falsificationist. Given the more complex formulation the verificationist has two advantages. First, he can maintain that even if the conclusion in (1) is put as:

$$\therefore \text{probably } (H \wedge i_1 \wedge i_2 \wedge i_3 \wedge \dots \wedge a_1 \wedge a_2 \wedge a_3 \wedge \dots)$$

it follows logically that H is true, for the truth of a conjunction implies the truth of each of the conjuncts. Secondly, the conclusion of the verificationist is in any case only a probable conclusion i.e., an inductive one and hence he has an advantage over the Popperian. On the other hand, the conclusion in (2) is the assertion of the negation of a conjunction and the only implication that could be drawn from it is that any one — i.e. a minimum of one — of the conjuncts is false. That is, it could be that H is true but that i_1 is false or a_1 is false and so on. This poses a problem for the strictly deductive view of the falsificationist. How could he assert that H is false?

Of course, Popperians do not think that the above argument challenges their view. They maintain that their formulation assumes the truth of the initial conditions and the auxiliary hypotheses, and that therefore they are entitled to draw logically the conclusion that the hypothesis is false. Although this could be claimed by the Popperian, actual scientific practice does not bear evidence to such a contention. To explain a number of things that I have been maintaining above, let me take an example from the history of science. The example takes two incidents in the history of the theory of gravitation. The theory of gravitation maintains that there is attraction between any two physical bodies, and that the force of attraction between two physical bodies is proportional to the product of the masses of the bodies divided by the square of the distance between them.

In symbols,

$$F \propto \frac{m_1 \times m_2}{r^2}$$

$$\text{This could be reduced to } F = G \frac{m_1 \times m_2}{r^2}$$

If we apply the theory of gravitation to the Solar system we can determine the motion of the planets. Indeed, a prediction that could be derived from the theory of gravitation is that the planets move in ellipses with the Sun as the focus. Now, although the attraction of the Sun is the main gravitational force acting on the planets, the attractions of the planets on each other also influence this motion. To determine the exact orbit and the other details of the motion of the Earth using the theory of gravitation, we will need a large number of initial conditions, viz., the mass of the Sun, the mass of the Earth, the mass of the Moon, the mass of Venus, Mars etc., the distances between these bodies and so on. If, say, the prediction is that of an eclipse of the Sun, then we will also need, for example, auxiliary hypotheses about light, e.g., that light travels in straight lines. It is all these, which together with the main hypothesis, i.e., the theory of gravitation, which give a prediction.

Given the above line of reasoning the first incident that I want to take is the discovery that the theory of gravitation did not give sufficiently accurate predictions about the motion of Uranus. That is, predictions using the theory of gravitation did not agree with the observed motion of Uranus. Three logical possibilities were open. First, there could be something wrong with the observations. Second, there could be something wrong with the initial conditions or the auxiliary hypotheses. Third, the theory of gravitation was incorrect and should be rejected. Now, if repeated observations give the same result, and there is no reason to suspect the observations, one of the other two possibilities has to be the case. Scientists are not prone to giving up their pet theories, any more than we are ready to give up our pet habits. Indeed this is one of the main contentions of the Kuhnian thesis. In any case, it is not easy to give up a theory of the stature of the theory of gravitation. Moreover, scientists give up a theory only when an alternative theory is available. And good theories, and very general theories about the universe, are hard to come by. There are not many Newtons, Einsteins and Darwins amongst us. Therefore, taking the easy way out, the tendency is to suggest that the initial conditions were wrong; in this case, that the astrological chart is wrong. There is another planet haunting the system but hitherto not observed by us. That planet also should figure in our initial conditions. Calculations were made. This, of course, led to the discovery of Neptune in 1848. It was a great triumph for the theory of gravitation and for scientific imagination. So, in practice, contrary to what Popper suggests one is not sure of the initial conditions. The theory need not be false.

However, there is the other side to the story. Similar problems about the predicted motion of Mercury made the scientist look for another planet in the vicinity of Mercury; that is, in the vicinity of the Sun. Calculations were made and telescopes were turned. The child was baptised at conception and before birth. The planet was called Vulcan. But there was no Vulcan! This time, the problem was solved not

by finding a new planet, but by the overthrow of the theory of gravitation. The theory was false. But not until Einstein could come out with the alternative — the Theory of Relativity — was the theory of gravitation rejected. Discrepancy was not sufficient. The alternative had to be there. After all scientists are very practical men.

What I have outlined as the deductivist verificationism and falsificationism come under what is known as the hypothetico-deductive method. The pattern of the method that I outlined could be presented thus:

<i>Stage I</i> <i>Preliminary</i>	<i>Stage II</i> <i>Discovery</i>	<i>Stage III</i> <i>Justification (hypothetico-deductive)</i>	
Paradigm $\rightarrow$ problem	discovery of hypothesis	$H \rightarrow p$	$H \rightarrow p$
		p	$\neg p$
		$\therefore H$	$\neg H$
		(more accurately these forms should include the initial conditions and the auxiliary hypotheses).	

6. Hypotheses

I have to say a few words about the concepts involved in this view of justification. These are hypothesis, prediction, and empirical test. Let me first dispose of the easiest, viz., prediction. What is meant by prediction here is anything that is logically derivable from the hypothesis and empirically testable. Prediction does not mean a future happening or something not observed in the past. In more technical jargon, a prediction is an observational consequence of the hypothesis.

What are hypotheses? Hypotheses are, as Popper calls them, conjectures. Scientific hypotheses are testable conjectures. There are sciences which are not empirical, viz. Pure Mathematics and Logic. Popperian falsifiability does not apply to these sciences. A consistent system of mathematics cannot be proved false. We are, therefore, talking here about empirical sciences. 'Testable' in this case will mean 'empirically testable'. So hypotheses here are empirically testable conjectures.

For logical and epistemological reasons it is best that we consider hypotheses as being acceptable, rather than as being true. At least, when I say that a hypothesis is true I mean that it is acceptable. A hypothesis, when it is found to be acceptable by test, is usually called a theory or a law. The distinction between laws and theories is helpful in understanding the nature of a hypothesis. A hypothesis usually is a generalization. A law is just an empirical generalization which could be reached (inductively) by generalizing from observed particular instances. It is something like the generalization, 'All crows are black'. We observe the individuals, may be a large number of them at different places and different times, and then generalize to get the rule or the law 'All crows are black'. Galileo's law that the acceleration of a body falling near the surface of the Earth remains

constant is another example. So are most laws in the physical sciences, like Boyle's, Charles', Hooke's, or Kepler's. This brings us to another useful concept, that of direct testability or direct verification. A hypothesis is directly testable if it is tested, not by observational consequences derived for it, but by particular instances which inductively lead to it. A theory, on the other hand, usually is only indirectly testable.

The theory of gravitation is not tested by measuring the force of attraction directly, but by testing the observational consequences derivable from it, like the motion of the planets, the path of a projectile and so on.

The main distinction between a theory and a law is that the theory is an explanatory principle, whereas a law is just an empirical generalization. A theory explains facts and, perhaps indirectly, the laws that are subsumed under it. A law does not explain. A theory answers the query "why?". Why does a mango released from the tree fall to the ground, instead of remaining static or moving upwards? Why does the acceleration of a body falling near the surface of the Earth remain a constant? The theory of gravitation answers these "whys". Explanation of why a particular body falls to the earth is an explanation of a fact. The explanation of why the acceleration of a freely falling body near the Earth is a constant is an explanation of a law; in this case, Galileo's law. Galileo's law does not explain why the acceleration of a freely falling body near the surface of the Earth is a constant. It merely asserts this regularity. Similarly, Kepler's laws assert an empirical regularity of the motion of the planets and the theory of gravitation explains Kepler's laws; Boyle's law asserts an empirical regularity which is explained by the kinetic theory of gases and so on. A theory, since it usually encompasses the facts coming under a number of laws, is a more general statement.

There is another distinction made about hypotheses. A generalization could be universal, or it could be statistical. 'All crows are black' is a universal generalization, for it covers each and every crow. Fifty per cent of the atoms of uranium will disintegrate during a specified time is a generalization, but it is not possible to predict the behaviour of any particular atom of uranium using this generalization.

It is beyond the scope of this paper to go into the structure and formulation of hypotheses. I will just mention a few of the characteristics of hypotheses which are of interest. A hypothesis is a statement and hence, an expression in a language. It has to be expressed as clearly as possible or in scientific language. Language has three levels — the syntactic, the semantic and the pragmatic. Researchers use all three of these levels. The possibility of general usage is, at least theoretically, greatest at the syntactic level and lowest at the pragmatic. Normally, the syntactic gives a structural form in symbols, the semantic gives an interpretation of it. For example

X	→	O	
could have either of the interpretations			(syntactic)
What led to inflation ?			(semantic)
or What led to the disappearance of Hitler's body			(semantic)
Nature of the pragmatic could be indicated by the following.			

The question is asked,

How did Hitler appear?

There may not be uniformity in the understanding of this question. Any of the following answers may be given to it; For Example,

1. A great nationalist with a vision of a great Germany.
2. A nervous megalomaniac.
3. A powerful man and a shrewd strategist.

Well, there is no agreement. This is the characteristic of pragmatic language. Perhaps the story of the seven blind men each describing "his own" elephant is a good example. It is thus clear that science, and especially scientific hypotheses, should employ syntactic and semantic language understood by the population at large.

7. Concepts

Concept formation in science is a matter which is of great interest. As science "progresses" old terms get new meaning and new terms and concepts are created. It is interesting, for example, to consider how 'gravitation' evolved as a concept historically or whether 'air' has the same meaning now as it did have five centuries ago. And what in the world is 'anti-matter'? From the field of social sciences the Id and the Super-ego would make good examples. But we are also entering here a difficult area in the philosophy of science, which, with the advent of relativism, has been saddled with the problem that a hypothesis and its concepts together form a separate language. That is, each theory 'creates' its own concepts. Relativism thus maintains that there are no connections between very general theories and hence deny the possibility of the reduction of one theory to another. More important for our purposes here is the fact that relativists deny the availability of a scientific method in the sense of the deductivists as outlined above. However, it is beyond the scope of this paper to consider these controversies.

8. Analogies and Models

I should also mention the important role of analogies and models in the construction or the formation of hypotheses. Huygen's wave theory of light was developed by analogy with the then familiar notion that sound was a wave phenomenon. Visualizations of the atomic structure had some analogy with the Solar system. Hydrodynamics influenced the conceptions in electrodynamics. There are two types of analogies. In the first kind of analogy the objects in one system are considered to have properties analogous to those in the other. The laws of the first system are then taken as a model to develop a theory for the second system. Thus the kinetic theory of gases uses the ideas about macroscopic elastic spheres like billiard balls. In the second type of analogy the relationship between the two analogous systems is abstract. Often some relationship is seen in the mathematical structure of the systems. For example, Maxwell saw a relation between gravitation and heat conduction. He noticed that the mathematical laws of the uniform motion of heat in homogeneous media are identical in form with those of attractions varying as the square

of the distance. "One had to only to substitute *source of heat* for *centre of attraction*, *flow of heat* for *accelerating effect of attraction* at any point and *temperature* for *potential*, and it was seen that the solution of a problem in attractions is transformed into that of a problem in heat."

9. Observation

A scientific hypothesis, above all, should be testable. That is, it should be possible to derive from it observational consequences which could be tested empirically. This takes us to the third concept, viz., observation. The importance of observation to science is that it is what gives science objectivity. Due to similarities in the nature of the human physical apparatus, we can agree on our perceptions fairly easily. Although there could be other conceptions of objectivity, I think it best to consider objectivity as given by things being inter-subjective.

The relation between observed facts and theories as well as empirical laws and theories has been a matter which has perplexed methodologists for generations. It was once thought that there is an invariant observational language and that concepts in the hypothesis could be given meaning in terms of the observational language. It is now increasingly realized that observation language is theory-laden.

There are various types of tests or observations. Natural observation is distinguished from experiment in that the latter is controlled inquiry. In the naturalistic observation, on which the social or behavioural sciences depend largely, inquiry could base itself on case studies, before-and-after the fact method, the control group method and so on. In observation the aim of the researcher is to focus on raw data in their natural surroundings. The researcher's aim here is careful semantic description of the situation whether he is studying the mating behaviour of birds or the gossiping behaviour of women.

The important thing in tests is that the data should be reliable and durable. For this to happen, detailed, non-distorted, non-participant observation is necessary. Bias in observation is to be minimized by various measures such as repeated observation. Accurate recording is necessary. Classification of data is useful. Today, both in observation and experiment, modern equipment, methods of measurement and analysis play a dominant role in obtaining reliable data. The latter of course, is a key problem in the social sciences.

It is not possible here to discuss at length various problems of empirical test. But I wish to touch on a particular aspect of the role of observation. We saw that the deductivist takes the hypothesis as his logical starting point. But there is also a tradition which says that "science begins with observation". This is the inductivist tradition, which goes back to the writings of Francis Bacon. This view considered the structure of scientific reasoning to be of the inductivist form:

$$O_1 \quad O_2 \quad O_3 \longrightarrow H$$

i.e. particular observations $\longrightarrow$ hypothesis or generalization.

With Galileo and after, inductivism declined. Indeed this view would not be able to accommodate the great discoveries of Newton and others. It is considered to be based on an erroneous view of induction that inductive leap is from the particular to the general. It is also said to confuse discovery with justification. But in the behavioural sciences the inductivist method probably has a role. Perhaps this could be said with more ease today, for deductivism itself is under attack.

10. Causation

There is only one other aspect of science that I wish to touch upon. This is important, especially in seeing the similarity or the contrast between natural and social sciences. This is the problem of causation.

Explanation in science is considered to be causal. Science is said to search for the causes of events. Thus the great methodologist and logician, John Stuart Mill, presented five methods or rules by which the scientist finds the causes of phenomena or the invariable connections in phenomena. On the other hand, causation or, at least, causal regularity, has been under attack since the time of David Hume.

Science was, in some way, associated with determinism. It is possible to predict the past, present and the future motion of a billiard ball, given certain information. Determinism is expressed by what is called the principle of causality which says that every event has a cause. This principle is not in vogue today. The concept of causation is a troublesome concept, but what is taken as associated with causality in science is predictability. But as we know even in the physical sciences there are events which are, in principle, non-predictable.

This brings us to the dilemma of the social sciences. Are causal explanations, causal relations, possible in the social sciences? Some methodologists like Winch think that they are not possible. Hence, social science is not possible as science. It is not possible to predict when a girl will smile or how she will smile. If it is possible to predict laughter, it ceases to be a "laugh". The spontaneity is lost. And then there is the problem of free will and causal determination.

The question which is of interest to us is, does all science need to use the concept of causal connection and if so, how is this connection expressed in science? There are types of explanations which some think are non-causal. They are the teleological and the functional. These are mostly associated with the behavioural sciences. The difference between the causal and the teleological explanation is as follows. A cause is something which precedes — something which "pushes". The teleological "pulls". In teleology things exist for the end, the purpose. The mother's life is explained by the son's triumph. In functional explanation facts are explained in terms of their function, the part which they play in an integrated system, the manner in which they are related to each other within the system. For example, each of the organs in our body has a separate function such as respiration, digestion and so forth. However, their function is meaningful only in terms of the part they play in the life of the organism as a whole.

11. Conclusions

In this paper I have tried to indicate the method of science as seen by the deductivists. There are two deductivist schools, the verificationist and the falsificationist. I said something about hypotheses, concept formation, empirical tests, and causality. I also touched on the views of two other contemporary schools of methodology, viz., relativism and inductivism. Deductivism was an attempt to avoid old-fashioned inductivism, but deductivism is now under attack from relativism. I would like to conclude with the remark that the present crisis in the philosophy of science, if resolved, would perhaps lead to a more satisfying account of the methodology of science.

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Scientific Method and the Social Sciences

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1. Introduction

Conflict, contradiction and variety are important and necessary aspects of the scientific enterprise. That is what gives science and particularly social science its vitality. This is also especially true of the social sciences in a semi-traditional or semi-modernised society like Sri Lanka's where there is a strong tendency for people to speak with one voice, where students for instance almost never question or disagree with their teachers, and are rarely equipped or trained or encouraged to do so, where subordinate officials never challenge their bosses, where criticism and dissent are an expensive luxury enjoyed only by a few well established and often well protected critics.

It may be a useful exercise to begin with a definition of the social sciences or at least to attempt a definition of the social sciences. I would say that in a sense, social science consists of the application of the scientific viewpoint and scientific method to the realm of human society. It consists of a number of fields of study such as Sociology, Anthropology, Political Science, Economics, History, Archaeology, Education, Law, as well as aspects of Geography, Philosophy and Psychology and a number of related sub-disciplines, whose principal objectives are to understand, record, monitor, influence, control and, above all, gain mastery over the various aspects of man's interaction with man and man's interaction with the natural environment. That is a partial generalised definition.

In Sri Lanka, in the last few years, largely due to the mediation of such bodies as the Social Science Research Centre of the National Science Council the concept of the study of society as a scientific enterprise has been for the first time been clearly stated. A scientific perspective is essential for the development of the social sciences. However, in the past these subjects often were classified with the humanities and that, in my view, often hampered the development of a scientific viewpoint in certain social science disciplines. As an Archaeologist this is something which I have often encountered because Archaeology is considered as an extension of the humanities and the arts which is at variance with current international thinking on the subject. However, now, for the first time in Sri Lanka we have begun to develop a concept of social studies as a science.

2. Scientific Method

The application of scientific method in the social sciences includes the systematic observation and documentation of social phenomena, the use of measurement, qualification, classification, analysis, interpretation and generalisation as well as the development of theoretical frameworks and methodologies appropriate to the various fields. Included in this is the formulation of laws and other generalisations relating to the social process

and the application of this body of knowledge to social practice. It is the latter realm of activity, the application of knowledge to social practice, which we call "Applied Social Science". It covers such areas as problem formulation, policy formulation and social engineering by which we mean attempts to refashion society in certain ways. By social control we mean attempts to control the movements and changes within society by means of monitoring, evaluation, criticism and the formulation of alternative policies. However, it is also important to point out that there are significant differences between the natural sciences and the social sciences, and some of these I shall try to indicate.

Firstly, social science deals with various forms of human activities which have a much greater variability than most natural phenomena. Social phenomena are dynamic and human society is generally subjected to far more rapid changes and transformations than the natural world especially when the natural world is left to itself free of human intervention. Secondly, the social scientist is himself a part of the processes that he is studying. The kind of separation that we may find at least superficially between subject and object in the realm of the natural sciences is almost impossible to achieve in the social sciences. Thus there is nothing called 'pure objectivity' in the social sciences; at most we only have a relative and limited objectivity in methods and techniques. That is, the vision of the social scientist always has a social basis, and he always displays a socially induced viewpoint which is as much a part of social reality and a social process as the phenomena to which a social scientist turns his attention. Thirdly, a distinguishing aspect of the natural sciences is the role played by experiments. And by experiments I mean the isolation and reproduction of particular phenomena in laboratory conditions. Often the laboratory of the social scientist is society itself. In the social sciences, the use of experiments is generally limited and, generally speaking, is replaced by observation, prediction and evaluation of ongoing social processes. It is of course true that in some areas of social sciences we are able by the use of techniques such as systems analysis, games theory and computerised mathematical and statistical models to simulate some aspects of social conditions and social interaction. However, the scope for such exercises is limited. Fourthly, in terms of the inductive versus deductive dichotomy there is a difference between the natural sciences and the social sciences. By induction we mean the process by which we arrive at conclusions by observing and putting together a whole class or group of perceivable facts. To put it simply, in induction we move from hard facts to hard conclusions. By deduction we mean the process by which we arrive at conclusions also on the basis of known or supposed facts, but by a series of premises, inferences and propositions. Such an argument consists of a whole sequence of propositions where each proposition is based on the one immediately preceding it. Of course all science is based on a combination of inductive and deductive methods. The two are closely interconnected. However, it is probably correct to assert that in practice deductive reasoning is prominent in the social sciences, while inductive reasoning tends to dominate in the natural sciences. And the reason for this is that by its very nature classes or groups of social facts, or social phenomena, or social processes are much more difficult to isolate than natural phenomena. This is one of the major reasons why social scientists usually use deductive methods in their research work.

3. Paradigms

The work of men like Karl Popper and Thomas Kuhn whose work in the history of philosophy of science demonstrates that the development of science was not a gradual, steady, step by step linear process of development. Just like historical and social change, scientific development proceeds by great periodic leaps and transformations. Such transformations are exemplified in the sciences by the work of men like Copernicus, Galileo, Newton and Einstein each of whom in turn completely overturned the ideas that existed before them and opened up entirely new possibilities and new realms of knowledge and development. Popper spoke of mutations where existing patterns of knowledge took sharp turns and evolved into completely new forms from what had been established and generally accepted up to that time. Kuhn went further than this and proposed his concept of the paradigm. By paradigms he means the entire structure or framework of mental attitudes, ideas, theories, principles, methods and techniques etc. within which the scientific knowledge and scientific practice of a given age took place. These paradigms or frameworks are inherited or implanted in the scientist by virtue of his or her training and by the prevailing intellectual and scientific environment and also by the various institutional and non-institutional channels along which scientific work progresses. It is rarely that the paradigm is questioned, often because it is never explicitly presented or explicitly known as a coherent framework. Indeed, it is not possible to question paradigms, if you do not know what they are. Instead, each generation improves on the work of the previous generation by a variety of additions. The result is a certain, but highly limited form of development; knowledge is increased in quantity and quality but within the parameters, within the boundaries of the established framework. However, at a certain point in this limited form of development that I have described, certain problems and difficulties, certain anomalies and contradictions appear. In other words, there arise contradictions between the data that you are encountering and the theoretical structures and traditions that you have inherited. At this point when these anomalies arise two alternative causes of action are possible. The scientist who is inhibited by his or her training or restricted by conventional intellectual viewpoint either ignores these anomalies, or accommodates them in some way, or explains them away. This is often an unconscious process that arises from the fact that one is prepared to see only what you have been trained to see. The bolder mind on the other hand begins to question the framework or paradigm and finally begins to search for an alternative paradigm. It is the construction of that new paradigm which sooner or later completely overturns the existing or older one. This concept of Kuhn, which I have summarised, perhaps rather crudely, opened out a new dimension in our understanding of the scientific method and of the development of science.

Kuhn's idea of a scientific paradigm was carried a step further, I would say, in the work of Karl Popper who put forward the idea of competing or co-existing paradigms. He calls this, the dynamic or volatile nature of science. Different sets of paradigms and theories exist at the same time and compete with one another which, he thought, would ultimately produce a higher or more developed or more complex paradigm, and therefore a more advanced dimension of scientific knowledge.

4. A Structural Model of the Social Sciences

In order to make this point clearer, I would like to put before you a structural model of the social sciences which, subject to obvious adjustments, is applicable to almost all the disciplines in the social sciences. The model (Fig. 1) begins with theories or paradigms which represent the mental structures within which our work takes place. Sometimes, some of us make these paradigms and theories explicit in our work. But mostly the theoretical standpoint is an unconscious and inherited one. But always an awareness of the nature of this theoretical standpoint improves the quality of the work, a point to which I shall return later in my final remarks.

At the second stage, we have the specific theoretical model or research design or, sometimes we can even say, a problem formulation because we are often faced with ready-made problems which have arisen in the work of other people.

The model we adopt is the conceptual side of our work which is always a product of a paradigm or a general theoretical system. The model provides us with a conceptual framework, and the methodologies with which we begin to examine social realities. It provides the guidelines and principles along which we carry out a study or investigation and sets out the aims and objectives of that investigation. It forms, so to speak, the spectacles through which we are able to view our data. It formulates the kind of question that we are posing and forms the broad principles and working methods that we select in carrying out our investigations. All this, the theoretical model, the research design, policy perspectives, the problem formulation, forms, as it were, only one segment of scientific work.

The next segment constitutes our actual face to face encounter with social reality. It deals with the actual objects of our study and the methods and techniques that we employ in the study. Rightly or wrongly, these working tools constitute the greater part of any basic training programme. Rightly, if we recognise that this is a part of the essential equipment of the social scientist and at the same time we recognise the paradigms that stand behind it. Wrongly if we limit ourselves to these working methods alone and mistake this equipment to be science itself. If we limit ourselves entirely to this realm of scientific activity we remain, at best, technicians and mechanics who do not really understand what we are doing or why we are doing it.

From that point, following my diagram again, we go to the interpretation of the material that we have gathered and analysed, the generalisations and conclusions that we were able to draw from this material and also, once again, a formulation of the problems that arise from it and so on. To recount the steps, we have the theoretical model, we select certain working techniques, we apply them in the field and we draw certain conclusions, policies or programmes, or generalisations from this material. But once the social scientist has reached this point, two possible courses of action are open to him. These two paths which he might follow may be called the prescriptive path and the critical or problematic path. The first of these, the prescriptive path is the one that believes, in a somewhat short-sighted way, that problems have a solution, and that the formulation of their solution, the

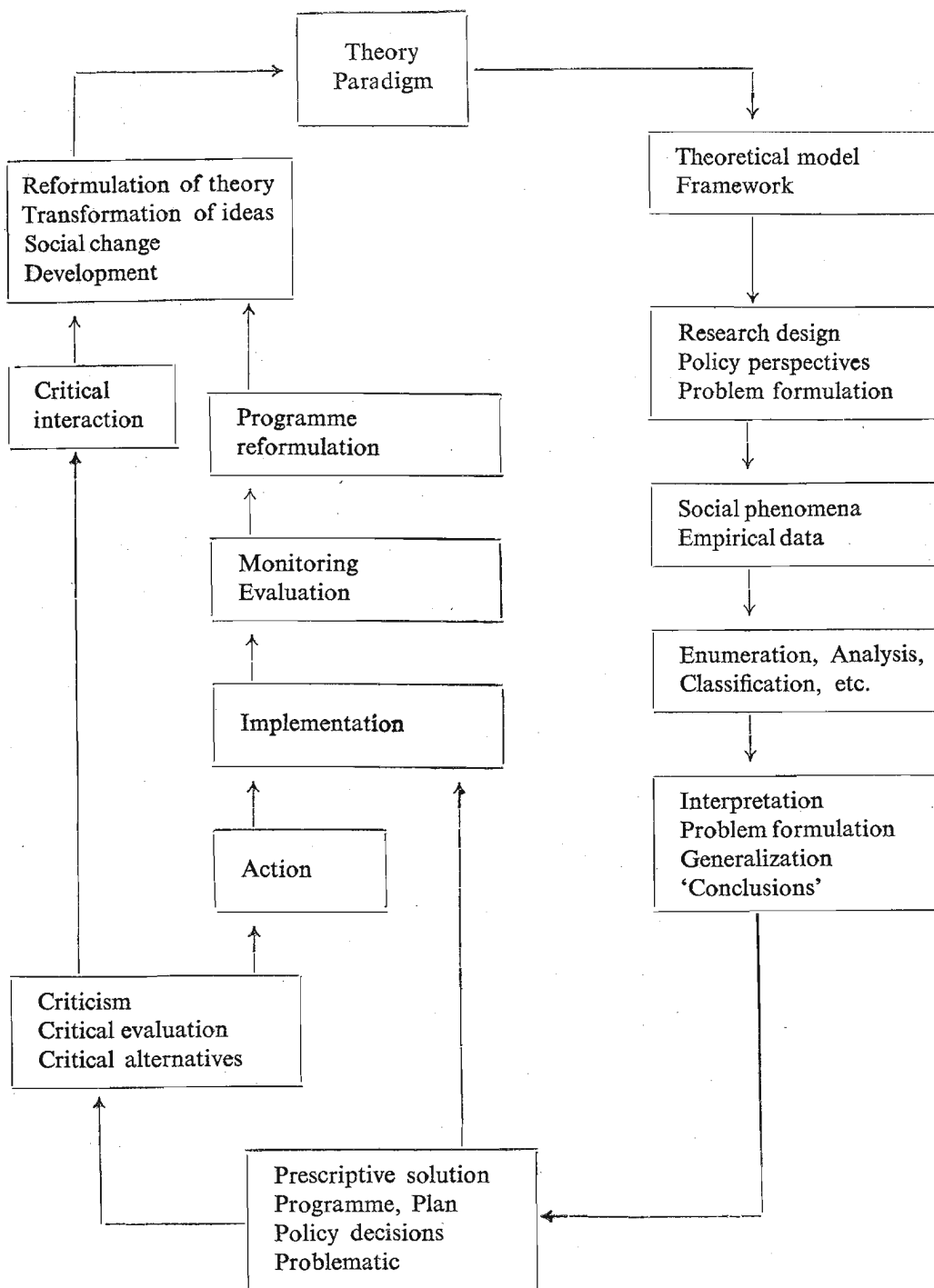


Fig. 1

formulation of a programme, the correct implementation, monitoring and evaluation of that programme and the taking of suitable corrective measures from time to time to adjust that programme are all that is necessary. That is what I would call the prescriptive. And this, I think, is a static and not a dynamic view of society. It is a view that believes that variables are contained within invariables and that human nature is constant. It fails to recognize that the history of man no less than the history of science is a history of development and change and transformation. Invariably such solutions are merely a restatement of the problem, or what such solutions do is create a fresh set of problems for somebody else to solve.

The second, path the critical or problematic path is one that elevates the problem to a level of abstraction, which formulates that problem as a part of a wider problem, a problem that is connected with a whole network of other problems and other dynamics and so on. It is a view that science like society is a continuous process of challenge, struggle and change. It sees the function of science not as a prescriptive or a solution providing process, but as one of continuous development and creativity and criticism. It is based on a dynamic and not a static view of society. It stresses variability. Unlike that view of social science which sees the function of the social sciences to be one of providing policies and programmes, simple generalisations and solutions, the problematic view sees the function of social science as one of continuous interaction between theory and practice. It is precisely such a concept which lies behind my crude model which starts with a paradigm or a theoretical viewpoint and then sets out to use that theory as an analytical tool or to test that theory against social reality itself. The sequence moves from investigation, analysis and interpretation to a process of criticism, and the formulation of problems and back again finally to a re-statement or re-formulation or, one might say, transformation of theory. That is the circular process which I have tried to indicate here.

5. Theory and the Empirical Tradition

This brings me to the final part of my lecture where I would like to deal very briefly with four related subjects. The first of these is the importance of theory, and the difference between the theoretical and empirical traditions. Secondly, the limitations of empiricism and the importance of empirical studies. Thirdly, the necessity and the limitations of statistics and finally, social standpoint and social function of scientific work.

The first of the above four points I would like to discuss in relation to the state of development of social science research in Sri Lanka. We are a poor, and a small and backward country. In such a context it is important for the social scientist to know exactly what the level of development is that we have reached by comparison with the advanced world. Unless we have that viewpoint it is very difficult to make any progress. At the same time, I think that we should be, and I certainly am, tremendously proud of what we have actually achieved. If you look at the history of our country, a 150 years ago we were still in the medieval world. Our entire intellectual world view was something which was entirely different from today's. We in our country, have made, in the course of a century or so, an enormous historical leap in consciousness. Our understanding of the world today is indescribably different from that which Sri Wickrama Rajasinghe had in

1815. I think that, backward and small and poor as we may be, we have made, at least in our own terms, on any world scale a tremendous development. Nevertheless, I would still assert that it is a reflection of the underdevelopment of the social sciences in our country that we have so far in all our social sciences fields paid very little attention to theoretical questions. We have virtually no concept of the paradigm or paradigms which, unknown to us, form the basis of our scientific work. In general, we have no more than a passing acquaintance with the great theoretical systems of our time which have provided the foundations of the social sciences in the 20th century. By theoretical systems, I mean systems like structuralism or structural functionalism as some call it, Marxism, phenomenology and also the traditions of empiricism and eclecticism, as well as a host of theories which in one way or another are products of these theoretical systems, such as a theory of economic growth, a theory of underdevelopment and so on. The nature of these theories, which I would say are the competing paradigms in the social sciences of our times, is an entire subject in itself and, today, I am not going to deal with what the nature of these theories is. I think, in fact, before we start discussing about the competing paradigms of our times, it is important to recognise as a general principle the importance of theory, and the importance of seeking out the theoretical basis of our work. The lack of a theoretical tradition is one of the great weaknesses of social science research in Sri Lanka. The reason for this is, perhaps, the dominant influence of empiricism in our intellectual and scientific environment, especially in the social sciences. I think that in my own field of the historical sciences it is a direct inheritance from the British tradition of empiricism which is very well developed in British historiography.

Empiricism has been called the theory of no theory. What empiricist tradition maintains is that facts alone are what is important, and that the accumulation of facts and of generalisations drawn from these facts will by themselves give an understanding of social reality. In other words if we carefully collect the facts an understanding of what lies behind them will automatically arise. There has been today, in the world as a whole, a tremendous development of interest in the theoretical aspects of the social sciences, and the limitations of empiricism have been clearly recognised. Even in Sri Lanka, the challenge to the empiricist tradition in the social sciences has already begun to be posed in one form or another. This has of course sometimes taken the form of what I would call eclecticism where bits and pieces of various theories and theoretical systems have been grafted on, implanted into the empiricist model. At other times it has taken the form of theoretical formulation or theoretical abstraction which is made without an adequate examination of social reality. That is the other side of the coin. One, a complete disregard of theory or the theoretical tradition, and the other, a complete dependence on and dominance of the theoretical abstractions without any real, considered, systematic investigation of social realities to which they refer. Thus we have had ideas with no basis in social reality, just arisen as notions in people's heads, which they try to project on to selective bits of social reality which they choose to use to develop those theories. What I would say is that a theory without a basis in fact is a false theory, while facts which are not absorbed into a theoretical construct remain useless and meaningless facts. That is why I proposed two important themes here, the limits of empiricism and the importance of both theory and empirical research.

The question of statistics is directly related to empirical research. The statistical method has come to form a particularly important aspect of the social sciences in Sri Lanka just as elsewhere. However, because most of our University curricula and university training programmes and so forth, by necessity, deal with statistical methods, I think it is important to realise that statistical data can never, by themselves, provide explanations. All they do is to demonstrate correlations between different aspects of social realities. It is just a working method. This brings me to my final remarks on the social role of the social sciences.

6. Social Scientist and Society

At the very beginning of my lecture, I said that the social scientist to a greater or lesser extent, to a greater extent than the natural scientist, was part of the very phenomena that he or she was studying. Or very simply, the social scientist is part of society. Therefore, if we see that the social scientist is part of society, we must also see that inevitably the social scientist and social science reflect the views and standpoints of various social interests, social groups, and social institutions which constitute that society. What theories and theoretical systems do is to systematize this viewpoint, and to make it possible for us to examine, not perhaps impartially or objectively but at least scientifically and systematically, these different standpoints so that we can test the validity and the workability or, we might say, the reality of various paradigms, theories and hypotheses and views which lie as bases of our work.

We have today in Sri Lanka at least four institutional areas in which social scientists work. We may list these four areas. First we have the government agencies or government departments or institutions of one kind or another. Secondly, we have the commercial agencies. I think that no matter how you define a social scientist, the largest amount of funding that goes into social science research even in this country today is in the commercial sector. Thirdly, we have research institutions, governmental and non-governmental and, finally, we have the universities. The institutional framework that we have does two things. On the one hand, it makes it possible for us to live and work as social scientists. But at the same time, there is no doubt, it restricts and inhibits us. In government agencies we tend mostly to work within the official policy framework, monitoring achievements or projecting the possibilities for policy based action. In commercial organisations the framework is even more limited to subjects like market research and the sociological investigation of productivity norms and so on. In research institutes, we are restricted by institutional policies and programmes especially in channels along which funding for research is available. And finally in the universities, although we are restricted to some extent by syllabi and curricula, we have a much wider field of operation and much greater freedom, but little resources. Nevertheless, whatever the institutional restrictions are, it is by scientific effort, by theoretical and empirical effort and by an understanding of the totality of science that we can rise above these limitations. I think, institutional limitations are, by the very nature of reality, inevitable and it forms in part, the necessary challenges in our work. But it is really by theoretical and empirical efforts that we have to go beyond these limitations and this is so if we look at the history of science itself, especially at the history of social sciences.

7. Conclusion

I think today there are three trends in the social sciences. The first is the tendency to maintain the *status quo*. Secondly, there is the internal development of science itself which provides one of the biggest momentums. Thirdly, there is a formulation called critical alternatives which can be traced back to the development of the social sciences in the 19th century. That is, today, at one end of the spectrum, there is an attempt to use the social sciences to protect and to reproduce the existing structures; to create equilibrium in situations of contradiction and crisis; to pre-empt the growth of conditions that would require fundamental change, changes in the social structures or changes in the dominant paradigms. At the other end of the spectrum there is an attempt to develop a critical, corrective or transformational role, to confront existing views and ideas and to provide impulses and perspectives for development and change. Science is above all a form or aspect of culture. In all the social forces that are at work in the formation of society and culture, the natural scientist and the social scientist occupy only a very small, if somewhat prominent position. It is not merely the extent to which they reflect the greater social processes that are at work, but also the extent to which they are consciously aware of their relationship to these social forces, that give depth and relevance to their work. In the final analysis, like society and culture, science is involved in a continuous process of development, change and transformation. The significance of our own work is in direct proportion to its relationship with these processes of development and change.

Theoretical and Empirical Perspectives in the Social Sciences

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1. Introduction

Frankly, I have been a little put off by the use of the term 'methodology' in social science research. In the under-developed countries, generally, methodology in the social sciences, it appears, has been equated more or less with the techniques of data collection and measurement. It is customary for the authors to state what their methodology is and by that what they really mean is something like the following: 'I carried out a sample survey of so many households over 3 or 4 months. I employed so many investigators and they processed this information on a computer. I thank so and so, and these are the tables and this is the report'. It turns out to be more a kind of investigative report rather than an attempt to deal with a problem in social science.

I think, in a sense, it is rather presumptuous for those who do research of the type that most of us, including myself, do to claim a methodology because, in the social sciences, methodology, to my mind, is essentially a philosophical question dealing with the classification and arrangement of abstract ideas and concepts in a complex logical system. I use the word 'complex' because the investigation or the analysis of any problem in the social sciences is necessarily complex. The physical scientist is able to carry out controlled experiments within a laboratory in order to isolate various elements in a compound. In contrast, problems in the social sciences are complex because they deal with numerous variables which are inter-linked and cannot be subject to controlled experiment.

The so-called methodology which one refers to in our kind of research is nothing more than the use of simple, well known, and fairly obvious techniques of measuring and summarising observable data. Almost invariably these techniques of measurement are limited in number and there is hardly a choice of alternative. There is not a sharp difference of techniques which might distinguish one social scientist from another in the adoption of these techniques. However, one social scientist differs from another not in the adoption or in the choice of techniques of this kind, but in the whole philosophical approach and his logical thought process. The identification of a problem differs from one social scientist to another. There are numerous ways in which they differ from one another which are hard to identify. It is not the kind of technical, objective technique which might distinguish one engineer from another. It is something more subtle.

I might say that most of the important and controversial problems in the social sciences are not amenable to the use of quantitative and statistical techniques. I am not trying to deny the use of quantitative methods. I regard quantitative methods as a kind of technical

tool which is rather subsidiary. They are subsidiary in relation to the identification of a problem, the conceptualisation of a problem, and the linking of one phase of a problem with another. The mere calculation or the computation part could be given to a technician and you might be able to acknowledge his contribution in a footnote. In fact I might even say that if a problem is amenable to the use of quantitative methods of this kind, then there is hardly a problem because you can say 'these are some data which I collected, I processed them on a computer which gave these results' and, one would have to say 'I will have to take your word for it'. But it is when you try to apply observable data, and it clashes with the concept that you cherish, that genuine investigation in the social sciences begins. Thus, it is really more important to find out the logical faults in the exposition and formulation of problems rather than mechanistic data gathering and summarising. The most exciting and most critical areas in the social sciences are those which are not amenable to mechanistic quantification and that is precisely why the social sciences have continued to be a kind of battlefield of competing ideas and ideologies. You cannot settle these controversies in a laboratory as a physical scientist might do.

Having made these preliminary observations, I shall, in the rest of my lecture, deal with three broad areas. I shall begin with the concept of the social scientist; the limitations of the social scientist himself leads to the limitations of social science. I will then go on to the second part which deals with the methodological procedures which are open to the social scientist. Thirdly, I shall go into the differences between theory and empiricism in the social sciences and, with that is closely linked, the relation between so-called micro studies and macro studies.

2. Social Scientist and Social Change

The study of social phenomena must aim at an understanding of the mechanisms of social change or stagnation taking into account the historical specificity of different phenomena or the historical and social milieu in which a particular phenomenon occurs. This requires the understanding of the mechanism of change or stagnation which necessarily leads one to examine the interests of different social classes and the way in which these interests affect the production and distribution of the national wealth. I am now thinking of economics and economic development.

In the real world economic factors or economic influences do not take place in an institutional or social vacuum, but are inter-meshed with political and social factors. Both production and distribution are obviously conditioned by the underlying social relations and by the political and ideological influences on these relations. Furthermore, there is a perpetual element of conflict in social phenomena, social policies and so on and the social scientist is not outside the pale of these conflicts. Social change impinges upon different interest groups both nationally and internationally. Unlike a business firm, society is not a homogenous entity. What is desirable and profitable for a business firm is more easily decided than what is desirable for society. That is to say there are social groups with contradictory or conflicting interests and individuals or groups may seek to espouse social change because they benefit from the change to the exclusion or to the detriment of others.

If the problems of social development — that is development or under-development in a practical sense — mean different things to different people according to whether they are on the top of the social pyramid or the bottom, the social scientist is not outside the pale of these conflicts and, in fact, he is often influenced by these conflicts. After all the social scientist deals in words, and words as instruments of communication are not neutral or value-free. One whom I regard as a nationalist, you might regard as a terrorist. A liberation to one man may be imprisonment to another. In other words one's social occasion may even limit one's views to those which are partial and incomplete. Social scientists may even leave unanalysed or not refer at all to certain phenomena, the unravelling of which is likely to pose threats to those who hold power. For instance, class exploitation, the subjection of women and notions about productive and unproductive output and consumption, essential imports and non-essential imports and so on.

Social scientists recently have also begun to speak of market economies instead of capitalist and socialist economies, avoiding reference thereby to the possibility of alternative socio-economic structures, with their corresponding systems of property rights and income distribution. One finds that Professor Rostow even tried to discard the word "industrial revolution" by substituting for it the word "take-off". For reasons that are better known to the economists they have also dropped the term "under-developed economies" and substituted the term "developing economies" even though the hard reality of most of these developing economies is that they are really under-developed. With pretensions to objectivity and scientific precision, social scientists have been resorting to a considerable amount of word play by which they try to conjure away the seamy aspects of the existing social order.

The other point which I foreshadowed earlier in one of my remarks is that no area of social science has been as much the subject of conflicting explanation and ideologies as the subject of economic stagnation and change. The purpose of this recapitulation is to indicate how vulnerable is the position of the social scientist himself because he lives in a situation where he is trying to analyse problems of which he is a part or in which he could be partisan. The American historical sociologist, Bernard Stern said that 'in matters concerning the functioning of society, ideas and ideologies served different interests' and he remarked that while science is neutral, scientists were not. They could be Fascists, Communists etc. They may be upholders of vested interests of one kind or another. The scientist is, therefore, not a dispassionate, impersonal individual but, in company with all professional workers, has a large emotional investment in his way of life defined by the institutional norms which govern his activities. Let me illustrate my argument with an example from economics where economists have, over the years, at certain crucial junctures connected with social transformation in history, shifted their ground, shifted their theoretical premises, shifted their whole framework and the so-called methodology and focus of looking at social problems to accord with the dominant mode of production and the social interests which it subserves. There has, thus, even been a re-orientation of economic theory as seen by the changing attitude of economists towards problems of production and, in particular, to the distinction between productive and unproductive labour or, what may loosely be regarded as, essential and non-essential output.

Although the classical economists themselves were either unable to see or were unwilling to admit the historical specificity of capitalism, they criticised the feudal order for the barriers and restraints it imposed on the development of productive forces by the rising bourgeoisie. The classical economists at that stage were concerned with unproductive output and consumption. This was precisely the criticism they levied against the ostentation and profligacy of the feudal aristocracy. Adam Smith disliked state intervention because state intervention gave rise to large sprawling bureaucracies and military establishments which he felt consumed society's resources which could be used for productive investment. Ricardo, who was a stock-broker, was critical of the extravagances of the Roman Catholic Church and he said that men should be given opportunities to worship God in a less expensive way. At that time they were very concerned about maximising capital investment and the whole growth process. However, the whole approach of economic theory itself shifted once the problems of capitalism became essentially not those of production but those of distribution, that is an inability to sell all the goods produced, surplus production, trade cycles and so on. In this new phase, which began about the year 1830 where Britain was concerned, capitalism produced what Marx called 'a herd of vulgar economic apologists', who abandoned the basic concerns of classical economics with problems of production and growth for a formal but distorted analysis of the economy in terms of market relations. The analysis was divorced from the social basis of production, thereby obscuring relationships of exploitation between one class and another, problems which had concerned or were noticed by people like Adam Smith and David Ricardo.

At the level of the market there is merely an exchange of an equivalence, a relation between things substituted for the relation between men and, at this stage, economists also began to predicate their analysis with assumptions about the universality of what is historically specific and transitory. Even the text book definitions of economics have reflected this. For example, Kenneth Boulding defines economics as follows: 'economic analysis is a body of general principles and a discipline of logic which may be applied to the interpretations of all economic problems past or present.' Thus the historical specificity of different social structures in which economic problems operate is completely removed. There is nothing of a social nature so that one cannot therefore distinguish a brothel from a manufacturing enterprise because the same principles of economics could apply. This emphasis on the market as the exclusive arbiter of value led to a jettisoning of the earlier distinction between productive and unproductive labour, or essential and non-essential output.

The attitude of present day economists to this question, the way in which they treat various forms of output, is attributable to their environment and to their social conditioning. One inhibiting element in this ideological stand is the presumption that the capitalist will not incur wasteful expenditures so that whatever expenditure he incurs is as essential to the society as to the capitalist whether that expenditure is in the form of a bribe to an administrator or represents the cost of political lobbying, expense account entertaining, or consumer advertising. For example, one finds that national

income statisticians do not adopt this distinction between productive output and non-productive output. They combine the whole thing and estimate the national income. So much for the vulnerability of the social scientist in the analysis which he purports to make; very often he is part of the problem.

3. Social Science Methodology

I will now try to get on to the second stage and discuss the methodological procedures of social sciences. There is a link between the first part of my lecture to explain that there is no unique analysis or unique solution in problems of social science and methodology in social science. There is a lack of finality in the analysis of the social scientists. The existence of these contending view points is not merely due to the conflict of interests which I have spoken to you about. The existence of these unsettled controversies and issues is also due to the methodologies which are open to the social scientist because, as I said earlier, in social science we cannot make controlled experiments. The variables in a social phenomenon are so numerous and their interrelations so complex that there are no mechanistic or invariant relations between them. Furthermore, observable data are limited. Unlike in the natural sciences, the phenomena cannot be observed in their most typical form. For instance, one cannot re-enact the battle of Waterloo to find out why Wellington won and Napoleon lost nor can one today carry out a survey of the Middle Ages. But if there is nothing else to be done, if there is no other technique, we cannot do any research on the Middle Ages because it is now too late. Of course information on certain contemporary phenomena can be gathered by means of a survey. However, one wonders how representative the data are. Perhaps they may not be so representative not because there has been any bias on the part of the man who conducted the survey, but due to sampling errors and, particularly, non-sampling errors. Thus phenomena in the social sciences cannot be observed in their typical forms because we cannot easily get data which typify the phenomena we are trying to observe, nor can controlled experiments be carried out so as to untangle the specific element of a phenomenon.

The socio-economic process basically is an indissoluble whole composed of the complicated network of human relations and responses whose general character may be disturbed by accidental elements that cannot be isolated. As Marx said, in the analysis of economic forms, neither microscopes nor chemical agents are of use. In the social sciences, facts and incontrovertible truths cannot always be gathered from observable data. However, this does not mean that these problems, which cannot be observed or experienced, cannot be analysed. In the absence of experiments analysis in the social sciences must rely largely on deductive reasoning and therefore becomes a process of distilling in one's mind the numerous properties of a phenomenon so as to capture the essential or the general properties of the phenomenon. Through such a process, the historically specific elements are isolated from the general. Thus if we are trying to study the plantations as a type, we should try to isolate those specific characteristics of a plantation in a specific historical or social situation from the general. In the same way, when you enter medical school, you begin to study the anatomy of the rat before you study the physiology and anatomy

of man because you are trying to reduce things to their basic, essential systems. Science means the study of general, basic, essential properties of a system. To see the basics, we should isolate the accidental disturbances which are not fundamental to the system, but which might arise in a specific situation.

Through such a process of deductive reasoning, distillation in one's mind, the historically specific elements are isolated from the general. Here again I have to refer to an interesting analogy of Marx where he referred to the different ways in which hunger is satisfied in different cultures. He said hunger is hunger. The hunger which is satisfied by the cooked meat eaten with knife and fork differs not from hunger that devours raw meat eaten with hands. We are trying to get to the lowest common denominator of a problem. That means we are trying to abstract the essential properties from non-essential properties. It is abstract concepts embodying the unalterable features of a phenomenon which would enable us to generalize and to see a unity in diversity. The plantations in Malaysia may be different from the plantations in Sri Lanka. Nevertheless, plantations in general could make up a plantation system which is different to non-plantation agriculture.

Generalization is the pre-requisite of science. For example, Marx's methodology was one of detecting the general in the particular and the particular in the general. This process of abstraction also involves questions regarding the priority to be accorded to different elements of a phenomenon. In social science, it is not enough to say that everything is equally important. Everything may be equally important in an abstract situation but in a specific situation you should be able to separate the more essential properties from the non-essential properties. Here I have to quote Oskar Lange — 'abstraction plays a particularly important part in political economy. This is because the economic process is very complex. Only by the use of abstraction can this complex of inter-connected and repeated human activities be unravelled and the economic relations between them together with their regulations be laid bare. The more complicated the subject of investigation, the more numerous the accidental elements which inter-twine with the essential elements'. So much for abstraction, and that leads to something else.

The principle of abstraction itself involves a decision on what to abstract and what not to abstract. This requires the formulation of a hypothesis or a pre-conception of what the problem is. A hypothesis might even be of a rough type but one is necessary because it will discipline you in the search for facts. What facts are you going to collect and what facts are you not going to collect? Two social scientists would differ not in the way they manipulate the facts because those are subject to commonly accepted techniques, but in what facts they leave uncollected, according to their particular view of the problem, the emphasis they place and the slant they give the problem. The hypothesis not merely indicates the kind of facts which might prove to be relevant or fruitful. It also provides a framework for the assembly of facts. It also means that facts cannot speak for themselves. They have to be interpreted within a theoretical or a conceptual framework. Without such a framework the analysis of facts and statistical material, laboriously compiled and elegantly presented, become limited to their algebraic relations, involving descriptive summaries of the data or the explanation of surface phenomena. There is little addition to knowledge beyond what statistics themselves make apparent.

Scientific knowledge, however, is not reducible to given facts. Knowledge is a construction which is based on facts. However, facts themselves are never given, but are always produced. They are the product of different theoretical or ideological practices. Theory is not a mere report of empirical data but an explanation of them. The correlations and co-variances are not self-explanatory. One could have a theory which explains correlations. You have been told how to measure facts and how to summarise them and process them. But the selection of facts and their arrangement or classification is not entirely a statistical matter but partly a philosophical question. It depends on one's hypothesis or pre-conception of the problem and on what aspects one is trying to highlight. The selection, arrangement, or classification of facts is a major practical consideration in the social sciences. The range of facts collected on any problem would require selection or judgement of the relevance of some facts as against others. Such judgement would pre-suppose some prior theoretical stands. The selection may be made arbitrarily owing to considerations of time, or manageability, or according to political criteria. Therefore, it is very important to examine the hypothesis of the social scientist because all the bias and all the errors could creep into the hypothesis long before he goes to the field. The very fact that he selects a given problem for analysis and leaves aside all the other problems means a judgement on his part. Has he selected the most significant problem even to go to the field and, having gone to the field, what are the aspects he is trying to highlight? All these will be reflected in the hypothesis and therefore when trying to evaluate research in the social sciences it is fundamental to identify and examine the hypothesis.

The process of abstraction requires a hypothesis. Then the problem of feeding data into this hypothesis to check the correctness of the hypothesis requires the comparative observation of the phenomenon in a wide range of settings. If you are studying plantation agriculture in Sri Lanka, you cannot really find out what the fundamental characteristics of plantation agriculture in Sri Lanka are unless you know the plantations as a system of production in the general setting extending beyond Sri Lanka. In the social sciences, to understand one situation one has to study numerous similar situations. This procedure of analysis is like examining several photographic slides of a landscape from various angles, each one with a different focus so as to obtain a generalized outline.

The need to formulate a hypothesis and also to look at a problem in numerous comparative situations also means that one needs a total approach to socio-economic problems. A total approach does not preclude an analytical method which extracts a specific element from a larger entity for detailed study. It may be impractical to start with studying the entirety of the under-development of the plantation system. Therefore one might have to study a particular aspect of the plantation system, plantations and labour, plantations and the technology of plantation production and so forth. Thus, one abstracts a particular aspect for convenience, but having abstracted these various aspects for convenience, one should not leave them as isolated studies. As R. Mills stated 'one should put back these fragments or bits and pieces, into the system to which they belong enabling a social phenomenon to be seen as an organic whole with complementary relations or reciprocities between these different parts.'

The next point is the need for multi-disciplinary or inter-disciplinary studies in the social sciences. Here again there was a sharp change which took place in the attitude of social scientists, particularly in the attitude of economists, to economic problems as social phenomena. In the case of the classical economists their approach to social science in general, and economics in particular, was inter-disciplinary. The first to incorporate political economy into their writings were the Scottish moralists including Joseph Hume who were concerned with the effects of the development of commerce and wealth on political power as well as on human happiness. It is also interesting to note that Adam Smith's designation at the University of Glasgow was Professor of Political Economy and Moral Philosophy. At the time he wrote the *Wealth of Nations*, he had a reputation from an earlier work called *The Theory of Moral Sentiments*. In the same way J. S. Mill subtitled his major work *Principles of Political Economy* 'With Some of Their Applications to Social Philosophy'. I am trying to illustrate how economists shifted their ground concerning what they regarded as an economic problem and how they fragmented the social sciences into different fields. For practical purposes, political economy, explained Mill, is inseparably intertwined with many other branches of social philosophy. Adam Smith himself recognized that a community comprised a series of different orders and societies and that the development of trade and manufactures affected the political power of the landed aristocracy. Marx of course conceived of human society as an interrelated system comprising of both economic and non-economic elements, contrary to what is usually thought that he merely concentrated on the economic aspects of the problem and discarded the non-economic aspects. In fact, in this connection, Engels explains that 'political conditions, etc. and even the traditions which haunt the human mind also play a part although not the decisive one. Without making oneself ridiculous, it would be difficult to succeed in explaining in terms of economics alone the existence of every small state in general.'

From the last quarter of the 19th century, in economics, as I mentioned earlier, there was a shift away from the study of production relations into an exclusive concentration on market relations. When economics confined itself mainly to a study of the exchange process, economic problems also began to be examined by taking the existing socio-political framework as given. This tended to detach economics from the other social sciences and led to a fragmentation of the study of the social process itself.

Furthermore, another related change was that economics began to be regarded as a positive science. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking which helps the possessor to draw up correct conclusions. The economist's role became to explain and explore, not to uphold or condemn. Devoid of prescriptive and policy implications and evaluating norms, economics serves to legitimize the political rule of the dominant class because we do not question the social order. Our principles of economics are applied equally to a capitalist economy, stone age to a socialist economy, because they are all reduced to the problem of scarcity, scarce means and unlimited ends.

With this narrowing of the focus of economics, there was also an abandonment of the earlier term for economics which was 'political economy' and they began to use the word 'economics'. Within this restricted intellectual framework, the problem of production

began to be viewed in terms of mechanistic relations between productive factors involving input-output relations and technical coefficients of production while the economic problem was detached from the political and social process. The economic process itself was fragmented so as to place emphasis on the scarcity of one factor or another, such as limitations in markets, or in enterprise, capital and in some more recent models, lack of human capital such as education and skills.

The changes in the framework, the focus, and the methodology of economics about which I have been specifically talking also had a parallel in sociology where a neo-positivist school of thought began to take root. Neo-positivists sought to discard normative elements and to renounce the possible role of the sociologist as an agent of social change. He was expected to be neutral. In spite of this, it is curious that sociology, which has been a late developer among the social sciences has not been pervaded to the same extent as economics by this ahistorical, apolitical, amoral approach. Along with history and politics, sociology has been reaching out, with far less inhibition, to areas of knowledge which require value judgement, investigations of property rights and power relations in society, and the exercise of what one may call the sociological imagination. Problems of development and under-development previously regarded as purely economic problems have also been brought within the purview of sociology. Therefore, sociology seems to pave the way for social action. It is linked up more with philosophy and based on the evaluation of development goals and the rational manipulation of society.

4. Empiricism

Another aspect of this change is — and this brings me to the third and final part of my lecture — that with the formalisation of economics and the abandonment of the framework of classical political economy, economics was also seized by an anti-theoretic tendency. That is to say it began to lean heavily on statistics and observable and quantifiable facts. Thus a great many studies in development economics, despite their title, belong to the field of applied economics and are in the nature of investigative reports devoid of intuition, reasoned thinking, or theory. In my view they have suffered from a severe empiricism based on questionnaires and social surveys. Studies on Sri Lanka's agrarian problems offer a good example. In most of these studies, there is a procession of statistical tables interspersed with explanatory notes on what the tables show. For the benefit of the lazy reader, the same facts are simplified further in charts and diagrams. The analysis remains at a superficial level. A large majority of writings that attempt synthesis and review contain trite statements and do not in any way enrich our understanding of the agrarian scene. Much of the research effort is devoted to the mechanical and repetitive process of data collection. The end result is the production of a conglomerate of statistical tables that overlap and duplicate one another.

Meaningful research in the social sciences require far more than the accumulation of facts and their arrangements under merely commonsense captions and subjecting them to algebraic manipulations. Much of the research and writings on the under-developed countries are either excessively theoretical or excessively empirical. There should be a

fruitful combination of empiricism and theories. Western scholars whose theoretical insights, I think, are sharply developed, are limited in their analysis by limitations in the range of data to which they have access. On the other hand, the scholars in the under-developed countries tend to burden themselves with a load of data to the neglect of a theoretical framework.

5. Macro and Micro Studies

In a macro study it may not be practicable to collect all the required data because you are operating on a vast expanse of problems. You take the whole world as your canvas. But if you are just writing on some village, you can pile up enough data so that empiricism is also linked with a kind of micro approach to social problems. You cannot collect data to write on the general problem of under-development. A macro study involves a theoretical perception of a phenomenon, because once you get on to the theoretical plane, then you are capable of handling a larger situation. A macro study has a character of its own. It is not just the aggregation of numerous micro studies, just as a collection of snapshots does not make a cinematic film. A macro study involves the visualizing of a problem in its totality, the perception at one sweep of a vast array of facts. It also involves a separation of the important and relevant from the trivial. An intertwining of facts and knowledge taken from disparate clusters separated by space and time. Further it requires an appropriate system of classification of such facts and knowledge and an ability to both disaggregate and compress, to synthesize and enlarge.

All this does not imply that micro studies are necessarily unrewarding. A micro study can powerfully illuminate a small area instead of throwing subdued light on a bigger expanse. There is an analogy which I would like to take-over from Professor Denis Robertson of the 'snake and the glow worm'. A snake, it is said, is able to cast its light on a narrowly focused area straight ahead of it while the glow worm can light up the entire surrounding area even though faintly. It does not mean that you can get a macro picture by doing one hundred micro studies. The macro picture has a character and a quality of its own which depends on the hypothesis, the abstraction, the sociological imagination and so forth. The point is there should be a fruitful combination of micro and macro studies.

PART II

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Social Science Research in Sri Lanka: A Historical Perspective

H. N. S. KARUNATILAKE

Central Bank of Ceylon

1. Introduction

Compared to many other developing South Asian countries Sri Lanka has had a greater volume of social, economic, demographic and other statistical information which has helped writers in their social science writings and stimulated them to make further investigations. Such data have been available in Sri Lanka over a period of more than one hundred years and the coverage has been extensive. Furthermore, the quality and reliability of early data have been quite satisfactory despite the fact that data and information collection and methodologies have not developed to the present levels of refinement and sophistication. An important consideration was that the writers in social science fields in the 19th century made full use of whatever data that were available and endeavoured to make comprehensive analyses. The British have throughout paid attention to the collection of information and statistics and several regular publications such as the Almanacs, Calendars and, later on, the Blue Books have carried a considerable amount of data with very few breaks in the series. It is therefore not surprising that a great deal of this historical data still awaits analysis and critical evaluation by the social scientist who is more interested in the past than in current developments or rather in the relationship between current and historical trends.

The most comprehensive bibliography on Sri Lanka prepared so far is H. A. I. Goonetilleke's five volume *A Bibliography of Ceylon* (1970). This reveals a wide range of studies in the field of the social sciences in general. Indeed, it is a fair judgement to make that in Sri Lanka research and writing in the social sciences have considerably exceeded those in the pure and applied sciences. In fact, in the period before the Second World War most of the studies on Sri Lanka have been in the fields of history, politics, constitutional change, sociology, culture, religion and allied subjects. A trend which has been increasingly evident today and something which this paper attempts to pinpoint is the increasing tendency for more recent studies in the field of social sciences to heavily lean towards political issues in the country. On the other hand, the studies made before the last three decades especially in the 19th century were less conditioned by political issues. Then the bias was clearly towards the elaboration and analysis of social problems. Studies done in the nineteenth century were primarily concerned with the social framework with the emphasis on the people, their customs, habits, religion, cultural and demographic characteristics.

2. Early Nineteenth Century

Perhaps, the correct approach to an assessment of the social and political influences on social research would be to look at it from a historical perspective evaluating the impact of social and political change on writing in the last 175 years, i.e. from the beginning of the British period.¹ In the early days of the British occupation of the island several books were published on Sri Lanka in quick succession. Their main purpose would seem to have been to give the reading public in Britain, the country from which the authors came, an insight into the history, manners and customs of the people who lived in the newly acquired British colony. The very early writers such as Davy, Cordiner, Percival, all attempted to describe Sri Lanka in all its variegated facets with varying degrees of success.

Most of the books written about the island in the early days of British rule came out between 1800 and 1820. Thereafter, until about 1840 there appears to have been a substantial void in the output of literature on Sri Lanka. This applies not only to books but also to articles and pamphlets. This is not too difficult to explain because these years coincided with a period of very little economic activity and development. The British were perhaps spending a lot of their energy and resources on consolidating the kingdom of Kandy which was ceded to them in 1815. This long spell of literary inactivity from around 1820 to 1840 was only broken by the two volumes written by Forbes, *Eleven Years in Ceylon* which was published around 1840. A brief account of some of the studies in the early British period, written mainly by administrators, government officials and members of the clergy may be relevant in order to indicate that during these early days of British rule social issues rather than political issues predominated and even if references were made to politics it was always in a historical context. The political aspects specifically seem to have received very little weightage because it was an accepted fact that the British had conquered the maritime provinces.

In the context of a situation where information and statistical data on social conditions were virtually absent in the early days of British rule, those who wanted to write on the social aspects made it a point to visit the different parts of the island to gather information and making detailed observation of people and events was the principal means of investigation. This is, to some extent, different from the approach of researchers of modern times who tend to depend, very often, too heavily on published statistical material or secondary sources with very little access to any direct understanding of the conditions about which they are writing.

¹ It is important to note that the first sociological study of Sri Lanka written by an Englishman and indeed the first book written on the island in the English Language was Robert Knox's monumental work entitled *An Historical Relation of the Island of Ceylon in the the East Indies*. The book was written during the Dutch occupation of Ceylon. Robert Knox was held captive for twenty years in the Kandyan Kingdom along with several other Englishmen and in 1681 on his return to England he wrote his book. It is a fascinating narrative of the Kandyan Kingdom, the Kandyan Court, the country, religion, manners and social organisation. It is an unparalleled source book for reconstructing the social and economic history of the society that existed in Ceylon in the seventeenth century. In Knox's study the political context was not entirely eliminated because he dealt with such aspects as the Kandyan king's despotic reign, the wars fought by the king and the attempts at rebellion against him. Knox also dealt with feudalism in the Kandyan Kingdom and with its complicated system of land tenure.

A significant work that emerged in the early days of British rule was the book *A Description of Ceylon* published by Rev. James Cordiner who was the chaplain to the British garrison on the island. This book was published in 1807 and contains a description of the geography of Ceylon, its inhabitants, natural products together with a narrative of a tour of the island in 1800.

There are several other books that came out in the early days of British occupation which are noteworthy and these include a study by Anthony Bertolacci, the first British civil servant who attempted to make a comprehensive study of the commercial and financial aspects of the country. The book is entitled *A View of the Agricultural, Commercial and Financial Interests of Ceylon* and was published in 1817. The book includes a series of appendices containing some of the principal laws, the Kandyans, the economic structure, ports, customs house regulations, and statistics relating to exports, imports, public revenue and expenditure. The information in these early books constitute primary information and much of it has been gathered by the writers themselves because, in the first decade of British rule, very little social and economic information had been published and what little that was available was largely confined to government revenue, exports and imports.

During this period none of the Almanacs, Calendars and Blue Books that carried basic data on the economy during the latter half of the 19th century had yet come out. Some statistical documentation and general information appeared for the first time after 1820. Anthony Bertolacci's book was followed by *An Account of the Interior of Ceylon and its Inhabitants* by John Davy who happened to be a doctor to the British forces that were stationed in the Island at that time. In this study too, in the absence of other forms of economic information, the writer has made use of his travels in the country to make extensive observations of the social conditions.

3. 1840 - 1899

The upsurge in economic activity that was associated with the growth of the coffee plantations after the mid 1830s presumably stimulated literary activity in the island. Most of the publications that came out during this period too continued to give accounts of the country as the British administration progressed. Here, again, the objective seems to have been to keep the people in Britain informed of conditions in Sri Lanka. In 1843 J. W. Bennet wrote *Ceylon and its Capabilities*. This study included an account of the natural resources, indigenous production, commercial facilities and a fair amount of statistics. This again was another reasonably comprehensive account of the economic and commercial situation in the island at the end of the first forty years of British rule of Sri Lanka.

In 1846 Henry Marshall wrote *Ceylon—A General Description of the Island and its Inhabitants*. This was a description of the island which included a historical sketch of the British conquest of the country. In 1849 Charles Pridham published *An Historical, Political, and Statistical Account of Ceylon and its Dependencies*. The tendency in the studies after 1840 was for economic aspects to predominate and this was largely because the economic environment after the 1840s had become quite different from what it was in

the early days of British rule. Two other books were published in the same period basically in the tradition in which the other books of the forties and fifties were written. The first was a two volume work, *Ceylon and the Cingalese*, by Henry Charles Sirr. This book again deals with the economic capabilities of the island and describes the economic conditions that prevailed at that time and the potential for further development. About the same time, two volumes entitled *Ceylon By an Officer Late of the Ceylon Rifles* were published.

During this period, by far the most important work that emerged in the shape of a comprehensive and incisive social and general commentary was the two monumental volumes on Sri Lanka by Sir James Tennent published in 1859. Entitled *Ceylon : An Account of the Island, Physical, Historical and Topographical*, this is probably one of the most popular and best known books on the country. It is highly prized and recognized as a comprehensive and authoritative work on the historical, social, economic and political conditions of the island in the middle of the last century.

In the first half century of British rule social studies about the island and its inhabitants came out mostly in the form of books. There were very few periodicals and journals. Most of the periodicals came to be published in the second half of the nineteenth century, especially after the sixties. One of the foremost journals that continues to be published even up to this day is the *Journal of the Royal Asiatic Society (Ceylon Branch)* (*JRAS*) which, from its first year of publication in 1845, has become a vehicle of sound historical, social and economic research on the island. From its inception, the objective of the Royal Asiatic Society has been to institute and promote inquiry and research into Sri Lanka's history, religion, language, literature, arts and the social condition of the present and former inhabitants of the island. The research studies it has frequently published in its Journal have been on such diverse fields as history, geology, epigraphy, mineralogy, climatology, meteorology, botany, zoology and fauna and flora.

When it was first published in the 1840s the *JRAS* was perhaps the only journal that regularly carried the fruits of serious research that was undertaken largely by the expatriate officials and academics in Sri Lanka. Its contributors have included the most prestigious writers and research workers who have lived in this country during the last hundred years. The main characteristics of the research studies published in this Journal have been their very close links with contemporary society, culture, traditions and the history of Sri Lanka. Most of the scholars who wrote to the Journal have been serious students of their respective areas of specialisation and they have laboured hard to carefully collect, sift and analyse materials on topics on which very little systematic information had been available up to that time. However, the kind of article which today has become more and more important in the political context did not find a place in the *JRAS*.

4. 1900 - 1947

Journals became a more popular medium of publication of research work in the social sciences and humanities in Sri Lanka after the turn of this century. The *JRAS* apart, the other journals which carried social and historical research during the period

before 1920 included the *Orientalist* and the *Ceylon Literary Register* which was first published in 1880 and at the outset mostly contained articles of literary value. But the *Ceylon Antiquary* and the *Ceylon Register* which was published in three different series from the year 1915 onwards were somewhat in the tradition of the *JRAS* although their coverage of subject areas was far more limited. These two journals published research pertaining to Sri Lanka's history, culture and other allied subjects. The *Ceylon Economic Journal* (*CEJ*) which briefly emerged soon after the depression in the 1930s continued to be in publication for a relatively short period under the editorship of Dr B. B. Das Gupta. It is presumably the first journal published in Sri Lanka exclusively on economic topics. The subjects covered in the *CEJ* were quite removed from the historical and sociological context of most of the earlier journals. Many of the articles in the *CEJ* were based on the economic background of Sri Lanka and the studies pertained to banking, commerce, trade, and financial affairs of the island.

While the first quarter of the 20th century was very fruitful where cultural and intellectual activities were concerned, the period from around 1925 to about 1950 could be looked upon once again as an era of vacuum in social research in the island. During this period, however, the government issued a large volume of statistical, social and economic information through the regular Blue Books, Almanacs, Sessional Papers and other publications which were put out from time to time. But the volume of research publications in the form of articles or in the form of books was very limited. Most of the writings in this period, especially after 1920, had a distinct bias towards the emerging political issues of Sri Lanka. This was the time when the nationalist movement had gathered momentum as an aftermath of the riots of 1915 which made the Ceylonese public aware of the rigors of British rule and its damaging effects. This was also a period when constitutional change took place, though very slowly, and the Ceylonese were progressively gaining political power into their hands. Other than pamphlets and small booklets written on the constitutional progress which the country had achieved, no major works of consequence even on politics appeared during this period. Being still under British domination it was not easy for people to write freely on the political situation and also to make evaluations with a sense of detachment.

5. Post-Independence Period

After the country gained Independence in 1948 the environment for research changed significantly in many ways and several factors contributed to this. Firstly, by this time, the country had its own university and there were many senior academics who made use of the vast body of material available on the social sciences to write on their individual fields of specialisation. The pioneering efforts were made by two categories of research workers. First, the academics to whom reference has already been made and second, those who were associated with the movement to gain Independence and contributed to the national and social awakening in the island.

At the same time, after Independence, several new organisations emerged and they became progressively equipped to undertake social research and to collect primary socio-economic data which would be of great use to other research workers. Other data gathering

government departments and institutions also stepped up their efforts to reorient their horizons and activities to national needs. The leadership in this direction was given by the Central Bank of Ceylon where the statute made specific provision for a Department of Economic Research, the first of its kind in the country. With a new interest in economic and social studies endeavours were made by independent groups of persons to bring out periodicals. One of the first attempts to do so was the publication of two important journals which had no official links. The first was the *Ceylon Economist* which continued to bring out volumes for a period of 7-8 years commencing in 1950 and then went out of publication. At that time, it was the only independent journal which contained economic writings. In 1952, the *Ceylon Historical Journal (CHJ)* also came into publication. It was sponsored by academics within and outside university circles. The *CHJ* carried articles mostly by university academics on history and related subjects. A great many of the articles in the journal touched on contemporary political issues and also historical factors that had conditioned current political problems. The journal continues to be published though infrequently. This may be due to the paucity of articles and also the multiplication of other journals with the same approach and background. In more recent years, especially the last ten the *CHJ* has begun to publish old works on Sri Lanka as a part of the series.

The University of Ceylon Review (UCR) although not exclusively concerned with social science research was also a vehicle for occasional articles on history, geography, economics and other disciplines in the social sciences. But its main bias seems to have been on studies pertaining to oriental studies, language, the arts and literature. After having been in publication for more than twenty years the *Review* is no longer being issued. One does not know whether this is a reflection of the paucity of research done at the universities or the lack of initiative on the part of the university authorities. It is now time that all the universities in Sri Lanka join together to revive the *Review* as a common vehicle for publishing research of whatever kind undertaken by the universities.² Its demise though gradual is also an indication of the general decline of research done by the academic community in the universities. University academics have from time to time published their research in book form but most of this represents the research that they have undertaken for their higher degrees, mainly doctorates.

Although the *UCR* which was an official journal of the University went out of publication, it seems to have been replaced by the *Ceylon Journal of Historical and Social Studies (CJHSS)* which is not a university publication but which has been brought out by a publications board which consists very largely of senior academics who have undertaken research for quite a long time and who have mainly been members of the university community at Peradeniya. The *CJHSS* appeared for the first time in 1958 and after ten years of publication it has brought out a new series starting in 1968. This journal has been the principal vehicle for transmitting social science research that has been done mainly by academics at Peradeniya to the public of Sri Lanka. The articles that have been published in this journal typically reflect the growing significance of the social and economic context

2 The University of Colombo has just brought out (in 1982) a *Review* on the same lines as the *University of Ceylon Review*.

in social science research. Perhaps, without exception the studies in this journal in the fields of history, law, politics, constitutional affairs and economics are related closely to significant social, economic and political issues of the country. It is also apparent that a fair amount of the research published in this journal has emanated from social and economic questions, not only because such issues have directly interested the researcher in the present context, but also because social research with a distinctly political flavour would be of interest to the reader and, therefore, the journal would have a much wider market.

Following in the same tradition another journal the *Modern Ceylon Studies (MCS)* has come out in publication from 1969 onwards. This, again, has been a product of the University of Peradeniya and the guiding lights have been mostly historians and economists who have had a lasting interest in social science research. The articles published in the *MCS* relate specifically to the entire field of social sciences including areas such as anthropology and psychology. Some of the material published in this Journal have been research specifically done for the *Ceylon Studies Seminar* workshops which have been frequently held in Peradeniya and whose proceedings and resulting papers have been published independently as well.

Another journal of importance has been the *Staff Studies* published by the Central Bank since 1970. The articles in this have been almost exclusively in the fields of economics and statistics and the papers have been written almost entirely by members of the Central Bank staff. The writers have been free to critically examine economic and social policy and to be independent and detached in their analysis. Since 1979 the *Staff Studies* has not been coming out regularly. The Marga Institute has also brought out a periodical entitled *Marga* which again has been a vehicle for scholars mostly in the non-government sector to publish their research. A new Journal has been just put out by the Agrarian Research and Training Institute (ARTI) entitled *The Ceylon Journal of Agrarian Studies*. The articles in this have been mostly written by the officers of the ARTI. In 1978 the Social Science Research Centre of the National Science Council of Sri Lanka began to publish the *Sri Lanka Journal of Social Sciences*. This journal is a biannual and it publishes articles covering the entire range of social science relating mainly, but not exclusively, to Sri Lanka.

The output of socio-economic research covering both the micro and macro levels increased substantially from the beginning of 1950. As already indicated social science research secured a new status by the establishment of the University of Ceylon and, moreover, weightage in the University in the fifties and sixties has been towards social science subjects. The science faculties were less developed and the largest body of students did subjects such as history, geography, economics and sociology. Furthermore, the largest number of faculty members also belonged to those departments where social science subjects were taught. Quite apart from this, a large number of scholars and expatriates who were undertaking research for institutions overseas, particularly universities in the U. K. and U.S.A., began to visit the country in large numbers. Many of them took a renewed interest in the political situation and one factor that spurred them on to research, especially in the field of politics and sociology, was the importance

that communal issues played in politics together with religion and caste. In most of the studies on politics and economics the main theme has invariably got linked to one of these three areas and the number of studies with such links have, in recent years, increased considerably. This is evident not only in the books embodying substantial research that have come out in the last two decades, but also in the articles and papers that are being published in the journals issued in this country and in journals concerned with Sri Lanka and South East Asia published abroad, particularly in the United States.

Although the writings on politics and sociology have today virtually inundated the documentation in the field of social science, substantial works dealing largely with economics have been few and far between. The first work on the economy of Sri Lanka which was more descriptive than analytical was the *Economy of Ceylon* by Ivor Jennings which was written when he was the Vice Chancellor of the University of Ceylon in the forties. Next, after a long spell, in 1966 D. Snodgrass attached to Yale University brought out his in-depth study entitled *Ceylon: An Export Economy in Transition*. In fact, of the macro analytical works on the economy of Sri Lanka Snodgrass' work stands out mainly because it makes a systematic fresh analysis of data that had been published over a long period of time. The analysis itself is devoid of any political undertones or policy prescriptions which normally become part and parcel of writings on economic subjects that embrace the economy as a whole. One of the few books published in the seventies on the economy of Sri Lanka was *The Economic Development of Ceylon* by H. N. S. Karunatilake which tends to review critically the development policies of successive governments since Independence.

However, the majority of publications, both articles and books, have been primarily in the areas of government, politics, constitutional change and sociology. With the exception of works in the field of history and archeology, strangely enough, in the other areas, research has been undertaken mostly by visiting scholars or by Sri Lankan scholars who have been living abroad for a considerable period of time and who have cut themselves away from the social milieu here. In the field of history a large volume of publications both books and papers have appeared in the last thirty years. Most of the substantial works, especially the two volumes of the *History of Ceylon* brought out by the University of Ceylon, have been objective studies devoid of any political or social prescriptions. Historians and the university academics have also produced a large number of individual studies which have covered the Portuguese, Dutch and British periods. Likewise, there have also been a large number of articles on history which have appeared in the *CJHSS* and the *MCS*.

Historians have also brought out general studies on Sri Lanka but these often tend to present an individual point of view. One such study is *Ceylon* by S. A. Pakeman published in 1964 which is really a broad analysis of Ceylon and the historical factors that have been most relevant to its understanding. Presumably this book has been written for the benefit of the reader overseas. Similarly, E.F.C. Ludowyk in 1964 wrote *Story of Ceylon* which is not really a substantial piece of research but a general study which links up Sri Lanka's history with the present. In 1964, S. Arasaratnam brought out a small book entitled *Ceylon* which is primarily a survey of political problems and unrest in modern Sri Lanka within a historical perspective. This book touches heavily on a common theme

of political and sociological research today which is the communal problem in the island or the conflict between different races. Essentially the focus in this book is on the three major communal groups the Sinhalese, Tamils and Muslims and a discussion of the 2,000 year old process of national development in the island.

Another historical study of significance is the *Modern History of Ceylon* also written by E. F. C. Ludowyk in 1966 without any political undertones. This is a comprehensive treatment of the British period in Sri Lanka's history. Special emphasis in the analysis has been given to the impact of British rule on the social and economic structure and the political and economic problems that have plagued Sri Lanka from 1931 to 1948. More recently K. M. de Silva has published *A History of Sri Lanka* which is a comprehensive survey of Sri Lanka's history from the earliest times to the present.

One of the earliest anthropological works on Sri Lanka was the *Veddas* by C.G. and B.Z. Seligmann which came out in 1911. In recent years studies in anthropology have been published by M. D. Raghavan, N. D. Wijesekera, Gananath Obeyesekere and a few others.

Among the early important socio-economic and geographical works was *Pioneer Peasant Colonization in Ceylon* by B. H. Farmer. This publication came out in 1957 and it is primarily concerned with the efforts of the Sri Lanka administration both prior to and just after Independence in the settlement of people in the Dry Zone. The book evaluates the success of these efforts and also the problems that have confronted the administration in doing so. A work that falls broadly into the same category but with an anthropological bias has been written by E. R. Leach entitled *Pul Eliya*. Here again, the focus of the analysis is on the problems associated with villages in the Dry Zone. The problems of development, settlement and the confrontation of the settler with the environment and other difficulties including shortcomings of the administration have been examined here. Books that fall into this category always tend to highlight the weakness of the political system and one could imply that a good part of the difficulties that pioneer peasant settlers have faced could be attributed to political and administrative deficiencies. G. Obeyesekere's *Land Tenure in Village Ceylon* is complementary to the work by Leach because kinship and land tenure feature in both studies. Obeyesekere has analysed tenurial problems in the context of Medagama, a village in the Dry Zone. The detailed analysis of land holdings with kinship charts constitutes an interesting example of modern anthropological techniques.

An even earlier sociological study by a Ceylonese has been *Sinhala Social Organization* by Ralph Pieris published in 1956. This is one of the author's very early works and represents a comprehensive account of the Sinhala society in the Kandyan kingdom. It analyses the social order in which the village community, village council, caste and other sociological factors have been living institutions. One of the pioneering sociological studies on a subject which has been of great importance but not much talked about and about which nothing substantial had been written for centuries has been the one brought out by Bryce Ryan in 1953. The book entitled *Caste in Modern Ceylon* has been a pioneering and monumental work and such a book at that juncture was most relevant because

it shows how the caste system operates amidst influences which contradict its basic premises. Sri Lanka has continued with the caste system although changes in the behaviour of Sinhalese have been brought about by western attitudes and increasing urbanization but these factors have not altered their sentiments. Bryce Ryan says that caste dominates in the fields of marriage and personal loyalties. This was a subject which was for a long time considered taboo for research by the people of this country and work in this field has nearly always fallen within the purview of visiting scholars. In a similar study Nur Yalman in his book entitled *Under the Bo Tree* examines the inter-relationship between caste, kinship, marriage and life in typical Kandyan villages.

More recently on the same theme, Janice Jiggins has brought out a comprehensive work entitled *Caste and Family in the Politics of Sri Lanka* showing the significance of caste as an important factor in politics in Sri Lanka and also how this has acted as a significant force in party politics and in successive elections that have been held in the country since Independence. This is the only study of its kind which has an analysis based on carefully collected and checked data.

The link between religion and politics has also been a focus of attention of many visiting research scholars. While religion has played an important part in Sri Lankan history, the role of religion in politics and in the present social context has been studied only recently. One of the first works in this field is by Francois Houtart entitled *Religion and Politics*. The study deals both historically and in the current context with the important role that Buddhism has played in leading the political trends and the political forces that have emerged at various times in Sri Lanka. However, a more important work which has an immediate bearing on the significance of religion in modern politics is the study by Urmila Phadnis on *Religion and Politics in Sri Lanka*. In this book she attempts a broad survey that extends over a period of 2,500 years but focuses attention on the structure and the role of the sangha in the formulation and implementation of cultural, economic and even foreign policy. She has also highlighted the changes that have taken place in the religion itself due to the involvement of the priesthood in secular affairs. The book was published in 1976 and perhaps, it is still the most useful book to understand the importance that religion tends to play in politics in the country at the present time.

Communal problems have been a favourite theme of researchers, not only because there is a vast fund of material on which they can draw upon, but there is also the fact that a lot of material representing one side or the other of a communal issue could always be assembled. Of course the quality of the writing would tend to depend on the bias or the point of view expressed by a researcher. One of the earliest books on this subject was *Communalism and Language in the Politics of Ceylon* published in 1967 by an American Robert N. Kearney. Although friction between the Sinhalese and the Tamil communities has existed for a long time, and was manifested in the outbreak of violence in 1958, yet it became a subject of analysis by scholars very much later. The only book that emerged from the communal troubles of 1958 was *Emergency '58* by Tarzie Vittachi. This was not really a serious political and sociological study but rather a description of the events that took place in 1958. Although there have been a plethora of works on the communal problem in the shape of articles and booklets brought out by various

organisations, more serious analysis of these problems have been still quite few in number. Nevertheless, the theme of communal conflict pervades a lot of other books on politics and government written by reputed researchers.

The most comprehensive account, although rather outdated in the present context, on the main political developments in Sri Lanka has been *Ceylon: Dilemmas of a New Nation* by Howard Wriggins. This book makes a broad survey of postwar political conditions but the narrative written in 1960 is not directly relevant to the present political and social context. Other studies with a wide spectrum of analysis have been two books by A. J. Wilson. One is *Politics in Sri Lanka 1947-1973* published in 1974 which is probably one of the more comprehensive accounts of political developments since the country gained Independence. The other study entitled *Electoral Politics in an Emergent State* deals with the general elections of 1970. Here again, the emphasis is on the problems emerging from the multi-ethnic society in the country and the issues that have stemmed from a basically rural society and how these have influenced the general political issues of the island. Another book which has recently been published by the same author entitled *The Gaullist System in Asia* is specifically a study of the new constitution that Sri Lanka adopted in 1978 and the role and powers of the Executive President.

Although in the field of economic research substantial individual works have been relatively few in number, monographs, articles and studies issued by organisations have increased to such an extent that the lack of individual research has been more than compensated for by the joint works of research groups or by studies from organisations. In this field with the establishment of its Economic Research Department the Central Bank, came to the forefront and it has over the last thirty years been a fountain of information and the source of a number of analytical works on the Sri Lankan economy. The Department itself has been primarily concerned with the collection, processing and publication of economic data. However, a considerable amount of time has also been spent on organising socio-economic surveys for the purpose of providing researchers with basic and up-to-date data which will contribute to the understanding of economic problems of Sri Lanka.

General research studies on specific micro subjects on the Sri Lankan economy have been published by the Bank. Every year, however, the Annual Report could be looked upon as a fairly serious piece of economic analysis and there is no doubt that the analysis, to some extent, has also been influenced by the contemporary social and political situation. The Bank has very often made constructive criticisms and looked meaningfully at Sri Lanka's economic problems in the hope that these observations would influence the decision-makers at the political level. To this extent, one cannot say that the research undertaken by institutions like the Central Bank has been without relevance to the prevailing socio-economic context. The criticisms and evaluations have often been made with the object of bringing about economic and social change which is desirable in the national interest.

More recently, a major source of research, particularly on problems pertaining to agriculture and the agrarian situation, has been the Agrarian Research and Training Institute (ARTI) which was set up in 1972. The output of work in the form of studies by individuals and joint efforts has been considerable. All these studies have been largely

based on data that have been collected in the field by research workers of the Institute. In this respect, the work of the ARTI in a broad perspective follows the discipline that has been established by the Economic Research Department of the Central Bank since 1950. However, the socio economic studies by the ARTI have tended to be too much pre-occupied with micro aspects and have lacked depth. This is because the Institute does not have adequate facilities for gathering macro data which embrace the economy as a whole and are relevant to policy formulation.

However, the data that have been collected by the ARTI and the analysis of problems in relation to the agrarian situation are of significance and are very closely linked to the present social context. Being basically an independent body the ARTI has steered clear of making political prescriptions although it has not always looked at problems related to agriculture and agrarian issues with a strict degree of detachment and objectivity. To this extent, it has not endeavoured to criticize the policies of the government and the Ministry of Agriculture which oversees its operations. On the other hand, however, the Central Bank has not been subject to the same limitations because it has had a tradition of doing independent work and there have been times when the Bank publications and reports have made very specific criticisms of government policy.

Another independent social and economic research organisation totally unconnected with the government and, perhaps, the only one of its kind in Sri Lanka, is the Marga Institute which has been functioning for a period of more than ten years. The Institute although it has done a fair amount of work has been guided in the choice of areas of social research by the agency that funds the organisation. It does not seem to have much independence in this respect because it has undertaken mainly funded research. This factor seems to have affected not only the quality of research, but often the approach taken seems to be conditioned by the criteria laid down by the funding agency and its outlook.

Social Science Research in Sri Lanka: A Contemporary Perspective

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1. Introduction

I do not wish to go into any historical aspects of social science research in Sri Lanka, but would like to confine myself to the post-independence period. I would like to start with the positive aspects of social sciences research in Sri Lanka in recent times. What I describe as the positive aspects must be looked at not only in the context of socio-political factors, but also in the context of other aspects that have a vital bearing on the nature, quality and quantity, of research. Of course it is difficult to separate these other aspects from the socio-political aspects because they are very closely interwoven. Nevertheless, I will start by dealing with certain aspects that have a bearing on social science research in Sri Lanka as a background to my identification of the positive aspects.

2. Personnel

When viewing the present state of social science research in Sri Lanka one has to first look at the research personnel available to do research. Obviously those serving in the universities in the disciplines relating to the social sciences would fall into this category and probably form a numerical majority among the researchers in the social sciences. Besides them are those attached to specialised research institutes such as the Agrarian Research and Training Institute (ARTI,) the Marga and certain other institutions such as the Central Bank where a part of the functions relate to research. If one were to take a census of the research personnel or potential research personnel, it would be found that the number is fairly large. However, if one were to look at the availability of personnel with formal experience and training in research it would be found that there is an acute dearth of personnel for social science research in Sri Lanka.

For example, in the universities, some of the departments that occupy key positions among the social sciences like sociology and anthropology suffer greatly from an inadequacy of people with research training and experience. This applies to other disciplines like economics and geography also. Now it is a debatable point whether one needs all that experience and training to undertake useful research. In this context, however, it is useful to note that those countries which have been very productive in social science research, are invariably fairly rich in experienced personnel. This is perhaps due to the fact that a certain amount of academic in-breeding is inevitable and desirable for any kind of research.

3. Facilities

Secondly, we must consider the opportunity and facilities that exist for research in the social sciences. Now these are serious constraints to the social science researcher in Sri Lanka, although they are not so formidable as often made out to be. But, at the same time, one could make the observation that, generally, opportunities and facilities tend to seek out those who are successful researchers, so that by themselves they are not very serious problems. However, for the young social scientist embarking on research the inadequacy of facilities, the lack of opportunity can in fact be a very serious problem. I can illustrate this point with a very brief example; the total research budget for what is one of the potentially largest research establishments in Sri Lanka, the Arts Faculty of the University of Peradeniya is less than the research budget available for a medium-sized research project at the ARTI. This situation has prevailed over a long period of time without any improvement. While on this I must add that organizations like the National Science Council are doing their best with limited resources to rectify the situation. However, here again, I identify a particular attitude of mind among the decision makers towards social science research which entertains the concept that somehow social science research is less important than research in the so called 'hard' sciences. This is illustrated by the relative ease with which funding could be obtained for research projects in the biological and physical sciences, but not in the social sciences.

4. Incentives

Thirdly, when it comes to incentives, in my opinion, this is one of the principal problem areas for the social science researcher in Sri Lanka the absence or the inadequacy of incentives. For some people incentives are no doubt there. Some people seek immortality out of research as their names enter publications. Some gain a certain amount of psychological satisfaction by publishing papers. There are others who find sabbatical leave, a very important incentive for research because unless you publish, the chances of going abroad on sabbatical leave become very remote. That is a very important and a very justifiable incentive. Some, of course, work for degrees and the rewards are the accompanying alphabetical ornamentations before and after one's name. All these are very good and important incentives, but when it comes to career incentives for the researcher, they are extremely limited. Very few take a researcher seriously when it comes to career prospects, promotional prospects and so on.

5. Freedom

There is, however, one major advantage which the social science researcher in Sri Lanka enjoys. That is, at least overtly, there is no political restriction on what he could research on, what he could write about and what he could speak on. This is an important advantage for the reason that not many other developing countries allow that freedom to their researchers. In many other countries with our level of development there is considerable political restriction on what one could research on and on what one could write about. It is against such a background that I would wish to look at the positive aspects of Sri Lankan social science research.

6. Volume of Research

In broad terms a considerable amount of research work in the social sciences is being done in Sri Lanka today. Each year, about 4 or 5 issues of research journals containing about 4 or 5 research articles each, come out. *The Journal of Historical and Social Studies* is the oldest and most regular among them, but, there are other journals, though less regular in appearance. Apart from the research journals, there are other research publications. Some of these are called occasional publications, some are called research study series publications and so on. Apart from that there are monographs and books and we also find that roughly about two or three Ph.D and M.Sc. dissertations are published every year. Thus taken in the context of the restrictive factors that I referred to earlier, it is a situation about which one could be fairly happy.

7. Types of Research

Next, I would like to deal with type of research that is being done in Sri Lanka. To avoid going into great detail, I would identify the research that is being done in terms of a three-fold typology. There is considerable overlap between the different types that I identify. They are not mutually exclusive types. One type of research is what I would like to call 'ideographic'. Ideographic research refers basically to research concerned with fact finding. This category includes a very wide range of writing. And at one extreme is found the census type of writing - population census, agricultural census and so on. In the same category but at the other extreme, one finds the fact finding type of research undertaken by individual scholars and institutions. They usually cover very narrow fields. These can be evaluation studies like the ones being occasionally done by the Central Bank or the ARTI. The purpose of some of these studies may be to fill gaps in available country-wide census. The methodology followed in these studies is very broadly similar. They involve sample surveys based on a questionnaire, and the tabulation and description of the data thus collected. That is roughly what is being done in a very great deal of research that comes out in Sri Lanka today.

The second type of research, in my typology is nomothetic research. Nomothetic research writings also encompass a very wide field. To describe rather than define nomothetic research, I would say this type of research includes the testing of hypotheses. You first formulate your hypothesis and then go to the field and verify whether the hypothesis is true or false. The elaboration of concepts through research also falls into this category. Then certain researchers try to work within a particular conceptual framework, the research writings of people who call themselves neo-Marxists being a good example. You enter into the research problem with a particular conceptual framework and deal with the problem from the perspectives of your concepts.

The third type of research, which has a great deal of overlap with the one I just identified, is generalised reviews, commentaries, and works of synthesis. Here the researcher does not bother very much to go into the field and collect original data. Instead, he takes as his raw material the facts found by others and attempts an overall synthesized review.

8. Empiricism

One of the foremost criticisms made against a great deal of research that has been done in Sri Lanka during the recent past is that there is a bias towards ideographic research. Observers use different terms to articulate this criticism; some people say that we are over-concerned with empirical data, others that there is an empiricism that pervades a great deal of social science research that has been done in Sri Lanka and so forth.

People who hold this opinion that we are far too much guided by an ideographic approach point to certain reasons for this. One of the reasons advanced is that this type of research requires very little effort and, even more importantly, it requires very little intelligence. It does not tax your mind very much to work out a questionnaire, go out and interview 100 informants, tabulate the data, analyse the data using some elementary statistical methods and describe what your statistics show. However, certain others have gone to the extent of asserting that the bias towards empiricism that pervades our research is due to our subservient mentality towards the academic world in the western countries. They have gone so far as to say that in being over-concerned with these empirical ideographic kind of research, we are in fact being only research assistants to our peers in the developed countries, particularly those in the Anglo-Saxon countries. Those who level this criticism against the social sciences claim that we have to breakaway from this tradition of being subservient to scholarship in the western world. This obviously is a controversial issue. All I would like to state is that there are arguments on both sides of this particular problem. My personal opinion is that on balance this is not a very serious problem. Empiricism or the concern about detailed data is an essential part of research and in this respect I feel that research in the social sciences done in Sri Lanka is not substantially different from research that is being done elsewhere in the world. Now, while I believe that this is not a serious problem, I would like to conclude my comments by identifying what I think are some serious shortcomings and problems in the type of research that is being done in Sri Lanka.

9. Shortcomings

The first shortcoming is that although the social scientists in Sri Lanka have not been inactive, their total contribution has been woefully inadequate. It is of relevance to note that there has been hardly any published research during the past 5 years by scholars of less than 30 years of age. I would like to add to this point the fact that there is not a single research journal in Sinhala.

The second concerns the quality of the data base in social science research. While a certain amount of empiricism in research is highly desirable, I often find that there is a lack of precision in the empirical data that form the basis of such research. Frequently, in describing their methodology the authors themselves very freely admit that their data are inaccurate. However, that admission is often forgotten in the main text of the discussion. However, in this context, I would like to make a contrast between a lot of research that is being done by local researchers and some research that has

been done by foreign scholars who come here. In my limited experience, generally, I find that the latter tend to concern themselves a great deal more than the former on getting accurate statistical data. So what seems to be the problem is not so much that we are over-concerned with statistical data, but that the statistical data which most research generates are of low quality.

The third problem which I would like to identify is that very little reading tends to go into research publications. For example, research studies are often published displaying total ignorance of related publications by others. Another way in which this problem manifests itself is that very often people come and ask you for research problems, which reflects the inadequacy of reading that forms the basis of research.

Finally, the fourth problem, which I would like to refer to is that much of our research is oriented towards a foreign readership and a readership that consists entirely of other researchers. We do not seem to care very much about the 'layman'.

10. Conclusion

In conclusion I would like to raise two issues which can be the subject of discussion and thought, 'What do you expect from a social science researcher in Sri Lanka' and 'What contribution has the social science researcher made to life in this country?'. Obviously one would not expect an immediate revolutionary impact from anyone's research. That kind of research is very rare indeed. However, this question is not entirely without relevance. If one were to look at the last 30 years one could probably think of Das Gupta's early studies on the villages that I think has had some general impact on policy. I would also probably include in this category B. H. Farmer's work on dry zone colonizations which I think has had some impact. There may be a few others but, by and large, social science research does not seem to have contributed very much to policy formulation and therefore to life in this country.

The Value and the Reorientation of Legal Research in the Modern Context of Sri Lanka

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1. Introduction

My topic revolves round the techniques of legal research and their re-orientation in the sociological context which obtains in Sri Lanka today. The techniques of legal research in Sri Lanka are largely conditioned by the nature of the legal system, and the special problems connected with its evolution. I will try to introduce you to some of the basic features of the legal system which prevails in this country and to indicate to you, how problems connected with the legal system would have a profound influence on the types of research which would prove useful in this country today.

I shall begin with some general remarks on the value of legal research and the manner in which it could contribute to the formulation of national policies. The major features of a legal system in a country should concern not only the legal profession and others directly involved in the study and the administration of law. All those with a sense of civic responsibility should take an intelligent interest in the problems, connected with the administration of the law. Law is indispensable to any social organization. The quest for justice and liberty has been among the most cherished ideals and deepest inspirations of mankind from the beginning of recorded history. No member of society who values freedom and justice as an essential foundation for his dealings with his fellow citizens and with the state can ignore the scope and the content of the laws by which he is governed. The legal system of a nation supplies the framework within which the spirit of freedom is preserved and justice done between man and man, and between man and state. In the final analysis the quality of the laws which represent the instrument of social control in any given society provides a reliable index to the quality of freedom and justice and, ultimately, to the quality of life itself within that society.

While there is a great deal that is of value in the legal system of Sri Lanka, it would be idle to deny that in many ways the form and substance of the rules comprising that system as it operates today, contain many defects. The defects which exist at present are due to a variety of reasons. Some of these are part and parcel of the legal heritage of the country. Others derive from the diversity and the complexity of modern legislation required to cater to the needs of the rapidly evolving society while others are inherent in sociological factors such as the multiplicity of ethnic and religious groups for the distinct needs of which the legal system of the land must provide. The causes underlying the present inadequacies of our legal system are very complex. But what needs to be emphasized is that there is one basic reason why improvement of the law and resuscitation of legal research has been so difficult to achieve. That reason is the inability to sustain the interest on the part of the

community as a whole, but particularly that of the intelligentsia in the relevant problems and their possible solutions. The inarticulate assumption easily made is that law is the business of lawyers, and that law allows little scope for a perceptive and sympathetic appraisal of its problems by laymen. Nothing is so conducive to the prevailing lethargy in matters connected with the re-orientation of legal research and the legal system as this indifference of the overwhelming majority of our people to issues which are fundamental to their daily lives. Certainly, the details and intricacies of the law are the pre-occupation of the lawyers. But few notions are so false as the belief that the broad principles on which the law is based and the general direction which the course of reform and research should take in the future, are all matters which could be left in the hands of the legal profession. If problems vital to the future development of the nation are to receive the attention that they deserve, and if constructive solutions are to emerge, the discussion must involve as large and as representative a section of public opinion as possible. It is proposed in this paper first to isolate some of the demerits of the present system and to formulate appropriate areas of research and proposals for reform.

2. Common Law

The first problem that I would like to deal with is the common law of the country, how it has come to develop and its present condition. It is an aspect of the legal legacy bequeathed to Sri Lanka by its colonial rulers that the Roman-Dutch law is still the basis of the general or the so-called common law of the Island. It was in force in the colony at the time of cession to the British Crown and it has continued to be applicable since then, subject to certain minor modifications and refinements. When the maritime provinces became subject to British sovereignty in 1796, the entire body of British Law was not imposed on those provinces. Instead, the British rulers continued to apply Roman-Dutch law purged of some of its obsolete features, and English law was introduced only piecemeal, either by express legislative provision or by tacit judicial acceptance as and when occasion demanded. The curious result of this policy was that at the end of a century and half of British rule, the Roman-Dutch law, an alien legal system in the eyes of the British, had become securely established as the basis of the common law of the country. The practical effect of this status conferred on the Roman-Dutch law is that in any matter not specifically provided for by statute, or by the provisions of a personal law applicable to particular sections of the people, Roman-Dutch law becomes applicable. Thus modern Roman-Dutch law is in vogue and is applied by the courts of Sri Lanka as a system which determines the rights and liabilities of our people in vital sectors of their life and experience. It embraces for the great majority of the people of this country such matters as the security of family relationships, liabilities for civil wrongs and breach of contract, the exercise of rights in respect of property and matters in relation to inheritance and succession. The application of Roman-Dutch law in Sri Lanka was a result of an historical accident. However, it is an accident which has had crucial repercussions for our society.

The primacy accorded to the Roman-Dutch law as a basis of the residuary common law of the Island has brought in its wake advantages as well as disadvantages. The main advantage of the Roman-Dutch law as it applies today is that it is flexible. It can be

changed to suit any situation which could arise but its disadvantages are equally serious. It is not found in any comprehensive form in any one place. It is difficult to ascertain the content of the law. This poses serious problems particularly in the present context of Sri Lanka, so far as the translation of the law is concerned, since its sources derive from early texts and from reported judgements not only in Sri Lanka but in so many different jurisdictions, including South Africa where the judgements are reported not even in English but in Afrikaans. Thus the task of translation becomes a very challenging one. That is perhaps the chief difficulty connected with the retaining of Roman-Dutch law as the common law of the country because it is difficult to translate even its basic postulates into the Sinhala and Tamil languages to make the provisions of the law understood by the vast majority of the people. That is one of the main problems with which legal research in the country would have to be concerned at the present time.

Then there are certain other practical difficulties which also arise from the nature of the sources of the Roman-Dutch law. The sources of the law are such that inevitably they give rise to difficult problems, especially in the context of an Asian legal system such as ours. The fundamental difficulty which permeates the whole system is the relative inaccessibility of its sources. The principles of the Roman-Dutch law on any given topic cannot be ascertained by the perusal of a single work or document or even by the scrutiny of a collection of works or documents which may be easily procured in any one place. The sources of the Roman-Dutch law are characterised by extreme diversity. They consist of Dutch statutory provisions known as *placaats* and glosses prepared by Dutch commentators on texts of the Roman law, an exposition by writers from different provinces of the Netherlands as to the prevailing legal practices and customs of their day. The complexity of the sources is enhanced by the consideration that on some points of law differences of opinion are expressed by different institutional writers. All these sources cannot be found outside a comprehensive law library and even when they are accessible they require study and analysis with considerable discrimination and legal acumen before the propositions they embody can be adopted as the basis of an argument or a conclusion. It is needless to point out that a complete understanding of a legal system which derives from so many sources presupposes linguistic expertise and sophistication at a level which is obviously impracticable in a country like Sri Lanka. Few laymen have any conception of the magnitude of the task which confronts a conscientious judge, a practising lawyer or a teacher of law in the context of the Roman-Dutch system when he is called upon to ascertain the content of the law on any given matter.

The difficulty is complicated by a further factor, namely that the people of the country are not all governed by any one system of law. You have the Roman-Dutch law as the residuary common law but that is resorted to only in situations where a personal law does not govern a particular section of the people. In the legal system of the country as a whole there is a series of personal laws. For instance there is the Kandyan law which applies to the Sinhalese of the up-country area, then there is the *Tesavalamai* which applies to Jaffna Tamils. There used to be the *Mukkuwa* law which was applicable in the province of Batticaloa, but which has now been abolished and there is, even today, the Muslim law which governs all Muslims in regard to matters of succession, inheritance, property rights,

marriage and so on. So there is this interplay of different systems within the framework of a single country and that inevitably enhances the difficulties which are attendant on the study of the law and on the undertaking of any serious legal research.

There are also problems arising from the fact that so many of our statutes which are applicable today have been enacted very long ago. For instance the criminal law of the country is contained in the Penal Code of 1889 which has not been up-dated or revised or improved in any important way for almost a hundred years. So it is only inevitable that some of the notions which it embodies are archaic. One illustrative example is the definition of insanity or disease of mind which is contained in the penal code formulated hundred years ago. Naturally, since then, there have been important developments in the fields of medicine and psychiatry. But those developments have not affected the content of the criminal law which is administered in the country today. The result of this is that the law has tended to lag behind advances in other disciplines and this is generally true of the laws of this country which impinge on science and technology. So there is a very vital need to up-date the law to make it consonant with present-day realities and needs and this, of course, requires a great deal of preliminary work.

3. Codification

In the recent past in this country a start has been made in the revision of the law by the revival of the Law Commission. A primary task of the Law Commission is to keep the laws of the country constantly under review, to suggest changes which are beneficial, and to present to the Minister of Justice proposals for the reform of legal education. There is in the country today a body of thought which feels that the best approach to legal reform is by way of a preparation of a code. As you probably know, the main examples of codification of the law are in France and Germany where very complicated systems were reduced to relatively simple provisions in a comprehensive code. That will not be a complete solution because the provisions of a code themselves have to be interpreted. There may be questions of doubt, questions of ambiguity and, from time to time, the provisions of the code may have to be elucidated and elaborated upon by the courts. But it would still constitute a significant improvement on the present structure of the law where judges of the courts, lawyers advising litigants, and the general public, have to inform themselves of the content of the law without the assistance of any such code. But if the preparation of a code is adopted as the solution suited to the needs of our society, then of course something has to be done before the code is thought of. That is, it would be necessary to understand the law as it exists today and identify its deficiencies. Before you can decide how it is to be improved you will have to be quite clear in your mind about the conditions of the law as it prevails at the present time. This requires painstaking research. It is possible. It has been done in other countries – for instance, in Scotland during the last ten years. The Scottish system is almost as complicated as ours. It goes back to Roman times. It has Roman origins. But in almost all branches of the law of Scotland, it has been possible for Scottish universities to produce a comprehensive exposition of the law which has served as the foundation of an ambitious programme for codification. A similar project has been undertaken with outstanding success in the U.S.A. where the American

estatement has been prepared with the assistance of academics, and the American restatement has also provided a basis for a codification programme. In this country, certainly, such a programme of restatement will be an essential preliminary. It is an indispensable prerequisite to any codification which may be done within the next few years.

4. Legal Publications

There are in the country today many constraints in regard to legal publications. The primary constraint is, of course, finance. Printing is prohibitively expensive today and legal publications have a limited market. This means that legal publications are usually priced at a level which effectively puts them beyond the reach of members of the public who may be interested in the broader issues such publications deal with, not the technicalities of the procedural law, but matters which are of concern to people in their everyday life. Fundamental rights are a good example. The 1978 Constitution of the Second Republic of Sri Lanka embodies a chapter on fundamental rights. We have been guided by the experience of other countries like India, the United States and some African countries like Nigeria. We have tried to incorporate in the Constitution a body of rights which are totally entrenched in the sense that they cannot be interfered with by governmental or executive action. There was a leading case in August 1980 when a student who had sat for the G.C.E. (A/L) examination went before the Supreme Courts and asked for an order that the University Grants Commission had violated the rights of that candidate by adopting a system of ratios as between two examinations for University admission. The argument of the student was there has been a denial of the criterion of merit, that the student had been deprived of the opportunity of being admitted to the Faculty of Medicine in the University of Colombo and that the process of selection resorted to by the University Grants Commission was inconsistent with the principles of equality before the law enshrined in the Constitution. In a judgement which can be described as a land mark decision with regard to fundamental rights in the country, the Supreme Court upheld the contention of the student and ordered the University Grants Commission to modify their system and to have a common merit list from which candidates selected to the different faculties would have to be drawn. These certainly are matters of momentous concern to all members of the public and those are aspects of the law which are far from technical. In fact all those who value democracy and the rights which go with the democratic system would have to be keenly conscious of these provisions of the law and they would have to strive to ensure their survival and their further development. Publications which are concerned with those areas of law are of interest to the public.

Another constraint on the publication of legal research in this country arises from the lack of personnel. We have very few people in the country who are qualified to undertake research of this kind and the problems are likely to be aggravated by the fact that now the University of Colombo has limited opportunities of training its younger lecturers abroad. Even in the case of the few available scholarships the awarding authorities have identified priority areas and the weightage naturally is for the sciences, particularly the applied sciences and medicine, so that the University in recent years has had difficulty in ensuring an adequate training for their assistant lecturers abroad and the Faculty of Law is beginning to feel that difficulty at the present time.

A third constraint with regard to publications which one would be able to identify, is the question of access to the law. Primary and the secondary sources of the law continue to be entirely in English. But since 1973 we have been teaching legal courses in the University in three media, English, Sinhala and Tamil. Thus every lecture is delivered in three parallel media. However, when it comes to research at the higher levels it is very important to make use of judgements in other countries, articles in journals, and this kind of material, unfortunately, is available only in English. Therefore, as a possible corrective, the University has embarked on an intensive programme for the teaching of English as a second language. But there again the University has been hampered by the lack of resources, and by the lack of teachers who are qualified to teach English as a second language to students in Sri Lanka. The problems connected with lack of linguistic expertise on the part of lawyers, who would otherwise have been equipped to undertake legal research, significantly hinders the development of legal research.

5. Law and Freedom

Any sophisticated legal system must necessarily accommodate conflicting interests. That happens in any branch of the law. For example, one of the fundamental rights ensured by the 1978 Constitution of Sri Lanka is the freedom from arbitrary detention and arbitrary arrest. All citizens in the country are also assured of freedom in regard to their persons, freedom of movement, and the freedom to decide without interference from any authority including the administration how they are going to lead their lives. If a person's rights are to be curtailed, to be abridged, or to be restricted, for instance by being taken into custody the procedural laws of the country define the situation in which it can be done and the modes by which an arrest can be made. Not every one can make an arrest. Police officers can do so in certain situations. In exceptional situations, members of the public can also avail themselves of that right. On an arrest being made, there is a certain procedure to be followed. For instance, if the person is in police custody he has to be produced before a magistrate within twenty four hours. So a judicial officer will have opportunity of addressing his mind to the question, whether there are adequate reasons to deprive the person concerned of his liberty, whether further remand is justified or whether the person arrested can be released on a personal bond or on bail. Thus the laws of the country ensure that the freedom of a person can be interfered with only in restricted situations and those situations are spelt out in considerable detail and with great clarity by the procedural laws which govern arrest and detention in Sri Lanka.

However, this is only one side of the picture. No legal system can ensure absolute protection of individual rights in that way and stop there. There may be a time of grave national emergency, for instance the insurrection of 1971, or there could be other situations in which the government may have to take extraordinary measures in order to ensure the security of the democratic system and, in those exceptional situations, it may no longer be possible to uphold in their entirety the procedural rights which are guaranteed by the ordinary laws of the land. For example, if the chapter on fundamental rights incorporated in the 1978 Constitution of Sri Lanka is examined it will be found that every person is declared to have those rights, but that there are qualifying clauses and provisos which set out that those rights can be interfered with. They can be detracted from on various

grounds, such as national security, danger to public health, danger to public morals or in the interest of the national economy. So the entire legal system assumes the character of a compromise between conflicting objectives. On the one hand there is the right to protect the freedom of the individual in all legitimate areas of activities, political, social, cultural and so on. On the other hand, there are situations in which the collective interests of the community have to be protected by conferring additional powers on the state to deal with exceptional emergencies.

The Constitution maps out a *via media* between these competing goals. Consider, for instance, the right of publication. A private citizen of the country should enjoy the right to criticize the politicians. If he thinks that a politician is corrupt, or dishonest, he should have the right to publish the facts which he knows and to make the criticisms which he thinks are legitimate. When self-criticism is suppressed, the culmination of such a process has been the emergence of dictatorship. This is generally true in most situations in world history. So the right of publication must be there and is guaranteed in a democracy. For instance, the very first amendment to the Constitution of the United States is concerned with the right of publication. It is one of the cherished freedoms which are respected and upheld consistently by the courts of the United States of America. In Britain and in Sri Lanka, it has not been spelt out in that way. But certainly, it is one of the most fundamental freedoms enshrined in the legal system of a country. Here again it will be realised that it is not an unrestricted right. It cannot exist in an unqualified form. There has to be some restriction, some check has to be placed on such a right. People cannot defame others with impunity. Just as you have a right to express your views, the person criticised has a right to protect his reputation. So there are two conflicting objectives. There again, the law has to take both these into account and to evolve a solution which is fair to both parties the man who has a view to express and the man who has a reputation to defend and to vindicate. These are all considerations which have to be taken into account in determining the content and the scope of a right-to what extent you should be allowed to publish your views, if harm is done to others and what are the steps which a legal system should take to protect the others who anticipate that harm will be caused. Various remedies are conferred by the law. One is the provision to claim damages. If somebody defames you, you are entitled to monetary compensation. If you feel that the defamation is such that no amount of money will compensate you for the loss that you have suffered, then there is the remedy known as the injunction. For instance, if something is going to appear in tomorrow's newspaper which is going to cause irretrievable damage to your reputation, the law gives you a remedy known as the injunction. You can go before the courts and you can ask that publication be restrained, that the court prevent that publication from being made. Thus while it is certainly desirable that research in the Universities and other institutions should not be curtailed, that uninhibited freedom of expression in matters legitimately connected with academic activities must exist, there may be situations in which the government may consider it necessary to curtail those rights in the larger public interest. That is inevitable in the present context.

6. Conclusions

I have outlined above some of the major difficulties confronting legal research in Sri Lanka at the present time. The research that has been done in the country during the last ten years, has been mainly individual contributions, contributions by individual teachers of law, individual judges and so on. I believe that a much more corporate endeavour is essential. The magnitude of the task requires a corporate effort involving collaboration among several persons and that requires organization and personnel. As I mentioned earlier a start has been made with the revival of the Law Commission and it is now a question of improving the machinery and of ensuring that the opportunities are properly utilized. If the major constraints on legal research in Sri Lanka with regard to finance, personnel, language and organization can be overcome I think a considerable amount can be achieved in this field in the near future.

PART III

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The Use of Models in Research

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1. What is a Model ?

The word 'Model' is used very often and yet many students have a fear for this word. Such fear is understandable as they have at their back of the mind only mathematical models. There are, of course, very complicated models but many of the mathematical models are very simple ones.

Models, broadly defined, are of interest not only to econometricians or biometricians but also to artists, architects, historians, sociologists, economists, philosophers, geographers and educationalists, not to mention the physical and biological scientists. However, models take different forms in different disciplines.

Science is generally identified with subjects where one does experiments in laboratories. In reality, however, beyond a certain level of research the methodology for all branches of science is the same. The specification of a model, testing the model and making inferences from the model are the common features. In science the model only reflects how one visualises the way in which the laws of nature or behaviour operate. Thus in simple language we could describe a model as a set of assumptions or hypotheses.

'Truth' is not known to anyone. It may appear different to different people. Everyone, therefore, visualises truth in a specific manner depending on how he is brought up, circumstances under which he lives, the types of books he reads, the concepts which he has preconceived and so forth. Thus in any research project hypotheses are stated in terms of an explicit or implicit model and attempts are made to establish their validity. How one tests the hypotheses and how valid these tests are will be discussed later.

2. Model Formulation

Anyone is free to formulate his own model. But this model should not be in conflict with the laws already established. This does not mean that laws already established cannot be disproved. They can be disproved but the steps that should be taken to disprove must be scientific. We may, on the contrary, find that the theory may be valid generally but may not hold good under certain circumstances. Take for example a model to find the supply pattern for a particular commodity. One may specify the model in the usual way and estimate the parameters. We expect the supply equation to have a positive slope but empirical testing may reveal that the slope is negative. Do we say that the result is inconsistent with the established theory or do we conclude that this is an exceptional circumstance ?

* In this paper I am confining myself mostly to the use of models in Economics but the reasoning could be extended to other disciplines.

We study in economic theory about the existence of backward bending supply curves. Can we therefore suddenly come to the conclusion that the supply curve is backward bending? One must first seek evidence to prove that the specification of the model and the method of estimation are reasonably acceptable, and second, prove with direct evidence that there is a possibility for the commodity concerned to have backward bending supply property.

One may like to know how one could conceive a model. Generally a research worker does not operate in a vacuum. He observes nature, how people appear to behave, what the laws of nature are, what theories that are established, research done in other countries and on the basis of this knowledge he visualises the probable behavioural patterns. Today several phenomena look obvious to us but for the pioneers they were a real challenge. For Adam Smith it was a real worry that water though useful was free but in contrast diamonds with no use fetched very high prices "Nothing is more useful than water, but it will purchase scarce anything, scarce anything can be had in exchange for it; A diamond on the contrary, has scarce any value in use, but a very great quantity of other goods may frequently be had in exchange for it".

3. Mathematical Models

In economics our main concern today is why prices are rising, why certain outputs are falling, why the rate of growth of population has shot up after 1945 and so on. We would like to find the reasons for them and isolate the effects of the various factors so that we may find remedial measures. These inquiries will need appropriate models.

Isolation of the causes may be very simple in most cases. However, in certain cases we may need complicated models. When several forces interact these interactions cannot be isolated by simple arithmetic. Therefore, from our observations and using the theoretical knowledge we have acquired, we spell out our hypothesis in mathematical equations, which is what is called a 'mathematical model'. In a mathematical model we have on the left hand side the variable to be explained (dependent variable) and on the right explanatory variables (independent variables) and an error term. The objective is to explain the variations in the dependent variable through the variations in the explanatory variables.

Because of the interaction of several factors which bring about changes in economic variables we cannot in all cases use a single equation model. Therefore, we need a system of equations. Some variables are called endogenous and others exogenous. It is difficult to define what is endogenous and what is exogenous. According to Klein, "the endogenous variables are those variables which are determined within the system of economic forces in a narrow sense, and they include such familiar magnitudes as output, employment, prices, profits, rents, interest. The exogenous variables are those which represent forces outside the confines of the economic system. They are determined by natural, technological, sociological, political or institutional forces which are assumed here to be non-economic".

The purpose of the model, therefore, is to describe the manner in which a particular system operates. It is the researcher's aspiration that he could discover to the best of his ability the actual operation of the laws of nature or behaviour. He cannot claim that only his model reflects the laws of nature or behaviour. Several alternative specifications can be made. The test of reliability of model depends on its capability to interpret historical facts and to make reliable forecasts. These forecasts are made with a specified level of probability. To quote Klein again "In the course of the search for models which are suitable for our purpose of forecasting and making policy recommendations we shall inevitably have to consider several alternative economic theories as admissible hypothesis. The acceptance or rejection of the hypothesis in the course of our search for truth will be our contribution to the problem". Mathematical models not only have the advantage of making forecasts about output, employment, foreign exchange earnings, etc. under the influence of various alternative economic policies but they can help the researcher to understand why his forecast did not come true and what further modifications are necessary to improve the efficiency of the model.

It is not possible to specify mathematical models in all branches of social sciences. But the process of formulation or testing of the models would be similar in that the researcher will have to collect information and find logical reasoning to substantiate his model. The reasoning is simpler if the information is quantifiable. Lord Kelvin explains the virtues of quantification in the following manner "when you can measure what you are speaking about and express in numbers you know something about it; when you cannot measure it, when you cannot express in numbers, your knowledge is of a meagre and unsatisfactory kind, it may be the beginning of knowledge but you have scarcely in your thoughts advanced to the stage of science".

4. Problems in Model Building

Economic variables are random variables in the same manner as variables in experimental sciences. The stochastic nature of the observed data is to a large extent the result of stochastic non-observable variables (random errors). The error component in models arises due to various factors. Among them are errors of measurement of dependent variables, approximation of one structure by another, omitted variables, and aggregation. The experimenter in the physical sciences can avoid this problem to some extent by replacing the natural conditions by laboratory conditions hereby freeing all variables other than the one to be explained from influences of error and shocks. In this respect, the problems facing social scientists are unique.

We are aware that the forces acting on the economic system are numerous. It is not possible for the researcher to take account of all such forces that determine the economic structure. Even if the collection of data in respect of all variables is possible and electronic computing facilities are available, there are various other constraints (especially degrees of freedom) which stand in our way. It is often sought to develop complex econometric models and estimating techniques to eliminate such difficulties but complicated models are not necessarily the most efficient ones. It is easier to understand and gain insight into problems through simple models.

Simplification of models without losing the characteristics of problems needs skill and dexterity on the part of the research worker. He should possess a sense of imagination and an inside knowledge of the subject in choosing the most crucial and appropriate variables to be introduced into the model. Thus different models are bound to produce different results. The efficiency of the model will have to be judged in terms of how it interprets history and its ability to make forecasts about the future.

Econometric models have in general three sub-sets of structural relations — behavioural (statistical equations), identities (definitions) and technical equations. The variables used in these models may be classified under endogenous, exogenous or endogenous predetermined. As we know the behavioural equations are not exact. These behavioural relations are made into equations by adding what we call random variables. The introduction of these random variables results in our seeking necessary econometric tools to handle them.

One aim of the whole exercise in econometrics is to determine the structure of the economy by estimating structural parameters, often referred to as population parameters. In physical sciences controlled experiments are possible and therefore the population parameters can be estimated with ease. But in economics and other social sciences, controlled experiments are not possible and we have to rely on the data that have been generated by society in the past. The economist's objectives may be similar to those of an engineer but his data are like those of a meteorologist.

The data generated with such shortcomings would inevitably cause bias and in some cases the estimates do not turn out to be efficient. Some of the shortcomings are errors of measurement, autocorrelation, multicollinearity, omitted variables, and non-quantifiability of variables (such as war and peace). The most crucial shortcoming in econometric models is the problem of estimation of single stochastic relations ignoring other relationships as though they have no part in determining the size of the variable to be explained. This is one of the important aspects to which much attention is paid in econometric theory. We are still not fully equipped to overcome these shortcomings.

In econometric analysis, subjects such as economic history, economic theory, mathematical economics, statistics and mathematics each has a part to play. Economic history helps in making objective observations, mathematical economics with the help of economic theory and mathematics helps to formulate the hypothesis and specify the model to be evaluated. Econometrics (as a specialized field of statistics) helps in estimating the structural parameters, testing them for reliability, making inference and hence in predicting economic variables. The economic structure so obtained can be used to formulate policies to achieve the desired targets. No parameters are accepted if they do not approximate theoretical values or values obtained from other sources. If the discrepancies are too large or are systematic and do not interpret history reasonably well the hypotheses are revised and retested. The model is tested further in other ways. One important test is to determine the extent to which the explanatory variables are able to explain the variation of the dependent variable. Another test is to make projections and to study the extent to which the projected values differ from the actual. Usually

the last few years data are left out in estimating the parameters in the first round. If the predicted values approximate the observed data, the left-out observations are pooled and reused in re-estimating the structural parameters.

No econometrician, however reputed, can say that his model is the appropriate model. He could only say that the particular model is best (in terms of fit, sign and size of co-efficients etc.) among all the alternative specifications. It may be best to build models on research undertaken by a team of competent men rather than by an individual if the model is to be used for practical purposes. They should discuss their assumptions, methodologies and results widely before the models are used for policy decision. Econometric models will have to be put forward in a scientific spirit, because these models if fully developed and properly used would eventually lead all investigators to the same conclusions irrespective of their personal whims and could therefore be suitable for decision making.

To quote Klein again "Econometricians do not operate in a vacuum, their methods are not purely mechanical in the sense that they do nothing but substitute in formulae. Any information of a qualitative nature that is available should be used by the econometrician in drawing inferences about the real world from his models. The non-statistical economist has only qualitative information from which to make judgements. The statistical economist has the same quantitative information plus a thorough knowledge of historically developed behaviour patterns, hence it may be said that the latter is better equipped".

Design of Models for Economic Planning

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1. Introduction

The major contribution of econometrics—that is the empirical study of economic behaviour with the aid of statistical and mathematical techniques—has been to provide the means to identify and measure the important relationships between economic variables. The object of this paper is to survey, in the broadest terms, procedures for the specification of a model of the economy of interest. In a second step that specification will be given numerical form by the estimation of its various parameters from data on its variables, collected from the performance of the economy over the recent past. The model is then no more than an equation system which describes the laws of motion of the economy together with the interdependencies which exist between the major variables.

Notice, it is a mathematical *model* of the economy which is the aim—not a perfect reflection of the economy itself. Inevitably there must be approximations where the mechanisms of economic behaviour are as yet imperfectly understood, in particular the speed and form of dynamic responses, where the required data are lacking; where relevant variables are not quantifiable (e.g. “confidence” influences investment behaviour; expectations influence stock building, etc.); and because there is necessarily a finite limit to the detail of the description possible—some variables and their determination have to be aggregated with a consequent loss of description and information. Finally, and this is perhaps the most important, the model’s parameters must be estimated on a restricted sample of recent data. They cannot be perfect estimates, i.e. complete in the sense that they describe the characteristics of the linkages between the variables valid for all circumstances—they are only valid for the kind of average behaviour of this sample of recent history. Thus, one can only expect the model to mirror the (approximate and aggregate) economic behaviour of circumstances similar to those of the recent economic environment. It cannot be valid for circumstances radically different from that. Whereas one may well consider that there should be one *ideal* model of the economy, i.e. the economy itself (although this is doubtful since different people will have different assessments of the initial position, the values of the unquantifiables, etc.) there will *never* in practice be *one correct* model wanting to be specified. Different approximations, different aggregations, different representations of the linkages will prove most suitable in different circumstances and for different intended uses of the models. All these approximations, and all the surrounding uncertainties as to how exactly the economy will react to new events (or has to past events), and the inherent uncertainties in the reactions of economic agents, all make the “best” specification very hard to find; and they make it essential that very considerable experience in handling the model must be available before it is used. Considerable experimentation may be necessary. It is at least as important that you know what your

model cannot do as knowing what it can do – and this is, evidently, intimately connected with the problem of picking the most appropriate model design. The process of building a model must introduce a full understanding of its shortcomings, and that in turn means the process of building a model is inextricably entwined with the using of that model. One learns by doing specification and uses are an interactive process which leads iteratively to a final estimated version which, while not perfect, is at least an adequate performer for the purposes for which it was designed and whose shortcomings are well understood.

I am not concerned here with the specification of any particular model. That specification must be done using all the appropriate economic theory and any supplementary information at hand, such as the institutional and observed behaviour pertaining to the economy under consideration. But by way of example, the likely steps a model builder would take in constructing various models are given. Nor am I directly concerned with techniques for the estimation or testing of the model, nor with a description of its statistical properties in any given area. That is a huge subject and, being technical, it is most conveniently summarised in standard textbooks on econometric theory. For the most part here we consider a model as given, but where it is not known with certainty we attach estimated probability functions to the uncertain parts. These probability functions summarise the likely distribution of errors which surround the three sorts of errors which a model, if used as if it were fixed, would make in forecasting—

- (a) *information errors*—uncertainty in the values that variables determined outside the system would take (including a summary of the uncertainty inherent in the behavioural reactions modelled);
- (b) *data errors*—uncertainty over the estimated model due to inaccuracy in the data used to derive it (including the debate over “what are the true facts”);
- (c) *model errors*—uncertainty in the estimated model due to a restricted and specialized sample of data having been used to derive the appropriate specification and the estimates.

Despite the attention given to scientific method, one may correctly have the feeling that the building of models is an art rather than a science. Economics has been described as a “would-be, may-be science”, and in view of the problems discussed below it inevitably must remain as such. In common with all techniques which rely on experience and also in this case an extremely intimate “feel” for the economy being measured, this is an art which cannot be taught; it can only be gained from extensive experience in the field. It is also not at all a simple matter - one cannot just specify relations from logic and/or observation as in natural sciences and fit them to facts experimentally because (a) there is no possibility of manipulating the economic system under repeatable identical experimental conditions (indeed there is no possibility of conducting experiments at all, let alone experimental design) (b) there is an inherent randomness in human behavioural reactions not found in physical systems, (c) there are observation problems (and measurement problems) which can never fully be overcome, (d) we must use restricted samples for study.

2. The Background

Interrelationships of economic variables have been displayed in a wide variety of econometric models, measuring the size and significance of the dependence of variables on one another from a set of historical data. The best known examples are those of national macro-econometric models. The earliest were those by Tinbergen for the Netherlands, the UK and USA at the time of the second world war. The success of these models, together with considerable advances in economic theory following the "Keynesian Revolution" and with the realization of the complexity and interdependence of economic processes, has inspired the construction of a whole range of models. The second major reason for the development of these models is the increasing commitment by governments, over the same period, to the achievement of certain social and economic goals.

Formally, a model specifies the set of constraints on the economic variables which a government must take into account in achieving those desired goals. Informally, the government may use a model to sketch and compare the consequences of various possible policy packages, or sets of likely circumstances, over its whole planning horizon, in order to choose its preferred strategy. At its simplest this may merely involve forecasting the variables of interest but it could also involve the optimisation of an objective function with respect to policy variables.

An important sufficient condition for the development and use of econometric planning models has been the introduction of large high speed computing facilities over the last 20 years. It will be observed that a typical feature of the models, and of the purposes to which they are put, is the very large quantity of information which must be treated.¹ Generally we wish to construct and then analyse the performance of a large number of, probably nonlinear, simultaneous difference equations (seldom of a low order) under a wide range of circumstances each over a number of time periods. Involved are nonlinear estimation methods, repeated solution of nonlinear equations and methods of mathematical programming. Re-estimation and re-specification of the models is then common practice, as more is learned of the properties and performance of the models as specified so far, for example in comparison with the actual outcomes of the true economy in real or hypothetical history. It will therefore be improved by considerable experimentation with various forms of the equations and adapted to match the actual performance of an evolving economy. Naturally to this we must add the second requirement of a comprehensive and reliable compilation of consistent national income statistics. These models place a considerable burden on the availability of a long time series, especially for quarterly observations, of a very large number of economic variables.

I stress these two sufficient conditions because they are the most difficult to satisfy with the third one of knowing how to use the model — in specifying a model. They are often forgotten in favour of the necessary conditions of knowing the estimation techniques which are a good deal easier to handle. Provided these sufficient conditions are satisfied, we may proceed to specification.

1. Often several hundred variables with 50 observations on each,, leading to several hundred equations with three or four times as many estimated coefficients.

3. Past Efforts

In the U.S. macro-models proliferate. Very simple macro-economic models first estimated by Klein led to the medium sized models of Klein-Goldberger (25 equations and annual data) and Michigan University (47 equations and quarterly data); both of which have been updated and expanded in several versions. More recently there has been a clear tendency for the size and detail of models to grow, enabling econometricians to explain separately many detailed components of the economy which otherwise would remain exogenous or be lost to sight in aggregation. The scope of the models has therefore markedly increased. In particular, nowadays, they are often designed for specific jobs; and consequently are often disappointing if used for purposes for which they were not intended. In the class of large general purpose models is the Brookings model with several hundred equations and exogenous variables requiring the estimation of several thousand coefficients; the well known Wharton model in its various versions of between 70 and 200 equations; more recently the Hickman-Cohen model has become available. Specific models are the Data Resources Inc. Model for a description in details of the components of demand (expenditure) and supply (production); the OBE (Office of Business Economics) model for government policy details; the FRB-MIT-Penn for detail on the monetary sector. All comprise a few hundred equations. Thus the disaggregation of models has proceeded over time, by sector detail, and in purpose.

In the U.K. the range is more restricted. An early small model was constructed at Oxford; a descendant of that is the forecasting and policy analysis quarterly model of the London Business School comprising about 300 equations plus a very detailed fiscal sector and recently expanded monetary policy sector. The Treasury has a very large (800 equations) but somewhat unproven model and there is a medium model in use at the NIESR (National Institute of Economic and Social Research). Those are all short run forecasting models. For long run projections and policy purposes, quite a different approach is taken by the growth model maintained at Cambridge University which is based on Input, Output interindustry accounting identities and a similarly specified linear expenditure system.

Models of this kind exist, but are used to varying extents in many other countries of the developed world. Most notable are the models in the Netherlands, also Canada, Australia and Japan. Similarly Sweden, Germany, France, Belgium, Israel, Taiwan, Greece, etc. have successful models. Some comments on the use of these models beyond academic purposes are made in the last section of this paper. Models of alternative systems (e.g. Russia) are also available. The final step of linking various national models to give an explanation of world trade flows has been undertaken and is operative in project LINK which has been extensively used in the past by the IMF in its work of assessing the trends of international trade.

Models have also been constructed for developing economies with a specific representation of their aid, investment and supply constraints, and particular goods and labour market problems. Examples are the models of India or Columbia and now one being developed for Sri Lanka by myself for the Ministry of Finance. Generally these have

concentrated exclusively on interindustry accounting identities but are gradually becoming more sophisticated in representing the main actors' behavioural reactions to constraints. Models also exist for dependent economies highlighting their special problems ; for example Puerto Rich (neo colonialism) Michigan State (automobile industry) or Massachusetts (industrial location and emigration). Extensions have also been undertaken in the form of economic area planning models and urban planning models.

The models cited above are not the only examples of simultaneous equation models in popular use. Commodity models are widely used to explain movements in a given market although perhaps they attract less attention and discussion. Quite often they are world market models and involve considerable institutional details and specialised knowledge of the particular market but they can be used by individual agents for planning: e.g. for the consequences for exchange rate policy, for foreign trade flows, or for stock control and price stabilization problems. These models have detailed explanations of the supply and demand of the given commodity and perhaps its immediate competitive and complementary goods. Such diverse products as tea, coffee, cocoa, jute, watermelons, meat, sugar and onions have been treated. Metals such as copper², tin, zinc, tungsten have also been considered.

It is a small step to construct these kinds of models within one economy – some examples are car industry, rail transport, or textile industry models. Really we are then considering models of particular sectors of the given economy. Many examples could be quoted in this context. The best known are perhaps those of the energy and agricultural sectors, housing, financial, complete demand systems, or even the wage-price sector.

4. The Interaction of the Use and Design of a Model

It should now be obvious that there will never be one model – or even one best model generally speaking – for any economic process; also that any model must be frequently revised and updated. But that apart, the crucial point is that the specification must vary according to the use to which the model will be put. The specification of the mode must first and foremost be dictated by the intended use for the model. Models designed for one purpose cannot be expected to be effective for some other; and if some particular model is effective for a particular purpose then a general model is probably less effective for any such purpose. In principle this results from size constraint on our problem, from differing constraints on data availability and reliability, from differing reliability in the underlying economic theory and from different levels of disaggregation and detail which are required for the different tasks.

The popular uses of econometric models are:

- (i) to explain the working of the component economic processes;
- (ii) to test specific hypotheses on the working of an economic process;

2. e.g. the joint Oxford—Rotterdam project to measure the scope for, and to provide rules of operating, any potential market stabilisation agreement.

- (iii) to make forecasts of what is likely to happen in the near future;
- (iv) to examine the likely impacts of various possible unforeseen events not under your control (forewarned is forearmed);
- (v) to explore the likely consequences should various possible events occur - in particular the impact of various possible policies and policy packages introduced by the controlling authorities, or the upshot of the set of policies introduced where more than one authority has a degree of control;
- (vi) to select suitable policies to achieve certain desired goals now and at points in the future (given expectations for exogenous events and the behaviour of other economic factors);
- (vii) to assess which of several policies are more effective for some target;
- (viii) to compute the best policies for (vi) for a given set of preferences; including the resolution of conflicting objectives and policy instruments which may be put forward;
- (ix) to analyse and assess the effects of past policies and events (with implications for future plans).

The idea that a government should accept specific responsibility for the management of the economy has been admitted only since the war. Then low unemployment was taken as a target. Now low inflation, reasonable rates of growth, a foreign trade balance, specific credit policies and perhaps a money supply regulation, currency stability, certain industrial structures, a fair income distribution over people and regions and certain expenditure patterns probably centered on investment policies - all of these, conflicting or not, are typical targets of economic policy. The main policy instruments include various types of direct and indirect taxation, taxes on imports and/or exports, interest rates, hire purchase conditions and other forms of credit availability, government debt management, investment incentives, the exchange rate, import restrictions, many components of government expenditure both current and capital - including the phasing of public investment programmes - and perhaps manipulation of nationalised industries, or a wages-prices policy. Typically unforeseen shocks to the economy come from world trade conditions, materials and other import prices or supplies, or events in a dominating commodity or market upon which that economy may depend.

In the Sri Lankan context the targets might be—

- (a) employment - with a derived consumption target;
- (b) to constrain the effects of the public investment programme on the balance of payments and external financing;
- (c) public and private savings;
- (d) sectoral rates of growth;

- (e) inflation;
- (f) urban-rural income distribution.

The principal instruments in use appear to be—

- (a) Taxes (corporate, personal, on exports, on imports, on turnover);
- (b) Public Expenditure (subsidies and transfers on food, replanting, fertilizers, investment concessions);
- (c) Public Investment Programme (size and phasing);
- (d) Exchange Rate;
- (e) Interest Rate or Domestic Credit Policy.

The main external “shocks” would probably be those in oil and other raw material prices, the slowdown in aid disbursements, movement in world tea or rubber prices, and possibly the weather on certain crops.

5. Pre-specification Steps in Model Design

Now, concentrating on national planning models by way of example, almost any model built for any of the purposes mentioned must include explanations for each of those targets, and probably for the major components upon which the targets depend. Moreover, an accurate representation of how the instruments and other major variables affect the targets, and how the government will react to economic changes and attempt to adjust their instruments is required. Then the particular features characterising that economy must also be built in. There can be no general all – purpose specification to fit all economies. Some industrial economies are subject to demand management and require demand – driven models. Others, typically the less developed, are supply constrained. Some suffer from investment constraints, others from balance of payments constraints, others are dominated by a particular industry or product market, and still others have regional problems or sharply divided economic sectors, say urban and rural, and so on.

Having settled the basic features of the model, the next problem is to decide on the level of disaggregation. Disaggregation over time gives a finer description of the structure of lags in the economic processes and is more useful for analysing business cycle developments and other short run policy analysis, problems of policy *impact* as well as policy *timing*.

Disaggregation by sector depends heavily on what is required from the model and what is necessary for an accurate explanation of each variable. Thus consumption is split into durable, non-durable and services on the argument that the speeds of adjustment of these expenditures are usually different, as are quantitatively and qualitatively the determinants for each; yet they are much the same for each item within each member of that classification. Aggregation would cause much accuracy and precision to be lost in the

specification and performance. Similarly investment is split into residential, business, plant and machinery, and government components. Imports, exports and employment are also often split into the main commodities and its components respectively. There are many other examples of a model expanding to accommodate a suitably accurate specification: Lipsey argues for the addition of a price equation to improve the Philips curve wage equation: Teigen presents the conclusion that the assumption of an exogenous money supply is untenable. Goldberger argues that a tax yield is not a proper policy instrument but tax functions must be included to represent tax rates which are.

Further an aggregated model may successfully predict GNP but have nothing to say about its components, nor about the effects of likely external shocks or policy changes. One may want a disaggregated model to give information on quite detailed components of the economy, to enable it to reflect changes due to structural shifts, external shocks or any possible policy shifts (which themselves may imply considerable disaggregation). Many targets and instruments operate at a micro level to affect the economy in a spatial sense (e.g. Dorrington and Renton investigated the effects of tax structure changes on the U.K. economy. Balanced-budget GDP was found to change 26 per cent more for given equal changes in the surtax rate as compared to those in a single persons allowances. Even more marked changes followed from the same changes in family allowances. A very detailed model is required for such exercises). Disaggregation decisions may then also follow from the intended use of the model.

On the other hand, too much disaggregation may be counter productive because the quality and coverage of the data becomes inferior. Unreliable or inconsistent runs of data will produce poor results. Aggregation not only uses more reliable data but also benefits from cancellation of errors, so forecasts are generally better on the same conditioning information. There have been a number of studies of comparative forecasting performance of different models which show this. But what is the advantage of that if none of the information or shifts mentioned in the previous paragraph can be treated, and turning points in the forecasts are missed? Anyone can successfully guess the major component of any economy on a "no change" or "same change as last period" basis since the economy evolves rather slowly. But that is not informative. So criticisms of models as compared to "calculations done on the back of envelopes" can be extremely poor criticisms indeed.

All these considerations of disaggregation and special features, being subject to the purpose of the model should, in conjunction with economic theory, make the general specification failure obvious. However, the use of the model may have a further particular influence on the specification of individual relationships, and the importance and effort attached to specifying the dynamic properties of the model. For example, the World Bank uses a standard annual model format when assessing the economic performance of many developing countries. This standard model frame includes no sectoral breakdown and requires, as inputs, the outputs of the economic policy of the government in question. It provides a picture in some detail via accounting identities (which follow from that government's *intended* objectives) of the financing of the import-export gap. There is no discussion of the policy outcomes (their advisability, their feasibility, their probability

(realism), or the capability of enacted policies to reach them) nor of the effects on specific sectors some of which the government will be specifically encouraging in a development and diversification policy; nor of those sectors on which the economy chiefly depends. Obviously, while the model is deliberately specified to be very useful for the purposes of the World Bank staff, it is quite unsuited as specification for forecasting or planning on behalf of the government in question.

From this argument we conclude—

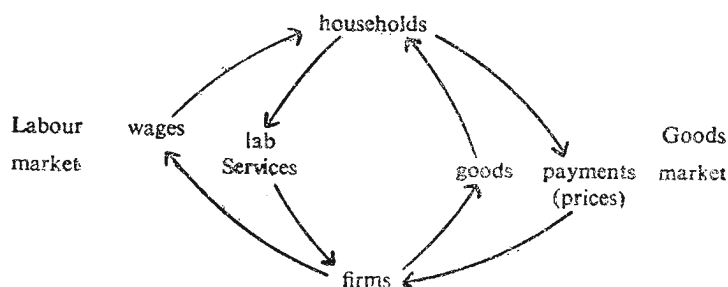
(a) A simple model concentrating on the really important influences on the targets and their lag structure will probably be quite adequate. The model should not be so simple as to preclude the necessary detail on the instruments and targets, or so simple as to be unable to reflect structural shifts and, more important, the dynamic responses.

(b) However, this simple model idea does not imply modelling by empirical linking “inputs and outputs” as in the merely accounting framework or black-box context. That would be modelling, without causal analysis, or without the application of any economic theory or institutional knowledge, in the reduced form. Since that cannot necessarily correspond with economic theory and observation, specification must follow economic theory and observation in the structural form.

(c) Disaggregation will then take place from the “top down” as dictated by the uses of the model. It is useful to start from a very simple aggregated prototype model.

6. The Flow of Funds, a Basic Model Structure, and Simultaneity

Traditional macro-economic texts start with a discussion of the circular flow of income:



physical goods and physical effort flow in one direction; for each unit of these there is a money counterpart flowing the opposite way. In either of those circuits, we can recognize potential leaks (of money, or goods) from the system and potential injections into it. If the leaks do not balance the injections, there must be a net loss or gain at that gap. The circuit would then be in disequilibrium because the result must be that changing quantities flow around the system. One is then interested in whether the laws of motion of the

system are such that the quantities adjust to close the gaps in time, or (as a special case of this) there is a controlling authority who will operate some controls so as to close the gaps, or whether there are conditions in the outside world which act so as to sustain the gaps.³

The potential gaps are :

- (i) Foreign trade: imports are money leaking out (goods in) and exports are injections in (goods out), so a balance of trade or resources gap is to be financed somehow by short or long run capital net flow in or out, or is to be closed by adjusting the flows and/or leaks and/or injections.
- (ii) Budget: taxes are money leaking out, government expenditures are money injections, leading to a budget deficit (surplus) to be financed by increases (decreases) in public debt, or to be closed by changes in government policy taking into account that the circular flows will also thereby change.
- (iii) Savings—investment gap: savings are a money leak, investment an injection, and any gap must be financed by credit expansion or reserves depletions; or be closed by altering conditions in the money (credit) markets and thereby the flows.

Evidently any remaining gap will ultimately be financed by the appropriate short or long term capital flows if adjustments in the goods or money markets have not fully closed the gaps. These capital flows can be generated within the domestic economy or by foreign loans (or aid programmes). Moreover the gaps may not be independent of each other. A large public investment programme in a low income/production country will entail a budget deficit and be supported by insufficient domestic savings and, if it has a large import content, imply a foreign trade deficit as well. Of course, the adjustment mechanisms which these gaps may set in motion can be a good deal more complex and wide ranging than those of the policy type cited above. There may be self-stabilising mechanisms in the economy itself, rather than those inserted by the authorities. Prices may adjust domestically in the goods market so that the values in the circular flow alter such that the gaps tend to close. They may alter likewise for foreign-traded goods. The budget and credit requirements will then be affected. Disequilibrium in the flow of funds will imply changes in labour demand and/or supply in the labour market since the general incomes are adjusting. Thus, we have three interdependent markets connected to three interdependent gaps. Adjustments in any one imply movements in all the others since the funds flowing around the system change; and that change itself then implies a further adjustment to the original gap or market (and then to the rest), and so on *ad infinitum* till a new equilibrium (or financing level) is reached. That is a *simultaneous* solution to the set of adjustments in all six components of this economy.

3. i. e. the system is dynamically stable in itself; or the system is not necessarily stable but the government acts as a stabilising force; or "foreigners" provided the means to plug the gaps.

The point for our purposes is that at the end of the day, making up the books will show that any outstanding gaps have been financed somehow — in an accounting sense. This is an economic equivalent of the conservation of matter: funds are neither gained nor lost to the economy's accounts although their ownership and form may change.

We must carefully distinguish this *ex post* view in which accounts necessarily balance, from the *ex ante* case (seen before adjustments or financing takes place) where the potential gaps, the forces of disequilibrium and, thus, movement appear. For it is the latter which are the key to the adjustments (i.e. type, size, speed, in which market, etc.) necessary, or the financing to be sought. For a successful planning or forecasting specification we must be able to model how much of each adjustment will take place in each interval, conditional on how much financing will be sought and obtained. To do that, it is necessary to have a (estimated) description of the behavioural reaction functions of the economic agents in each market; that is to say the impact that these disequilibrium gaps or financing have, via the agents' decisions on the economic variables concerned. The reactions will generally be distributed over time, so that we also capture the dynamic responses of the economy. In this way we can, in principle, determine the values arrived at by the economic variables of interest at different moments and in varying circumstances, rather than just suggesting an accounting framework to lie behind a particular scenario. The market adjustments made can be in either price or quantity form (e.g. as changes in price inflation, quantities produced, interest rates, money or credit supply, wage inflation, unemployment or labour supply). All the familiar concepts of economic theory appear in these reaction functions — propensities to consume and import, price and income elasticities of demand and of supply, cross-price elasticities (substitutes and complements), interest elasticities, derived demands for labour and capital services, wage-price-unemployment interactions, and so on. Adjustments in the leaks and injections beyond these induced by adjustments in the markets will be the result of policy reactions of the authorities — also a behavioural matter. As such they pose the policy problem conditional on a knowledge of how the markets work. Since the policy makers are not the only decision makers influencing the path of economic evolution (and here one cannot ignore the impact of foreign as well as domestic economic agents) a model which fails to explain decisions via behavioural reaction functions can hardly be a successful forecasting or planning device. This holds even when the policy authority assumes total control (in attempting to be a sole decision maker) unless the economy is closed, as the planners of East European countries have found to their cost. In short, it is essential that we have the explanatory power to show how and why the economy moves to each new position; in addition to an accounting system (both interindustry and financial) to picture that position when we get there. While the latter is interesting for assessing income and wealth, it is uninformative on the development of the economy and, thus, for forecasting and planning.

The flow of funds is given concrete form in the model via three possible definitions of GNP.

- (i) GNP = sum of value added in sectoral outputs (supply) ;
- (ii) GNP = sum of demand categories (consumption, investment, net foreign trade, net budget, etc.) ;
- (iii) GNP = sum of income types (wages, profits, dividends, rent, etc.).

Ex post they must be identical, but they will differ *ex ante* whenever gaps appear. Confronting one with another shows where adjustments are necessary—they may be in the demand or supply of goods, in the money used to support those demand and supply levels (money market), or in the incomes available to support demand and supply income (labour markets). Dissaggregation in each definition allows us to see which component is adjusting. Moreover, given that savings = income — consumption, each gap is represented in this three-way classification, so the closure or financing of them is represented. The way is now open for policy analysis. Our problem is to model the determinants of these various components, their interdependencies, and their adjustment mechanisms.

Sometimes simplifications are possible in this scheme because certain constraint exist which prevent the adjustment of one of the quantities. Then the economy must adjust to the level of the lowest constraint, and that is all that need to be modelled. For example, the western economies were demand constrained between 1930 and 1970⁴ and therefore subject to demand control. The Soviet type economies are supply constrained and subject to rationing, and others are income constrained (many developing economies). In the last category are economies which have found the means to finance their gaps⁵ rather than close them. Demand and supply controls are not themselves necessary although demand need not equal supply *ex ante* so that unintended inflation, shortages, unemployment may result in excess of that planned. In this context, one must recognize that these constraints which block adjustments can be administrative, e.g. where consumption is planned as a residual so rationing is achieved by queuing; or a release of the money supply so rationing by inflation follows; or import quotas are imposed; or indentured labour (such as the land army) is used. Some constraints are short run phenomena only.

Most economies have something of all three gaps from time to time. A model of them, and the three markets and their adjustment mechanisms or constraints, represent the basic characteristics of the economy and the likely future bottlenecks. In the case of Sri Lanka all the gaps are open at the time of writing and require considerable local and foreign financing. The gaps are largely derived from one source—the public investment programme. Constraints to be captured also are clear in the goods market because of heavy specialization on four agricultural crops (three for exports). In the money markets there is a domestic savings mobilization problem and massive aid and loan injections. In the labour market there is a clear skilled labour constraint (and unskilled labour surplus). That adjustments are taking place in the gaps is also obvious from policy provision, inflation and the shortages of certain materials and inputs leading to the under-utilization of capital. It is not obvious that any of these features had been analysed and anticipated by the planners.

7. Illustrative Models

As an example of a model and to the points above, consider the case of an industrial economy in which the government is interested in forecasting and policy analysis in a period when its principle concern is with the problems of demand management. A Keynesian demand-driven model is therefore appropriate, elaborated to consider full employment, inflation and foreign trade targets at least. We would start with.

4. Excepting the war years.

5. e. g. foreign grants & loans, labour, e. t.

- (1) $S = Y - C(Y)$ $I = I(r)$ and $S = I$ or financed gap (goods markets)
 (2) $M^D = m_1(Y) + m_2(r, p)$ and $M^S = M^D$ or financed gap (money markets)
 (3) $Y = Y(N)$ $w = Y'(N)$ $w = w_0 + W(N)$ (labour markets)

and $Y = wN$ or a financed income = full employment gap where S = savings, Y = aggregated demand, I = investment, r = rate of interest, M = demand for money, p = price level, M^S = supply of Money, N = labour force, W = wage rates sticky below w_0 ; and the bracket terms denote functionals with $Y'(\cdot)$ being the first derivative and $C(Y)$ being consumption expenditure. Such a model is no use. It is too aggregated, it contains no proper policy variables and no dynamics so there is no link over time periods such as in a variable capital stock, K . We also need a trade sector and some price determination. This might lead to the following

- (4) $C = a_0 + a_1 \frac{Y-T}{P} + a_2 C_{-1} + u_1$ (consumption)
 (5) $I = b_0 + b_1 \frac{Y}{P_{-1}} + b_2 K_{-1} + b_3 R_{-1} + u_s$ (investment)
 (6) $F = r_0 + C_1 \frac{Y}{P} - C_2 F_{-1} + C_3 P_F / P + u_3$ (imports)
 (7) $E = d_0 + d_1 T_s + d_2 P_e / P + u_4$ (exports)
 (8) $Y/P = C + I + G - F + E$ (real GDP)
 (9) $T = O_0 + o_1 Y + u_5$ (net tax yield)
 (10) $K = I + K_{-1}$ (capital stock)
 (11) $Y/P = f_0 + f_1 L + f_2 K + u_6$ (real output given labour demand),
 (12) $P = g_0 + g_1 \frac{WL}{Y/P} + g_2 P_F / P + u_7$ (prices)
 (13) $W/W_{-1} = h_0 + h_1 \frac{N-L}{N} + h_2 \frac{P}{P_{-1}} + u_8$ (wages)
 (14) $N = k_0 + k_1 (N-L) + k_2 W/P + u_9$ (labour supply)
 (15) $M/P = m_0 + m_1 Y/P + m_2 r + u_{10}$ (money demand)
 (16) $P_e = n_0 + n_1 P + u_{11}$ (export prices)

There are now 13 endogenous variables (determined within the system) jointly depending on 7 lagged dependent variables and 4 exogenous variables (determined outside the system). The lagged endogenous variables are subscripted by -1 to indicate a one period lag and are determined within the system at an earlier date, but are fixed if we consider the model at any given instant. The endogenous variables are on the left in each equation (of which only C , I , K , E , and F are in real terms). Targets might be Y , I , P , $N-L$, $E-F$ among others. The exogenous variables are P_F = price of imports; T_w = volume of world trade; G = real government expenditures, R = rate of interest. The latter two might be instruments along with o_1 , h_2 and possibly others. The lower case letters ($a_1, \dots, n_{11}$) are parameters that would have been estimated. u_i $i = 1, \dots, 11$ are stochastic random errors, following some probability law, to represent the errors of specification and the natural

variability or uncertainty in these behavioural relations. This model overcomes many of the difficulties mentioned for the model (1) — (3) but is still highly aggregated and could not handle some of the problems discussed in the previous sections. Therefore, disaggregation could now go ahead to tailor the model for the uses desired of it. The specification of (1) — (3) or (4) — (16) is an obvious, but highly simplified consequence of traditional economic theory. Its derivation was therefore a problem in economic theory. A more detailed development and criticisms of such specifications may be found in general texts, or in the discussion of any particular econometric mode, such as those mentioned in Section 3.

The equations of the model are of four kinds :

(a) Behavioural (stochastic) — testing empirically the behavioural theories of economic activity, e.g. (4) .

(b) Technical (stochastic) — testing relations with a scientific or physical rather than behavioural base, e.g. (II).

(c) Definitional (identities)— accounting relations in the flow of funds.

(d) Institutional — probability identities but with the property that in any event they may be changed at will by the economic management.

As an example of the finished product, an empirical model which has been used frequently is Klein's Model I of the U.S. :

$$C = 16.786 + .02 \Pi + .225 \Pi_{-1} + .8(W_1 + W_2) + u_1$$

$$I = 17.784 + .231 \Pi + .546 \Pi_{-1} - .146 K_{-1} + u_2$$

$$W_1 = 1.599 + .42(Y + T - W_2) + .164(Y + T - W_2)_{-1} + .135t + u_3$$

$$Y = C + I + G - T$$

$$\Pi = Y - W_1 - W_2$$

$$K = K_{-1} + I$$

$$D = W_1 - 2\Pi \text{ where}$$

C = consumption, I = investment, W_1 = private wage bill, W_2 = govt, wage bill,

Y = national income, Π = profits, K = capital stock, D = income distribution,

T = tax bill, G = government expenditure, t = time (1931 = 1)

Here C (current welfare), I (future welfare), and D might be targets ; and T , G and W_2 the government's instruments.

8. Specification — Use Interactions

At this point one sees something of the position of economic and statistical theory in the model building process. Having settled the basic structure and a tentative specification of the economic relations by economic theory and observation, these specifications are confronted by data and the parameters estimated by statistical techniques (such as least squares). Then the results are assessed equation by equation. The standard diagnostics of statistical theory will be used (t-ratios on individual coefficients, F tests ($\bar{R}^2$) on

equations, Durbin-Watson tests of the stochastic specification (and omitted influences), that the sign and size of the estimated coefficients accord with prior knowledge or observation of such a relation). As a result respecification of that relation will be necessary, removing insignificant explanatory variables, introducing new ones, finding the exact form in which a variable actually influences the dependent variable. The specification/estimation phase will be repeated until a satisfactory equation is found. This can take quite a lot of experimenting especially where economic theory is weak, such as in specifying the dynamic lag structure of a causal influence.

It is useful to emphasize the distinction between causality and coincidence here. Statistical methodology and statistical tests cannot specify causality, they can only indicate where *in that particular sample* significant correlations have been found and estimate the degree of dependence of one variable on another. They cannot say that the same would be observed when different circumstances prevailed. In particular they cannot say which variable causes which, but just whether they are associated. Consider the wages-prices example. Some say wages cause prices to rise in order to cover costs; others say that prices cause wages to rise in order to preserve living standards. In fact if observations are taken at discrete intervals you cannot distinguish which is causing which, since both processes will appear to hold simultaneously. They are jointly determined variables, dependent on a group of third party variables (import costs, demand pressure, government policy, etc). Statistical theory cannot be used to specify the model it only provides checks on the significance of the estimated results from the given sample. Specification and re-specification must therefore agree with economic theory, and observation of the system.

We have argued that the estimated relations should appear suitable for the use for which they are intended. If they are for forecasting then they must produce forecasts which accord with common sense, observation, and in particular they must "forecast" known history correctly at least in terms of directions of movement, turning points, etc. A proper test is to forecast outside the sample, i.e. the "forecasting" of history before the sample, or between the sample and the present. Similarly they should simulate the observed responses of the true economy to various known stimuli. They should reproduce the same cyclical patterns and the same phasing between movements of different variables, which have been observed in the data. They should show the same patterns of uncertainty in the dependent variables and so on. They should show the same patterns of dynamic behaviour⁶ (signs and sizes of disturbances) in response to given shocks. As and when these characteristics fail to appear we must return to the specification stage, and try again. Those tests can be very stringent, and certainly will be extensive considering the number of variables and planning periods which will be of interest. That is why I stressed earlier that a knowledge of how to use the model was an extra and vitally important condition for successful model design.

Throughout we have talked as if the testing were only done equation by equation. Each equation will have explanatory variables which are "predetermined" in the use of that equation but are endogenous in that they are explained elsewhere in the model. Some

6. i.e. whether cyclical, or rise and fall, or any dynamic development to a new higher or lower level.

will be lagged endogenous. Therefore the hard work in this interaction starts when we test the model *as a whole* for its ability to forecast sensibly, “forecast” history, simulate real or hypothetical events, reproduce the correct dynamic responses to stimuli etc. It is quite possible to have well performing individual equations which collectively perform badly. The same use-respecification interaction here must be gone through again, but it is now considerably more difficult to trace the sources of unsuitable behaviour than in the single equation case. At this stage one should also check that the model suggests the expected outcomes from certain policy packages (and policy strategies) as a whole. The specification process is genuinely a “learning by doing” operation.

It will be noticed now that we are checking the consistency properties of the model as a dynamic simultaneous equation system. This is because the economy is in reality a set of constraints which force those consistencies, and which, in planning or forecasting, we must respect if we are to produce information with any connection to reality. Not to do so is to ensure failure in the short or medium term. With many targets, but policy instruments restricted both in number and variability, the planning of an economy becomes a very complex task if inconsistencies are to be avoided. Potentially there are target inconsistencies (the achievement of one implies the partial non achievement of another, e. g. the inflation-unemployment trade-off) sectoral inconsistencies (with finite resources the achievement of a target in one sector hinders the achievement of that in another; again there is a trade-off to be exploited), dynamic inconsistencies (when the natural dynamics of the economy serves to undo the achievement of a target — achieved in one period — in some later period), and policy inconsistencies (the policy introduced in order to achieve some target (partially) offsets, by way of side effects, the impact of another instrument designed to achieve another target). And none of these problems have anything to do with the planning methodology—or lack of it—employed. The difficulty of resolving all these conflicts and removing inconsistencies remains whether you try to plan formally in the sense of solving a set of simultaneous differential equations or informally in the sense of selecting broad policy measures aimed at steering a restricted number of targets towards some desired values. The latter policy measures are designed to induce certain operating conditions such that the behavioural responses by the economic agents tend to realize the required targets. The formal planning methodologies tend to be associated with centrally planned or command economies. The informal (or indicative planning as it was once called) tends to be associated with western liberal regimes. Apart from the fact that more loosely defined objectives are easier to achieve (or more difficult for critics to find failures to be denounced), the resolution of the inconsistency remains a problem in *any* planning exercise. It is a property of the system, not of the planning methodology ; it remains whatever the philosophies of planning techniques (and governments) may come and go.

9. The Model and the Administrative Planning Structure

A natural question to ask at this stage, is how much use in practice is made of these economic planning models by planning agencies. The answer to that question sheds light on how the information produced by the model may be used most efficiently. It is as important that the administrative structure surrounding the model should be

sound, as it is to have a good model. For the best of models will be valueless if its information is mishandled or not used. Thus, this structure is an integral part of model design. In addition, collecting together the points which planners "in the field" have found to be the important features of a planning system provides a summary of the points to be included in the system design.

In general the models used for planning purposes by the governments of the Soviet bloc have been of the (non-behavioural) "user and materials balances" in an inter-industry accounting framework type⁷, with a single centralized planning authority. In the developed Western Countries the models have been of the behavioural type (fitted to a national income accounting system) or decentralized indicative planning. The concern over the unsatisfactory treatment of the supply sectors has, in the latter case, led to some integration of the two approaches.

In less developed nations government economic planning is often in the form of solutions to a sequence of specific, (often viewed as unconnected) "one-off" problems such as urban unemployment, rural/urban income imbalances, encouragement of industrial investment, foreign exchange shortages, the dominance of particular products such as coffee, cocoa, tea, tin, tourism, etc. This situation manifests itself in the many plans which are a series of public investment projects neither linked nor integrated with the general development of the rest of the economy.

The question posed is extremely difficult to answer satisfactorily. It supposes considerable institutional knowledge of many governments — knowledge which is certain to become obsolete fairly rapidly. Of necessity the information of the exact institutional structure and procedures surrounding the model available to the outsider will be sketchy; and in some cases the secrecy which must naturally cover the planning discussions, is also found to cover the planning procedures. But nearly every country uses some form of forecasting model, simple or sophisticated.

In the Netherlands planning models are housed in the Central Planning Bureau. The models used are an annual one concentrating on supply functions, employment and foreign trade for planning long term developments, and a quarterly one for short run forecasts and policy adjustments. As a rule the short run model is used for problems of stabilization based on projections of exogenous events, and the long run model to study the possibilities for growth compatible with a moving equilibrium in demand and supply in the labour, capital and foreign trade markets. The Central Planning Bureau is independent of any political control and is a purely research organization with close connections with Dutch Universities. It therefore can, and does, publish its own analyses of economic problems. However, the government supports the Bureau and, particularly valuing the independence of its views, regularly consults the Bureau and its models to provide technical information on the likely consequences, and feasibility of a whole range of economic policy formulation problems. Through its directorate, the advice of the Bureau will be presented and argued at all levels up to, and directly into, the Cabinet. The initiative, and

7. as represented by Input - Output tables.

terms of reference, come from the government. Then in return advice will be presented in terms of various options and the likely outcomes. The final policy decisions lie entirely with the government but the methods of research to provide that advice are at the discretion of the Bureau. The Bureau does not handle problems of Central Banking policy; here the Central Bank's research staff are consulted instead.

In the U. K. the main points of the Treasury's planning procedures have been set out in the *Report of the Committee on Policy Optimisation* (HMSO, Council 7148, 1978). Again we see a deliberate split between the model builders (technicians) and the policy makers who must analyse and decide between the available policy options. The reason for this split is that the former group understands the model, its statistical basis and limitations very well, but the political and economic possibilities (i.e. what is acceptable and what is feasible) rather poorly. With the latter group it is the reverse. It is necessary to avoid misunderstandings and failures in communications. A policy coordinating committee consisting of all Deputy Secretaries (Departmental heads) of the Treasury and chaired by the Permanent Secretary, and a Macro-economic group consisting of the Undersecretaries⁸ concerned with Macro-economic issues, represent the policy makers. The technicians form a Forecast group with two components (the short term and model group; the medium term and policy group) up to undersecretary level. The two groups do not meet together but when each meets, the Economic Advisory Section attends as well to acts as liaison, interpreters and possibly referees.

Short term forecasts are made twice a year processed through the following system. The initial assumptions for the forecast are usually based on unchanged policies and assumed exogenous events (in consultation with the home and overseas specialists, the industrial group, etc., within the Treasury), which may be proposed by the forecasters but they must be approved by the Policy Coordinating Committee. A preliminary forecast is made from the model. It is then discussed, sector by sector, with specialists from other Treasury divisions and other Departments of government (e.g. Department of Trade, Energy, Bank of England, Ministry of Agriculture, etc.). The information, comments and criticisms are then used to produce a first draft forecast from the model with adjusted assumptions, corrections or even alterations in the model itself. This forecast generates further forecasts of foreign and domestic financing and industrial production detail, through sub-models which are linked to the main one and need the collaboration of specialist government departments. A two day seminar follows for reviewing these forecasts, attended by the technicians and the Economic Advisory Section. All decisions taken there are then reviewed again as a second draft forecast is made incorporating them. A report describing the forecast and the assessment of the uncertainties is made available to all Ministers, the Cabinet, Officials and some other departments. Although the forecast is the best single estimate, it is essential that the uncertainties and difficulties associated with it are also explained to the policy makers.

The forecast goes to the two committees of policy makers who discuss the policy implications (the macro-economic group is consulted first on more technical matters). The Secretariat of the Economic Advisory Section summarises the outcome of those

8. responsible for each division within a department.

discussions in terms of the policy implications. This passes to the policy Coordination Committee (now including the senior members of the forecasting group) who set the terms of reference for the examination of the policy options from the model. Some proposals will also come from earlier considerations of the forecast by those concerned with policy analysis. A systematic analysis of the policy options is then prepared from the simulated outcomes given by the model. Fully worked out variants in the effects of different policy packages are set out. This draft is considered again by the Policy Coordinating Committee, together with the original forecast and other comments from elsewhere in the Treasury. The Permanent Secretary may initiate further discussions to amend the picture and correct the advice presented to the Ministers in that draft. The final version is then sent to the Chancellor and through him to the Cabinet. The choice between options remains theirs.

This whole exercise is kept distinct from the medium terms strategy considerations. The latter follows very much the same pattern as the short term exercise in policy analysis. The Policy Coordinating Committee exercises more control in setting the assumptions and simulations to be considered. The results and further simulations are considered by the Economic Advisory Section before a draft report passes to the Policy Coordination Committee again for further discussion and amendment before going on again to the Ministers. There is therefore a split between short and medium term policy analysis, neither of which are properly integrated or necessarily mutually consistent. Throughout, the Central forecast is kept separate from any policy options about that forecast which may be analysed.

The weaknesses suggested by the planning systems described above are the lack of any mechanism to guarantee the integration and consistency of medium and short term plans and the lack of consultation or feedback from the political authorities over any desired modifications (either in proposing the terms of reference for policy analysis, or in discussing the results). It is desirable to avoid both, directives from above, and any possibility of a rationing determined by the civil service agencies involved, of the options investigated. In particular, there is no means of consultation with the major interest groups such as labour, business interests, regional authorities, etc., who although not part of the planning structure will have important advice and modifications to propose. Some of these points are reflected in the procedures adopted in other countries.

In the U.S.A. procedures are rather informal. The members of the Council of the Presidents Economic Advisors can, if they wish, make use of the projections provided by any of the models although they are unlikely to initiate specific exercises. With so many models, many of them specialized, it is even possible to take a consensus of model results, as well as a consensus of advisors' opinions, which is a luxury probably very valuable for the elimination of faulty information. The Federal Reserve Bank system also makes extensive use of its own rather sophisticated models for planning its strategy on monetary issues. These models are housed in its research division, and the policy and forecasting information is made available to the board of governors.

The Japanese economy, noted for its success in recent years, has made use of econometric models in planning since 1960. Their procedure is to set up a long run planning model and then try to fit short run stabilization, regional and industrial policies into

its presentations; policies which remain distinctly subservient to the long run strategy. Five main targets have been taken; social capital, manufacturing sector, rate of growth exports, investment in human resources, and income distribution. Then they experiment with several possible long run rates of growth (of a 10 year horizon) with a view to balancing the limiting factors of labour, energy, foreign exchange, savings, and key commodity markets. Next a larger short run model is used. It contains the national income and labour market sectors plus behavioural and policy relations. Instrument values are selected after experiments to show which are effective in achieving the targets set out at the previous stage—such as the share of government purchases and transfer payments in GNP and various tax rates. Finally the exogenous information is used in the model—most of it is derived as that consistent with the rate of growth obtained earlier. And that means the short run, regional and industry models can be used to give projections and help policy formulation. The results are consistent sectorally, dynamically and with respect to policies.

The French economy has a long history of centralised economic planning. Since 1971 a large nonlinear model has been used for extensive simulations on policy and non-policy variables. Again the policy maker may commission studies and he must choose his own policy. The modellers only present a range of options. Three alternative rates of growth in GNP are considered to give the long run framework. The model is then used to check the physical consistency in National Income. Outputs are broken down into agricultural, industrial and services outputs. These are further disaggregated into individual industrial outputs. Rather detailed single equation models give a fine disaggregation of demand components under the headings of consumption, investment, imports, exports and autonomous (committed) government expenditure. Intermediate industrial demands are obtained by input-output methods, leading to employment demands whereas labour supplies are estimated by demographic and other studies. Consistency of projections is obtained by iterating around the cycle of the projections of physical quantities. Finally policies on fiscal and monetary measures are set to make the financial model give consistent projections comparable with the physical balance just obtained. The plans are consistency and comparative static plans with no dynamics, and presumably difficult to revise.

The Belgium Economic Plan is a five-year plan but each year the corrections necessary to guarantee the realization of the Plan at the end of the five year period are made in the economic budget. The Plan is regionalised.

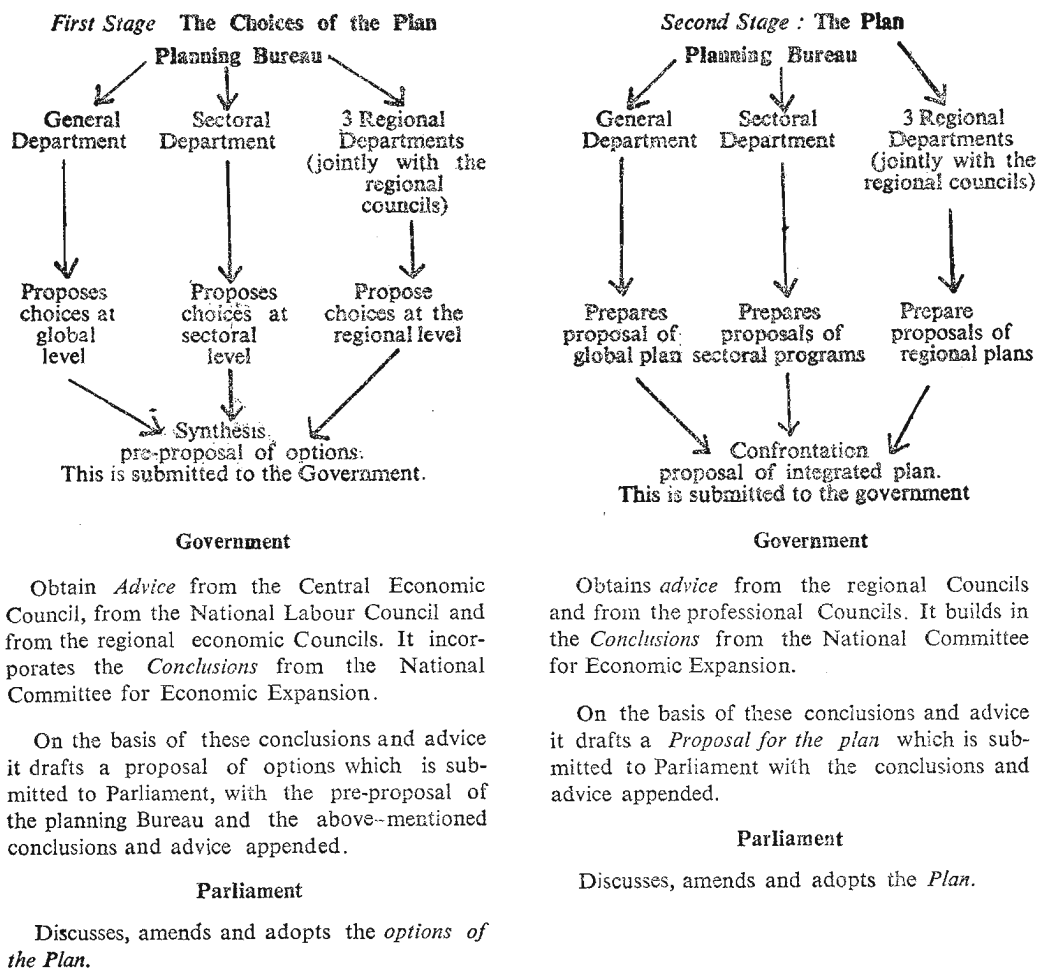
The Plan is : (i) binding for the Public Authorities only in as far as investment expenditures are concerned ; (ii) contractual to the extent that the state can get enterprises to agree to contracts which offer them benefits if they follow certain prescriptions provided in the Plan.

The Plan is built in two stages. At the first stage, the Planning Bureau evaluates and discusses the economic and social choices which are technically feasible with the social (Trade Unions and federations of Belgian enterprises) and regional (regional economic

councils) partners. This results in a proposal of options from which the government makes a selection which it then submits to Parliament. The latter amends and, eventually, votes the law determining the, options of the Plan.

The second stage consists in the drafting of the plan and in the determination of its concrete objectives in terms of the law on the options.

The following scheme summarizes the procedure :



The planning bureau generates Global macroeconomic projections by means of the RENA model. It is a regionalised, dynamic, non-linear macroeconomic model of the Belgian economy. The model has no sectoral dimensions. It is essentially used to test different variants of economic policy, by means of simulation techniques. Certain optimisation exercises have been conducted by the Planning Bureau.

From the global level, sectoral studies are obtained from input-output models, whose predictive versions are derived from the results of the RENA model. To guarantee consistency with the RENA model has caused problems of convergence and so the Planning Bureau is at present preparing a model integrating the sectoral and regional aspects.

Various other models are used or are being prepared to study specific aspects of economic policy, analysis of employment, demographic indicators, etc.

10. Conclusions

In conclusion, it is sometimes questioned how far governments should trust information generated by econometric models. In Britain, with a characteristic amateurism which has possibly been rather distinctive in recent history, it is often argued that better forecasts and policies will result from much simpler procedures,—“calculations done on the backs of envelopes”. This argument has effectively been answered by those requirements mentioned now placed by governments on their economic policies. Whereas it is relatively easy to understand a single relationship, the possible effects of several simultaneous relationships acting in concert on a variable, with feedback influences included and subject to several impulses over several consecutive planning periods, are next to impossible to grasp. In forecasting, the range of detail required, side effects, the dynamic effects and consistency of forecasts of different variables can only be handled by (simultaneous difference equation) econometric models. Only then is the simulation of many situations and policy packages in this detail possible. Another general point is that we need the means to rationally revise policies as changes and mistakes reveal themselves. And again it is an extremely valuable contribution of econometric modelling that it summarises the uncertainty in the forecasts and policy analysis ; where it is concentrated and what limitations it imposes. It is generally the non-model people who claim more for the models than is justified. And so it is instructive to read a pure economist on econometric modelling for confirmation on the most important comment that is made in this paper. That is the advice generated from econometric studies is no more than advice and guidance. It cannot supplant the function of the decision maker and his responsibility but can only be complementary to him. There will always therefore be room for ad hoc adjustments to any of the results we have discussed in the light of the judgement, experience, or extraneous information of the planner. Indeed judgemental forecasts are now common practice. That is small adjustments are made to the model's forecasts which reflect the planners assessment and perception of the uncertainties and inaccuracies involved. There is a considerable literature on the tortuous manipulations of constant adjustments which may be used to supplement or justify judgemental forecasts. The fact is that these studies show that the planners have lost none of their initiative, but know how to treat the model as a guide. It does not invalidate the model's information but it does recognise that the model is not perfect and the combination of planner and model is more powerful than either alone i.e. “Models are to be used but not necessarily believed”. The model will get variables into the right numerical area, ensure consistency of plans and forecasts, solve the issue of detail, and guide the planners thinking on likely consequences and the relative sizes of variable the planners then take over. The model has the function of concentrating the mind. It points out where the data are weakest, where our understanding of the economy is weakest

where the decision making machinery and/or plan implementation machinery is most in need of improvement or overhaul. The model makes systematic our understanding of the difficulties in making decisions and the interdependencies in the economy. All of this holds even when projections and policy making do not interest us *per se*. To quote Samuelson "I would no more dream of tackling the back of an envelope before I had looked at the Wharton, and Michigan and St. Louis models than I would dream of doing so on the basis of tea-leaves or reading Alfred Marshall's Principles. In other words, we dwarfs of judgement see as far as we do because we stand on the shoulders of computer giants".

Case Studies as a Method of Research

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Case studies focus attention not on the total population but on an individual unit in that population. It could be an individual, a family, an institution (e.g. school) or a group (e.g. class) within an institution. The intention is to study the unit in question at great depth and to seek to establish generalizations about the wider population from which it is drawn.

As a method of research case studies suffer from several limitations. Firstly, the selected unit may not be representative or typical in which case it is misleading to generalize. Secondly, the unique perspective of the researcher could enter into and distort the research. In case study there is a lot of opportunity for the biases of the researcher to be brought into the research. Thirdly, one has to ensure the confidentiality of the unit under study. What I mean is that if you study one person at depth, you have to win his confidence and respect his desire for privacy in order to obtain information from him which often is a difficult task. This of course means that if the findings are confidential (or the identity of the unit is confidential) nobody else can verify one's research findings.

However there are advantages in doing case studies. Firstly, as I described earlier, they provide indepth description. Secondly, case studies can generate hypotheses. Thirdly, it is possible to study a human being as a unique individual, which is especially useful in educational research.

Surveys as a Method of Research: A Socio-Economic Survey of the Mahaweli

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In empirical social research, you could either select a problem first and then subsequently select your geographical area of study or *vice versa*. For example, the problem could be the non-repayment of cultivation loans taken by farmers. After having selected the problem you select your area. In doing so, naturally you take into consideration certain scientific factors. However, non-scientific factors such as the availability of time, money and personnel also could be important. The second approach is to first select an area and then select a problem. That is precisely what happened to us,¹ because the Man and the Biosphere Programme is interested in the Mahaweli area, and in that sense the area was pre-selected for us. It was left to us to select a problem within this area. What we selected was 'what are the problems that arise when you settle people in a new area?'. It is a simple one and therefore the methodology we adopted was equally simple.

In answering this question we have to consider three basic issues which I think arise in any type of research. Firstly, 'from whom are we going to collect these data?' Secondly, 'how are we going to collect these data?' And thirdly, 'what type of data do we have to collect from these people to answer the question that we have raised?' So what I want to describe is how we attempted to answer these three questions, what problems we have had so far, and how we solved them.

The first question—'from whom are we going to collect these data?' As you know the Mahaweli area in the Kalawewa basin is divided into a series of blocks. You get larger blocks called H1, H2, H3 and H4, and each of these larger blocks have been subdivided into smaller blocks depending on factors such as topography and so on. The blocks that we selected were block 301, 302 and 303 and we selected these blocks for very good reasons. Firstly, they were very close to Galnewa township, secondly, we got a house very close to that area so that we did not have to walk long distances; and thirdly, this area had been settled about 3 seasons before we started this survey. After selecting these 3 blocks, we had to select a sampling frame. For this the Mahaweli Development Board gave us the list of allottees. In the Mahaweli Settlement area, people have been settled in clusters, like in earlier settlement schemes. In each cluster, an individual has been given a half an acre homestead. Also you get different types of villagers (settlers). First you get the Purana Villagers who have been residing in the area Prior to the new development. Secondly, the new settlers who have been brought from outside, and thirdly, there are the encroachers who have been living in this area for the last 10 or 15 years.

1. The research study which is described here is done in collaboration with Dr. Jayanthi Perera and Mr. Wilson of the University of Colombo.

We selected a sample from each group. Then we went to locate these individuals, and to our regret we found that some of these people have not occupied their homesteads. That is one mistake we did — to allow ourselves to be guided by the Mahaweli Board list. Having rectified the mistake a sample was chosen as follows: Purana villagers—100; New settlers—35 ; Encroachers—100. Thus we had a sample of 235 individuals.

Once we selected the sample the next problem was to collect the required information from the members of the sample. This was a difficult task especially since they were so widely distributed and we did not have any good transportation in the early stages. Thus we had to visit them on foot. At this stage, we had to consider two problems. One was, if we wanted to find out the problems that emerged in the area, we had to overcome the problem of recall. So there were certain alternatives open. One was to interview all these farmers through a one-shot survey. You could have got the data by this method but the data would not have been accurate. (There is not much point in going and asking a farmer about the fertilizer he applied 6 months ago.) To overcome the problem of recall, we divided the sample into two groups. One group we started interviewing once in two weeks. Because of the other constraints that we have had to face, we could not interview them more often. The second group we started to interview right through the cultivation calendar, in three stages; once soon after the sowing stage was over ; second, about 2 months after sowing; third, after the harvesting was over. We broke it up according to the paddy calendar. We interviewed the two groups both in *Maha* and *Yala*, one group was interviewed about 6 times and the other about 24 times.

In this way we got some good information. Firstly, the quality was good. Secondly, we were able to establish a rapport with the farmers, who anticipated our regular visits and appreciating our genuine interest in collecting good data were prepared to co-operate. Also we felt that we had overcome the problem of recall. Moreover because we interviewed them once in two weeks, we were able to get a continuous picture concerning the income and expenditure patterns, marketing problems, financial problems, social problems and so on over a period of about 18 months. That in brief is the methodology we adopted in collecting data.

What type of data should be collected from the farmer ? This was a very big problem. We divided the information we needed into several sections. For example, one section dealt with agricultural practices and under this we had a sheet for each practice—field preparation, sowing, fertilizer application, application of other agro-chemicals and so on. In this manner we had a wide range of topics and on each topic we had a small questionnaire. The questionnaire was about 30-40 pages long but this was no drawback because the farmers realised that we were genuinely interested in their information. In the case of the questionnaire, it was not completed in full by all the farmers. For example, if the farmer said that he could not apply the agro-chemicals, that sheet was not filled. Thus, on average only about 10-12 sheets were filled. Here there was one problem. We had to devise a method to find out whether the investigator had attempted to get answers to all the questions from the farmer. To overcome that, we had a check sheet with all these topics in single questions—“did you fall ill”? yes/no ; did you apply fertilizer? yes/no”, and so on and the investigators before starting the interview had to tick them off.

Based on these studies, we submitted about 3 or 4 reports, but at the end of it we had to ask some fundamental questions. We had assumed we could answer the question 'what are the agrarian problems that had arisen in this area?' by interviewing farmers. At the end of the survey, we realized, that we could not identify all the problems that emerge in an area by interviewing only the farmers. We also realized that it is difficult to understand the farmer's present behaviour unless you know his past. We had made that mistake of ignoring the past. Our survey said that some farmers were very good and some farmers were very poor, in so far as performances were concerned. And we had data-education and soon, which enabled us to arrive at certain conclusions, but some of these variables did not fully explain the differences. So we decided to go back into their past and after two seasons in blocks 301, 302, and 303 we went to 306, 6 miles away.

We thought a new block would be able to give us more meaningful answers which we were unable to find at the previous blocks. First, we decided not to accept the list given by the Mahaweli Board. Secondly, we did not want to take 3 blocks, because we felt that by spreading our resources too thinly we were failing to collect good information. Thus we concentrated on one block. The first thing we did was to send the investigators around to every house to fill a two-page basic schedule. It revealed that of the people who had been allocated land, about 85 people were not in residence. So we took as the sampling frame, those who had been given land in this area and were cultivating the land in this area only.

Then again we decided not to interview farmers on a once a month basis during the cultivating calendar because we realized that the information that we get from a farmer at intervals of 30 days was not very accurate. Therefore we decided to select a smaller sample of about 120, and interview each farmer once in two weeks. The methodology we adopted was the same as before but we modified the questionnaire slightly depending on the experience that we had gained.

In order to find out about the farmer's past we had a separate schedule by which we collected information on the pre-Mahaweli experience from all the farmers in the sample. This was a one-shot survey. In that sense, the information that we got on fertilizer use and use of agro-chemicals was not very accurate. However, on the other hand we were able to arrive at certain conclusions pertaining to the block, which I think were very important if one were to provide feed-back information to the Mahaweli Board. For example, we were able to say what proportion of the land remained uncultivated, how many people had not come into residence, how many people were migrating, how many people had marketing problems in the area and so on.

When we finished block 306, we decided to go to block 307, because this block had been recently settled and we had a nice bungalow to stay near block 307. Here we realised that there was not much point in doing a complete survey because the information which we have already had on block 306 was applicable to block 307 as well.

Before I wind up, I want to ask one or two questions. How useful is the survey method? What are we going to achieve by doing a survey? I am convinced that even if you do ten more socio-economic surveys in area H, you are not going to come up with any

more answers than what we already have. I am also convinced that if a few people who are knowledgeable on individual topics get together, they will come up with certain answers which will not be very different from the answers that come up by doing a detailed survey. In other words I am prepared to argue that in agrarian studies the survey stage of research is over in Sri Lanka. We have enough information now. Surveys are useful if they are going to be for a specific purpose (if you want to find out how much fertilizer you should order for area H for the next season you do a quick survey). But on the broader problems such as what is wrong with the extension system? What is wrong with our co-operative system? and so on, we have a good understanding. Therefore, I am convinced that we should do more case studies. That is, I would prefer to go into a block in Mahaweli area, spend a weekend, just walk around to get the feel of the area, select about 6 or 7 settlers and then study them in detail and ask them what their problems are. And based on that I will form a few hypotheses on these case studies and test those hypotheses over a larger area. I believe that in order to answer some of the questions that we are faced with, detailed case studies are absolutely necessary because of a variety of problems. Firstly, because the one-shot survey is not going to give you very valid information, and secondly, farmers are not on the same wave length as you when answering questionnaires.

In conclusion I would like to raise one last question concerning the role of case studies; how significant are they and how should we do it? In trying to collect information from a group of individuals, or to answer a particular problem, should we confine ourselves to that particular target group or should we go beyond these people and supplement this information, by doing other studies as well? Our Mahaweli studies have convinced us that in the next stage, we have to interview all the officers, all the shopkeepers and even people in Galgamuwa and Kekirawa. It is only then that we will be able to come up with answers to some of the problems that have emerged in the area.

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Types and Sources of Data for Social Science Research in Sri Lanka

R. MAHALINGASIVAM

Ministry of Finance and Planning

1. Introduction

For all areas of research, collection of information is vital. No inquiry on legal, medical, economic, sociological or any other problem is possible without information. In other words evidence will have to be collected and analysed before one could come to any conclusion. More than collection, reliability of the information is crucial. If reliable data are collected then the balance work is relatively simple. If a study takes 3 years the period devoted to collect statistical data and other evidence could be as long as nearly 2 years. In most cases the process of data collection will go on until the analysis is completed.

The researcher should know what information to collect, where to collect, how to collect and how to check the reliability. One should know, a priori, the data to be collected on the variables he proposes to use for his study. The causal factors will be known from what one observes, what theories one would have learnt about laws of behaviour, knowledge gathered from reading similar studies etc. Thus, invariably, it is possible to identify a large part of the variables that will have to be used. The others will become known to him as he proceeds with the research.

2. Types of Data

Available data are normally classified between primary and secondary sources of data.

Data are collected by government departments, ministries, public corporations, business firms, banks, research organisations such as ARTI* and Marga Institute, trade organizations like the Chamber of Commerce etc. There are also data collected through census and surveys and published by the institutions which collected them. Census of population, census of agriculture, census of industries, Socio-Economic Survey 1969--70, Consumer Finance Survey 1973 are a few such examples. Several survey results are also published by the ARTI and Marga Institute. In addition there are a number of institutions such as the Ministry of Finance and Planning, Ministry of Plan Implementation, Labour Department, Registrar General etc. where data are collected but all information collected is not published. All information collected and issued by these collecting organizations is called primary data.

* Agrarian Research and Training Institute.

Census data cover the entire population, but the sample surveys cover only a certain percentage of the population. Censuses are costly and take a lot of time for collection and processing. Because of this censuses are conducted once in ten years or so. But sample surveys can be conducted for specific purposes and are less costly.

In general research workers very often depend on surveys for data. Since surveys cover only a part of the population it does not mean that survey results are inferior to those obtained from censuses. Under some circumstances the survey results are more dependable than census data.

There are publications such as the Statistical Abstract, Central Bank Annual Review of the Economy, UN Year Books, International Financial Statistics etc. which compile information collected by other institutions. These are the secondary sources. Although it is more convenient to make use of secondary sources it is preferable to make use of primary sources.

The reasons why we prefer primary sources of data are as follows :

- (a) Secondary data may have errors in certain variables due to carelessness on the part of the compiler of data or due to printing errors.
- (b) Secondary data may not have the correct definition or indicate the method of collection or compilation.
- (c) If the information was obtained from a sample survey the user may not know the type of sample used, the size of the sample, the reliance he can place on the information collected and the adjustment he should effect to make the information suitable for his study.
- (d) The data may be aggregative and the researcher may not find details and breakdowns which may help him to choose the most appropriate variables.

The research worker has several options for collecting data :

- (i) Using published sources (see Appendix I for such sources) ;
- (ii) Using unpublished sources ;
- (iii) Collecting information by himself through sample surveys.

Of these the published data are the least expensive but in most cases they may not serve the purpose if sufficient care is not taken.

3. Shortcomings

The published and unpublished time series data are mostly not in forms which are readily usable for research. Therefore, sufficient attention must be paid to process the data before use. In contrast to time series data we have cross section (sample survey) data where this problem is less acute.

There is a great deal of information buried in the files of government departments and corporations. Even officers working in these departments do not realise the value of such information. Sometimes several departments collect information on the same area and invariably they are not the same. Such information is often quoted especially in public statements by different high officials on different occasions but it is very seldom that listeners as well as readers notice differences in the data quoted. Therefore, newspaper sources will not be the most appropriate ones for numerical informations.

Published data also have the shortcoming that they often do not supply the information needed for a particular research study. For example, the National Savings Bank may publish the amount of deposits collected each year but the researcher may be particularly anxious to know who the savers are - large entrepreneurs, middle-income wage earners, lower income wage earners etc. This information may not be even available in the records of the Bank as they may not have even collected this information from the depositors. To cite another example, when we wish to know separately the construction expenditure on new houses for owner-occupation and for renting, published information may not be available. In such cases one may have to check with the departments which collect these data. If this attempt fails the researcher will have to collect them himself by means of sample surveys.

Not all variables can be measured directly. In such instances proxies may be used in some cases to reflect the variable indirectly. In other cases other devices must be adopted. Some variables cannot be quantified at all. For example if one tries to explain with the help of a model the monthly earnings of agricultural labour, he will find that their earnings would depend on the season, say *Maha* and *Yala* cultivation seasons. In the model, seasons will have to be used as independent variables. How could one measure seasons? In such cases we use what are called 'Dummy variables'. Sometimes the researcher has to first define the concept in measurable terms. For instance, if one wishes to study the causes of poverty, the question arises as to how one should measure poverty. The term poverty itself depends on value judgement. Therefore, one has to first define what he means by the term poverty and then evolve a measure.

4. Need for Definition

In order to assist decision makers and other researchers, we should recognize the need to define variables. If they are not defined clearly, problems could crop up at various stages. This is more so because the same variable may mean different things to different agencies in a country, to different countries and at different times. For example, in the *Socio-Economic Survey of Ceylon 1969-70* the term 'Household' was defined as a group of two or more persons related or unrelated, who combine to occupy the whole or part of the housing unit and provide themselves with food and other essentials for living. Boarders were included if their number did not exceed three, but lodgers were excluded. Domestic servants who occupied the same premises and shared household meals were included. Persons who were temporarily away from their home were included as members of the household, while temporary guests were excluded. In contrast the Consumer Finance Survey 1973 dealt with spending units. Unless we understand the distinction between the two definitions and make suitable adjustments information in the two surveys is not

comparable and hence we are bound to make mistakes. Another example where simple unadjusted comparisons could be misleading concerns surveys on employment and unemployment where often the definitions used change from one survey to the next.

In forecasting the production of paddy several people make mistakes because they do not understand the meaning of asweddumized area and base their forecast on gross asweddumized area. Asweddumized land under paddy is defined as land which is ridged, bounded and prepared for the cultivation of paddy. Even here the output is calculated using net asweddumized area which is 85 per cent of the gross asweddumized area.

5. Need for Checks

If the research undertaken is to yield meaningful and useful results, as indicated earlier, the quality of the data is important. Therefore, the users of data must make sure of the suitability, reliability, accuracy and consistency of data. If wrong information is fed in, one should end up with wrong results. However if any one claims that he had obtained meaningful results after using inaccurate data, the decision maker should be extremely suspicious of the findings. The consequences of using inaccurate results for policy decision could be grave.

Thus a person who collects the data must also check the reliability of the data. For instance if someone observes some sudden jumps in a statistical data series he should make sure that such jumps had not taken place due to some change in definition, or method of computation. If the sudden change is due to a change in computation methodology one should ensure that the two sets of data are linked (splicing by averaging overlapping values) through the data which overlap. If this is not done any findings of your research using published data will be misleading. For example, the data given below would indicate how people can be misled by published data.

Table showing the Import Price - Index for Investment Goods

Year	(1) Index No * as given in the 1968 Report 1958—100	(2) Index No ** as given in the 1969 Report 1967—100	(3) Index No as given in the 1969 Report but converted to 1958—100
1958	100	49	100
1959	111	54	110
1960	120	59	120
1961	112	55	112
1962	92	45	92
1963	98	48	98
1964	96	94	192
1965	132	92	188
1966	185	90	189
1967	204	100	204

Source : Columns (1) & (2) Central Bank, Annual Reports

* All indices are worked with fixed weights based on the experience of the 5 years 1964—1958

* * Indices from 1964 onwards are based on the experiences of 1965-67 and are not strictly comparable with figures prior to 1964. Figures prior to 1964 which had been calculated on the experience of the 5 years 1954—58 (base year 1958) have been spliced to the new index (base 1967=100)

When the index published in the 1968 Report (Column 1) is compared with the index published in the 1969 Report converted with 1958 as base (column 3) it will be noticed that the changes in the indices over the two year period 1964 and 1965 are significantly different. In the first, import prices of investment goods have slightly fallen in 1964 but in the other they have almost doubled. In 1965 and 1966 it is the opposite, column 1 records a rise. In the first, import prices of investment goods have slightly fallen in 1964 but in the other they have almost doubled. In 1965 and 1966 it is the opposite, column 1 records a rise but column 2 records a fall, the rise being of significance during 1965 in Column I.III. When the figures in the 1969 Report (1967—100) are converted to the 1958—100 base (column 3) this discrepancy is considerably reduced except for the years 1964 and 1965.

When different institutions publish different statistics for the same variable, reconciliation becomes very necessary. For example, the Customs Department publishes data on imports of rice, flour, sugar, textiles, dried fish etc. During one period the first three commodities were monopoly imports of the Food Commissioner, the fourth that of the Salu Sala and fifth of the Ceylon Wholesale Establishment (C.W.E.). There used to be vast differences between Customs statistics and the statistics maintained by the importing institutions. There was a committee set up to investigate the causes for differences. The Committee after a detailed study identified the various reasons why the importing departments' data were more reliable than customs data. On a research undertaken earlier on per capita consumption of rice we found that meaningful results were obtained when customs data were used, and not when data of importing departments were used. However, in the light of the findings of the above Committee researchers were careful when they used Customs data. Because of the above limitation we abandoned our findings. Recently, the customs statistician had again tried to reconcile his figures with those of the Food Commissioner's. His report gives reasons why the Food Commissioner's statistics on imports of flour is an underestimate of the country's total imports. Now I feel that we should not have abandoned our earlier results.

To cite another example, the national income data and gross domestic capital in formation data published by the Central Bank are different from those published by the Department of Census and Statistics. Although some attempts were made to reconcile these differences they did not go very far. Researchers almost always use Central Bank data because they are available early. One does not know whether other sources are more dependable. For example, production data on state corporations are published by the Central Bank very early but they differ from those made available subsequently by the corporations themselves. Therefore, a lot of reconciliatory measures are required to make the data more reliable.

Most of the research publications carry a section on the sources of data. This helps one to familiarize oneself with similar work which had already been undertaken earlier. When a researcher reads articles in his field of research he may get some notion about where the information could be obtained from. Further, such reading will also give references to other studies already made in the area. Similar references to sources of data could also be had in administration reports, Royal Commissions or Presidential Commission reports and so forth.

In some studies the data required may be in respect of foreign countries. The most common sources for such data are the UN and IMF publications. In addition there may be international associations which publish data on specific areas. For instance, the International Tea Bulletin published by the International Tea Council provides information about tea. Similar sources exist for rubber, sugar, coffee etc. Since these data may also have the shortcomings enumerated above, checks will be meaningful here too.

Some data are now being stored in computer data banks. Such data can also be used. Such data I believe, will be continuously revised so that the data may be dependable and could be used conveniently by researchers.

Appendix I

The schedule below gives some idea about the types and sources of primary data in Sri Lanka (with methodology followed in some areas).

- (1) Land Area—Survey Department
- (2) Climate —Meteorology Department
- (3) Population—Various censuses of population or estimates by the Census & Statistics Department based on Registrar General Department data.
(Population by race, religion, literacy, age and marital condition, urban and rural population, gainfully employed population by industry and occupation group are available in Census data).
- (4) Vital Statistics (births, deaths, marriages, divorces etc.)—Registrar General.
- (5) Labour and Employment (Trade Unions, strikes, index numbers of earnings, monthly earnings by trade, employment)—Department of Labour.
- (6) Agriculture :—
 - (a) Paddy—Crop cutting surveys on a sample basis to estimate paddy yields (stratified multi-stage random sampling with D.R.O. division as basic strata, D.R.O. Division sub-stratified into major irrigated, minor irrigated and rainfed area. Each plot selected for sample survey is of size (33'X16½'). Paddy acreages collected each season on a parcel-wise basis on P1 Forms (a parcel is defined as a plot cultivated by one or more persons and surrounded by paddy land cultivated by other persons or by land which is not paddy). Ancillary data on crop damage etc. are collected at village level on Form P II.
 - (b) Tea, Rubber & Coconut—Acreage, production etc.—Tea Board, Rubber Controller and Coconut Development Authority, Census of Agricultural data.
Costs of production of Tea, Rubber and Coconut are estimated on the basis of information collected from a questionnaire sent out by Dept. of Census & Statistics.

- (c) Highland crops & Livestock statistics—Collected on H forms and L form primary data collected through *Grama Sevaka* by the Dept. of Census & Statistics.
- (d) Food Balance Sheet—availability of food and nutrition per capita per day computed by Dept. of Census & Statistics with data from Govt. Departments, State Corporations, Customs.
- (e) Forest area—Forest Department, Dept. of Census & Statistics, Forest Inventory Survey.
- (f) Timber—State Timber Corporation.
- (g) Fisheries—Department of Fisheries (Census and Sample survey).
- (7) Industrial production—Industries Ministry, Central Bank, Dept. of Census & Statistics, Industrial Development Board, Ministry of Textile Industries, Ministry of Rural Industrial Development, Greater Colombo Economic Commission.
- (8) Buildings—Department of Census and Statistics, Ministry of Local Government, Housing and Construction.
- (9) Energy—Ceylon Electricity Board, Ceylon Petroleum Corporation.
- (10) Transport—Buildings Dept, Motor Traffic, Police, Ceylon Transport Board, Railway, Ceylon Shipping Corporation, Customs Department, Air Lanka, Immigration and Emigration.
- (11) Communications—Posts & Telecommunications.
- (12) Prices—Colombo Consumer Price Index—Dept. of Census & Statistics (Based on Family Budget Survey of Colombo, Urban Working Class Families in 1949—50).

Wholesale prices (Colombo Town)—Dept. of Census & Statistics and Central Bank.

Retail prices (Colombo Town)—Dept. of Census & Statistics and Central Bank.
Fish prices—Fisheries Dept. Dept. of Census & Statistics and Central Bank.
Share prices—Brokerage firms.
- (13) Trade (Imports & Exports) — Customs Department.
- (14) Balance of Trade and Balance of Payments—Central Bank.
- (15) National Income—Central Bank & Dept. of Census & Statistics.
- (16) Public Finance—General Treasury.
- (17) Foreign Aid—General Treasury.

- (18) Banking, Insurance etc. (Money Supply, reserve position, rates of interest, savings deposits)—Central Bank.
- (19) Mortality and Morbidity—Department of Health Services
- (20) Crime—Police.
- (21) Status of prisoners—Prisons.
- (22) Education (Schools, students, teachers etc)—Ministry of Education, Ministry of Higher Education, University Grants Commission.
- (23) Tourism (arrivals, nationality, average duration of stay etc.)—Ceylon Tourist Board.

Main Published Sources

- (1) Registrar General's Annual Report
- (2) Customs Returns—Dept. of Customs
- (3) Statistical Abstract of Sri Lanka (Annual)—Dept. of Census & Statistics
- (4) Central Bank Annual Report—Central Bank
- (5) Administration Reports of government departments and state boards and corporations
- (6) Royal or Presidential Commission Reports
- (7) Accounts of the Island
- (8) Auditor General's Reports

Use of Archival Data

K. D. G. WIMALARATNE

National Archives

1. Introduction

The judicious selection and use of source material is an important factor in the field of research pertaining to any discipline. Even the application of any research technique will depend on the source material handled by a researcher, especially in the field of social sciences, where data are recorded on material either handwritten, typed, printed or taped, accumulated or accessioned from various sources authentic or otherwise.

Among the various source material used by the research students in the field of social sciences, archival sources are important for two reasons : (1) Archival records are accrued under certain national archival laws and not purchased, collected or accessioned as other source material. (2) They are sometimes unique and primary and also contain the archival quality or the integrity and authenticity as they are created unconsciously and accumulated by the various state institutions in their normal administration and transferred to the archives under national archives law for permanent preservation. They are preserved under the best possible conditions in the archives for the use of administrators and also constitute an indispensable national resource for research in all branches of learning including the humanities, the social sciences and the physical sciences.

There is one criticism which could be levelled against a major percentage of the records preserved in the National Archives, viz. that they necessarily reflect only the official viewpoint of the administrators of a given period as they contain documentation of policies, programmes and operations i.e. the reliable official memory of governments. Nevertheless, this official aspect of the source material could be supplemented to some extent by other source material which is in private possession. Many such privately-owned manuscripts have either been copied or documented by the National Archives and the Historical Manuscripts Commission through surveys of private manuscripts in the country. Moreover, information contained in the official archives could be checked with the material reported in the contemporary newspapers of the period the researcher is interested in, especially the newspapers critical or opposed to the government of that period. Even the oral history archives could shed light on a particular subject of a given period.

2. The Archival Collection

A research worker will be interested to know what types of records accrue to the Archives under the *National Archives Law* and other legal enactments implemented by the Archives. They could broadly be itemized in the following manner.

- (1) Inactive records of Government and semi-Government institutions which have an enduring value and selected for permanent preservation are transferred to the Archives 25 years after their creation. These include records of Ministries, Departments, Local Bodies, courts, corporations and statutory bodies.
- (2) Records of Public Offices which are to be closed down or wound up.
- (3) Records of Commissions of Inquiry, Committees of Inquiry and Presidential Commissions of Inquiry to be transferred within three months of the rendering of the final report of such commission or committee.
- (4) Copies of every annual report, statement of accounts and any other publication issued by any public office acquired within thirty days of issue.
- (5) Specimen of each new postage stamp, first-day cover, postal order form, money order form, aerogramme and post card issued by the Postmaster-General acquired within thirty days of issue.
- (6) Cancelled specimens of every new denomination of currency note and every new coin issued by the Central Bank acquired within thirty days of issue.
- (7) A copy of every map, plan, chart or other publication issued by the Surveyor-General for sale to the Public acquired within thirty days of issue.
- (8) A Candidate of any election or by-election for parliament or any local authority should transmit a copy of any election literature within thirty days of issue.

Under Legislative Enactments—

(a) Under Chapter 179 of the *Printer's and Publisher's Ordinance* a copy of any book published in the Island is preserved as the legal deposit copy.

(b) Under Chapter 180 of the *Newspapers Ordinance* a copy of every newspaper published in the Island is preserved as the legal deposit copy.

3. Arrangement of Archival Material

It is appropriate here to discuss in brief the arrangement of source material in the Archives as this would indicate to the researcher how to use the source material one is interested in.

All the archival records are arranged according to the "Principle of Provenance" i.e. arrangement according to the source of origin, where all records originating with any given institution are grouped together to form "Archive groups" or "Record Groups" of that particular institution. Thereafter, records within the group are arranged following the original pattern in which they stood under the agency which created them. Accordingly archival or record groups are the largest physical units which indicate the structure of the original administration that gave them birth. Once the main archival group is determined the sub-groups or the records of various branches created by an institution are identified and within the sub-groups record series or classes and sub-series or classes and individual files and items are determined. Items or record files may be arranged as circumstances dictate, either chronologically, geographically or alphabetically. This arrangement is followed to preserve the integrity and the originality of the archival records.

4. Use of Primary Archival Data

The use of primary archival data in a research study would enable the research student to prove his thesis or contention in a much more conclusive and authoritative manner than using secondary source material which may be contested or disproved easily. The value and quality of a research will also depend on the usage of primary and contemporary archival material which will help the researcher to understand and interpret past events rationally minimizing the distortions.

In an attempt to study the various aspects of the Portuguese period of Sri Lanka, (1505—1640 A.D.) a research worker will be disappointed as primary archival data are not available. The Portuguese who ruled the Island created valuable records relating to the maritime districts of this country. However, none of the Portuguese Archives have survived as bulk of the records were destroyed by the Portuguese themselves before their capitulation to the Dutch. The only documents which were saved from the siege of Colombo were also accidentally destroyed by the Dutch in 1700 A.D.

However, a student interested in the administration of lands by the Portuguese could use the copies of their *Thombos* and Quit Rent-Registers for the years 1614 and 1618 which are obtained from Lisbon. Accordingly, for a study of Portuguese activities in Sri Lanka one has to use and rely on the archival source material preserved in Portugal.

A student working on the Dutch period of Sri Lanka is in a much more advantageous position as the Dutch archives have survived. They consist of a continuous series beginning with the minutes of the military council held on a warship in Galle Harbour in March 1640 a little while before the fortress was attacked.

There are approximately 8000 primary records of which 5000 belong to the Central Dutch Government which operated from Colombo and the rest to the provincial unit—The Galle Commandant. In both groups the records are represented from 1640 to 1796 which cover the whole administrative set-up during the Dutch Period. The Dutch land *Thombos* pertaining to the maritime districts of Sri Lanka are an invaluable primary source material for the study of their land administration, movement and settlement of population, caste, service tenure and other related subjects. This source material is unique in the sense that it is not available even with the Colonial master the Dutch. It must be pointed out that so far no research student has made a serious attempt to use these data in an indepth study. The Head and School *Thombos* of the Dutch could be considered as records containing a wealth of material to be used in genealogical studies of the 17th and 18th centuries.

The "Political Council" chaired by the Governor was the highest administrative body under the Dutch. All the ordinary (1640-1796) and the secret (1665-1796) minutes of this body which contain the policy decisions of the Dutch Administration are available. Memoirs left by the Dutch Governors from 1650-1794, which elaborate in many cases the personality of the author, give us the best insight into the civil administration of the Dutch Period. A memoir offered any high official an excellent opportunity for explaining the

measures taken during his tenure of office and the state of affairs in general. Moreover, correspondence of the Governor in Sri Lanka with Patria (Holland) and Batavia is also a rich source material to study every aspect of their rule in the fields of trade, education, agriculture, laws and customs of the people and the relations of the Dutch with the independent Kandyan Kingdom.

Like any other well organized administration, the Dutch too issued proclamations, publications and orders, which had to be observed by the general public. Dutch publications are called "Plakkaten" or "Plakkats" which means "affixed notices". These plakkats throw light on their administration and the problems they encountered when ruling an alien country. The implementation and the impact of these plakkats on the Sri Lankan society would form an interesting piece of research. For example, one plakkat issued on 1st November 1780 abolished the Poya or the Full-Moon day as a holiday for the first time, which was enjoyed by the people of Sri Lanka since the introduction of Buddhism in the 5th century B.C.

The archival data for the study of the British administration (1796-1947) form the largest and the richest collection in the archives. This primary archival source material was formed as a result of the accrual of records from the Colonial Secretary's office which was the hub of the administration during the British period and various departments created during that time.

A research student using the primary archival data available for the British period could commence with the records of the policy making institutions which operated during that time. Firstly, the records which represent the two most important administrative bodies, i.e. the Executive and Legislative Councils. The proceedings and the decisions of these two councils consist of a continuous series from 1802—1931 & 1833—1931, respectively. However, the proceedings are also available in the printed form from 1870 in Hansards and in the newspapers from 1832.

Archive Groups which are related to the inward and outward correspondence (Despatches) between the Secretary of State for Colonies and the Governor of Sri Lanka contain a continuous series from 1798 to 1948. These include the enclosures sent with the despatches on various aspects of administration of the colony. One problem encountered by a research student using these despatches is the absence of confidential correspondence of the Governor on important issues. In order to supplement this, one would have to seek copies of these confidential despatches in microfilm from London. Moreover, the observations made by the officers of the Secretary of State for colonies regarding the despatches sent by the Governor of Sri Lanka could only be obtained in London. When using the despatches one should guard against the partisan viewpoints or reports of the Governors, who based their correspondence on the information and material supplied by the British officials and natives who supported the British. Nevertheless, the inward and outward despatches throw light on the administration of the policy makers at the highest level.

There are two very important record groups but rarely used by the research students which consist of the inward and outward correspondence of the heads of various government departments and institutions with the Colonial Secretary (Governor) on various

aspects and problems of administration. These two archival groups contain source material at the grass-root level where the thinking of the British civil servants, the impact on the colony and the reaction of the natives are recorded.

The rest of the archive groups under this period relate to the provincial, local and judicial administration of the Island. In particular the records on provincial and local administration throw useful light as these reflect the impact of the ruler on the ruled. Indeed the study of British colonial policy and its impact on Sri Lanka cannot be considered complete without utilizing and referring to this source of primary archival material preserved in the archives.

The archival material available since the gaining of independence on 4th February 1948, consists of the records of the public institutions and bodies which were established after Independence. Moreover, the creation of state corporations and statutory bodies since 1957 added a different kind of archival source material as the objectives and ventures of these corporations were much more broad based than the government departments. In addition minutes of evidence, proceedings and other material generated by official commissions and committees are also deposited in the Archives.

The establishment of the Presidential archives in 1978 introduced a new feature to our archival system where future scholars will gain access to the official, semi-official and even private records of the executive presidents of Sri Lanka.

5. Use of Secondary Archival Data

The use of the available secondary archival data for a research project could sometimes usefully supplement and complement the primary archival data he is making use of. Although one could identify certain archival data as secondary because they are in print, it does not mean that they are not valuable material for research. One reason is that the data contained in these secondary sources would be contemporary in spite of the fact that they are in print.

The Gazettes (1802 to-date), Proclamations, Orders, Regulations, Minutes of Governors, Ceylon Almanac (1815—1862) continued as Civil List from 1863, Hansards (1870 to-date) Blue Books (1821—1938), Legislative Enactments, Parliamentary Acts and Laws, Sessional Papers (1860 to-date) Administration Reports (1867 to-date), Census Reports (1814-1971), Civil Service Manuals (19th and 20th centuries), Gazetteers (19th century), which are government publications, could be utilized as valuable source material.

Ferguson's Directories (1863 to-date), and newspapers-Sinhala (1860 to-date), English (1832 to-date), Tamil (1864 to-date) and Malay (1925-1952) and publications received for legal deposit (1885 to-date) although considered as secondary source material, contain important information for research. For example it is always better to cross-check with other available sources whether the information contained in the newspapers was reliable.

Field Data Collection

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1. Introduction

Field data collection as the title connotes is the collection of data in the field as opposed to abstraction of information from published documents. Field data could be any of the following four main types; socio-economic data, agricultural data, industrial data or commercial data. The collection of each type has different techniques as well as its own problems. In this paper only socio-economic data collected through household surveys will be discussed.

2. Definition of Household

What is meant by a 'Household'? Some of us have the general impression that it is a biological unit, i.e. a group of blood-relatives living together and sharing meals in a given housing unit. However, for socio-economic surveys we do not use a biological definition of household. Instead we use a much broader *de facto* definition to include all those who live together and cook together. In Sri Lanka, in this definition of household we include servants and boarders who share meals with the rest of the household.

3. Frame for the Survey

Here the term 'Frame' refers to a list of households from which the sample is taken. In Sri Lanka usually the household list prepared at the last census is used to select the households for official surveys. The list generally suffers from defects such as omission, duplication, obsolescence and other inaccuracies. Hence the list has to be either revised or an entirely new list prepared before the sample is selected.

The revision of an existing list or the preparation of a new list is described as a 'Listing Operation'. Like in all aspects of field surveys, in listing operations also there are many practical problems that must be overcome. In particular the enumerators employed for the job must be properly instructed and supervised. Experience indicates that some enumerators resort to deception and supply either incomplete or fictitious household lists.

4. Enumerators

Enumerators can belong to two categories: those who belong to the permanent field staff of the organization conducting the survey or those who have been selected for the particular survey on a temporary basis. Experience in this country suggests that of the permanent field staff about 10 per cent are useless and therefore, we should select an extra

10 per cent to do the field work. If we select people temporarily, often they leave halfway through the survey when they get another job or do slipshod work as they are not going to lose in the long run. They know that they will be discontinued after the field work is over. Hence one should exercise great care in the selection of enumerators.

5. Deployment of Enumerators

When we deploy enumerators, the general practice is to give the enumerators areas in close proximity to their homes. Although this has some advantage as far as cost is concerned there are a lot of disadvantages. The enumerator being a person known to the respondent, the latter will be reluctant to disclose certain information on income, demographic characteristics and family planning. Also the enumerator being a local person can bias the result to suit his interests.

In order to eliminate possible errors due to faulty enumeration, statisticians use a technique known as an Inter-penetrating network of sub-samples (IPNS). Suppose in a given area there are 1000 households to be surveyed by 10 enumerators. The 1000 households are divided at random into 100 units, each consisting of 10 households. These units are allocated to each enumerator again at random. Thus, the sample covered by each enumerator will be spread throughout the area at random. Then, when the results are tabulated using statistical techniques such as the analysis of variance and fractile graphical analysis it is relatively easy to isolate any enumerator who has failed to perform his job satisfactorily. Assuming that such cases are proportionately few, say 10 or 20 per cent, we are still left with an adequate sample to complete the analysis.

6. Method of Data Collection in the Field

Data could be collected by either (a) direct observation or measurement or (b) inquiry. Only a certain type of data can be collected by direct observation or measurement. Most of the information has to be obtained by inquiry. The respondents do not always give truthful or correct answers. Sometimes they are ignorant, or cannot recall, or make a deliberate attempt to suppress information.

To get better results, the questionnaire approach rather than the schedule approach should be used. In the former case, the questions are so designed as to get the correct information. In the latter case it is left to the ingenuity of the enumerator to elicit accurate information.

7. Commencement of Field Work

It is absolutely necessary to have good rapport with the respondent. This will help to obtain accurate and reliable data. A brochure explaining the purpose of the survey, the organization conducting it, with a guarantee that personal information will not be divulged but statistical averages only will be published, should be distributed in advance to the respondent. This should be in the language he is most fluent in. The enumerator should carry out the work at the time and day convenient to the respondent. He should be humble in his approach and win the goodwill and confidence of the respondent.

8. Persons Interviewed

As far as possible the chief occupant of the household should be interviewed. If the chief occupant is ignorant or not available some other knowledgeable member of the household can be interviewed instead. It is best to conduct the interview in private. If embarrassing questions have to be asked, it is best done discreetly.

9. Pilot Survey

A pilot survey is generally done to test the questionnaire, train enumerators and determine the probable cost and size of the sample required. In short, in a pilot survey, field conditions are simulated.

10. Supervision

No field survey should ever be undertaken without proper supervision. The supervisor should accompany the enumerators to the first few houses to ensure that the enumerator interviews the respondent according to instructions. He must go afterwards to determine whether the enumerator actually visited the house during the survey. Also, he must do consistency checks pre-planned by the survey organization. It is also his function to ensure complete coverage, completeness and consistency of information as far as possible.

11. Non-Response

In no field survey do we get a one hundred per cent response. Therefore action should be taken to eliminate or reduce non-response as far as possible. The crudest method of handling non-response is to simply ignore the non-respondents. However, this can introduce errors into the survey because it almost invariably happens that the pattern of the people who respond is different from those who do not respond. Another solution to the problem is to substitute new households equal in number to the non-respondents. This will help to reduce but not necessarily eliminate the non-response errors. A still better method is to reach the non-respondents by a second or third visit. For example, if nobody was available in a particular household when it was visited by the enumerator, a second visit is made. The period earmarked to conduct the survey can be extended, and a sub-sample of non-responding units can be taken and enumerated. This technique cannot be used for data dependent on time factor (e.g. Census).

12. Post-enumeration Survey

Wherever a complete enumeration such as a census is undertaken, it is necessary to determine the extent of under-enumeration. For this purpose a sample of census households is taken and the sample information is matched with the information obtained at the full census. This will help to determine the extent of under-enumeration.

Questionnaires

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When social scientists require data which must be reported by individuals out of their own experience, direct communication becomes necessary. The instrument which is most frequently used for measuring characteristics, attitudes, expectations, perceptions and anticipated behaviour of a respondent is the questionnaire. The best method of obtaining responses to a questionnaire is the personal interview, particularly where some of the respondents may be illiterate. Some of the more important guidelines in formulating questionnaires are summarized below.

A question may be asked or read as written, or it may be a form to be filled in, accompanied by instructions. Questions may be open, i.e. to be answered in the words of the respondent, or they may be closed questions, with answers in categories specified by the researcher. The latter is easier to process but the possibility of misinterpretation by the respondent is greater. Closed questions may take many forms, ranging from dichotomies to multiple-choice and rankings.

A questionnaire must be pilot-tested in order to remove ambiguities in questions, to make questions comprehensible to both respondents and interviewers and to make the questions fit all respondents.

It is rarely that a question does not receive an answer. Care should be taken to make sure that the respondent has the required knowledge, because respondents may not like to admit ignorance. Answers to questions involving memory-recall become less accurate the greater the time that has elapsed since the event.

Direct questions do not always yield accurate information on items such as age, income, social class, inside information about job or institutions or the respondent's own shortcomings. Indirect questions often become necessary in such instances. Ranges or categories may have to be introduced in place of actual values.

Questions which lead to socially desirable responses should be avoided because they do not yield correct information. A respondent's true attitude has been found to be revealed when he is asked to put himself in another's position and answer the question concerned.

Questions that take one side of an issue should be avoided, e.g. asking about advantages without disadvantages may lead to biased responses.

In asking some questions the reason has to be kept in mind, e.g. questions on employment during a season of unemployment may evoke biased responses.

Words and expressions which are not familiar to the respondent lead to erroneous or biased answers, because the respondent may not admit that he has not understood the question. Technical words and terms should be defined. This becomes necessary even

in a simple question such as "What is the distance to your co-operative store?" In this case the real distance may be very different from that along a short-cut used by the respondent. A further problem arises here in that an individual's perception of distance may not agree with actual distance.

A question should be limited to one idea, and should be as short as possible.

Leading questions, i.e. questions that suggest answers, should be avoided. A question that begins with "Do you sometimes" has greater chances of eliciting a positive answer, while one that begins with "Do you always" is more likely to draw a negative response. Words such as "all, every, sometimes, never, and not" should be avoided as far as possible.

An open question does not lead the respondent and therefore may suggest new lines of investigation that have not occurred to the investigator, but, by not leading, it may elicit a superficial answer, or answers which may be irrelevant to the survey. A closed question, while overcoming the disadvantages of the open question, enables the respondent to conceal the lack of understanding, or to avoid giving the correct answer if it is not in the check-list. Some respondents may consider several answers relevant, but may be prevented from stating them if asked to select one answer. Asking for the most important answer or for a ranking of answers sometimes gives a better picture of the correct situation.

Questions should be arranged in such a way that they follow each other in a connected manner. Questions of a personal nature should be asked towards the end, after some rapport has been established between investigator and respondent. A questionnaire that takes a long time to fill, say more than an hour, may not be a success.

Today survey data gathered through questionnaires are often processed with the help of a computer. Experience suggests that wherever possible it is highly desirable for the persons chosen for programming and data processing to have a social science background. It can avoid a great deal of confusion and mistakes that otherwise could occur due to the unfamiliarity of the persons concerned with concepts and terminology in the social sciences. However, if such persons cannot be found — and this is often true of computer programmers who tend to have non-social science backgrounds — the non-social scientists chosen for the job should be associated with the project at least from the questionnaire formulating stage. This will ensure an interchange of ideas which will be of mutual benefit to the programmers and investigators as well as the researchers.

In survey-based team research projects sometimes the principal researcher tends to keep aloof and hand over the task of the survey and data analysis to colleagues or subordinates and he only wants the results. But this is an unwise practice. The principal researcher should participate in the project at all stages including the questionnaire formulation and pilot test stages. The researcher who knows the theory and wants to test a hypothesis has to be present to define concepts when the questionnaire is formulated. The pilot test stage is also important because most of the errors in the questionnaire would be revealed at that stage.

The Interview Method

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1. Introduction

In any branch of knowledge where human behaviour is the subject of study, one has to elicit most of the information from human beings themselves. One method of eliciting such information consists of disciplined and organized conversation designed to achieve a specific purpose. It is such conversation that I define as the interview method.

The interview method is employed in the collection of data and information by conducting field surveys. There are several reasons as to why researchers have to collect data by means of field surveys. Firstly, the available data may not be up-to date. Secondly, they may not be sufficiently reliable. Thirdly, they may not be in a form that is suitable for the planned study.

There are other reasons for the need to collect data by means of field surveys, especially in the developing countries. Over the past few decades interest in planning and development in the developing countries has been growing. This has necessitated the collection of a mass of new information and data on various types of variables without which practical planning is found to be almost impossible. Moreover, the most recent trend in some of these developing countries has been to lay emphasis on regional development. In Sri Lanka, for example, we have a regional development programme going on under the name of District Integrated Development. A great deal of factual information is required to formulate such regional level plans, but unfortunately very little of it is available. Hence the need for collection of fresh data.

2. Methods of Collecting Field Data

There are at least six methods used commonly to collect field data. The first is the survey method. In surveys one goes to the field with a questionnaire and collects the necessary information after interviewing the selected respondents. The enumerator or researcher may make one or several visits, the number depending on the requirements of a particular survey.

The second is the 'cost route' method. Under this the enumerator might have to visit the respondents several times, again depending on the requirements. The difference between the first method and this is that in the first method one does not take into account the changes that take place in the field over time. Under the second method, in addition to recording the data we get from the respondents an attempt is also made to incorporate into the study certain observations relating to the changes that go on in the field.

The third, which is normally employed in classical anthropological studies, is called the participant-observation method. In this method the enumerator or researcher while collecting data and information makes an attempt to gain insights relevant to the study by participating in the activities in which the respondents are engaged. By this means the researcher is able to closely observe the underlying behavioural patterns which remain elusive to the mere interview method.

The fourth is the non-participant observation method. In this method the enumerator or interviewer does not actually participate in the activities of the respondents. He observes them and their activities from a distance and without direct involvement.

The fifth is the direct measurement method. One might wonder whether there is any need for direct measurement in social sciences. There are instances where, even in the field of social sciences, the enumerator or researcher has to collect data by means of direct measurements in the field. For example, in agriculture, data relating to field size, output and yield may have to be collected by means of such measurements.

The sixth and the last is the group interview. The group interview consists of getting a number of persons together rather than isolating one member from the group and then discussing the relevant issues with the group. The purpose is to verify whether there is a consensus regarding the issues under consideration.

From the above it is seen that the interview method is used in three — the first two and the last — of the six methods of field data collection.

3. Preparatory Work

A considerable amount of preparatory work has to be done if we are to conduct fruitful interviewing. It has to be well-organized and well-disciplined as the main objective is to elicit selected information in a reliable manner.

I have been able to identify several major steps that have to be taken in preparation for conducting interviews. The first of these consists of selecting the area of research both geographically and subject-wise. Next, the people residing in the selected survey area have to be kept informed of the intended field investigation. This is very important as the success of interviews depends on the degree of co-operation one gets from respondents. Unless the correct relationship is established and the information needed for that is provided this co-operation is not likely to be forthcoming. This aspect should receive particular attention as people in general and villagers in particular are cautious of unknown outsiders who probe into their affairs.

Several methods can be employed to gain the confidence of prospective respondents. If a vast area has to be covered press notices or announcements over the radio can be used. Otherwise it is possible to make use of government employees functioning at the village level. In our country *Grama Sevakas*, Cultivation Officers and Agricultural Extension

Workers (*Krushikarma Viyapthi Sevakas*) are the village level government officers often used for this purpose. Making use of influential people in the selected survey area also becomes necessary. There are both advantages and disadvantages in these methods.

If we use either press notices or announcements over the radio, we might not be able to reach some of the illiterate or the poorer groups of people and hence they would be unaware of the intended survey. If one enlists the help of village level officials there is the advantage of their being known to the people of the selected area. When introduced by them, the enumerator or researcher is likely to be taken more seriously by the people. At the same time there are certain disadvantages because when village level officials accompany the researcher there is a likelihood for the expectations of the interviewees to rise. They would suspect the researcher to be a high government official coming to identify and solve their problems. An expectation of this nature in the respondents inhibits the flow of accurate information we are looking for. Placed in this situation respondents normally overstate their problems and understate their wealth, income, consumption, savings and so forth. There is another danger. Since the village-level officials are familiar with the villagers the former may even try to dominate the interview by not allowing the villages to express their free opinions. Moreover, the official accompanying the researcher might try to attend to some of his official matters with the selected respondents and thereby use some of the time that otherwise might have been available for the interview.

It is important to remember that no ready-made formula could be given as to which method is most suitable. This depends on the situation and the context. Good judgement has to be based on one's experience in the field. However, it is useful to bear in mind the points discussed above so that one is, at least, aware of the problems that have to be avoided.

4. Administrative Arrangements in the Field

Not many administrative arrangements may be needed in the field if the researcher himself is going to conduct interviews with selected respondents. However, very often the researcher may not be able to conduct such interviews by himself. Then enumerators have to be employed, and one has to look into their comforts and needs. Unless they are kept happy by attending to their problems, there cannot be much hope of getting the desired results. As regards the enumerators' problems arrangements have to be made for transport and accommodation. Sometimes, there may be other kinds of problems that develop as a result of the loneliness and the monotony of work they are made to go through. Due to these, if enumerators give a useless set of data, the resources and time spent become a wastage. Therefore, at the stage of selection, it is advisable to pay attention to the enumerators' personal and physical condition. When these considerations are taken into account it is preferable if the researcher is able to have full command of all the resources available—personnel, financial etc.—in making the necessary administrative arrangements. However, sometimes in collaborative research (e.g. Universities and Government) there could be dual control. Indeed there are occasions when enumerators are chosen and paid for by one and are expected to work for another.

When the researcher is not the paymaster he might find it difficult to discipline the enumerators and this could affect the quality of work. Therefore, if the researcher has no command over the resources, it is always advisable, as far as possible, to convince the persons who have got the resources of the importance of making proper arrangements for the field staff to function in keeping with the survey requirements.

5. Interview Programme

A well planned interview programme is essential for a successful field survey. Selection of the sample of respondents and giving the enumerators a set of questionnaires alone are not sufficient. A timetable must be laid down. In the programme provision must be made for the following items : (a) interviewing of respondents on fixed dates ; (b) procedure to be followed in solving problems encountered by the enumerators without much loss of time and money ; and (c) intermittent meetings between the researcher and the interviewers.

6. Selection and Training of Enumerators

The selection and training of enumerators is an important aspect of any survey as the success of data collection depends on the persons who are selected for the job and the training given to them. In the selection of enumerators, age, sex, education and experience are some of the important aspects that must be taken into consideration. Due to some constraints if interviewers with lower qualifications have to be selected, then in compensation they have to be given a longer period of training. The attitude of interviewer is also important. All persons are neither fit nor willing to do this kind of job because it needs patience and hard work. Without patience, the interviewer may not be able to get the necessary information. In addition to the correct type of attitude the cultural background of the enumerator also becomes relevant. For example, a man who has been brought up in an urban environment might fail to function satisfactorily as an interviewer in a rural area.

It is advisable to select initially a few more than the required number of interviewers to allow for dropouts during and after training. The period of training depends on the educational level of the interviewers and the type of work they are expected to do in the field. The latter depends on the complexity of the research project and the type of respondents who are to be interviewed.

The training has to be conducted in the classroom as well as in the field. The available time may have to be allocated between the two according to the situation and to suit the particular needs. In the classroom firstly, a general idea can be given of the area where the survey is going to be conducted. The interviewers must be made familiar with the beliefs, customs and the ways of behaviour of the people who are to be interviewed. There could also be other aspects of life peculiar to the area. For example, weights and measures used in the area may be different from those that are in general use. If the interviewers go to the field without getting a knowledge of these, they are likely to face difficulties in both getting the information and also filling questionnaires.

Secondly, questionnaires have to be explained in great detail. Unless sufficient time is devoted to this there is the risk of the questions being understood in different ways by different persons, including interviewers. Definitions have to be worked out according to the variables chosen and these have to be clearly explained to the interviewers.

Thirdly, the interviewers need proper guidance and even some training in the technique of interviewing.

Filling questionnaires by the interviewers must be an essential part of field training and this must be done under the direct supervision of the researcher so that any mistakes can be pointed out and corrected as and when they are made.

At the end of the training class, a detailed instruction manual for the use of interviewers in the field should be prepared and a copy given to each. This helps them clarify any doubts that may occur when they go to the field after their training.

7. Meeting Respondents

In meeting respondents for interviewing several aspects have to be taken into consideration: (a) locating respondents, (b) introducing interviewer to respondents and, (c) introducing the research study and its purpose to respondents. In all this an assistant recruited from the survey area itself can be helpful. Respondents in certain instances would want to talk first and come out with their own problems. In such instances the interviewer should be prepared to listen to them. Respondents must also be given the assurance that whatever information collected would be used only for the study purpose and kept confidential. Establishing the correct relationship with the respondent in this manner is important. Becoming too familiar with the respondent is undesirable as he would tend to feel embarrassed to divulge some of the information. The importance of the need to meet the respondent at a time convenient to him should not be overlooked.

8. How to ask Questions ?

There are at least 10 points that an interviewer must bear in mind when asking questions from respondents.

1. The language the interviewer uses must be understood by the respondents.
2. A teaching style should not be adopted in talking to respondents.
3. In explaining the questions given in the questionnaire care should be taken not to distort their meaning.
4. The interviewer also should refrain from asking leading questions which suggest a certain answer and introduce a bias.
5. Unreasonable or embarrassing questions should not be asked.
6. Sensitive topics must be either avoided or handled discreetly.
7. Probing is necessary.

8. Care must be exercised to note down any discrepancies in the answers given and to elicit the most accurate information as far as possible without giving the impression of disbelief to respondents.
9. Even though respondents may give inaccurate answers or behave in a resentful manner interviewers should not get involved in any arguments with them.
10. The interviewer has to be very skillful and cautious in getting correct information on the following aspects:
 - (a) output and income generally underestimated;
 - (b) cost generally overestimated;
 - (c) Labour inputs: farmers are usually unable to give them to meet the survey requirements;
 - (d) savings and assets not readily divulged to an outsider;
 - (e) Land sometimes given in local units and measures and the nature of tenure is not readily disclosed;
 - (f) qualitative variables pertaining to knowledge, attitudes and opinions—careful recording is necessary to guard against possible misrepresentation.
 - (g) The distinction between opinions and facts—questions designed to elicit facts must be separated from those designed to elicit opinions.

9. Mechanics of Recording

Recording must be done as far as possible when the interview is in progress. Whenever necessary explanatory notes should be included in the questionnaire itself. Doubtful points must be verified and rechecked. The completed questionnaires must be rechecked and corrected before despatching to the researcher as instructed.

10. Problems in the Field

In conclusion, brief mention should be made of a few problems one has to face in carrying out a field survey by using the interview method :

1. Cheating by interviewers ;
2. Lack of response from respondents ;
3. Offending influential persons in the local community—this could make data gathering a very difficult and unpleasant task ;
4. Difficulty of locating and meeting respondents ;
5. Determining the head of a household—i.e. the person who makes the managerial decisions of the household ;
6. Identifying the family unit in a household.

It is only by means of good planning and thorough preparation before a field survey is carried out that these problems can be satisfactorily overcome.

Data Collection in the Social Sciences with Special Reference to the Open Interview Method

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This study consists of three parts. Part 1 provides a brief account of an array of data collection methods adopted by the social scientists. Part 2 is devoted to an examination of the open interview method and its relative advantages in data collection. In this section the open interview method is compared only with the direct questionnaire method which is perhaps the most commonly used method of field data collection. Finally, the strategies that the investigator should adopt in conducting an open interview are set out in Part 3.

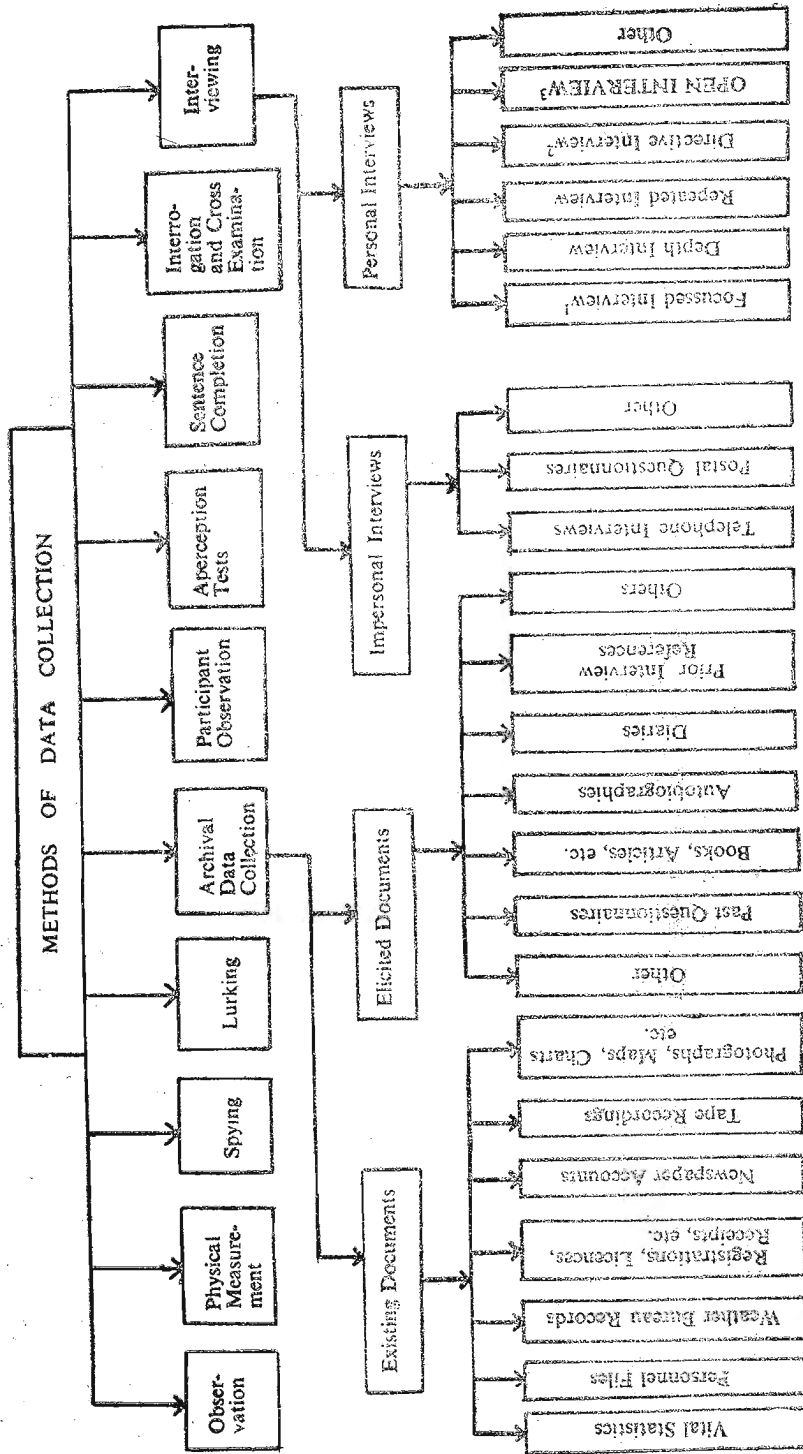
1. Data Collection Methods

Social scientists adopt various devices to collect raw data and the selection of a particular method depends on a number of factors. They include :

- (a) the objective of the research study ;
- (b) the resources such as finance, equipment, material and man-power available ;
- (c) the time available design a research project, plan and execute field work, process data and write the research study; and
- (d) the preference of a particular method by the researcher and the skills that he has acquired in the use of that particular method.

The existing data collection methods are being constantly improved in their application to collect field data and new methods are evolved from time to time. *Thematic perception tests* and *lurking* are two such new methods in use. A brief survey of the available literature on data collection devices adopted both in the developed and the developing countries enables us to identify a number of methods. They are presented in Fig. 1.

Observations—It is perhaps the simplest and the oldest method of data collection. The researcher makes observations to familiarize, experience or understand a place, object, person, situation or phenomenon.



- Note:
1. Focused interview is also called semi-structured interview or semi-standardized interview.
 2. The other names used to denote directive interview are: direct interview, standardized interview, active interview and controlled interview.
 3. Unstandardized interview, unstructured interview, passive interview and guided interviews—all refer to Open Interview.

FIGURE 1

Physical Measurement—A researcher sometimes makes a physical measurement of observed phenomena. If a researcher observes that an omnibus is overcrowded he may count the number of passengers to determine the degree of overcrowding in that bus. In this situation, the physical measurement (or count) which follows the observation assists him to refine or give precision to his original observation. Still, in another situation, a physical measurement may precede a concrete observation or determination. For instance, only if a bushel of paddy is physically weighed is the investigator able to determine or observe the exact weight (in pounds) of that bushel of paddy.

Spying—This method is employed to familiarize, assess and determine specific positions in advance. Spying is common in world power politics. It prevails at international levels (Russians spying on Americans & *vice versa*), national levels (Watergate bugging) and at local levels (in political campaigns). The police uses its intelligence service (spy service) to assess in advance the likely strength of street riots and strikes. In spying, the investigator remains unobtrusive and often he uses equipment ranging from the most sophisticated to the simplest. Spying involves a very high element of risk. If exposed the investigator may even face death, torture or imprisonment.

Lurking—Lurking may be defined as a process of observing a particular thing by loafing about stealthily during a very short period of time. A researcher may lurk to get some sort of evidence to either accept or reject a particular suspicion or doubt in his mind. Unlike in spying, it will have no continuous flow of action. It is done on the sly and the lurker moves quickly out of the scene. Like spying, lurking is risky but to a lesser extent. At the most a lurker may be heckled, blamed, ridiculed, or threatened if found lurking.

Archival Data Collection—It is the examination of documents in search of necessary information. This method is particularly useful to the historians and other social scientists to study a subject in a historical context. Archival data could be collected from two types of sources. They are the *existing records* and *elicited documents*. Existing records generally contain recorded statements with very little or no interpretation of the facts recorded. Vital statistics, weather bureau records, registrations, licenses, receipts, newspaper accounts, films, tape recordings, photographs, and maps fall into this category. The elicited documents contain interpretations of facts collected or known in advance. They include past questionnaires of surveys, text books, journal articles, feature articles in newspapers, diaries, autobiographical records, prior interview references etc.

Participant Observation.—In this method, the investigator participates in the activities of his informants in so far as circumstances allow. Often it is necessary for the researcher to live and sometimes work with his informants, conforming to their life styles and, where necessary, to learn the language of the community. The most important thing is that the investigator has to gain admission to the society in which he plans to work, observe and collect data. Hence very often the traditions and customs of that society have to be adhered to by the investigator to get him accepted by his informants. Only when the investigator is acceptable to the society and no longer a total stranger is the 'social distance' sufficiently reduced, facilitating close observation. It is usually the anthropologists who use this method to collect necessary data.

Perception Test.—The use of thematic perceptions test is a relatively recent technique developed in the United States. It is simply the use of pictorial aids to elicit inner feelings of a respondent's past experiences and interpretations of those experiences. For instance, if the researcher needs to get interpretations of the past experiences of cyclone victims, a photograph indicating a person or a group of persons marooned in a cyclone is shown to them. Then they are able to recall their past experience of cyclones and describe them effectively to the investigator. In studying the farmers' perception of drought in the 'dust bowl' of the United States Saarinen (1966) employed this method very successfully. When a photograph of a person standing on a sun-baked, cracked land, looking downwards rather dejected, against a background of a dust storm, was shown to the informants, they gave their own experiences of past droughts and what they felt about droughts that frequented their homeland, without any difficulty in recalling or describing drought. This method has become increasingly popular in the 1970s particularly among those who are engaged in natural hazard perception studies.

Sentence Completion.—Like the perception test, the sentence completion device could be used effectively to collect raw data needed in attitude measurements. Suppose the researcher needs to know the nature of the psychological stresses and material losses of the victims of a recent cyclone, this method could be used effectively. Rather than directly asking a cyclone victim, "What are the losses that you incurred during the recent cyclone?", it would be best to inquire in the form of an incomplete sentence such as 'During the recent devastating cyclone among others we lost. ' and allow the informant to continue the statement. He will very willingly and frankly continue to say all what he lost during the cyclone in question. However, a sentence completion device may not be able to be used successfully among illiterate informants. If an informant is illiterate the sentence completion method boils down to the directive interview method because the investigator has to read out the sentence and wait for an answer which is more or less the same as asking a direct question.

Cross-examination and/or Interrogation—This method is used to collect guided information from a respondent. If the investigator decides in advance that the respondent is likely to evade the provision of correct information, then, a certain amount of psychological stress is brought on him. In a court of law a witness is required to swear before the judge that he "tells the truth, the whole truth and nothing but the truth". The lawyer, in the course of a cross-examination often asks "rapid-fire" questions and makes constant cross checks of the evidence furnished. Such devices bring psychological stress on the respondent and he is kept strictly to a guided tract in providing information. To understand the implications of the case before the courts and collect sufficient evidence to pass a fair judgement, such a device is indeed appropriate even though the respondent's freedom of expression is limited and strictly guided. A police officer interrogating an accused also often brings psychological stress on the respondent in order to gather sufficient evidence to pursue legal action in respect of the case in which the accused is involved. Instances are not rare where even physical force is brought on the accused in interrogation.

Interview.—When historically viewed, it is to be observed that this method was first used to diagnose ailments and recommend therapy or prescribe medicine. With the passage of time it was adopted as a criterion to select physically fit and reasonably intelligent persons for employment.

Interviewing is the process in which two parties conduct a face-to-face cordial verbal exchange of ideas in which the investigator attempts to elicit information and expressions of opinions or beliefs from the informant. Such a dialogue is intended to yield some sort of *measurement* or evaluation of the opinions or beliefs expressed at an interview however rudimentary. The ultimate objective is to relate the variables measured to one another at the interview itself or shortly afterwards or to possess required information to make an evaluation at a later date.

Interview techniques are vast and varied. Next to the archival data collection method interviewing remains the most popular method adopted by the social scientists to collect upto date and reliable data. Unlike in cross-examination and interrogation the investigator should not try to dominate an interview. An interview turns out to be an interrogation or cross-examination no sooner than the investigator attempts to dominate, control, demand or ridicule the respondent. Unlike in an interrogation or cross-examination, at a interview the respondent has the liberty to refuse participation.

All interviews could be broadly divided into *impersonal interviews* and *personal interviews*. Impersonal interviews are used to collect information without the investigator meeting the respondent in a face-to-face situation. Telephone interviews and the use of postal questionnaires are two commonly used impersonal interview techniques. Personal interviews are cordial verbal exchanges between two parties in a face-to-face situation. The two parties involved could be of varying numerical strength: one investigator and an informant; one investigator and several informants; two investigators and several informants or several investigators and several informants. The situation where several investigators question a single informant becomes more an interrogation than an interview.

There are several types of personal interviews. Often the same process of interviewing is given different names by different social scientists (Fig 1) which is a problem of taxonomy. A brief introduction to some of the major interview types is provided in the few paragraphs below.

Focussed Interview— A focussed interview is used to gather more information about a concrete situation which is already known to both the investigator and the informant. The informant is interviewed by the investigator to know exactly what the former thinks about the subject in question. Thus, the selection of informants for a focussed interview is strictly determined by the fact that the particular situation under reference is known to the investigator and the informant. It is often focussed on the subjective experience, attitude, emotional responses and definite mental association in respect of the particular concrete situation under study. If the investigator wants to know the views of those who have seen a particular film that the investigator himself has seen, the informants have to be selected

only from among those who have seen the same film and the questions have to be based on the subject matter of that film. The interview is focussed on a particular subject matter and a particular group of informants.

Although the whole situation is carefully structured and the major areas of inquiry are mapped out in advance, the informant once selected is given the freedom to express his definition and views of the situation that are presented to him. This type of interview is, sometimes regarded as *semi-structured* or *semi-standardized* interview.

Depth Interview — It aims to elicit information especially related to personality dynamics and motivations. This type of interview can effectively reveal psycho-social situations which are not otherwise readily known and yet may be crucial for understanding observed behaviour and repeated operations and attitudes. However, unless the researcher has a highly specialized training in this method of interviewing for collection of information on specific areas of mental situations such as calamity, it is best not to adopt it because it needs psychoanalytic penetration. Sometimes an allowance of sufficient time is necessary for the emergence of genuine feelings of the informant. In certain situations the investigator must have a lot of patience in extracting information from the respondent. Sometimes effective consoling of the informant is necessary. Yet in another situation, the adoption of aggressive strategies such as "rapid-fire" questioning to elicit information quickly and rather forcibly from an emotionally distorted informant becomes a necessity. In such varied situations an amateur can do more harm than good to a depth interview. Above all, an amateur investigator could do lasting damage to the mental situation of an informant. Hence amateurs, particularly on their own, should not employ this method to collect raw data.

Repeated Interview — It is sometimes argued that a repeated interview is not a method by itself but only an aspect of the *directive interview*. Surveys such as Sri Lanka's *Consumer Finance Survey* could be cited as examples in support of this argument. In Sri Lanka's *Consumer Finance Survey*, certain information is required to be collected repeatedly over a specific period of time. In such a survey if one of the objectives is to determine the average household expenditure on the consumption of food, the selected households have to be visited daily or once in every two or three days for a week or two, to collect the necessary information as accurately as possible. Repeated visits are necessary because it is difficult for the informants to keep in mind all the expenses incurred on food items over an extended period of time.

The repeated interview under reference here is closer to the focussed interview which also refers to situations which have been at least partially known and/or analysed prior to the interview, rather than to the above cited example of repetitive collection of consumer data. If the investigator wishes to know how the voters make up their minds as the election day draws nearer and nearer, repeated interview is the best method. It is common knowledge that voters change their minds as the election day draws nearer and nearer. But what is essential to know is how it takes place and what ratio of voters are in favour of which candidate. Hence, the voters have to be repeatedly interviewed at

certain specific time intervals of from time to time as the need arises to update the knowledge about the constant change of minds of the informants. It is difficult to know this from a single focussed interview.

2. Open Interview

An open interview is simply a group discussion. The group should be formed with a manageable number of informants, preferably 6 to 10 persons. It is essential that a restricted number of informants is selected so that the discussion is kept well under the control of the investigator (s). The investigator needs to be skilful in selecting suitable participants to take part in the discussion. A prior familiarization with the people in the community would be of immense use to the investigator to select suitable participants.

The attempt here is to show where the open interview method can be best employed to collect data necessary for a research project. It seems that this could best be achieved by comparing the open interview method and the directive interview method with each other.

- (i) In an open interview, it is necessary to have some pre-thinking to formulate at least some major questions necessary to collect the required data. For the investigator's convenience, it is useful to have a list of questions by his side so that at the end of the interview he can make sure that no major questions remain unanswered. However, if the researcher himself is the investigator and the objectives of the research very clear to him, then he need not necessarily have a rigid questionnaire by his side. He can develop the questions as the interview proceeds. Thus, there is much flexibility in developing the questions in an open interview. It is certainly an advantage in that the informant could be encouraged to state his concrete view on the subject matter of the question put to him. The informant has the full liberty to describe whatever event or point that seems important to him. In the directive interview, the questions are pre-planned and listed in a document with a sequence that the researcher thinks is the best to assist the informant in providing the required information. Even the wording of the questions is pre-determined. The investigator generally has no freedom to change the questions, wording of the questions, or the order of the questions in the questionnaire and the informant must answer only the questions put to him.
- (ii) In the directive interview method the fact that no freedom is given to the investigator to re-cast, reword or change the order of the questions after doing them in a pilot survey has a distinct advantage—i.e. it minimizes the investigator's bias particularly if he is a novice. Whereas in the flexible open interview method, such provisions could lead the investigator's as well as the informant's bias to creep into the data collected particularly if the investigator is not vigilant. However, these faults could be averted if the researcher himself is the investigator or the researcher can employ experienced investigators to conduct an open interview. If circumstances force to use inexperienced amateur investigators it would be safer to use the directive interview method than the open interview method.

- (iii) In the case of the directive interview method, it is encouraged to conduct the interview on a person-to-person basis to avoid disturbances from others while the interview is in progress and to enable the informant to provide information privately and even strictly confidentially where necessary. These norms appear to have come to stay in the directive interview method which was evolved and popularized in the highly individualistic urbanized western societies.

The physical distance between two neighbours in a western society may be as short as few yards but the 'social distance' that they maintain could be immense. Hence, individualism is so significant that an informant may not mind an outside official or a research worker knowing his (informant's) whereabouts, assets, behaviour, attitudes, etc. But as he generally believes that everybody in his community should mind his or her own business and not those of others he would be unwilling to see that the people in his community come to know about his affairs or lend ear to what he is telling another. Hence, the directive interview method has been found to be one of the best methods of data collection from those in the western societies. However, the directive interview method would not be the best method of data collection everywhere. In community-conscious rural communities such as those in Sri Lanka, experience shows that people are unwilling on their own to keep on answering direct questions from a stranger. The informants prefer to answer questions along with the other members of the community. This tendency needs the special attention of the researcher in adopting the interview methods to suit two different environments—rural and urban.

The informant in a rural community often needs a dialogue. He wants to talk about an issue raised by the investigator and to impress his viewpoint. He often does not mind the members of his community knowing about at least most of the things that he has to say, if not all. He is in fact hesitant to divulge information to a total stranger and as such he prefers his community members witnessing most of the things that he communicates to a stranger. This is why in an open interview the informants feel free, relaxed and get articulated when necessary, in discussing with each other rather than in answering questions put to him by a stranger in an isolated situation.

The friendly atmosphere created in an open interview enables even the correction of mistakes by fellow participants in a good spirit. Verifications are also made by informants themselves from the fellow informants where necessary. Experiments show that most non-responsive informants at direct interviews often turn very good informants at open interviews because amidst other informants a vulnerable informant becomes very responsible as fellow informants attempt to correct and guide him.

However, there is one danger in adopting the open interview method. That is, the possibility of informants going out of point and even getting out of control in the course of discussion. In such a situation the investigator must be careful and direct the informants in the proper direction.

In summing up the argument, it is necessary to emphasize the point that while the directive interview method is best suited to elicit information from the informants in highly individualistic urban societies both in the West and in the Orient, the open interview method could often prove satisfactory to elicit information from those informants in community conscious rural Sri Lanka.

- (iv) The directive interview method incorporates the basic principles of measurement and it makes information comparable from case to case. It is undoubtedly the best method to gather an array of personal data as accurate as possible for statistical comparison. For instance, to know the informants' age, marital status, level of education attained, employment particulars, income and consumption data the directive interview would be the best. The directive interview method is also ideally suited where it is required to maintain consistency in information collected from a large number of individual informants scattered over a wide area or over the whole country. However, where interpretations and attitudes are to be determined about matters such as causes of street riots, general strikes, social effects of technical changes, adoption of improved practices in agriculture, reactions to rising cost of living, psychological consequences of students living in a university hostel etc., the directive interview often fails and the open interview becomes the most suitable method.
- (v) The directive interview method is the best suited to minimize errors which are likely to be made by the investigators and informants of different levels of literacy and intelligence in the course of an interview seeking quantifiable personal data. This is because the rigidly pre-planned questionnaire for a directive interview strictly guides the investigator in the interviewing procedure however inexperienced he is. In contrast a high percentage of error may remain in data collected in an open interview conducted by an inexperienced investigator.
- (vi) When novices are employed as investigators the timing of an interview becomes easier under the directive interview method than under the open interview method because in the former the specific questions are laid down in a pre-planned and often pretested questionnaire and each question normally takes a limited period of time to complete. An experienced investigator may time the discussion of each question in an open interview minimizing the informant's inclination to describe irrelevant matters and thereby save time to explore the relevant information. Such an investigator may also be able to assist informants to recall matters of importance offering appropriate words

and phrases when the informants get stuck for words. Careful guidance aids the informant's stream of thought to flow smoothly, making the whole exercise interesting and worthwhile. However, the inexperienced and unskilled investigator often fails to achieve them in open interviews. In the hands of unskilled investigators, the informants not only go out of point but also attempt to fabricate the information in an open interview.

- (vii) In the structured questions of directive interviews sometimes the questions are asked with a multiple choice. However, the researcher may not be able to give a very wide range of answers for the informant to choose from. The informant may have completely different answers to the question asked. For instance consider for a moment that the investigator is asking the informant the reason (s) for non-payment of short-term cultivation loans and provides the following possible answers to the informant to choose from ;

- (a) Low income ;
- (b) Crop failure ;
- (c) Heavy indebtedness ;
- (d) Excessive family consumption expenditure ;

For non-repayment of past cultivation loans the informant may have a reason or reasons other than those from (a) to (d) above. He may have a totally different reason or reasons such as:

- (e) no inclination to repay cultivation loans as others do not repay their loans ;
- (f) lending agencies are not keen on recovering loans ;
- (g) the co-operative employees misappropriate the loans repaid; and
- (h) the belief that the government would eventually write-off the loans in default.

In a structured questionnaire prepared to use in a directive interview there is no provision to gather certain unexpected but very valid reasons for loan default. If an open interview is conducted to ascertain the reasons for non-payment of loans, there is a strong possibility of some informants stating one or more of those set out in (e) to (h) as the actual reason (s) for non repayment.

- (viii) In certain instances the open interview is very economical and less time consuming. If the researcher wants to determine the average tractor charges in a village, it could be obtained in an open interview by asking the informants to indicate the average figure rather than asking in a directive questionnaire from each individual or a sample of informants selected from the village and processing those data. Our experience is that (Table I) the average per acre yield in different field zones in a village could be obtained easily in an

open interview with a tolerable degree of error rather than attempting to get the same information by interviewing all or a sample of farmers using a directive questionnaire. The latter would prove extremely cumbersome and sometimes impossible because the number of holdings in different field zones could be far too many to consider during a limited period of time. Besides, some land owners may not reside in the same village and as such even if a sample of farmers is selected, many of them will not be available to collect the necessary information.

Table 1
Villagers' Generalized Yield Per Acre in Different Field Zones

Name of Village	'Old Field' Zone			'Field Blocks' Zone			'Parkland' Zone			'Forest' Zone		
	At first interview	At second interview	Average	At first interview	At second interview	Average	At first interview	At second interview	Average	At first interview	At second interview	Average
Galkiriyagama	18	25	21.5	40	40	40.0	10	15	12.5	15	20	17.5
Galewewa	25	20	22.5	50	55	52.5	12	10	11.0	20	20	20.0
Katupatwewa	20	20	20.0	45	55	50.0	12	15	13.5	25	25	25.0
Kapirigama	25	30	27.5	50	60	55.0	18	20	18.0	20	30	25.0
Thodamaduwa	35	40	37.5	40	45	47.5	30	25	27.2	30	35	32.5

Note —These estimates were made by farmers themselves who took part in discussions held in each village. The yields that they indicated for the different ones during the two interviews held were averaged (shown under the column 'Average' so as to avoid extremes of estimates)

Source —M. U. A. Tennakoon, *Rural Settlement and Land Use in North Central Sri Lanka*, M. A. Thesis (unpublished, Syracuse University, N Y 1974, p 170 : Table 23)

Some may consider that the collectively agreed upon figures of average yield per acre at an open interview are unreliable because the informants are likely to make irresponsible or dishonest statements. It could be safely assumed that once a lie is uttered, it cannot be repeated in the same way after a lapse of a period of time whereas, a truth told is very likely to be repeated exactly in the same way even after a lapse of a long period of time. Based on this assumption, the average per acre yield of different field zones mentioned above obtained by the farmers in four traditional rural settlements *purana* villages were recorded during early 1972 and the same villages were revisited after three months. The same farmers were interviewed to obtain the same yield data on the pretext that the information collected earlier was lost. On completion of the interview for the second time, it was found that the differences in average per acre yields obtained for the different field zones at the two interviews were negligible (Table 1). Thus, the quick and less costly open interviews could be effectively used to cross check data and to clear doubts about previous data collection if any.

- (ix) The administrators as well as the researchers particularly in the developing countries are under constant pressure to submit fact-finding reports, feasibility reports, project reports, work plans, etc., within very short periods of time. Most of these assignments are expected to be completed within few weeks or within a month or two. If the necessary information is not available and the time allocated is insufficient to administer a directive questionnaire, an open interview would be the most suitable device to collect urgently required field data.
- (x) The open interview is useful to formulate hypotheses before collecting data in the field. A researcher having a clear hypothesis will know exactly what type of data he needs well in advance of field work. Hence, he is in a position to collect only the relevant data. Even to formulate a hypothesis some background knowledge of the subject is necessary and a kind of fact-finding mission with a few open interviews would be of immense use. If, for instance, the intuitive knowledge of the researcher prompts him that *the adoption of HYVs has not increased the net farm income of small farmers*, it could well form a working hypothesis. But it would be best to find support for this suspicion or the "hunch" by talking to a group of persons in open interviews. Such a discussion would provide additional confidence to the researcher if the informants express views similar to what the researcher holds and sometimes he would still be able to reformulate and strengthen his hypothesis.

From the foregoing discussion it would appear that it is not possible to make a generalization and say that one method is always superior to the other in collecting field data. Both interview methods—the directive interview method and the open interview method — have advantages and disadvantages like any other data collection method.

The method best suited to collect raw data necessary for a research project or for a particular section of a research project may not be equally suited for another research project or some other section of the same research project. For instance, if the sole objective of the research project is to determine the average milk consumption by age groups in a particular settlement there is no choice but to conduct a directive interview because that is best suited to get personal consumption data. But if the sole objective of a research project is to find out the prevailing tractor charges in different settlements an open interview in each village would suffice to get that information because tractor charges are fairly well known.

However, in an islandwide survey such as the *Consumer Finance Survey* where information on both these areas (milk consumption and tractor charges) are necessary the two types of field data collection—directive questionnaire method and the open interview method — could be harmoniously employed. Sometimes the data collected in one method could be cross-checked using the other method. For instance, if there are doubts about the cost of inputs, labour wage rates, and yield data obtained in a directive interview in rural areas, the accuracy of such data could be cross-checked by collecting the same information in the same localities by conducting open interviews. In these cross-checks a perfect

agreement may not be possible. But if the difference detected is negligible it would give a very high degree of confidence to the researcher to accept the information collected in the first interview. Where the differences are of great magnitude re-investigation to secure more reliable information would be necessary and that must be done for the sake of accuracy.

What method is to be selected to collect information for a particular study is entirely the researcher's choice. It is he who knows best what the purpose of the research is and what information he needs.

3. How to Conduct an Open Interview

The open interview being more flexible than the rigidly structured directive interview the investigator requires a very high degree of skill in conducting an open interview successfully. He is required to change strategy to suit the informants of varying levels of literacy and interests. In this situation, it is difficult to lay down a code of conduct as such. However, it would be useful to provide some guidelines as follows :

- (i) The investigator is required to have clearly in mind the objective(s) of the research project.
- (ii) He must remember that the success of a research project depends heavily on the accuracy and consistency of data collection in the field.
- (iii) He must properly introduce himself and spend sometime in the community (at least a day in advance) talking to as many people as possible and skilfully select a small group of (6-10) informants who are capable of discussing relevant problems clearly. (It is necessary to restrict the number of informants to have an effective control over the discussion).
- (iv) He must request the selected informants to meet at a place and time convenient to the informants and not to the investigator.
- (v) He must be confident that he has won the full confidence of the informants before the commencement of the interview.
- (vi) If there is more than one investigator in an open interview, making gestures among the investigators and talking in a language that informants cannot understand have to be avoided unless there is an unavoidable reason to do so. Too much cross-conversation among investigators and conversations in a language alien to the informants can arouse suspicion in the minds of the informants which could prove highly injurious to the interview.
- (vii) It is very essential to avoid conversation in an open interview in any manner unappealing to the informants. If possible, the local style of talking and local phrases and terms should be employed in conversation.

(viii) In the conversation it is necessary to prevent the discussion from breaking down. To keep the conversation flowing, where appropriate, careful probing may be attempted by :

- (a) repeating the question that is being discussed ;
- (b) making an expectant pause ;
- (c) repeating the respondent's reply sometimes deliberately wrongly so that the informants are enthused to rectify it and elaborate it further ; and
- (d) injecting neutral questions such as—
 Anything else ?
 Could you tell more about your thinking on this ?
 Could you tell me about what you have in mind ;?
 Why do you feel that way ?
 Am I correct if I say? etc. etc.

Also the investigator may encourage the informants' expression of views with comments such as ;

I see ! ;
 That is interesting,
 Yes, I now understand ;
 It is incredible!
 It is amazing !,
 Is that so ? etc. etc.

- (ix) The investigator must show a keenness to listen and understand the problems of the informants even if all what informants utter seems irrelevant, because the informants like the investigator to listen to them. Once the informants are convinced that the investigator is willing listen to them, they are willing to provide meaningful and true information.
- (x) In an open interview if the investigator is not alert a leadership among the informants may emerge and that leader might try to override the others' views. In such situations the investigator has to be very diplomatic and make provision for others to speak, minimizing the chances of the one who is dominating the others in conversation.
- (xi) If an informant in the open interview is in the habit of providing distorted information, the other informants should be encouraged to discuss his points of view and come to a collective agreement.
- (xii) In situations where the informants attempt to give divided opinions the investigator must quickly move into the conversation as the moderator and a compromise has to be made to bring the whole group together.

- (xiii) It is necessary to record the information in brief form and to write an expanded note on the outcome of the survey afterwards. Recording of most of the information provided would be very much easier if there are two investigators. More than two investigators would lead to too much duplication of recording.
- (xiv) Throughout the investigation and during the stay in the community, the investigators total conduct has to be exemplary. He is even required to be in a plain attire. The informants as well as the other members of the community will be constantly observing the investigator. The impressions of the informants always have a profound influence on the information that the investigator receives. Hence, be good to get good information.

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Reliability of Data

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1. Introduction

Reliability of data can be discussed from two points of view. One is the accuracy of our observations in research relative to the actual situation which that situation is expected to reflect. The other is the concept of error in sampling which can be measured by means of statistical formulae. In this paper I shall restrict myself to the first which is concerned with problems in collecting field data and their interpretation. The rest of the paper is divided into four sections. In the first section I shall briefly touch on the need for reliability in research data. In the second factors affecting reliability will be discussed. In the third section I shall focus attention on the methods that can be employed to assess the reliability of data. The final section provides a few kinds as to how to achieve reliability in one's own research data.

2. Need for Reliability

Research, it is said, is an exercise in search of the truth. Thus the first and perhaps most important reason for trying to get reliable data lies in the intrinsic value of such data. Second, we do not normally collect data for their own sake but for some purpose. For example, government agencies and research institutions collect data to help formulate policy. Therefore reliable data are essential to formulate policies which can achieve pre-determined objectives. Third, we must critically examine the reliability of data that are collected because that is the only way in which we can improve the quality of data thus collected.

3. Factors Affecting Reliability

My concern here is with socio-economic data. In that context it is necessary to draw attention to the difference between natural science and the social sciences because some of the major factors affecting the reliability of data arise from the method of their collection. In the natural sciences we collect data generally under controlled conditions and we design experiments under controlled conditions to obtain various results. But this procedure is generally not available in the social sciences where data have to be collected in situations where many factors are not under control. Social scientists collect data about human behaviour by going to the field where a multitude of factors simultaneously affect the behaviour of the subject under study. Under such conditions it is generally difficult to collect accurate data.

Secondly, in the natural sciences, the person who generates the data and the person who uses the data are mostly one and the same person. In contrast, in the social sciences, they are produced not as a result of research studies but as a by-product of various routine activities of government departments and other state and private agencies. This method of collection is an important factor which makes for less reliability of socio-economic data.

Thirdly, even when data are collected for a specific research project the mechanics of collection can lead to a drop in the degree of reliability. The researcher is the person who knows best that he wants, what variables he is actually trying to measure and so on. However, due to practical reasons it is not always possible for the researcher to go to the field and a field investigator may be employed for the task. The investigator of course may not have the same degree of motivation and the level of knowledge and understanding of the project as the researcher himself, and therefore fail to collect data of a quality that the latter wants.

Fourthly, doubts about the reliability of data could also arise because the researcher might have access only to the tabulated final data but not to the disaggregated raw data. This is especially true when the researcher has to depend on data collected by institutional sources such as the Central Bank or the Department of Census and Statistics. Even when one conducts one's own survey, the scale of the survey may be such that it is practically impossible for the researcher to be intimately involved in all its various stages from the preparation of the questionnaire to collection, coding, processing and tabulation of data. If one were to rely on others for data collection and processing there is always possibility that inadequately trained or motivated personnel could produce unreliable data.

Fifthly, reliability of data could also vary depending on the nature of the data required. For example, in household surveys the data that are collected on demography and education are generally relatively reliable. In contrast, data on income, wealth, savings, tax payments and so on are generally less reliable, because often the respondents are reluctant to supply accurate information on such matters. Furthermore normally, there is no way of checking whether the respondents have spoken the truth or not.

Sixthly, the reliability of data can also be affected by the definitions and classifications one adopts in a survey. An obvious example is the measurement of "unemployment". There is no standard definition of unemployment used in surveys of unemployment conducted in countries such as Sri Lanka. Consequently there are wide margins of differences which cannot be explained by sampling errors alone, in the rates of unemployment estimated by the various surveys.

Seventh, the time that the researcher is willing to devote to the collection of data can also affect their reliability. This is especially true of field data collection. For example, it is generally difficult to obtain reliable data on farm inputs by means of a single interview with the farmer. Usually the respondent is unable to recall accurately such information from memory. Therefore, it may be necessary to visit the farmer several times during the cultivation season to gather reliable data.

The time factor can affect the reliability of data in another way as well. In the social sciences we are often interested in time series data stretching back several years and sometimes decades or even centuries into the past. Generally, there is no means of checking the accuracy and reliability of such data collected in the past. Furthermore, in the case of time series data there is a tendency for the quality of the data on a given subject to improve and the coverage to widen as time goes by so that changes indicated by time series become hard to interpret.

4. How to Assess Reliability

The assessment of reliability of data cannot be separated from the interpretation of data. The first and most obvious test of reliability of data is to match the data against the original hypothesis with which the research study was begun. If the data do not support the hypothesis, this does not necessarily mean that the hypothesis is wrong but that the data may be unreliable. A simple rule of thumb in this is to rely on a commonsense interpretation of data. For example, in a farm study if it is found that fertilizer applications and yields are negatively related it is better to question the reliability of data rather than doubt the hypothesis that fertilizer applications have a positive impact on yields. In such an event it is better to review the data for possible errors in collection, processing or tabulation. Sometimes it is also useful to compare one's own results with those obtained by others in similar studies. Normally, a vast discrepancy cannot exist.

5. How to Achieve Reliability

The collection of data is an integral part of the research process. Thus the reliability of data will depend not only on the quality of the field survey but also on the formulation of the problem and the definition of variables. When a questionnaire is used to gather data, it should be pre-tested. The questionnaire should sharply focus on the variables on which data are required. It is also desirable to build-in consistency checks into the questionnaire. The researcher must have full control over the field work and exercise close supervision over the field staff. It is also essential to process and analyze at least a small sample of the data while the field work is in progress, so that any errors that may remain can be corrected. Finally, the researcher must exercise equally close supervision at the data processing and tabulation stages.

6. Conclusions

In conclusion I would like to draw attention to two points. One is that the researchers must honestly report the degree of reliability of his data so that others can evaluate the findings in proper perspective. The other is that we must always be conscious of the fact that it is generally not possible to achieve absolute reliability in data in the social sciences.

PART V

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Descriptive Statistics - An Introduction

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1. Use of Statistics

The term statistics is sometimes used to refer to a set of figures. But the formally accepted meaning of the word statistics is in reference to statistical methods or to the subject that deals with methods by which quantitative information can be summarised and interpreted. The use of statistics comes whenever you start counting and taking measurements. However, this does not necessarily mean that anything you count makes up statistics. Statistics arise when the measurements taken are subject to variability. For example, in counting the number of legs a dog has, statistics does not arise because a dog having four legs is a predetermined fact. Instead of counting the number of legs, if you start measuring the lengths of the dogs, which is a variable, then you are taking a statistical measurement.

Statistics are used when there is a real-world problem to solve. To solve the problem, you must have knowledge of the problem. You must define it carefully and then model it in some sense. After modelling on the basis of assumptions using probability theory it is possible to deduce from the model what the behaviour of an ideal set of data should be. Ideal data do not exist. But if the model is correct, then that would be the behaviour of the ideal data. To test whether the model is correct, data are collected from the real world and examined. If the data fit into the model, then you have answered your real world problem. But usually, this does not happen quite so easily. You have to argue from your sample data and make statistical inference regarding the real population under consideration.

Now a large volume of data is cumbersome to handle. Therefore the initial step is to summarise this information in some sensible fashion. This is the area referred to as Descriptive Statistics. It is very simple, but it does form a very large part of statistics. Normally the descriptive part accounts for about three-fourths of the statistical analysis.

2. Qualitative Data

In descriptive statistics it is useful to distinguish between two types of data. One is qualitative data and the other is quantitative data. Qualitative data refer to data which are not characterised by a numerical quantity. For example, if you measure preference—whether you like a certain brand of tea or cigarette—you are asking questions which do not have numerical values associated with them. Summarising qualitative data is very simple. All you have to do is to count the number of people who fall into the various categories. For example, in the sex-distribution of a population, there are two categories and you count the number of males and the number of females separately. You can present it in a table in absolute numbers and if necessary in percentages as well. It is easier to interpret percentages than absolute numbers. In addition to presenting the information in the form of a table, it is often suitable to be able also to present it in the form of a graph or a chart because pictures have a stronger impact on the eye.

3. Quantitative Data

In the case of quantitative data, it is difficult to get sensible information by simply looking at raw numbers. For example assume that there is a set of 50 households and information is available on the number of occupants in each household. Now just looking at these data will not convey very much to you. You have to summarise them as an initial step in the analysis. Though at a glance you can say that most of the households have say, 4 occupants, you would perhaps like to condense your data a little more. The simplest method is to group the data, and be able to say something like, there are 8 households with 1 occupant, 21 with either 2 or 4 occupants, 11 with 5 to 7 occupants and so forth. This information also could be presented by means of a graph, chart or picture. However, these latter forms of data presentation should be used with care because sometimes they can convey a misleading impression to the user.

4. Average

The average is one of the most common tools used to give a representative figure for a collection of numerical information. There are three types of averages, the mean, median and mode. The use of each depends on the question to be answered. For example, (1) What is the average income of a household in Sri Lanka? (2) What type of rice does the average person prefer to eat? (3) What is the average height of an adult Sri Lanka male? To answer the first question the best is the median because according to its definition, half the values of the population lie above it and half below it.

Thus if the median household income in Sri Lanka is say, Rs. 400/- per month what it means is that half of the population receive an income of above Rs. 400/- per month, while the other half have an income below it. The mean is not appropriate to measure average income because the income of a few very rich people can lead to a very large value.

As regards the second question, "What type of rice does the average person prefer to eat?" the best average is the mode, which is the value which occurs most frequently. For example, if there are a few different kinds of rice, red rice, white rice, par-boiled, raw and so forth, and you count the number of people who fall into each of these categories, the mode gives you the type of rice eaten by the most number of people.

As regards the third question, i.e. the average height of an adult Sri Lankan male, the procedure is to take a representative sample, count each person's height, divide by the total number of observations. This would give a representative average for the population. Thus the mean, median and mode should be used depending on the nature of the question to be answered.

5. Dispersion

If you have two sets of data and you want to compare them, just quoting the means of these two sets of data is not enough. Usually it is necessary to have a measure of the spread of your observations. For example, say, you have two sets of students, four each, who are given a particular test. Suppose the mean mark of each group is 50, but the spread

is very different. For instance, the spread in group I may be from 45 to 56, while it is 25 to 90 in group II. To select a student of average ability, it is better to use group I because with group II, it is likely that your selection will result in a candidate who is either very weak or very clever. It is thus necessary to consider also the spread or dispersion of the measurements. We normally use either the variance or the standard deviation as a measure of dispersion of a collection of statistical data.

Some Statistical Techniques Applicable to Social Science Research

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Data in social science research are often gathered in the form of frequencies in categories or as ranks. Even if interval scales are used for measurement, it is seldom that they satisfy the requirements for interval scale measurement. Moreover, we are often in doubt as to whether the assumptions needed for parametric tests such as the *t* test and the *F* test are satisfied. It is therefore, appropriate and reasonable to use tests that are suitable for categorized data or ranked data.

In this presentation we will consider some parametric and non-parametric tests that can be applied to categorized or ranked data. In each case, we will take a problem and illustrate the application of a statistical technique appropriate for the situation.

Problem I—To test whether data relating to a question of interest obtained from a sample indicate a significant trend in the population.

Data —Frequencies ; i.e. the number of persons or events that belong to a designated category (e.g. answer “Yes”) and those who do not.

An investigator finds that 60 out of a random sample of 100 housewives from a certain district answer “yes” to a particular question. He wants to know whether these frequencies could have come from a population in which the opinion is evenly divided on this particular question.

When we have frequencies in two alternative, mutually exclusive categories from a single sample not smaller than 10, the Chi square test can be applied to test the null hypothesis that the split in the population is a 50-50 one.

In this situation, chi square can be calculated by the formula :

$$X^2 = \frac{(f_1 - f_2)^2}{N}$$

where f_1 and f_2 are the frequencies in the two categories and N is the size of the sample. In our example, $f_1 = 60$, $f_2 = 40$ and $N = 100$. Thus,

$$X^2 = (60-40)^2/100 = 400/100 = 4.00$$

The df to enter the X^2 table is 1. For 1 df, the obtained X^2 value is significant at the 0.05 level, So, we can reject the H_0 at the 0.05 level of significance.

Public opinion poll results or survey results are often reported as percentages. Although significance tests can be made on percentages or proportions using the normal distribution table, it is more convenient to convert percentages or proportions to frequencies and do a Chi square test. A percentage, when multiplied by $\frac{N}{100}$ or a proportion by N , is converted to a frequency.

The general formula for Chi square is

$$X^2 = \sum \left(\frac{(f_o - f_e)^2}{f_e} \right)$$

where f_o is the observed frequency and f_e is the expected or hypothesized frequency. Thus when we hypothesize a 50 - 50 split in the population, f_e for both categories is 50. In our example above, we observed a 60 - 40 split and we hypothesized a 50 - 50 split. Hence

$$\begin{aligned} \text{our } X^2 &= \frac{(60 - 50)^2}{50} + \frac{(40 - 50)^2}{50} \\ &= 2.00 + 2.00 = 4.00 \end{aligned}$$

If we hypothesized a 75-25 split in the population,

$$\begin{aligned} X^2 &= \frac{(60 - 75)^2}{75} + \frac{(40 - 25)^2}{25} \\ &= \frac{(-15)^2}{75} + \frac{(15)^2}{25} \\ &= 3.00 + 9.00 \\ &= 12.00 \end{aligned}$$

according to which X^2 value, we can confidently reject the null hypothesis that there is a 75 - 25 split in the population.

It is important to note that in both categories in the split, the expected frequency must be not less than 5 before we apply the X^2 test. This will not be a problem if we use large samples.

Problem 2—To test whether two independent samples differ significantly with respect to an attribute.

Data —Frequencies in two categories for each sample.

Suppose an investigator conducts a survey regarding the settlement of bank loans by farmers in two districts. He observes that, out of a sample of 30 farmers in District X 20 have not settled the bank loans while in District Y, only 8 out of 26 have not done so. Do the two districts differ in this matter ?

These data can be entered in a fourfold contingency table as follows :

	<i>Did not settle</i>	<i>Settled</i>	<i>Total</i>
X	20 A	10 B	30 A + B
Y	8 C	18 D	26 C + D
Total	28 A + C	28 B + D	56 N

The four cells in the table are coded A, B, C and D as shown. Chi square is calculated by the formula :

$$\begin{aligned}
 X^2 &= \frac{N(AD - BC)^2}{(A+B)(C+D)(A+C)(B+D)} \\
 \text{.....Applied to the data in our problem} \\
 X^2 &= \frac{56(20 \times 18 - 10 \times 8)^2}{(30)(26)(28)(28)} \\
 &= \frac{56(360 - 80)^2}{(30)(26)(28)(28)} \\
 &= \frac{56(280)^2}{30 \times 26 \times 28 \times 28} \\
 &= 5.82
 \end{aligned}$$

The degrees of freedom for a fourfold table is also one.

Thus, for 1 df, the obtained X^2 value is significant at the 0.02 level. We can reject the null hypothesis of no difference with confidence.

Note that the expected frequency in any cell of a fourfold table must be not less than 5.

The above test is equivalent to a significance test for the difference between two independent proportions or two independent percentages. The identical probability statement will be made if we did a significance test for the difference between the two proportions or percentages, but doing the X^2 test is more convenient than doing either of those two tests.

Problem 3—To test whether a change that has taken place in regard to an attribute in a sample is significant.

Data —Frequencies in two categories for a sample on two different occasions as before and after undergoing an experience.

Suppose an investigator wants to determine whether a farmer-education programme has had the desired effect. He conducts the survey before the introduction of the education programme and judges that 15 out of 40 farmers were efficient. He repeats the survey after the education programme and judges that 28 out of the same 40 farmers were efficient.

The Chi square test can be employed to determine whether the education programme had the desired effect.

The data can be entered in a four-fold contingency table as follows :

		<i>BEFORE</i>		
		<i>Inefficient</i>	<i>Efficient</i>	
<i>AFTER</i>	<i>Efficient</i>	16 A	12 B	28
		9	3	12
	<i>Inefficient</i>	C	D	
		25	15	40

The four cells in the table are coded A, B, C, and D as before. Since the data relate to the same group of persons, they are correlated. This fact has to be taken into consideration when the significance of change is tested. The following formula makes allowance for this.

$$X^2 = \frac{(/D-D/-1)^2}{A+D}$$

Applied to the data in the four-fold table given above,

$$\begin{aligned} X^2 &= \frac{(/16-3/-1)^2}{16+3} \\ &= \frac{12^2}{19} \\ &= 7.58 \end{aligned}$$

For 1 df, this is significant at the .01 level. The null hypothesis of no difference can be rejected. The education programme has been very effective in bringing about the desired change.

Problem 4—To test whether two independent samples have come from the same population.

Data —Scores in an interval scale or ratings or ranks when both samples have been combined and ranked. If scores or ratings are available, the two samples are combined and ranked in ascending order, having regard to ties.

Suppose an investigator obtained the following data for two independent samples. Columns 1 and 2 give the original scores for samples 1 and 2. Columns 3 and 4 give the same scores arranged in ascending order. Columns 5 and 6 show the ranks assigned to the scores in the two samples when the two samples are combined. If the data were ranks when the two samples were combined, the ranks of the two samples are simply listed separately as in columns 5 and 6.

1	2	3	4	5	6
38	47	34	40	1	7.5
35	45	35	40	2	7.5
37	42	36	42	3	11
40	43	37	43	4	12.5
40	45	38	45	5	15.5
45	47	40	45	7.5	15.5
34	40	40	45	7.5	15.5
36	45	41	47	10	18.5
43	40	43	47	12.5	18.5
41	48	45	48	15.5	20
389	442			$R_1=68$	$R_2=142$

The Mann-Whitney U Test is an excellent test to be used in situations like this, particularly when we are not sure of meeting the assumptions of normality and of homoscedasticity (equal variances) needed for the parametric t test, or when the measures are not in at least an interval scale.

When both N_1 and N_2 are 8 or greater,

$$Z = \frac{[2R_1 - N_1(N+1)] - 1}{\sqrt{N_1 N_2 (N+1)/3}}$$

expresses the difference between the two groups as a unit normal deviate by which the significance of the difference can be evaluated.

R_1 and R_2 , the sum of ranks of the two groups are obtained, and the smaller sum is substituted in the formula. If the smaller sum happens to be R_2 , the R_1 and N_1 in the numerator of the formula are altered to R_2 and N_2 . $N = N_1 + N_2$

For the data in our example,

$$\begin{aligned}
 Z &= \frac{/(2) (68) - (10) (21) / -1}{\sqrt{(10) (10) + (20 + 1)/3}} \\
 &= \frac{/136 - 210 / -1}{\sqrt{700}} \\
 &= \frac{-73}{26.4575} \\
 &= -2.76 \\
 P &< 0.006
 \end{aligned}$$

The null hypothesis of no difference can be rejected.

The Mann-Whitney U test has about 95.5% power efficiency of the parametric t test applied to the same data if they were available in at least an interval scale, which is demonstrated below.

$$\begin{aligned}
 X_1 &= \frac{389}{10} = 38.9 \quad \Sigma x_1^2 = 113 \\
 X_2 &= \frac{442}{10} = 44.2 \quad \Sigma x_2^2 = 74 \\
 t &= \frac{38.9 - 44.2}{\sqrt{\frac{113 + 74}{18} \left(\frac{1}{10} + \frac{1}{10} \right)}} \\
 &= -3.68 \\
 \text{For } df = 18, \quad P &< .005
 \end{aligned}$$

A less efficient non-parametric test that can be applied to the data of this same example is the median test. To apply the median test, we split each sample at the common median for the two groups combined. For our data, the common median is 41.5. The split of the two samples at this point is shown in the fourfold table below :

	Sample 1	Sample 2	Total
Above Median	2	8	10
Below Median	8	2	10
	10	10	20

We then calculate a X^2 as we did in Problem 2 above. For the data in the fourfold table,

$$\begin{aligned}
 X^2 &= \frac{20 \left(\frac{1}{64} - 4 \frac{1}{20} \right)^2}{10 \times 10 \times 10 \times 10} \\
 &= \frac{20 (50)^2}{10,000} \\
 &= 5.00
 \end{aligned}$$

For $df = 1$, $0.02 < P < 0.05$

Problem 5—To test whether two correlated samples have come from the same population.

Data —Original scores for several matched pairs of persons or several persons measured twice. The unit of measurement need not be equal as in an interval scale.

An investigator obtains measures for two related samples or for one sample on two different occasions.

Suppose he obtains the following data for 22 matched pairs of persons :

X	Y	$D = X - Y$	Rank of $ D $	Rank of D 's with less frequent sign.
37	23	+ 14	14.5	
44	34	+ 10	10	
55	59	— 4	3.5	3.5
70	25	+ 45	19	
26	16	+ 10	10	
39	12	+ 27	18	
26	16	+ 10	10	
30	25	+ 5	5	
85	60	+ 25	17	
83	69	+ 14	14.5	
74	74	0	—	
36	36	0	—	
59	70	—11	12.5	12.5
59	61	— 2	1	1
36	29	+ 7	8	
81	70	+ 11	12.5	
58	52	+ 6	6.5	
19	34	—15	16	16
11	7	+ 4	3.5	
45	42	+ 3	2	
14	14	0	—	
19	13	+ 6	6.5	
			190.0	33.0

The Wilcoxon Signed-Ranks of Difference Test is appropriate for analysing data of this type. The difference between the two scores of each matched pair is entered with the sign + or —. These differences, leaving out the zero differences, are then ranked, disregarding the sign. The ranks of differences with the less frequent sign are then entered in a separate column and their sum is obtained.

When the number of non-zero differences is 8 or more,

$$Z = \frac{/2T - N(N+1)/2 - 1}{\sqrt{N(N+1)(2N+1)/6}}$$

expresses the difference between the two samples as a unit normal deviate which can be evaluated by reference to the table of the normal curve function. T is the sum of + or — ranks, whichever is the smaller sum and N is the number of non-zero differences.

For the data in our example,

$$\begin{aligned} Z &= \frac{/(2)(33) - (19)(19+1)/2 - 1}{\sqrt{(19)(19+1)(2 \times 19 + 1)/6}} \\ &= \frac{/66 - 190/ - 1}{\sqrt{(380)(39)/6}} \\ &= \frac{-123}{\sqrt{2470}} \\ &= -2.47 \end{aligned}$$

For a two-tailed test, $P < 0.014$. We reject the null hypothesis of no difference between the two populations.

This test also has a power efficiency approaching 95% of that of the parametric t test. If we did a t test with the same data, we would have

$$\begin{aligned} \underline{t} &= \frac{165/22}{\sqrt{\frac{(22)(4729) - (165)^2}{(22)^2(21)}}} \\ &= 2.72 \end{aligned}$$

For $df = 21$, $0.01 < P < 0.02$

Problem 6—To test whether C correlated samples have come from populations with equal means.

Data —Original scores or ranks 1 to C for each of R matched groups.

An investigator assigns at random one subject to each of C experimental conditions from each of R matched groups. Each matched group is ranked 1 to C. If scores or ratings are obtained, the C subjects in each matched group are assigned ranks from 1 to C.

Suppose he obtains the data (each matched group ranked 1-5) as given in the table below :

Group	Experimental Condition				
	1	2	3	4	5
1	2	1	4	3	5
2	1	2	4	3	5
3	3	2	1	5	4
4	1	2	3	5	4
5	4	3	5	2	1
T_c	11	10	17	18	19
T_c^2	121	100	289	324	361

The Friedman two-way analysis of variance by ranks is appropriate for testing the null hypothesis that the several samples came from the same population.

Procedure : T_c , the sum of ranks for each column, is obtained.

When $C > 3$ and $R > 9$ or $C > 4$ and $R > 4$,

X_r^2 follows approximately the X^2 distribution df being equal to $C-1$
df being equal to $C-1$

X_r^2 is calculated as follows :

$$\begin{aligned}
 X_r^2 &= \frac{12}{RC(C+1)} \left(\sum T_c^2 - 3R(C+1) \right) \\
 &= \frac{12}{5 \times 5 (5+1)} (1195) - 3 \times 5 (5+1) \\
 &= \frac{2}{25} (1195) - 90 \\
 &= 95.6 - 90 \\
 &= 5.6
 \end{aligned}$$

For df = 4, $P > 0.10$

Null hypothesis cannot be rejected.

Tied ranks within rows do not disturb the Friedman test. Power efficiency agrees very closely with F test applied to original scores (not given in the above table).

Problem 7—To test whether G independent samples have come from the same population.

Data —Scores in an interval scale or ratings or ranks when all G samples have been thrown together and ranked. Scores or ratings are also ranked, having regard to ties.

An investigator wants to compare four independent groups, each consisting of 5 persons. Suppose he obtains the data of the table given below :

Group 1		Group 2		Group 3		Group 4	
Score	Rank	Score	Rank	Score	Rank	Score	Rank
23	4	19	2	28	7	41	16
20	3	29	8	40	15	48	20
30	9	38	14	44	18	45	19
18	1	32	10	37	13	35	12
27	6	24	5	33	11	43	17

$$R_1 = 23$$

$$R_2 = 39$$

$$R_3 = 64$$

$$R_4 = 84$$

$$R_1^2 = 529$$

$$R_2^2 = 1521$$

$$R_3^2 = 4096$$

$$R_4^2 = 7056$$

The Kruskal-Wallis one-way analysis of variance by ranks is an appropriate test to test the null hypothesis that the G independent samples have come from the same population.

Procedure : R , the sum of ranks for each group is obtained. The H statistic is calculated by the following formula :

$$H = \frac{12}{N(N+1)} \sum \frac{R_g^2}{M_g} - 3(N+1)$$

If all M_g are greater than 5, H follows approximately the X^2 distribution with $df = G - 1$

$$\begin{aligned}
 H &= \frac{12}{20(20+1)} = \left[\frac{23^2}{5} + \frac{39^2}{5} + \frac{64^2}{5} + \frac{84^2}{5} - 3(20+1) \right] \\
 &= \frac{12}{420} \left[\frac{529}{5} + \frac{1521}{5} + \frac{4096}{5} + \frac{7056}{5} \right] - 63 \\
 &= \frac{12}{420} (2640.4) - 63 \\
 &= 75.44 - 63 \\
 &= 12.44
 \end{aligned}$$

For $df = 3$, $P < 0.01$

The H_0 that the G samples came from one population is rejected at the 0.01 level.

If there are tied ranks and the obtained H fails to reach the tabled value in the X^2 table, a correction may be made.

For this, we calculate the quantity given by

$$1 - \frac{\left(\sum t_s^3 - t_s \right)}{N^3 - N}$$

t_s being the number of ties at any rank. Then we divide H by this quantity to obtain the corrected H . If the obtained H is large enough to reject the null hypothesis, the correction is not necessary.

That is a test that may be used when homogeneity of variances is suspected. It has a power efficiency of 95.5%.

Problem 8—To estimate the degree of association or correlation that exists between two attributes one or both of which have yielded data in more than two categories.

Data —Cross-tabulated data in the form of frequencies in a contingency table, where each attribute is divided into more than two broad classes. Even when measures on a continuous scale are available, they can be reduced to a few categories if the other attribute yields information in a nominal scale.

Suppose an investigator has information relating to two attributes (say, Parental Occupation and University Course selected for) of a group of persons. Parental occupation is differentiated into three broad classes and University courses are also differentiated into three broad categories. Fictitious data are given in the table below.

				Parental Occupation			Total
				I	II	III	
University Course	A	..	100	..	60	..	200
	B	..	130	..	160	..	400
	C	..	160	..	240	..	600
Total				390	460	350	1,200

Pearson's Contingency Coefficient gives a statistical index to the degree of correlation that exists between the two attributes. It is given by the formula.

$$C = \sqrt{\frac{X^2}{N + X^2}}$$

when x^2 is calculated by the usual method. For the data in the table above,

$$\begin{aligned}
 X^2 &= 1200 \left[\left(\frac{(100)^2}{390} + \frac{(60)^2}{460} + \frac{(40)^2}{350} \right) / 200 + \left(\frac{(130)^2}{390} + \frac{(160)^2}{460} \right. \right. \\
 &\quad \left. \left. + \frac{(110)^2}{350} \right) / 400 + \left(\frac{(160)^2}{390} + \frac{(240)^2}{460} + \frac{(200)^2}{350} \right) / 600 - 1 \right] \\
 &= 1200 (0.19019 + 0.33389 + 0.50857 - 1.00) \\
 &= 1200 (0.03265) \\
 &= 39.18 \\
 C &= \frac{39.18}{\sqrt{1200 + 39.18}} = 0.178
 \end{aligned}$$

To test the null hypothesis that there is no relationship between the two variables, we test the significance of the obtained x^2 value. For $df = 4$, $p < 0.001$. We decide to reject the null hypothesis of no relationship.

C cannot be compared with a product moment r or an estimate of it unless a correction is made. Contingency coefficients themselves are not comparable unless they are derived from tables of the same size. The upper limit for C derived from a 2×2 table is 0.707; for a 3×3 table, it is 0.816; for a 10×10 table, it is 0.949. Also, C can never be negative.

Despite these limitations, C is a very useful statistic for the social scientist. No assumptions regarding the nature of the variable need to be met. There is no better measure of relationship to be used when nominal scale data are available in more than two categories.

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Statistical Methods for Social Science Research

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The growing use of qualitative as well as quantitative statistical information in social science research has resulted in an ever increasing utilisation of statistical methods. A cursory inspection of current international journals on social sciences and allied disciplines amply demonstrates this. It, therefore, highlights the necessity for the social scientists to familiarize himself with and acquire some knowledge of statistical methods.

1. Analysis of Cross-Classified Data

Survey data are presented in many different ways. A very common way is that of classification. When the members in a sample have been doubly classified, that is, classified according to two characteristics or *attributes*, the results can be presented in a rectangular table (see for example, Table 1.1). Such a table is known as a *contingency table*. The size of a contingency table is generally indicated by the number of rows and columns it contains. For example, Table 1.1 is of size 3 x 3. Table 1.1 is symbolically presented in Table 1.2. The figures such as n_{11} , n_{12} , ..., n_{33} in the body of the Table 1.2 are called the *cell frequencies*. Instead of two attributes, several may be used in classification of the members.

Table 1.1

Distribution of Sample of Head of Households According to Educational Ability and Occupational Achievement

Educational ability	Occupational Achievement			Row total
	Low	Medium	High	
Low	16 (12.0)	51 (40.8)	53 (67.2)	120
Medium	14 (14.0)	62 (47.6)	64 (78.4)	140
High	20 (24.0)	57 (81.6)	163 (134.4)	240
Column Total	50	170	280	500

Note: Figures within parentheses are explained in section 1.1

Table 1.2

Symbolic presentation of observed frequencies and margin totals in Table 1.1

	C_1	C_2	C_3	Total
R_1	n_{11}	n_{12}	n_{13}	n_{1+}
R_2	n_{21}	n_{22}	n_{23}	n_{2+}
R_3	n_{31}	n_{32}	n_{33}	n_{3+}
Total	n_{+1}	n_{+2}	n_{+3}	n

Table 1.3

Further symbolization of frequencies in a contingency table (for use in sec. 1.2)

	$\dots C_i \dots$	Total
R_i	$A(n_{ij})$	$B(n_{i+})$
Total	$B(n_{+j})$	$A(n)$

1.1 Test for Independence in Contingency Tables

When a sample of people or things has been classified as in Table 1.1, it is reasonable to enquire whether the two classifications are independent. What is meant by independent is that the magnitudes of the all frequencies are in conformity with the proportions indicated by the margin total, that is, the row totals and the column totals. For example, suppose the two classifications in Table 1.1 are independent then we expect the upper-left corner cell frequency to be $(n_{1+}) \times (n_{+1})/n = (120) \times (50)/500 = 12.0$. Similarly, we expect the lower-right corner cell frequency to be $(n_{3+}) \times (n_{+3})/n = (240)(280)/500 = 134.4$. The cell frequencies expected under independency of the two classifications are given within parentheses in Table 1.1.

The observed frequencies differ considerably from the frequencies to be expected had the two classifications of the individuals in the sample been independent of each other. The question now is whether these discrepancies between the corresponding entries in the table are such as could have arisen from random sampling errors alone or whether they are indicative of a real difference between categories in the two classifications. To answer this question we usually calculate what is called the *Chi square statistic* using,

$$X^2 = \sum_{ij} \frac{n_{ij} - \frac{(n_{i+})(n_{+j})}{n}}{\frac{(n_{i+})(n_{+j})}{n}} = \sum_{\text{all cells}} \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected frequency}} \quad (1.1)$$

Thus, for Table 1.1 we have,

$$\begin{aligned} X^2 &= \frac{(16 - 12.0)^2}{12.0} + \frac{(51 - 40.8)^2}{40.8} + \dots + \frac{(163 - 134.4)^2}{134.4} \\ &= 1.33 + 2.55 + \dots + 6.09 = 28.06 \end{aligned}$$

However, formula (1.1) gives only an approximate value for the required statistic. The exact value of the Chi-Square statistic is given by,

$$X^2 = 2 \sum_{ij} n_{ij} \log \left\{ n_{ij} + \frac{(n_{i+})(n_{+j})}{n} \right\}$$

$$= 2 \left\{ n_{ij} \log (n_{ij}) - n_{i+} \log (n_{i+}) - n_{+j} \log (n_{+j}) + n \log (n) \right\} \quad (1.2)$$

where log refers to natural logarithm (and not logarithm to base 10). We shall use formula (1.2) in place of (1.1) to calculate the Chi-square statistic in contingency tables.

For Table 1.1, formula (1.2) gives,

$$X^2 = 2 [16(2.77) + \dots + 163(5.09) - (120(4.79) + \dots - 280(5.63) + 500(6.21)]$$

$$= 28.30$$

Any Chi-square statistic is characterised by a number associated with it, which is called the *degrees of freedom* (d. f.). If any of the four cell frequencies in Table 1.1 are known to us, then other cell frequencies in it can be obtained with the help of margin totals. Therefore, Table 1.1 is said to possess 4 degrees of freedom. Generally, a contingency table of "r" rows and "c" columns has (r-1) (c-1) degrees of freedom. Thus, for Table 1.1, (3-1) (3-1) = 4 d.f.

We may restate our problem as follows. Test,

Null Hypothesis, H_0 = The occupational achievement of an individual is independent of his educational ability

against, Alternative Hypothesis, H_1 = The occupational achievement of an individual depends on his educational ability.

If we test at 5% level of significance (that is, we are 95% sure that we take the correct decision) using Chi-Square Table, we have,

$$X^2_4 (=28.30) > X^2_{4, 0.05} (=9.49)$$

Hence, we reject H_0 , and conclude that educational ability significantly affects the occupational achievement.

In situations where we reject the null hypothesis which postulated that there is independence between the classifications, we may say that there is association between the classifications. In such situations, it is useful to examine the direction of the association too. It can be accomplished by comparing the observed and expected frequencies in the

cells at the opposite corners of the contingency table. In the above example we see that by comparing the observed and expected frequencies at the upper-right and the lower-left cell of Table 1.1 $53 < 67.2$ and $20 < 24.0$. Thus, the direction of the association is that lower educational ability is a hindrance to higher occupational achievement.

1.2 Decomposing Contingency Tables

Once the Chi-square statistic is computed for a contingency table, sometimes it is useful to decompose the original table into several sub-tables. The purpose of such a decomposition is to partition the original Chi-square into several components which will provide a better understanding of the relationship between the characteristics under study than what is available from the overall Chi-square alone. By knowing the sub-tables of the original table that give significant Chi-square we can find specifically where the relationship is located within subsets of that categories of the two characteristics.

To illustrate the technique, let us consider the data in Table 1.4 which presents the distribution of sample of Grade I students according to the number of years of pre-school training they had and their progress in Grade I.

Table 1.4

Distribution of Sample of Grade 1 Students According to the Number of Years of Pre-Schooling and Progress in Grade I

No. of years of pre-school training	Progress in grade 1			Total
	Weak	Medium	Good	
0	2	23	7	32
1	14	31	12	57
2	12	25	6	43
More than 2	6	12	0	18
Total	34	91	25	150

In an attempt to see whether there is any association between the number of years of pre-schooling the Grade 1 students have had and their progress in Grade 1, we may proceed as in Sec. 1.1. Thus, we have (at the 5% level of significance)

$$X^2_{6, 0.05} (=15 \cdot 16) X^2_{6, 0.05} (=12 \cdot 59)$$

from which it can be inferred that there is a significant association between the pre-school training a child has had and the progress he/she has made in Grade 1.

Let us now decompose Table 1.4 into two sub-tables as in Table 1.5. Again on proceeding as in Sec. 1.1 we have (at the 5% level of significance),

$$\text{For Table 1.5 (a) : } X^2_{2, 0.05} (=7.40) > X^2_{2, 0.05} (=5.99)$$

$$\text{For Table 1.5 (b) : } X^2_{4, 0.05} (=7.76) > X^2_{4, 0.05} (=9.40)$$

Table 1.5

A Decomposition of Table 1.4

(a)					(b)				
Pre-school training (years)	Progress in Gr. I			Total	Pre-school training (years)	Progress in Gr. I			Total
	Low	Medium	High			Low	Medium	High	
0	2	23	7	32	1	14	31	12	57
1 or more	32	68	18	118	2	12	25	6	43
					2+	6	12	0	18
Total	34	91	25	150	Total	32	68	18	118

Thus, Table 1.5(a) reveals that there is a significant association between the progress of children in Grade 1 and the amount of pre-school training they have had. The direction of association is such that (since 7.53 and 3226.7, where 5.3 and 26.7 are the respective expected frequencies) children without pre-school training tend to show "high" progress than the rest. Table 1.5(b) reveals that progress in Grade 1 is independent of the number of years of pre-school training.

It is possible to summarise the various Chi-squares we have calculated in order to see more clearly how the overall Chi-square breaks down. Such a summary is in Table 1.6. without decomposing the overall Chi-square it would have been difficult to arrive at the above detailed understanding of the data.

Table 1.6

Decomposition of overall Chi-square of Table 1.4

Source	d f	X ²	Significant
With & without pre-schooling Vs Progress	2	7.40	Yes
With varying no. of years of pre-schooling Vs Progress	4	7.76	No
Total	6	15.16	Yes

For a given contingency table there are many ways to decompose the overall Chi-square. Therefore, it is useful if we can have some rules to follow when decomposing contingency tables. The rules are simpler to express if the frequencies in a contingency table are defined as being of two types as shown in Table 1.3. One type (A) consists of the cell frequencies (n_{ij}) and the table total (n). The other type (B) consists of row totals and column totals (n_{i+} and n_{+j}).

The two rules for decomposing contingency tables are :—

- (1) Each frequency in the original table must appear once and only once as a frequency of the *same* type in one of the component tables.
- (2) Each frequency which is in a component table but not in the original table must appear in another component table as a frequency of the *other* type.

Note the manner in which we have fulfilled these two rules in decomposing Table 1.4 into Tables 1.5 (a) and 1.5 (b).

2. Association and Correlation in Social Data

Much of the effort in analysis of social data is directed towards evaluating and interpreting *associations* among variables. One way of defining association is as follows. Two variables are associated when the distribution of values of one differs for different values of the other. When working with ordinal or metric data, we often speak of “correlation” than of “association”. Correlation suggests two factors increasing or decreasing together, while association suggests two factors occurring together. The level of association (or correlation) is usually indicated by a suitable measure constructed for the purpose. Out of the many measures of association available in the literature only a few will be presented here.

The choice of a measure of association for a given problem depends, among other factors, on the scale of measurement used in measuring the characteristics. The measures outlined in Sec. 2.1, namely χ^2/χ and χ are suitable for nominal level data. The index in Sec. 2.2 is for ordinal level data. Finally, correlation coefficient in Sec. 2.3 is for metric data.

2.1 Goodman and Kruskal's Index of Proportional Reduction of Probably Error.

Consider the data of Table 2.1 which deal with the relationship between the level of mass media exposure and knowledge of fertilizer recommendation of a sample of farmers. Suppose we select a farmer from the area from which this sample has been taken. Should we guess that his knowledge about fertilizer recommendations is good or bad ?

Table 2.1

Distribution of a Sample of Farmers According to the Mass Media Exposure and Knowledge of Fertilizer Recommendations

Level Mass Media exposure	Knowledge of Fertilizer Recommendation		Total
	Good	Poor	
Low	25	55	80
High	20	10	30
Total	45	65	110

Note: $\chi^2_1 (=5.64) > \chi^2_{1, 0.05} (=3.84)$

Since, out of 110 farmers in the sample majority have a poor knowledge of fertilizer use we will be better off, although not by much, in guessing that his knowledge is poor. Suppose, however, that we are told that he has high mass media exposure. Then a better guess is that his knowledge of fertilizer use is good, because out of 30 with high mass media exposure majority have a good knowledge. The additional information about the farmer's background helps us to make a better guess about his knowledge of fertilizer use.

How much better will be our guess, if the extent of mass media exposure of the individual is known to us? Without this information we should be mistaken 45/110 of the times. With this information, we shall be mistaken in 10 of the 30 cases and in 25 of the 80 cases : a total of 35 of the 110 cases. Our error is reduced from 45 out of 110 cases to 35 out of 110 ; a reduction of probable error of 10 cases from the original 45. We shall take the proportional reduction of probability error as the measure of association in the table, and denote by (knowledge/media exposure).

$$\begin{aligned}
 &\text{The formulae for } \lambda_{y/x} \text{ when the row variable (x) is given and predicting the column variable (y) is } \left\{ \begin{array}{l} \text{largest column} \\ \text{total} \end{array} \right\} \\
 &\quad \sum_{\text{over all rows}} \left\{ \begin{array}{l} \text{largest cell frequency} \\ \text{in row} \end{array} \right\} - \left\{ \begin{array}{l} \text{largest column} \\ \text{total} \end{array} \right\} \\
 &y/x = \frac{\quad}{n - \text{largest column total}} \quad (2.1)
 \end{aligned}$$

For the example discussed above,

$$\lambda_{\text{(knowledge/media exposure)}} = \frac{(55 + 20) - 65}{110 - 65} = \frac{10}{45} = 0.22$$

The above value of $\lambda_{y/x}$ is interpreted as follows : There is a 22% reduction in the probable error in predicting the knowledge on fertilizer when we are told about the farmer's level of media exposure.

The index lies between 0 and 1. It is zero if the knowledge of the x classification is of no help in predicting the y classification and then we may say that there is no predictive association. It is 1 if the knowledge of an individual's x class completely specifies his y class and then we say that there is complete predictive association. It needs to be emphasised that this idea is not completely equivalent to statistical independences and association as referred to by Chi-square statistics.

The above index is an asymmetric measure since, in general $\lambda(y/x)$ and $\lambda(x/y)$ will not be identical. It is possible, however, to develop a symmetric measure of mutual association by assuming that half the time we are predicting in one direction and half the time in the other. The formula that results is,

$$\lambda = \frac{\sum \left\{ \begin{array}{c} \text{largest frequency} \\ \text{in row} \end{array} \right\} + \sum \left\{ \begin{array}{c} \text{largest frequency} \\ \text{in column} \end{array} \right\} - \frac{\text{largest row}}{\text{total}} - \frac{\text{largest column}}{\text{total}}}{2n - \text{largest row total} - \text{largest column total}}$$

For the data of Table 2.1,

$$\lambda = \frac{55 + 20 + 25 + 55 + 80 - 65}{2(110) - 80 - 65} = \frac{10}{75} = 0.13$$

This may be interpreted as follows: there is a 13% reduction in the probable error of prediction when we are given information about media exposure half the time and information about knowledge of fertilizer use half the time.

2.2 Goodman and Kruskal's Index of Predictive Association λ , in Ordered Classes

This index depends on the number of pairs in which attributes are positively associated and the number of pairs in which attributes are negatively associated. Let us first see how positive and negative pairs are counted.

Suppose we have the following rankings of three undergraduates called Alwis, Basil and Charlie, on both ability in mathematics and ability in chess playing.

	Alwis	Basil	Charlie
Ranking in Maths	1	2	3
Ranking in Chess	2	1	3

We can now examine the three pairs of the three undergraduates and see whether mathematical and chess playing abilities are associated in each pair. The results are as in Table 2.2.

Table 2.2

Pairing of 3 undergraduates ranked on two qualities

Pair	Rank in Maths	Rank in Chess	Direction of Relationship
(1) Alwis	1	2	Opposite (—)
Basil	2	1	
(2) Alwis	1	2	Same (+)
Charlie	3	3	
(3) Basil	2	1	Same (+)
Charlie	3	3	

Let us denote by P the number of positive pairs where there is a direct relationship and by Q the number of negative pairs where there is an opposite relationship. Then for Table 2.2, $P = 2$ and $Q = 1$.

Suppose now we have 30 undergraduates classified according to both mathematical ability and chess-playing ability as in Table 2.3. To calculate the number of positive and negative pairs for such a table.

Table 2.3

Thirty Undergraduates Classified According to Mathematical and Chess-playing Abilities

Mathematical ability	Chess - playing ability			Total
	High	Medium	Low	
High	6	3	1	10
Medium	4	5	1	10
Low	0	2	8	10
Total	10	10	10	30

We have the following rules :

- (i) The number of positive pairs, P , is the sum obtained by multiplying each frequency by the sum of all the frequencies that are both *below* and to the *right* of it, and
- (ii) The number of negative pairs, Q , is the sum obtained by multiplying each frequency by the sum of all frequencies that are both *below* and to the *left* of it.

It needs to mention that before applying the above rules, we must arrange the rows and column of the table so that they are similarly ordered from top to bottom and from left to right, as in Table 2.3.

Applying the above rules to Table 2.3, we have

$$\begin{aligned}
 P &= 6(5 + 1 + 2 + 8) + 3(1 + 8) + 4(2 + 8) + 5(8) \\
 &= 96 + 27 + 40 + 40 = 203
 \end{aligned}$$

$$\begin{aligned}
 Q &= 1(4 + 5 + 0 + 2) + 3(4 + 0) + 1(2 + 0) + 5(0) \\
 &= 11 + 12 + 2 + 0 = 25
 \end{aligned}$$

The formula for δ , the Goodman & Kruskal's Index of Predictive Association in terms of P and Q is,

$$\delta = \frac{P - Q}{P + Q} \quad (2.3)$$

For the data of Table 2.3,

$$\delta = \frac{203 - 25}{203 + 25} = \frac{178}{228} = 0.78$$

This indicates that among pairs where there was difference in both abilities, the proportion in which high mathematical ability went with high chess-playing ability was 78% greater than the proportion in which high mathematical ability went with low chess-playing ability.

The index lies between -1 and +1. It is +1 if the data are concentrated in the upper -left to lower -right diagonal of the table and is -1 if the data are concentrated in upper -right to lower -left diagonal of the table. δ is a symmetric measure.

2.3 Pearson's Product - Moment Correlation Coefficient

When we work with data in interval or ratio scale generally we want to know the extent to which there is a *linear relationship* between the variables, a situation in which a change of a certain number of units in one variable results in a proportionate change in the other variable. A measure that indicates the strength of the linear association between two variables is the well known *correlation coefficient* r . If x and y denote the two variables, the correlation coefficient is defined as follows :

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2} \sqrt{\sum (y - \bar{y})^2}} \quad (2.4)$$

In calculating r , it is easier to use the following formula :

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}} \quad (2.5)$$

To use (2.5), we need first to calculate the five quantities $\sum x$, $\sum y$, $\sum xy$, $\sum x^2$ and $\sum y^2$.

The correlation coefficient lies between -1 and +1. It is +1 if there is perfect positive relationship between the variables (i.e. when the graph of the points lie on a straight line sloping upwards). It is -1 if there is a perfect negative relationship between the variables (i.e. when the points lie on a straight line sloping downwards), r is a symmetric measure. While r can be interpreted as a measure of the closeness of the data to a straight line,

r^2 can be interpreted as the proportion of variation in one variable that is explained by the other. Note that $r=0$ indicates only the absence of a linear relationship ; in such a situation it is possible a curvilinear relationship that exists.

As an example consider the data of Table 2.4 which are from the *Sri Lanka Fertility Survey—1975*.

Table 2.4

Percentage of women who want no more children or have been sterilized,
by the number of children living

No. of children living (x)	=	0	1	2	3	4	5	or more
Percentage of women who want no more children (y)	=	2	14	50	73	87	93	

Taking "5 or more" as "5" for Table 2.4, we have, $\sum x = 15$, $\sum y = 319$,
 $\sum xy = 1146$, $\sum x^2 = 55$, $\sum y^2 = 24247$. Now substituting in (2.5),

$$r = \frac{6(1146) - (15)(319)}{\sqrt{6(55) - (15)^2} \sqrt{6(24247) - (319)^2}} = \frac{2091}{\sqrt{105} \sqrt{43721}} = 0.976$$

This value, since it is very close to +1, indicates strong linear relationship between the two variables under study. Further we observe that $r^2 = (0.976)^2 = 0.952$.

This may be interpreted as 95.2% of the variation in data on percentage of women who want no more children is explained by the number of living children they have.

Table 2.5

Variation in cost of production per copy of a school text book according to
the number of copies printed

No. of copies (Thousand, x)	1	2	3	5	10	20	30
Production cost per copy (Rs. y)	10.2	5.5	4.1	2.8	2.1	1.6	1.4

As an another example consider the data of Table 2.5. Let us calculate the correlation coefficients (a) between x and y and (b) between $1/x$ and y. For that we need,

$$\sum x = 71, \sum y = 27.7, \sum xy = 142.5, \sum x^2 = 1439, \sum y^2 = 167.87$$

$$\sum (1/x) = 2.2167, \sum (y/x) = 15.2133, \sum (1/x)^2 = 1.1447$$

Then using (2.5) we have,

$$(a) r_{x,y} = -0.6766$$

$$(b) r_{1/x,y} = 0.9996$$

While (a) indicates an inverse moderate relationship between x and y , (b) indicates that there is a perfect linear relationship between $1/x$ and y . Thus the transformation of the variable x to $1/x$ has provided us with an "improved" relationship.

The correlation coefficient is one of the measures in statistics that is more frequently misused than used correctly.

3. Relationships in Social Data: Regression Analysis

Sometimes it is desired to know how well several independent variables taken together explain the variation in the dependent variable. The criterion used is how closely a function of the independent variables—having a specified form with unspecified parameters—could predict the dependent variable. Regression analysis is an important and general statistical technique in drawing such inferences.

3.1 Simple Regression Model

A simple regression model has two variables, one called the independent variable and the other called the dependent variable, which are usually denoted by x and y respectively. In symbolic form, a simple regression equation can be written as :

$$Y = \alpha + \beta X + e \quad (3.1)$$

where α and β are called *parameters* which need to be calculated and e is called the *error*. The parameters are determined using the *principle of least squares*. For testing hypotheses concerning the parameter, we assume that errors (e 's) are independently normally distributed with zero mean and same variance².

To present the result in a convenient form define the following "corrected sum of squares".

$$\begin{aligned} CS(x^2) &= \sum x^2 - n(\bar{x})^2 \\ CS(xy) &= \sum xy - n(\bar{x})(\bar{y}) \\ CS(y^2) &= \sum y^2 - n(\bar{y})^2 \end{aligned}$$

where $\bar{x}$ and $\bar{y}$ are the means of n observations of x and y respectively. The following are well known results.

$$\text{Estimate of } \beta = b = \frac{CS(xy)}{CS(x^2)} \quad (3.2)$$

$$\text{Estimate of } \alpha = a = \bar{y} - b\bar{x} \quad (3.3)$$

$$\text{Estimate of } \sigma^2 = s^2 = \frac{1}{n-2} [CS(y^2) - b^2 CS(x^2)] \quad (3.4)$$

$$\text{Standard error of } b = s_b = s \sqrt{\frac{1}{CS(x^2)}} \quad (3.5)$$

$$\text{Standard error of } a = s_a = s \sqrt{\frac{1}{n} + \frac{(\bar{x})^2}{CS(x^2)}} \quad (3.6)$$

To test whether each parameter is significantly different from zero, we use the appropriate "t—statistics,"

$$t = \frac{a}{s_a}; \quad t = \frac{b}{s_b} \quad (3.7)$$

Here "n-2" indicates the degrees of freedom. A measure of goodness-of-fit of the fitted regression equation to the data is given by the coefficient of determination R^2 where

$$R^2 = \frac{[CS(xy)]^2}{CS(x^2) CS(y^2)} \quad (3.8)$$

By multiplying by 100, R^2 is usually expressed as a percentage. Then $100R^2$ lies between 0 and 100 ; figures closer to the upper limit indicate a better fit.

As an example let us fit a simple regression equation (3.1) to the data of Table 2.4. We see that it is appropriate to consider the number of children living as the independent variable (x) and the percentage of women who want no more children or have been sterilized as the dependent variable (y) . Then we have,

$$\begin{aligned} CS(x^2) &= 17.50 & CS(xy) &= 348.5 & CS(y^2) &= 7286.83 \\ b &= 19.91 & a &= 3.38 & s^2 &= 86.68 \\ s_b &= 2.23 & s_a &= 6.74 & R^2 &= 0.952 \end{aligned}$$

The fitted regression model is usually presented as,

$$\begin{array}{rcl}
 y & = & 3.38 + 19.91 x \\
 \text{Standard error} & & 6.74 \quad 2.23 \\
 \text{t-value (d.f. = 4)} & & 0.50 \quad 8.93
 \end{array}
 \quad R^2 = 95.2\% \quad (3.9)$$

Since $t_4 (=0.50) < t_{4, 0.025} (=2.776)$ we observe that the constant term is not significant at the 5% level. This points out that a better model for the data in Table 2.4 is,

$$Y = \beta X + e$$

which indicates a straight line through the origin. Here we use the following results.

$$\begin{aligned}
 b &= \frac{\sum xy}{\sum x^2}, s^2 = \frac{1}{n-1} [\sum y^2 - b^2 \sum x^2], \quad b = s \sqrt{\frac{1}{\sum x^2}} \\
 R^2 &= \frac{[xy]^2}{(x^2)(y^2)}
 \end{aligned}$$

Now the fitted regression model is,

$$\begin{array}{rcl}
 y & = & 20.84 x \\
 \text{standard error} & & 1.16 \\
 \text{t-statistics (d.f. = 5)} & & 17.97
 \end{array}
 \quad R^2 = 98.5\% \quad (3.10)$$

We observe that (3.10) is a better model than (3.9) for data in Table 2.4. Equation (3.10) tells that for every additional child a family receives about 1 in 5 families decides to have no more children.

3.2 Multiple Regression Model

The concept developed in Section 3.1 can be easily extended to situations with more than one independent variable. Then in place of the simple regression model, we have the *multiple regression model* which can be written as,

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + e \quad (3.11)$$

We do not intend to present the formulas for the estimation of parameters of (3.11) and the other quantities, but the reader is referred to a standard text like N.R. Draper and R. Smith (1966) *Applied Regression Analysis*.

During the application of regression analysis to social data where some of the variables are in nominal or ordinal scale, special treatment is necessary. Suppose we have the three variables, monthly income (y) age (x_1) and education which is in ordinal scale with three categories primary, secondary and tertiary. Then we may define the dummy variables x_2 and x_3 to represent education as follows :

	X_2	X_3
Primary	0	0
Secondary	1	0
Tertiary	1	1

We then use the regression model defined as,

$$y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$$

which provides us with the following interpretations :

For given X_2, X_3 , $\alpha + \beta_1 X_1$ represents the mean income for those with primary education

For given X_1, X_3 , $\alpha + \beta_1 X_1 + \beta_2 X_2$ represents the mean income for those with secondary education

For given X_1, X_2 , $\alpha + \beta_1 X_1 + \beta_3 X_3$ represents the mean income for those with tertiary education

3.3 An Overview of Regression Analysis

In a regression model there several assumptions that need to be satisfied by the variables and the errors. One of the assumptions is that the independent variables are not strongly correlated among themselves. This assumption is usually invalid in socio-economic variables. This is known as the problem of *multicollinearity*. The best way to minimise the effect of multicollinearity is to select the variables carefully. Sometimes it may be possible to replace the independent variables by one or two uncorrelated "new variables" which are defined as linear combinations of the original variables, using the *principal component analysis*.

Another assumption is that variance σ^2 is constant and independent of the values of x_i 's. When σ^2 is correlated with x_i 's the problem is known as *heteroscedasticity*. This may be overcome using *weighted regression analysis*.

Another problem with the residual errors may be that the errors are *autocorrelated* instead of being independent. This problem is more important in the analysis of time series data. Survey data being cross-sectional, the problem may not arise. The *Durbin-Watson test statistic* can be used to detect autocorrelation in the residuals. If autocorrelation is present it will be advisable to make appropriate transformation of the variables which will make the residuals independent.

Formal conditions which the variables and residuals should satisfy for the valid application of a regression model are rarely satisfied by socio-economic data. However, it is encouraging to observe that a regression model is fairly robust unless the departures from standard assumptions are serious.

All mini-computers have package programmes for regression analysis. So the actual computational work has been simplified a lot. However, it is always advisable and instructive to tabulate the data in simple contingency tables and present the data in various graphical forms before going in for a large regression model.

4. Analysis of Variance

The analysis of variance (ANOVA) is a statistical procedure which makes it possible to compare the effects of the variables being studied, first independently of the effects of all other variables, and second in all possible combinations with one another. In ANOVA

all the standard general theories of statistics such as point and interval estimation and hypothesis testing come into play. Although the ANOVA was originally developed in the analysis and interpretation of data collected from agricultural experiments, in recent years, the technique is being extensively used in disciplines in which experimental designs are not always possible, such as in social sciences. Assumptions made in the ANOVA are—

- (a) The populations from which the samples are drawn are normally distributed (or at least similar in distribution).
- (b) Samples are randomly drawn.
- (c) The observations in each sample are independent (hence the test is not appropriate for paired observations).
- (d) Common variance exists among the populations from which the samples are drawn (i.e. the so called heteroscedasticity is absent).

For some models of ANOVA the assumption (a) may be violated if the samples are large, and also assumption (d), if the number of cases in each sample is the same. But, in general, if the assumptions are not clearly met, the ANOVA will yield false results. The purpose of the analysis is to partition the variance of the dependent variable into components attributable to each of the influencing variable.

4.1 Replicated Two-way Classification

Consider the data in Table 4.1 which presents the yields of four varieties of paddy in three locations in each of the three districts Kalutara, Kandy and Anuradhapura. By analysis of variance of these data we will be able to answer the following questions :

- (i) Is there a significant difference between the yields of the four varieties of paddy, or between any group of paddy varieties?
- (ii) What is the additional yield (above the overall average) due to each paddy variety?
- (iii) Is there a significant difference between the yields in the three districts?
- (iv) What is the additional yield (above the overall average) from each district?
- (v) Is there a significant “interaction” between paddy varieties and districts?
- (vi) Which of the paddy varieties can be recommended for each district?
- (vii) What is the expected average yield in each district with the recommended paddy variety?

Table 4.1

Yields of 4 varieties of paddy in 3 locations in each of 3 districts

(bushels per acre)

Paddy variety	DISTRICTS		
	Kalutara (D_1)	Kandy (D_2)	Anuradhapura(D_3)
P_1	71, 75, 72	79, 81, 78	75, 73, 79
P_2	66, 70, 65	69, 68, 66	68, 70, 72
P_3	61, 63, 62	68, 66, 68	71, 74, 68
P_4	64, 62, 65	69, 70, 73	79, 81, 77

The computations during the analysis becomes simpler if we code the data by subtracting a construct number from each of the observation. We proceed with the coded data in Table 4.2.

Table 4.2

Coded data obtained by subtracting 70 from each observation of Table 4.1

	D_1	D_2	D_3	T_{i++}	$\bar{y}_{i++}$
P_1	1, 5, 2	9, 11, 8	5, 3, 9	53	5.89
P_2	-4, 0, -5	-1, -2, -4	-2, 0, 2	-16	-1.78
P_3	-9, -7, -8	-2, -4, -2	1, 4, -2	-29	-3.22
P_4	-6, -8, -5	-1, 0, 3	9, 11, 7	10	1.11
T_{+j+}	-44	15	47	18 = G	—
$\bar{y}_{+j+}$	-3.67	1.25	3.92	—	0.5 = $\bar{y}$

We assume the following Model :

$$(i = 1, \dots, 4, j = 1, 2, 3 \text{ and } k = 1, 2, 3)$$

where

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + e_{ijk}$$

Y_{ijk} = Observed yield,

μ = Grand mean,

α_i = Additional yield due to i^{th} paddy variety,

β_j = Additional yield due to j^{th} district,

γ_{ij} = Additional yield due to ij^{th} interaction effect,

e_{ijk} = Error assumed to be $N(0, \sigma^2)$

We calculate the following “sums of squares” :

$$CSS_{Total} = \sum_{ijk} y^2 - \frac{G^2}{abc} = (1^2 + \dots + 7^2) - \frac{18^2}{(4)(3)(3)} = 1097$$

$$SS_{Paddy} = \frac{1}{bc} \sum_i T_i^2 - \frac{G^2}{abc} = \frac{1}{9} (53^2 + \dots + 10^2) - 9 = 436.11$$

$$SS_{District} = \frac{1}{ac} \sum_j T_j^2 - \frac{G^2}{abc} = \frac{1}{12} (44^2 + \dots + 47^2) - 9 = 355.17$$

$$SS_{Error} = \sum_{ijk} y^2 - \frac{1}{c} \sum_{ij} T_{ij}^2 = 1109 - \frac{1}{3} (8^2 + \dots + 27^2) = 702.6$$

$$SS_{Interaction} = CSS_T - SS_P - SS_D - SS_E = 203.05$$

The results are usually presented as in Table 4.3 which is known as ANOVA Table.

Table 4.3

ANOVA Table for data in Table 4.1

Sourde	d.f.	s.s.	Mean ss Square = $\frac{ss}{df}$	F value	F 0.05 (from F— table)
Between paddy	a—1 = 3	436.11	145.37	33.96	3.01
Between districts	b—1 = 2	355.17	177.58	41.49	3.40
Interaction	(a—1)(b—1)=6	203.05	33.84	7.91	2.51
Error	ab(c—1) = 24	102.67	4.28 = s^2	—	—
Total (corrected)	abc—1 = 35	1097.00	—	—	—

On comparing the last two columns in Table 4.3, it can be inferred that,

- (a) There is a significant difference between the yields of paddy varieties.
- (b) There is a significant difference between the yields in the three districts.
- (c) There is a significant “interaction” between the paddy varieties and districts.

The additional yields due to each factor are calculated as follows :

Due to paddy, $\hat{\alpha}_i = \bar{y}_{i+} - \bar{y}$

Due to districts, $\hat{\beta}_j = \bar{y}_{+j} - \bar{y}$

Due to interaction, $\hat{\gamma}_{ij} = \bar{y}_{ij} - \bar{y}_{i+} - \bar{y}_{+j} + \bar{y}$

Thus we have the following results,

P_3	P_2	P_4	P_1
-3.72	-2.28	0.61	5.39
D_1	D_2	D_3	
-4.17	0.75	3.42	

$\hat{\gamma}_{ij}$ Values

$i \backslash j$	D_1	D_2	D_3
P_1	0.94	2.69	-3.64
P_2	2.94	-1.31	-1.64
P_3	-0.61	-0.19	0.18
P_4	-3.28	-1.19	4.47

Finally, we have the following recommendations with the respective expected average yields

District :	Kalutara (D_1)	Kandy (D_2)	A'pura (D_3)
Paddy variety :	P_1	P_1	P_4
Expected Average yield,			

$$\bar{y}_{ij} = \mu + \alpha_i + \beta_j + \gamma_{ij} : \bar{y}_{11} = 72.7 \quad \bar{y}_{12} = 79.7 \quad \bar{y}_{43} = 79.0$$

5. Non-Parametric Statistical Methods

Non-parametric statistical methods are based on explicitly weaker assumptions than such classical parametric procedures as Student's t — tests, regression analysis and analysis of variance. The underlying motivation for the use of non-parametric methods is the reluctance to make the traditional parametric assumptions, in particular (but not only) the assumption of normality. An advantage of some, but by no means all, non-parametric methods is that they are easy and quick to apply.

5.1 The W Test for Two Independent Samples

The Wilcoxon - Mann - Whitney (W-M-W or W) test is used for two independent samples. The objective is to detect whether the two underlying populations are centered differently.

Consider the data in Table 5.1 which presents annual incomes of independent random samples of households from two villages.

Suppose we want to test the null hypothesis that the underlying populations are identical. Suppose the alternative hypothesis is that village "X" is poor, so that one-sided test is appropriate.

Table 5.1
Annual Incomes of Samples of households
from two villages

Village "X"	Village "Y"
3000	3500
4000	5000
5500	7000
8000	7500
	8500
	9000
	10000
	12000
No. of m-4 observations	n = 8

Table 5.2
Combined ranking of data of Table 5.1
and W Statistics

Village "X"	Village "Y"
3000(1)	3500(2)
4000(3)	5000(4)
5500(5)	7000(6)
	7500(7)
8000(8)	8500(9)
	9000(10)
	10000(11)
	12000(12)
Sum W = 17 of ranks	

We combine the observations X and Y and rank them as in Table 5.2. The actual income levels have now been replaced by ranks providing a test that is not affected by skewness of the data—thus a distribution-free test. The test statistic W is the sum of all the X ranks. Thus,

$$W = 1 + 3 + 5 + 8 = 17 \quad (5.1)$$

In large samples, when $n > 7$, W is approximately normally distributed with,

$$\text{Mean, } \mu = \frac{1}{2} m(m + n + 1) \quad (5.2)$$

$$\text{Variance } \sigma^2 = \frac{1}{12} mn(m + n + 1) \quad (5.3)$$

when m and n are the number of observations in each sample. Thus, we can use the normal tables for significant tests.

In our example, $m = 4$ and $n = 8$ and thus,

$$\mu = \frac{1}{2}(4)(13) = 26, \quad \sigma^2 = \frac{1}{12}(4)(8)(13) = 34.7$$

To test the null hypothesis we calculate the value of "z" and compare it with the value of z from the normal table at a given level of significance. Now,

$$z = \frac{W - \mu}{\sigma} = \frac{17 - 26}{\sqrt{34.7}} = -1.53$$

Since at the 5% level of significance $z = -1.64$, the above value of z does not fall into the critical region. Hence, we accept the null hypothesis that the underlying populations are identical.

5.2 The Kruskal-Wallis Test : One - way Analysis of Variance by Ranks

The Wilcoxon-Mann-Whitney test for two independent samples, presented in Section 5.1, may be extended to the situation of k independent samples, where $k > 2$.

Consider the data of Table 5.3 in which four teaching methods are compared for effectiveness with four groups of students in grade 2. Suppose we want to test the null hypothesis that the four teaching methods are equally effective against the alternative hypothesis that certain teaching methods are more effective than others.

Table 5.3

Scores obtained by grade 2 students under each teaching method and the computation of the test statistic.

Teaching Method			
A	B	C	D
70(13.5)	65(9.5)	70(13.5)	80(21)
89(25)	65(9.5)	68(12)	81(22)
86(23)	60(3)	58(2)	75(19)
73(16)	72(15)	61(4)	74(17.5)
63(6.5)	57(1)	74(17.5)	63(6.5)
64(8)	62(5)		78(20)
67(11)			88(24)
Totals $R_i = 103$	43	49	130
No. of observations $n_i = 7$	6	5	7

To apply the Kruskal-Wallis test, we first rank the observations from the lowest value to the highest value, taking care to assign the average rank in the case of tied observations. The test statistic is as defined below and it has a chi-square distribution with $(k-1)$ d.f. when $k \geq 3$ and smallest $n_i > 5$.

$$T = \frac{12}{n(n+1)} \sum_{i=1}^K \frac{R_i^2}{n_i} - 3(n+1) \quad (5.4)$$

where $n = n_1 + \dots + n_k$, total number of observations

R_i = total of ranks for i^{th} sample

n_i = no. of observations in i^{th} sample

k = no. of samples.

For data of Table 5.3

$$T = \frac{12}{25(25+1)} \left[\frac{103^2}{7} + \frac{43^2}{6} + \frac{49^2}{5} + \frac{130^2}{7} \right] - 3(25+1)$$

$$= 9.11$$

since $T (=9.11) > x_{3, 0.05}^2 (= 7.81)$, we can reject the null hypothesis at the 5% level of significance and conclude that there is a significant difference between the effectiveness of the four teaching methods.

5.3 Runs test for Testing Randomness

One of the most crucial assumptions (even more important than the normality assumption) we frequently make in statistical methods is that our observations constitute a random sample. Let us see how we can test a given sequence of observations for randomness.

Consider a coin tossing experiment which has resulted in the following sequence of heads (H's) and tails (T's) :

$$\begin{array}{cccccccccccccccccccc} \text{T} & \text{T} & \text{T} & \text{T} & \text{T} & \text{H} & \text{H} & \text{T} & \text{T} & \text{H} & \text{T} & \text{T} & \text{T} & \text{H} & \text{H} & \text{T} & \text{H} & \text{H} & \text{T} \\ \text{H} & \text{T} & \text{H} & \text{H} & \text{T} & \text{H} & \text{T} & \text{T} & \text{H} & \text{H} & \text{H} & \text{H} & \text{T} & \text{T} & \text{T} & \text{H} & \text{H} & \text{T} \end{array}$$

Suppose we want to test the null hypothesis that occurrence of heads and tails is random (In other words, we are testing that the coin is unbiased).

The test procedure is based on the number of *runs* in the set of observations. Any sequence of like observations, bounded by observations of a different type, is called a *run*. Thus, in the above set of observations, first 5 T's constitutes one run, next 2 H's another run and so on. It is convenient to indicate each run by drawing a line under each sequence of like observations, as in the example above. If we denote the total number of runs by U , then we have $U = 21$. Further, denote the number of H's and number of T's by m and n respectively. When both m and n are large, U has approximately a normal distribution with,

$$\text{Mean, } \mu_u = \frac{2mn}{m+n} + 1$$

$$\text{variance, } \sigma_u^2 = \frac{2mn(2mn-m-n)}{(m+n)^2(m+n-1)}$$

The approximation is usually good enough for practical purposes when m or n exceeds 20. The null hypothesis is tested using a two-tail test ; if U is either too small or too large we suspect non-randomness.

In our example; $m = 18$, $n = 22$ and we had $u = 21$. Thus,

$$\mu_u = \frac{2(18)(22)}{18+22} + 1 = 20.8$$

$$\sigma_u^2 = \frac{2(18)(22)(792-18-22)}{(18+22)^2(18+22-1)} = 9.54$$

The two-tail test for the null hypothesis at the 5% level of significance is given by the following rule :

Reject the hypothesis if

$$Z = \frac{u-20.8}{\sqrt{9.54}} \geq 1.96$$

Accept the hypothesis otherwise.

In this example, $z = 0.06$ and so we accept the null hypothesis and conclude that the occurrence of heads and tails is random.

Measurement and Scaling of Scores

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1. Introduction

Measurement consists of assigning numbers according to rules to objects or persons to represent quantities of attributes. Procedures for assigning numbers have to be carefully formulated so that the scale of measurement that is used will faithfully reflect the attribute being measured.

Data obtained by measurement are subjected to various manipulations before we derive meaning from them. The nature of the scale of measurement sometimes restricts the kinds of statistical manipulations which can be made with the data. It is therefore useful to become familiar with the different kinds of measurement scales. When these scales are classified according to certain properties, they are also referred to as levels of measurement. The properties relevant to the question are magnitude, equal intervals, and absolute zero point.

When a scale has magnitude, a datum obtained by using the scale can be judged as greater than, equal to, or less than another datum obtained from it. A temperature of 29° is greater than that of 28° and less than 31° . If the measured temperature of two towns is each 29° , we say that they have an equal temperature.

Equal intervals relate to the property of the unit of measurement being the same at whatever point on the scale it occurs. The difference between 28° and 31° represents the same difference in temperature as between 35° and 38° .

A scale has an absolute zero point if it can indicate that nothing at all of the attribute being measured exists. When the number of children in the family is recorded, absence of any children is denoted by a zero.

A scale of measurement that has magnitude, equal intervals and an absolute zero point is a ratio scale. If a child weighs 28 kg. and his father weighs 56 kg., we can say that the father weighs twice as much as his son.

An interval scale possesses magnitude and equal intervals, but not an absolute zero point. A temperature of 30° is not twice the temperature of 15° .

A scale that reflects magnitude but does not possess equal intervals or an absolute zero is called an ordinal scale. A teacher ranks 10 students in a class according to their height. We know that the student ranked 2nd is taller than the one whose rank is 3, and he in turn is taller than the one ranked 4th, but we do not know what difference in height exists between the 2nd and the 3rd as well as between the 3rd and the 4th.

When all that a scale can do is to classify objects or persons into discrete groups or categories without any relation to magnitude, it is called a nominal scale. Classifying persons according to their religions or geographical location is an example of the use of a nominal scale. Although numbers can be used as labels for different categories, any kind of magnitude is not implied in their use.

2. Derived Score Scales

Obtained or raw scores are sometimes transformed to derive scores having desirable scale properties. The main purpose of such transformations is (1) to make scores from different tests comparable and (2) to change the shape of the distribution.

Measurements of human characteristics can rarely be obtained with reference to an absolute zero point. Nor can it be maintained that equal differences between raw scores represent equal differences in the trait being measured. Because of these limitations, the distribution of scores of a representative group is often taken as a frame of reference for transforming raw scores to make them comparable.

2.1 Percentile Ranks

The percentile ranks of a score is the percentage of persons in the reference group who obtain scores lower than or equal to that score. If in a distribution of scores, 72% of the group scored 61 or less, the score 61 is said to have a percentile rank of 72. Percentile ranking of scores assigns a rank to each score on a scale of 100.

The easiest way of computing percentile ranks is through the cumulative percentage distribution. Consider the distribution of scores in the following table :

<u>Raw Score</u>	<u>f.</u>	<u>Of to the mid point</u>	<u>Percentile Rank</u>
63	4	48	96
62	6	43.0	86
61	8	36.0	72
60	8	28.0	56
59	10	19.0	38
58	4	12.0	24
57	4	8.0	16
56	3	4.5	9
55	2	2.0	4
54	1	3.5	1
<u>N = 50</u>			

Column 3 of the table gives the cumulative frequency to the mid-point of each score. This is obtained by counting the number of persons below the score and adding one half of the number of persons getting that score. The percentile rank in column 4 is obtained by multiplying the value in column 3 by $\frac{100}{N}$.

When the data obtained are in the form of ranks, percentile ranks are best obtained by using the formula

$$PR_{(R)} = 100 \frac{(N - R + .5)}{N}$$

Where R is the rank to be converted to the percentile rank (PR) and N is the number of persons in the group. Suppose X has been rated 4th in a group of 10. His percentile rank will be

$$PR_{(R)} = 100 \frac{(10 - 4 + 0.5)}{10} = 65$$

The figure below explains this.

1	1	1	1	1	1	$\frac{1}{2}$	$\frac{1}{2}$	1	1	1
10	9	8	7	6	5	4	3	2	1	

3. Rank Order

When raw scores or ranks are converted to percentile ranks, a person's performance in different tests can be compared or different persons can be compared with one another.

It is not legitimate to sum percentile ranks to obtain composite scores. The percentile rank scale is an ordinal scale. Thus it does not possess equal points or an absolute zero point.

3.1 Standard Scores

Conversion of raw scores to standard scores yields a set of scores which are comparable and are of equal units. Here again, the group becomes the frame of reference. Standard scores are obtained by a linear transformation.

The first step in computing standard scores is the calculation of the mean and the standard deviation of the distribution. Each obtained score is expressed as a deviation from the mean and this deviation is divided by the standard deviation. The result is called a standard measure or a z score. The mean of the z score scale is 0 and the standard deviation is 1. As the scores below the mean will be negative and all except a few scored will have decimal fractions, it is customary to carry the linear transformation a step further by multiplying the z score by 10 or some such convenient number and adding a constant such as 50 or 100. The multiplier will be the new standard deviation and the constant will be the new mean.

Suppose the mean and the standard deviation of a distribution of scores were 40 and 12, and a person's obtained score was 56. When this score is transformed to a standard score of a scale with 50 as mean and 10 as its standard deviation, we will have—

$$\begin{aligned}
 Z &= \frac{(X - M) S'}{S} + M' \\
 &= \frac{(56 - 40) 10}{12} + 50 \\
 &= 13.3 + 50 \\
 &= 63
 \end{aligned}$$

Different distributions of scores become comparable when they are transformed into a common scale of standard scores. Whatever the earlier unit of measurement was, the new unit of measurement is a common one. In the “50—10” scale used above, the unit of measurement will be $\frac{1}{10}$ th of the standard deviation.

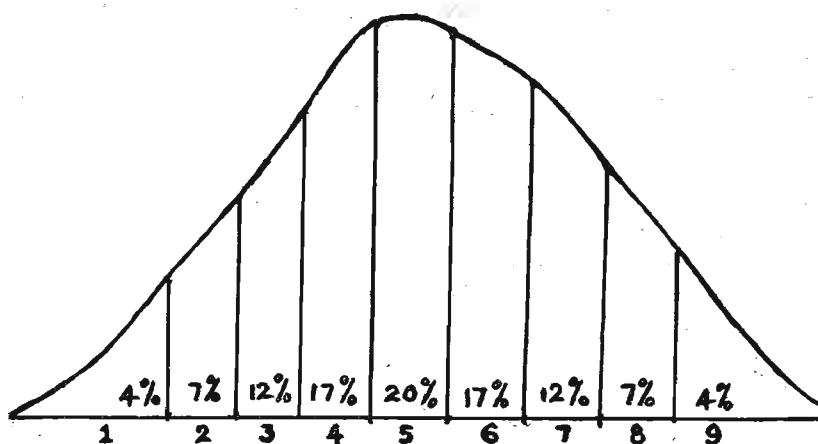
However, it should be noted that the comparability of standard scores does not hold for skewed distributions unless the distributions have the same degree and direction of skewness.

3.2 T Scaling

When the shapes of distribution differ, the procedure known as T scaling is adopted. This not only leads to comparable units, but also normalizes the distributions. The first step in converting a set of scores to T scores is to obtain the percentile ranks or the cumulative percentages corresponding to the scores. The next step is to enter a table of the normal curve function to find the corresponding z values. The z values are then multiplied by 10 and added to 50. For example, suppose a percentile ranks of 72. The z value obtained from the table of the normal curve function corresponding to an area of $0.72 - 0.50 = 0.22$ above the mean is $+0.6$. Multiplying this by 10 and adding 50, we obtain a T score of 56. The distribution of T scores will always conform to the normal curve.

3.3 Stanine Scaling

While the T scale has, by definition, a mean of 50 and a standard deviation of 10, the Stanine scale has a mean of 5 and a standard deviation of 2. It has only 9 scores in the scale, i.e., from 1 to 9. The unit of the scale is one half of its standard deviation. Thus the middle score 5 occupies the middle area of the normal curve having as its lower boundary the perpendicular drawn at the z value of -0.25 and the perpendicular drawn at the z value of $+0.25$ as its upper boundary. This area is approximately 20% of the area under the normal curve. Hence, in a distribution of Stanine scores, the middle score of 5 is assigned to the middle 20% of the group. The 17% above the middle 20% get the score of 6, and the 17% below the middle 20% get the score of 4. The figure below shows how the 9 scores in the scale are assigned to the various sections of the distribution.



All that one has to do to convert a set of scores to Stanine scores is therefore to arrange them from the highest to the lowest and assign 9 to the highest 4%, 8 to the next 7%, 7 to the next 12% and so on until the lowest score is assigned to the lowest 4% of the group.

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Scaling Methods*

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1. Introduction

Scales that measure physical attributes and properties are precise and well established. There are well defined set rules of measurement. For example the length of a rod can be measured in centimetres thickness and (weight also can be measured) accurately. In a yard stick a 'Zero' indicates non existence of a property in an absolute sense. If one rod is twice as long as a second rod it is a meaningful comparison.

In sociological, psychological, educational and other similar disciplines such well established, precise scales of measurement are not available. When one says person 'A's height is 65 inches, weight is 120 lbs and IQ is 98, one can accept his height and weight with no doubt in mind, but doubt the IQ measure. If one remeasures the person A with the same scales used in measuring on the first occasion one will find that his height is 65 inches and weight is 120 lbs but may not record the same IQ (98) as was recorded on the first occasion. If one measured height and weight with different scales (centimetre and grams) still one will get exactly the same height and weight once one converts metres and grams into inches and pounds. However, in the measurement of intelligence, if i.e. a test other than the one used on the first occasion is employed, the chances of recording the same IQ (98) are rather remote. Despite such difficulties there is a need to find some procedure to construct scales to measure social and psychological variables.

A well established measuring scale requires two properties. One is the property of identifying a 'zero' point to indicate non-existence of the property being measured. The second is the property of *equal units of measurement* to measure different degrees of the property or attribute being measured.

These two necessary conditions of a satisfactory measuring scale can be further illustrated by drawing examples from physical scales-length weight. When you say that the length of a rod is one inch it indicates there is an inch unit from an absolute zero point. If the length is 'zero' it means there is no length. When one says length is 3 inches it indicates that there are 3 equal 'inch units' of length. An inch on any part of the standard foot-ruler will be equal in length.

In socio-psychological measurement when one says that person A's intelligence is 'zero' that does not indicate that he absolutely has no intelligence. Similarly, when one says A's IQ is 98 and B's IQ is 99 that does not say that B is definitely one IQ unit better than A. Therefore in using measurement scales in the Social Science one has to be rather cautious.

* The author is indebted to A. L. Edward, W. L. Hays and C. Selliti et al., and on some occasions have directly taken material from their books listed under reference.

Measures from a well established scale facilitates mathematical manipulations—addition, subtraction, multiplication and division. Measurement is assignment of numbers to objects and events. These numbers come from a set rule-scale. Usually numbers can be added, subtracted, multiplied and divided, though not always.

If a measuring scale has no absolute 'zero' value and equal units of measurement, mathematical functions are unwarranted with measures that are taken by such scales.

Example :

The length of rod one is 12 inches and rod two is 24 inches. Therefore, the two rods together will be 36 inches long—additive property – ($12 + 24 = 36$). Rod one is 12 inches shorter than rod two – ($24 - 12 = 12$ ”). Rod two is twice as long as rod one—($12 \times 2 = 24$). Rod one is only a half of rod two—($12/24 = 1/2$). All these statements are true.

However, if we state that person A's IQ is 75 and person B's IQ is 150 we cannot make similar statements. A's IQ plus B's IQ will not make an IQ of 225. Also B cannot be sighted as twice as intelligent as A. These statements have no logical meaning. The absence of an absolute 'zero' point on the IQ scale as well as the absence of equal IQ units as units of measurement do not warrant such applications.

Since variables such as IQ are measured by scales which have no 'absolute zero point' or 'equal units of measurement', these measures do not qualify for ordinary mathematical operations. However, psychometry, sociometry and econometry offer certain solutions to overcome these problems of measuring psycho-sociological dimensions. Techniques of scaling attempt to offer satisfactory solutions to these problems.

Physical measurement scales possess unambiguous equality of units because such equality has been operationally clearly defined for them. Two weights are said to be equal if they balance when placed on a suitable weighing device. If we are willing to accept the requisite operational definition to every psycho-sociological dimension these properties can also be measured on a scale that has the same properties as the scale of weights. Problems arise in psycho-sociological measurements because of two reasons.

- (1) Experts cannot agree on a clear operational definition of the attribute to be measured.
- (2) The attribute is defined in terms of operations for which the symbolic processes of mathematical manipulations can be given no useful operational meaning.

Angoff (1960) states that 'any set of measurements can be expressed in terms of a scale with equal units, in some sense, if only we can agree on a definition in operational terms of what is meant by equality. Torgerson (1958) compares social and behavioural sciences with physical sciences and illustrates that constructs and connections between /among constructs are not neat and clear social and behavioural disciplines as in physical sciences. As a result, it is difficult to have precise statements and operational definitions.

When operational definitions are not possible due to weaker connections between constructs, measurement procedure also becomes weaker. Measurement is assignment of numbers to objects or events. In assigning numbers one must have a scheme. The measurement rule tells how to go about putting each event into the proper category in the scheme. All branches of science, in fact, make use of sets of qualitative labels, classes or categories along with the measurement rules specifying how to assign events, objects or subjects into given categories.

2. Scale Construction

In selecting items for inclusion on a scale two criteria are commonly used. Firstly, the items *must elicit responses that are directly or indirectly related to the construct* being measured. The relationship does not necessarily have to be so evident. Depending on the psychological or sociological construct intended to be measured, at times, there is a considerable advantage in using indirect items.

Secondly, items *must differentiate among people* who are at different levels or points along the construct being measured. This is the discrimination power of the item. The item should have the capacity to discriminate respondents who possess varying degrees of an attribute. Differentiation not only depends on the scale but also on the method of scoring. An item may discriminate the respondents, say at five different points on the scale but if scoring was done, assigning the same score to the first three levels and a different score to the other two levels, discrimination will appear only at two points of the scale as a result of scoring.

Example : We must strive for loyalty to our country before we can afford to consider world brotherhood.

	<i>Strongly Approve</i>	<i>Approve</i>	<i>Undecided</i>	<i>Disapprove</i>	<i>Strongly Disapprove</i>
Score	1	2	3	4	5
	(Discriminates at five points on the Scale)				
Score	1	1	1	2	2
	(Discriminates only at two points on the Scale)				

Broadly speaking there are three types of scaling techniques—

1. Differential Scales –
2. Summated Scales –
3. Cumulative Scales –

2.1 Differential Scales

A differential scale consists of a number of items whose position on the scale has been determined by some kind of ranking or rating operation performed by judges. Differential scales can be constructed under different methods.

- (a) Method of paired comparison.
- (b) Method of equal appearing intervals.
- (c) Method of successive intervals.

are some of the better known methods of scaling. Only the first two (a) and (b) above, will be discussed here.

(a) *Paired Comparisons*—

In the 1920s Thurstone (1927a, 1927b) invented this technique. It is a method of ordering stimuli-objects/events—along a sociological or a psychological continuum. For instance, a consumer can rank order seven varieties of vegetables in terms of his utility. Utility is a psychological continuum.

In paired comparisons one stimulus is evaluated or valued against another in pairs. Say, beans as a vegetable can be compared with cabbage with carrot and so on. Similarly cabbage can be valued against beans, carrots and so on. If one vegetable can be valued against the other six vegetables in pairs, then, if you have N objects/events to judge, you will have $n^2-n/2$ pairs to be judged.

In paired comparison scaling we let a large sample of judges (sampling considerations are to be followed) to make their judgements taking a pair of stimuli at a time. By getting comparative judgements of the kind described above, we can obtain an empirical frequency corresponding to the number of times that one stimulus (i) is judged to be more favourable than the other stimuli (j). We let (1.0) $f_{ij} = i > j$ where f_{ij} is the frequency with which i is judged better than j . Once we divide the f_{ij} by the total number of judges (N), we can get a proportion of times that i is judged better than j .

$$(1.1) \quad P_{ij} = f_{ij} / N$$

Now we have two metrics, one having frequencies, the other with proportions. These can be denoted as F and P metrics respectively. These proportions can be transformed into unit normal deviates (Z_{ij}) by means of the normal distribution.

TABLE 1
F Matrix for 7 Vegetables Judged by 94 Judges

Vegetable	1	2	3	4	5	6	7
1	47	65	75	80	75	86	80
2	29	47	51	54	62	68	81
3	19	43	47	49	59	60	63
4	14	40	45	47	49	63	67
5	19	32	35	45	47	51	55
6	8	26	34	31	43	47	57
7	6	13	31	27	39	37	47

TABLE 2
P Matrix for 7 Vegetables Judged by 94 Judges

Vegetable	1	2	3	4	5	6	7
1	.500	.691	.798	.851	.798	.915	.936
2	.309	.500	.543	.574	.660	.723	.862
3	.202	.457	.500	.521	.628	.638	.670
4	.149	.4268s	.479	.500	.521	.670	.713
5	.202	.340	.372	.479	.500	.543	.585
6	.085	.277	.362	.330	.457	.500	.606
7	.064	.138	.330	.287	.415	.394	.500
Sum	1 1011	2 329	2 884	3 042	3 479	3 883	4 372

TABLE 3
Z Matrix for the 7 Vegetables Judged by 94 Judges

Vegetable	1	2	3	4	5	6	7
1	.000	.499	.834	1.041	.834	1.372	1.522
2	— .499	.000	.108	.187	.412	.592	1.089
3	— .834	— .108	.000	.053	.327	.353	.440
4	— 1.041	— .187	— .053	.000	.053	.440	.562
5	— .834	— .412	— .327	— .053	.000	.108	.215
6	— 1.372	— .592	— .353	— .440	— .108	.000	.265
7	— 1.522	1.089	— .440	— .562	— .215	— .269	.000
Sums	— 6.102	— 1.889	— .231	.226	1.303	.596	4.097
Means	— .872	— .271	— .033	.032	.186	.371	.585
Scale Value	.000	.603	.839	.904	1.058	1.243	1.457

For illustrative purposes assume that the seven vegetables were judged by 94 judges. The Tables 1, 2, 3 present the F, P and Z Matrices respectively derived from the judgements.

By Summing the Z_{ij} values column-wise, we get the $\sum Z_{ij}$ values. Once we divide the $\sum Z_{ij}$ by the number of stimuli, we can obtain the average scale value for each of the seven vegetables.

$$(1.2) \quad \bar{Z}_i = \sum Z_{ij}/n$$

Vegetables with negative scale values are those judged to be less favourable than the average of the scale values of all statements and those with positive scale values are judged to be more favourable than the average.

Since the scale values ($\bar{Z}_{ij}$) are with minus values, to avoid minus signs the absolute value of the largest negative scale value ($\bar{Z}_i$) was added to every Z_i . The last row in Table 3 presents the scale values assigned to indicate the utility value of the seven evaluated vegetables.

Similarly, attitudes, values, interests, aspirations and many other psycho-sociological constructs can be evaluated and scaled.

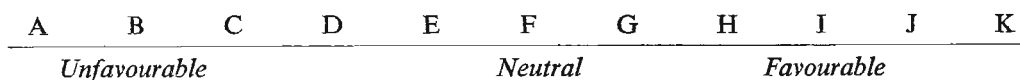
Though there is no absolute zero value in our scale, we have arrived at an arbitrarily fixed relatively meaningful zero point. Though it does not say absolute absence of a property, it indicates the absence of the property with respect to the other objects or events evaluated.

(b) *Equal Appearing Intervals*

Thurstone and Chave (1929) introduced this technique which is very commonly used today. The procedure followed in this method can be listed step-wise.

- (1) Gather a large amount of evaluative statements related to the construct/attribute to be measured and scaled.
- (2) Select a sample of judges (at least more than 50) to judge these statements.
- (3) Ask judges to classify these statements according to their judgements into eleven piles. Say the least favoured statement to pile one and second least favourable to the second pile and so on in respective order of preference. The eleventh pile will have the best favoured statements.

The following diagram illustrates this:-



Only the middle and the two extreme cords on which the statements were to be sorted are to be defined for the judges. The eleven point rating scale then becomes the psychological continuum on which the statements have been judged.

- (4) Once all the judges have made their judgements by sorting statements to the eleven piles, a frequency count (f) as well as the proportions (P) can be computed (see Table 4). In Table 4, an illustrative example is given, where 3 statements and a sample of 200 judges are used.

Once the proportions are computed, the cumulative proportions (cp) can be computed.

- (5) Compute the median value or pile to which it is assigned by the group of judges. The median is the point where the cumulative proportion (cp) will add up to 0.5. In the 1st statement of the Table 4, the median value lies between F and G (0.40 and 0.72).

Table 4
Judgements obtained by Equal Appearing Intervals

Statements		Sorting Categories											Scale Value
1	f	22	2	6	2	6	62	64	26	18	8	4	
	P	.01	.01	.03	.01	.03	.32	.32	.13	.09	.04	.02	6.8
	CP	.01	.02	.05	.06	.09	.40	.72	.85	.94	.98	1.00	Q—1.7
2	f	0	0	0	10	40	28	50	26	28	14	4	
	P	.00	.00	.00	.05	.20	.14	.25	.13	.14	.07	.02	6.9
	CP	.00	.00	.00	.05	.25	.39	.64	.77	.91	.98	1.00	Q—2.8
3	f	0	0	0	2	8	6	26	44	56	44	14	
	P	.00	.00	.00	.01	.04	.03	.13	.22	.28	.22	.07	8.7
	CP	.00	.00	.00	.01	.05	.08	.21	.43	.71	.93	1.00	2.0

Median value (scale value) can be computed with the help of the following formula :—

$$\text{Mdn} = 1 + \frac{(.50 - \sum P_b)i}{p_w} \quad \text{Medn} = 1 + \frac{(.50 - \sum P_b)i}{\left(\frac{p_w}{p} \right)}$$

where, Mdn = Median (scale value)

1 = The lower limit of the interval in which the median falls.

P_b = The sum of the proportions below the interval in which the median falls.

P_w = The proportion within the interval in which the median falls.

i = The width of the interval which is assumed to be equal to 1.0.

Using the above formula we can compute a scale value for the statement I on Table 4

$$\text{Mdn} = 6.5 + \frac{(.50 - .40)}{(.32)} \cdot 1.0 = 6.8$$

Similarly, for every statement we can compute the scale values.

Statements that have too broad a scatter are to be discarded because such items are ambiguous and irrelevant to the construct being measured. Therefore, another statistic is needed to indicate how big the spread is. Inter-Quantile Range (Q) is often used for this purpose.

$$Q = C_{75} - C_{25}$$

where,

$$C_{75} = 1 + \frac{(.75 - p_b)}{\left(\frac{p_w}{p} \right)} \quad \text{and}$$

$$C_{25} = 1 + \frac{(.25 - P_b)}{\left(\frac{p_w}{p} \right)}$$

where, l = Lower limit of the interval in which the C^{th} centile falls.
 $\sum p_b$ = The sum of the proportions below the interval in which C^{th} centile falls.
 p_w = The proportion within the interval in which the C^{th} centile falls.
 Substituting values from Table 4, we can compute the Q value—

$$C_{75} = 7.5 + \frac{(.75 - .72)}{(.13)} = 7.7 \quad \frac{(.7 - .72)}{(.13)} = 7.5$$

$$C_{25} = 5.5 + \frac{(.25 - .09)}{.31} = 6.0$$

$$Q = C_{75} - C_{25} = 7.7 - 6.0 = 1.7$$

Similarly Q values can be computed to investigate the spread (discriminant dispersion) looking at both scale value (median) and the Q items that will be selected for the scale.

Now the standardized equal appearing interval scale can be administered to measure the degree of presence of a particular construct in an individual.

These statements can be arranged in random order and presented to subjects with instructions to indicate those that they are willing to accept or agree with. Taking the agreed responses and the scale values assigned to those statements the attitude score can be obtained.

2.2 Summated Scales

The Summated Scale is better known in the literature as the Likert scale. Likert presented this method in 1932. In a summated scale, the subject is asked to react to a series of items. The subjects will respond to each item in terms of their own agreement or disagreement with the statements. The Likert scale is usually a five point scale—it often uses five categories ; Strongly agree, Agree, Undecided, Disagree, Strongly disagree. Each item will be scored. Very often unfavourable responses are indicated with a 'negative score' and a favourable responses with a 'positive score'. The total score is a summated score. However, rather than just scoring, by assigning an arbitrary scoring key such as 0, 1, 2, 3 and 4 one could also obtain *normal deviate weighting* of response categories. Table 5 presents the weighted normal deviates for the five response categories of an item.

TABLE 5

	Strongly Agree	Agree	Undecided	Disagree	Strong disagree
(1) p	.130	.430	.210	.130	.101
(2) cp	.130	.560	.770	.900	1.101
(3) mid point cp	.065	.345	.665	.835	.951
(4) z	-1.514	-.399	.426	.974	1.641
(5) z + 1.514	.000	-11.115	1.940	2.488	3.151
(6) z rounded	00	1	2	2	3

In Table 5, first the proportion of subjects responding to each of the five response categories is indicated. Row (2) *cp* indicates the cumulative proportion. Row (3) gives the cumulated proportions to the mid-point, that is, the proportions below a given category plus $1/2$ the proportion within the category. Row (4) indicates the normal deviates for the corresponding mid-point cumulative proportions. Row (5) illustrates how the negative *Z* values were converted to positive values by adding the absolute value of the largest negative value. Row (6) presents the rounded *Z* value. Similarly, every item has to be weighted. The final score of a subject will be the total score obtained by summing scores for the individual items.

Selection of items for a summated scale is done after an item analysis. The steps to be followed in an item analysis are as follows :—

- (1) Administer a large number of items to a realistic sample.
- (2) Score the items either using the normal deviate score or with an arbitrarily fixed scoring key (this was discussed above).
- (3) Obtain the total summated score for each individual and rank order the individuals on total score.
- (4) Take the top 27% and the bottom 27% of the subjects in the rank ordered list. Those two groups—High and Low—are the criterion groups which are to be used in item evaluations.
- (5) Prepare a list with item responses of the subjects of the two groups. The following gives an idea of the procedure :—

TABLE 6

<i>High Group</i>		<i>Low Group</i>	
<i>Individual</i>	<i>Item Score</i>	<i>Individual</i>	<i>Item Score</i>
1	4	1	1
2	2	2	0
.	.	.	.
.	.	.	.
i	3	i	2
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
n _H	5	n _L	3
Sum	$\sum X_H$	Sum	$\sum X_{Li}$
	H		
Average $X_H = \frac{\sum X_H}{n_H}$		Average $X_L = \frac{\sum X_{Li}}{n_L}$	

Using the item scores, we can compute the average item score ($\bar{X}_i$) for the two groups.

- (6) To evaluate the items the average score of the High and Low groups can be compared by obtaining the following statistical ratio :—

$$t = \frac{X_{Hi} - X_{Li}}{\frac{\sum (X_{Hi} - \bar{X}_{Hi})^2 + \sum (X_{Li} - \bar{X}_{Li})^2}{n(n-1)}}$$

The value of t is a measure which indicates the extent to which the item discriminates the high and low groups. Edwards (1969) suggest items with a t ratio of 1.75 or higher, a better item to have on the scale.

The summated scale has certain advantages.

- (1) It permits the use of items that are not manifestly related to the attitude being measured. In Thurstone Scale judges limit the item pool.
- (2) Relatively easy to construct.
- (3) The Likert type permits the expression of several response levels (usually five) whereas the Thurstone scale offers only two alternatives (agree or disagree). As a result the summated scale is considered more reliable.

There are disadvantages as well.

- (1) The Likert scale is regarded as an ordinal scale where neither equal units of measurement nor an absolute zero point is present. On the other hand Thurstone's is considered as an interval scale.
- (2) The summated score of a Likert scale does not indicate clearly the pattern of individual behaviour. Several individuals can have the same score but obtained through different behavioural patterns.

2.3 Cumulative Scales

Louis Guttman originally introduced the cumulative scaling technique which is now better known as Guttman's Scalogram Analysis. Guttman's method emphasises internal consistency so that different items do represent different quantitative positions on the same basic dimension. Items are expected to be related to one another in such a way that, ideally, an individual who replies favourably to item Z will also reply favourably to item 1. Similarly one who agrees with item 3 will also agree with items 2 and 1. As a result, when once score is known his response pattern is obviously known.

For example, consider the following three items (extracted from Hays - page 70):-

- a. Students should have voice in University policy—(Agree/Disagree).
- b. Student should be consulted on matters such as curriculum changes (Agree/Disagree).
- c. Student representatives should sit with the Board of Regents in decisions affecting all University policy (Agree/Disagree).

If the above items were presented for response, it is logical to expect one who agrees to item "C" will also agree to items 2 and 1. An individual who does not agree to B cannot be expected to agree to item C.

The following table shows the response pattern expected by a Scalogram :

TABLE 7

<i>Individual</i>	<i>Items</i>				<i>Individuals' Total Score</i>
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	
1	X	O	O	O	1
2	X	X	O	O	2
3	X	X	X	O	3
4	X	X	X	X	4
Item Score	4	3	2	1	
Rank	1	2	3	4	

We do not know in advance that a given set of items necessarily falls along a single continuum from least to most favourable. It is the purpose of Scalogram analysis to set items to satisfy that condition or order.

There are different methods of Scalogram construction. Steps of one of the simpler method is listed below.

- (1) Guttman scale is strictly undimensional. Therefore, one has to collect/write statements which are strictly related to the dimension to be measured.
- (2) Collect a large number of undimensional items. Lots of items may have to be discarded if they do not fit in well with the rank order analysis.
- (3) As in the Thurstone's method, select a large group of judges and ask them to sort out the items to 11 piles, according to their judged favourableness or unfavourableness toward the issue. At this stage itself, items with great variability should be eliminated.

- (4) Selected items at step 3 above, will now be formed into Likert-type items with five response categories, and administer the likert-type scale to a large number of individuals. As in the Likert scale now looking at the total score, from a High and a Low group and compute the item discrimination indices. Items with the highest discriminatory coefficients will be selected and be placed in rank order.

Guttman's scale appears to be theoretically sound but it has its own disadvantages.

- (1) The scale is basically an Ordinal scale. Therefore, as a scale, it has its inherited weaknesses that are common to an ordinal scale.
- (2) It is difficult to stress on a unidimension because a statement which is thought to be unidimensional to one person may appear multidimensional to another person.
- (3) Such a scale may not serve the purpose when an object or an event is complex.
- (4) Construction procedure involves relatively more work than the ones discussed earlier.

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PART VI

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Computers in the Analysis of Data in the Social Sciences

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1. Introduction

Digital computers may be employed to handle a vast variety of tasks ; for the processing of scientific and commercial data and for the real time control of machinery and scientific equipment. Here we shall be concerned with the processing of data.

The use of a digital computer influences both the volume of data that can be analysed and the type of analysis that may be performed. The amount of data can be much greater than when purely manual processing is done. Also, with the aid of a computer, sophisticated analytical techniques may be applied. Although the use of computers is spreading, the existence of a technical 'jargon' tends to discourage the beginner. One of the objectives of this paper is to show that the jargon is in fact quite simple and that it need not act as a barrier between the computer and the research worker.

The technology of computing has undergone continuous change during the last few decades and is likely to do so in the foreseeable future. For instance, at the time of installation in 1970, the computer at the University of Peradeniya was considered a medium-sized one. Today it would be more appropriate to refer to it as a mini-computer. In the following paragraphs we shall consider a level of technology applicable to the computing installations that have been available in Sri Lanka for a decade or so. Where appropriate we shall refer to the more modern computers installed during the last three years.

In commercial data processing, large quantities of data are subjected to simple operations such as addition, sorting and ordering. On the other hand, in the physical sciences, very often, a small amount of initial data is subjected to sophisticated mathematical manipulations. The kind of applications that we are interested in—processing of data in the social sciences—usually fall somewhere in-between. That is, the number of observations lies somewhere between a few tens and a few thousands, while the mathematical techniques applied would be laborious but not impossibly so using manual devices.

2. Hardware

This refers to all the mechanical and electronic assemblies that do the processing. With modern installations the user need not familiarise himself with the hardware at all. The only aspect that is of importance would be the cost of using the hardware. However we shall describe below some of the common items of hardware.

The Central Processing Unit.—This is the single most expensive item of hardware and often governs the charges for using the computer. The CPU has three important properties that are of scientific interest. These are, the size of the main memory, the speed at which calculations may be performed and the repertoire of machine instructions.

The smallest unit of memory is the binary digit or bit. This is a piece of electrical circuitry which can exist in one of two states, e.g., current flowing or current not flowing, voltage present or voltage absent, clockwise magnetic field or counter clockwise magnetic field. For purpose of logic we can assign a bit to any variable which may exist in one of two states, e.g., 0 or 1, true or false, male or female. The science of information theory tells us that all information may be represented as an array of bits. Therefore all logical reasoning can be reduced to the processing of bits. Note that no claim is made for any possible equivalence between logical reasoning and human intelligence.

In practice the bit is far too small a unit for convenient processing. The 'byte' which consists of an array of eight bits is much more convenient. Since a byte consists of 8 bits it can hold one of 256 possible values. Most computers use one byte each to hold an alphabetic character and several bytes to hold a number.

In the jargon the size of the main memory is expressed in K's. The K stands for Kilo or 1024, which is approximately one thousand. Thus, e.g., the computer at Peradeniya has a main memory of 32K or 32 768 bytes. For the type of problems that we are interested in, a memory of 8K would almost always be sufficient.

The speed at which calculations can be done is governed largely by the speed at which information can be transferred to and from the main memory. The minimum time required to extract a unit of information from the memory is referred to as the access time. The access time of a modern computer is typically less than one micro-second. Most arithmetic operations take several units of access time. The repertoire of machine instructions varies widely from computer to computer. Basic operations such as addition, subtraction, test for equality are always available. Any operations that are not available may be synthesised using the available instructions. Modern programming languages are designed so that the user may be completely unconcerned about the repertoire of machine instructions.

Input Devices.—The computer must be supplied with information in a form which can be 'read' by a machine. This may be done by employing punched card, punched paper tape, flexible magnetic disk (called floppy disk or diskette), or through a keyboard connected to the computer.

Punched card (Hollerith card) is a popular medium for input. A card has 80 columns and 12 rows. Each decimal digit, letter, or symbol such as the decimal point, is represented by a unique arrangement of holes along a column. Thus a card may carry a maximum of eighty characters, initially the cards are prepared on a key-punch machine. This machine has a keyboard which resembles that of a typewriter but has no lowercase letters. It is not directly connected to the computer, i.e., it is 'off-line'. Several key-punch machines are required to keep a computer busy.

The punched cards are fed into an 'on-line' card read machine. This machine converts the pattern of holes along each column into an electrical signal which is transferred to the memory of the computer. The speeds of card reads vary from 200—1000 cards per minute, i.e., 16,000—80,000 characters per minute.

Punched paper tape may be used as an input medium. Tape punching machines are cheaper than the key-punch machines used in the preparation of Hollerith cards. Also tape read machines are cheaper and often faster than card read machines. However, if during preparation, an error occurs, it is necessary to tear the tape and to splice it. For this reason and also because a deck of cards can be rearranged, Hollerith cards are more popular than paper tape.

With the more modern installation, the input data may be placed on a floppy disk via a key-board : the floppy disk is then loaded on a read machine wired to the computer.

An on-line electrical typewriter may be employed to input information to the computer. However, this is very wasteful of computer time except in the case of large computers with multiple terminals.

Output Devices.—The fastest and most common output device is the line printer. The maximum speeds of line printers vary from 80 to 1200 lines per minute. The standard line lengths are 120 and 144 characters. Lower case letters are usually not available on line printers.

A printed output may also be obtained from a typewriter. This is much slower than the line printer, a typical speed being 60 characters per minute.

The processed output may also be placed on card or tape. This is a very useful facility if the output data are to be processed further at a later date.

The processed output may be directly transmitted to a graph plotter. This is a slow but versatile machine. The results of the processing can be plotted on a graph saving considerable manual labour. The axes, scale factors and cardinal points can be drawn automatically under the control of the computer. The graphs may be annotated and titles inserted.

Back-up Storage.—Back-up or auxilliary storage usually takes the form of magnetic tape or magnetic disk. When the volume of data is too large for the main memory or when the data are to be analysed on several occasions it may be transferred from the input device onto tape, hard disk or floppy disk. This may be done directly or at some intermediate stage in the processing.

The capacities of disk packages vary from the equivalent of one million alphameric characters to that of 20 million. These capacities are greater than those of the largest main memories. The CPU can communicate with the disk unit(s) at speeds that are much higher than it can with the input/output devices described earlier. A typical speed is of the order of 200,000 characters per second.

Data kept in auxilliary storage are usually referred to as a 'file'. If the file is maintained on a disk, a relatively small block of information (record, sector, cylinder or bucket) may be accessed directly without having to go through the whole file as would be the case with a card file. The disk unit would get at the required block within a few thousands of a second.

Storage on magnetic tape is cheaper than that on disk. However communication between the CPU and the tape drive is slower because the tape has to be wound up to the point where the required data are recorded. A magnetic tape 1 inch wide and 2,500 feet long wound on a reel of $10\frac{1}{2}$ inch diameter can typically store the equivalent of 20 million characters.

A floppy disk stores 0.1—0.5 million characters.

Since the disk cartridge or the reel of tape can be removed from the drive mechanism they provide unlimited off-line storage. When carefully protected from heat and humidity, disk and tape files can be as reliable as punched card or hard copy.

3. System Software

In order to put the computer to use the CPU must be given detailed instructions. While the computer is running these instructions are in a form referred to as 'machine code'. Since the machine can handle only bits, a machine code program is a bewildering array of 1s and 0s. The system software usually provided by the manufacturer insulates the user from machine code and allows him to communicate with the computer using ordinary numbers and Latin characters.

The Operating System.—This is the most important part of the system software. Some part of it is always held in the main memory. The user provides certain control information, in order to set up the machine to handle the particular job. The control statements required vary widely among different installations. For scientific jobs, generally very few control statements are required and it takes very little effort to learn the sequence. Usually all that is required is to supply information that tells the computer what programming language is being used and what input/output devices are to be held on-line.

The Compilers.—Modern computers may be programmed in what are known as problem oriented or high level languages. Some examples of such languages are, FORTRAN (FORMula TRANslator) ALGOL (ALGORithmic Language), COBOL (COMmon Business Oriented Language), RPG (Report Program Generator), BASIC, APL and PASCAL. A program written in such a language consists of a sequence of statements. These statements resemble statements in English and mathematical notation. Of the languages referred to above, FORTRAN has been designed for scientific work while COBOL and RPG are used in commercial applications. For social science work, the scientific languages would be generally appropriate but RPG may be useful for some problems. Currently, the most widely accepted of the scientific programming languages is FORTRAN.

The source program is input to the computer through a medium such as punched card. It is then converted to machine language by the system software. The suite of programs that does this is referred to as the compiler. The compiled program may be stored in auxiliary storage or executed immediately. The data associated with the problem are provided at the time of running.

4. User Software

The term 'User Software' refers to programs written by the user or by a programmer under the direction of the user. Such programs are generally written in high level languages.

Communicating with a Programmer.—Modern high level languages are so convenient to use that there is no reason why a research worker who can presumably handle the mathematics required by his work cannot write the program himself. However, perhaps because of the lack of regular access to a computer, many research workers find it necessary to employ a programmer. In this case it is necessary that the research worker has some idea of the capabilities of the computer installation. On the other hand the programmer must be supplied with very comprehensive information regarding the type of data, the exact form in which it is to be presented and the mathematical procedures to be employed. The form of output required should be described in detail. The mathematical procedures may be explained with the aid of flow charts. The formats of the input and output can be described with the aid of 'coding sheets'.

Sub-programs—Most user programs consist of a main program together with a number of sub-programs. When the main program is run, the computer calls up the required sub-programs. A user may write a sub-program if he finds that the same procedure is to be repeated several times at different points in the main program.

Very often users call up sub-programs that are available as part of the program library maintained at the installation. The program library is maintained in auxiliary storage or in the form of punched card. Each sub-program has associated with it some literature which defines the function that it performs and the conditions under which it may be used. Particular care should be taken to see that such conditions are not violated by the nature of the data or by the main program.

5. When Does One Use a Computer?

The factors to be considered before deciding to use a computer : time cost, ease of access to a computer, availability of consumable items (card and printer paper) and the availability of the services of a programmer. Since the last three factors are clearly beyond the scope of this paper, only the first two will be considered here.

The actual computing time usually forms a negligible part of the total time taken for the project. Usually most of the time is taken in preparing the data, entry of data in a form suitable for key-punching, validation of the data and preparation of programs. The time taken for writing programs can be reduced if suitable library programs are available.

Often the mathematical procedures are simple but the volume of data is large. In such cases the cost of hiring the computer may be roughly estimated by calculating the time taken to read the cards and to print the results.

The fact that the volume of data is large does not necessarily justify the use of a computer. Let us consider a hypothetical example. Suppose that we have a large number of values of a parameter and we wish to calculate their mean. This could be done manually or with a hand calculator by passing over the data once only. Perhaps we may have to pass over it again to check the first calculation. If we were to do this job on a computer the punch operator must pass through the data at least once. If the data are checked on a card verifying machine the operator requires two passes. Similar reasoning applies for any other input medium. Clearly, using a computer for this job would add to the cost and delay the results.

Now let us suppose that we wish to calculate the standard deviation as well. With a simple calculator we should have to pass over the data twice and possibly twice more for checking. Therefore at this stage it may be worth considering the use of a computer.

If, say, the same data were to be arranged in ascending order, it can be shown that the number of passes required is approximately $N(N + 1)/2$, where N is the number of items. Clearly the use of a computer will save considerable time and labour if not money, provided N is large enough. Thus a simple rule is that the use of a computer is advantageous if the same data are to be passed over a large number of times in order to get the desired information.

6. Validation of Data

The importance of ensuring that the input data are error-free cannot be over-emphasised. In manual processing any absurdities in the data usually show up during the processing and can then be corrected. Unfortunately a computer has no discretion at all and the data are treated as legitimate. Therefore, before processing proper is started, as many checks as possible should be applied. For this purpose too the computer may be used. The checking procedures would depend very much on the nature of the data but we shall consider two general methods briefly.

If the limits of each item of data (numeric or alphabetic) can be established beforehand, the computer can be made to reject all records containing any item of data outside the limits allocated to that item. If the limits are not known beforehand, likely limits, erring on the narrow side, may be placed. The rejected records can be re-examined and the limits adjusted.

The computer can be programmed to check for known logical interrelationships between different items of data. For example, in a demographic survey, if the number of expectant women drops by one due to erroneous punching of a card the resulting error in the predicted may be insignificant. If however the missing punch has been transcribed into a man's record and further processing done some of the results may look rather odd. This type of situation can be avoided by subjecting the data to extensive validation using the computer itself.

Errors are frequently introduced when the raw data are transcribed into a format suitable for key punching. The best thing to do is to avoid this stage altogether by designing the forms on which the data are collected in such a manner that punching can proceed directly from the forms.

The extensive validation of data results in the rigid definition of their numerical and logical properties. This is a great help to the programmer when he is designing the programs and also in tracing program errors.

7. Validation of Programs

In principle the validation of programs is more difficult than that of data. There are no known general methods to 'prove' that a program will work the way it is intended to work. Therefore, if a programmer is employed, the research worker may have to accept the accuracy of the programs on faith. However, one simple and very effective although not 100% fool-proof method of program validation is to run every program or sub-program on a sample of the data. The test sample could be randomly picked or artificially created. Either way, the sample should be picked by the research worker and not the programmer. The computer results for the test sample can be compared with manually obtained results. Even the slightest discrepancy between the two sets of results should be traced to the point of origin.

The output can be formatted so as to facilitate simple checks such as row, column and grand totals in tables. Again any discrepancy must always be traced to the point of origin because although punch operators, programmers and even research workers often make mistakes, the probability of the computer making a mistake that cannot be detected is so small as to be completely negligible.

GLOSSARY OF COMPUTER JARGON

The following is a glossary of terms that occur often in computer "jargon". The explanations have been taken from some authoritative and popular English-English dictionaries. The meaning when used as a technical term is identical to, very close to, or derived from, the meaning in non-technical English.

Abbreviations : n. — noun, v. — verb, adj. — adjective

ABORT	v. to arrest in development at an early stage
ACCESS	n. opportunity of approach or entrance
ACCUMULATOR	n. a thing that can collect or amass
ALLOCATE	v. to place or locate
ALPHANUMERIC	n. relating to alphabetic and numeric representation
AMPERSAND	n. the character representing "and", &
ARRAY	n. order ; group of things arranged in some order
ASSEMBLE	v. to collect or put together parts of
ASSIGN	v. to specify, to allocate, say, a value
CARRIAGE	v. conveying, transport
	n. part of machinery for shifting position of other parts

CHARACTER	n. a letter, sign, figure, stamp or distinctive mark
COMPILE	v. to draw up, collect ; to put or bring together, in a meaningful manner
CONCATENATE	v. bring together or link as in a chain
CONFIGURATION	n. mode of arrangement
CONSECUTIVE	adj. following in regular order or one after another
CONSOLE	n. frame containing keyboards, stops, etc. eg. of organ
CURRENT	adj. belonging to the period of time now passing
DECK	n. a pile of things (cards) laid flat
DECREMENT	n. the quantity lost by decrease
	n. the act of decreasing
DETECTION	n. state of being found out or discovered
DIAGNOSIS	n. a formal determining deception or identification
DISTINCT	adj. different or well defined
DUMMY	n. a sham or counterfeit article taking the place of a real one
EVALUATE	v. to determine the value of
EXCESSIVE	adj. beyond what is usual or right
EXECUTE	v. to carry into effect
EXECUTABLE	adj. that which can be executed
EXPLICIT	n. not implied merely but distinctly and plainly stated
FACILITY	n. means or opportunity which gives ease in performance
FORMAT	n. the size, form or shape in which a book, page, line, or card is issued
HEXADECIMAL	n. a container through which grain (cards) passes in mills (cardreads)
IMPLICIT	adj. relying entirely on or implied though not plainly expressed.
INCREMENT	n. an amount or thing added, the act of adding
INVALID	adj. without validity, null, void
LINKAGE	n. an act or mode of linking or the fact of being linked
LITERAL	adj. expressed by letters of alphabet
LOOP	n. that which diverges from the main and joins it again
MANIPULATE	v. to handle or manage
MODE	n. way, manner or form in which a thing is done or happens or exists
NEST	n. an accumulation or set of things fitting one within another
ORIENTATE	v. to place or determine the position of, relatively to fixed or known directions
OVERFLOW	v. to flow or run over, or pass out in part as under pressure
	n. that which flows over
OVERRIDE	v. to pass over or to set aside,
PARAMETER	n. a line or quantity which serves to determine a point line, figure, property or quantity in a class of such things.
PARENTHESIS	n. a pair of round brackets(.....)
PERIPHERAL	adj. in a surrounding region
PRECISION	n. quality of being exact or accurate
PROCESS	n. a sequence of operations or changes undergone
PROTOCOL	n. rules of formal behaviour
RANDOM	adj. irregular, haphazard (i.e. without order)
RECORD	n. register or a book of writings of any facts or proceedings
	v. to set forth
REDUNDANT	adj. superfluous or excessive
SCAN	v. to examine critically and to mark out
SEQUENTIAL	adj. that which is in sequence i.e. a set of things following in order of some principle

SIMULATE	v. to have or assume a false appearance of
STACK	n. a large built up pile
	v. to pile into a stack
STATEMENT	n. that which is stated, expression in words etc.
SUBSCRIPT	adj. written beneath
SYMBOLIC	adj. that which by custom or convention is a representative of something else
SYNTAX	n. grammatical structure in sentences.
TERMINATE	v. bring or come to an end
TRANSFER	v. to convey or change over from one place to another
TRUNCATE	v. to cut short (top or end)
UPDATE	v. to bring up to date
UNDERFLOW	n. (current) following beneath surface
VALIDATE	v. to make legally or logically good

Data Presentation

NIMAL SANDARATNE

Central Bank of Ceylon

“When you can measure what you are
Speaking about and express it in numbers,
You know something about it, but when
You cannot express it in numbers, your knowledge
Is of a meagre and unsatisfactory kind”

LORD KELVIN

1. Introduction

Having gone through a series of lectures on the conceptualization of research, the designing of research projects and surveys, the designing of questionnaires, the collection of data and the analysis of data, you have come to the last stage of the process, the presentation of the data that have been collected. This is indeed a very important step because it relates to the communication of your research findings. If you do not communicate your research findings adequately and effectively much of the efforts and expenditures on developing and designing the research project and all the care in the collection and processing of the data would be of little benefit to the community. The way in which data are presented, discussed and interpreted is crucial to the effective communication of the research findings.

Yet, relatively little has been written on this area compared to the other aspects such as data collection and analysis. This is no doubt due to the fact that data presentation is an art. Experience is indeed the best means of acquiring the skills. Yet a few hints, guidelines and consideration could assist a beginner and what is attempted here is just that.

This lecture will deal with the following :—

1. Preliminary and Basic Considerations in Data Presentation
2. Formats of Reports
3. Textual Presentation of Data
4. Tabular Presentation of Data.

2. Preliminary and Basic Consideration in Data Presentation

First :—BE CLEAR ABOUT THE OBJECTIVES OF THE REPORT OR SURVEY OR RESEARCH

Without the writer being clear about the objectives of the survey he will be unable to sift the data, emphasise what should be emphasised and omit what is unnecessary. Without a clear idea of the objectives of the research, the report writer will tend to include all the data that have been collected and what is presented will lack purpose and clarity.

In fact the objectives of the data collection or survey should be clear at the design stage and the type of presentation of data decided upon at that stage. This would minimize the collection of unnecessary data as well as ensure that needed data are collected in a form that is useful and necessary for the final report.

Second :—BE CLEAR TO WHOM THE REPORT IS ADDRESSED : WHAT IS THE TARGET AUDIENCE

This is one of most difficult things in practice in social science research undertaken by public institutions. In the case of academic research like post-graduate thesis and journals the target audience is clear. It is academics with scientific training in the same field. One could use scientific words with precise meaning, use formulae, often skip steps in the logic or calculations and get the point across clearly and without ambiguity by the use of statistical measures such as regression coefficients, standard deviation, significance tests etc. The only difficulty in presentation of data for the academic community is the need to strictly adhere to acceptable standards and norms and styles of presentation required by the University or Journal.

A much more difficult task is the presenting of a report whose target audience ranges from the academic community to the general public and includes sponsors of research, other professionals administrators and politicians. The usual advice given is that one cannot write a successful report addressed to such a cross-section target audience. Therefore one should write separate reports for each target audience.

In practice this is not possible. One is able to write only a single report. Therefore what does one do?

Here are a few suggestions :

- (1) Write a chapter summarising the findings with cross references to the detailed chapters. The summary chapter could be fairly comprehensive in giving the findings and should be written simply and fairly briefly. This would be in non-technical language.
- (2) Each chapter's introduction and conclusions could be written in non-technical language.
- (3) Indicate that (1) & (2) have been done for the use and benefit of the non-technical reader and for the reader who has no time to read the entire report. Also asterisks may be used to indicate other sections in the report which are useful for this same audience.
- (4) In the report itself where technical jargon is used attempt also to state the salient features in simple language. If the writer is clear in his own mind about the scientific presentation, this task of simple expression in common language is not too difficult.

- (5) Remember that there are statistical measures which can be understood by laymen and use them. Examples are mean, range, percentages and other ratios. Even statistical measures like regression coefficient can be interpreted in simple language. Though a certain amount of precision may be lost in such interpretations the conclusion can be clearly conveyed.
- (6) Footnotes giving explanations and definitions of scientific and statistical terms is another useful device.

This discussion, I hope, makes two things clear. One is that writing to a mixed audience is difficult but not insuperable. The other is that it is a compromise which like all compromises does not yield the best results. However, given situations where there is no option, your ingenuity must find the means of presenting the best report to a mixed audience.

If you have the option of writing several reports certainly write separate reports for different target audiences.

Third :—ALWAYS DRAW UP AN OUTLINE BEFORE COMMENCING A REPORT

An outline clarifies your thinking. You can see whether there is a logic in your organization of the report. It is easier to change the outline than attempt to change the report once written. This is especially so because often reports have cross references.

Fourth :—DON'T MAKE YOUR REPORTS EXCESSIVELY LONG

A short concise report is likely to communicate the findings much better than a long one. Where useful but not directly relevant data have been collected, place these in an appendix rather than clutter the main report and thereby lose the attention of most readers.

Fifth :—USE AIDS LIKE DICTIONARIES, THESAURUSES, CONVERSION TABLES AND HAVE THEM WITH YOU WHEN WRITING

Dictionaries will minimize spelling errors, when in doubt always consult them. Thesauruses are books containing a host of similar words, synonyms and antonyms generally arranged and classified by ideas. They are very valuable in choosing a better word than the first one which comes to your mind. Conversion tables permit you to give the data in units other than those in the tables. This can be useful especially today when you may use the metric system but the readers are more used to other measures.

Sixth :—GET AT LEAST TWO PERSONS TO READ THE DRAFT REPORT

The report writer is not likely to see errors he has himself made. Therefore one person who knows the subject should be given to read and comment. Another person not connected with the subject matter of the report and representative of the target audience should be given the draft report. This latter person should be asked to comment on particularly whether the presentation is clear and asked to mark sections which are not clear. This should be followed by discussions.

If possible the writer himself should “keep off” the report for a length of time and do a final reading, forgetting that he was the writer.

3. Formats of Reports

The contents of a Report may be divided into four parts and consists usually of the following sequence :

Part I	1. Title Page
	2. Foreword/Preface
Pre-Report	3. Table of Contents
	4. List of Tables
Part II	5. Introduction
Introduction	6. Problem Formulation
	7. Methodology—
Methodology	(a) Research Design
	(b) Sampling Plan
	(c) Data Collection
	(d) Data Processing
	(e) Response of Survey
	(f) Adaptations made, if any.
Part III	8. Presentation of Data
Findings of Research	(Contents of Chapters would vary with nature of inquiry)
	9. Conclusion
	10. Summary
Part IV	11. Appendices (a) Questionnaire
	(b) Instructions to investigate
Additions	12. Appendix Tables
	13. References

Although usually the summary is placed as the last item in Part III, there are good reasons to make the Summary Chapter the first Chapter in this part. This is one means by which the summary could be conceived of as a self-contained report for a general audience. Another device that is now quite fashionable is to publish a separate report as a summary—it is often called an “Executive Summary” and is often published very attractively.

4. Textual Presentation

The preliminary and basic considerations in data presentation outlined earlier have a relevance here. But these further guidelines may be offered.

- (1) *The Textual Presentation should not be a verbal restatement of the tables.*

A verbal restatement of a table apart from being repetitions, is an uninteresting and boring exercise both to the writer and reader. Tables are a far more concise method of data presentation and the purpose of having the tables is defeated if every row and column is described.

The text should draw attention only to the important and significant aspects of the table.

- (2) *The text should attempt to interpret the tables in the light of the experience in the field.*

The interpretation of the tables include the modification of the figures and cautioning the reader from interpreting the figures too rigidly. This implies that those who were involved in the field work should do the writing of the report. If the writers of the report have themselves conducted the field work they would have a "feel" for the data. The figures in the table could then be modified in the text. Some illustrations would make the point clearer.

For example, consider the well known bias in the collection of income data. Several categories of respondents would not disclose their true incomes. Despite efforts to obtain correct figures and cross-checks in the questionnaire itself (as for example reconciliation with expenditure information) it may be realized that the income data presented in the tables have a downward bias. This may be especially so with respect to a particular occupational or income category. While there may be some categories whose information is fairly correct others may be purposely understated. By indicating these limitations in the data contained in the table in the textual presentation, the report will prevent exaggerated interpretations that are likely with the figures alone.

Another example is where the data collected and tabulated are correct but do not disclose the whole truth. An example of this type is where for instance in the distribution of interest rates it may be found that 25 per cent of the loans is without an interest charge. However, from your experience in the field you may be aware that those who do not charge an interest overtly do commit their borrowers to certain conditions which in fact amount to a hidden interest charge. Landlords who lend without an interest charge may require their tenants to pay higher rents or sell the produce at a lower price. Boutique keepers who lend without an interest charge may sell to their borrowers at higher prices. These facts which are not included in the table could be discussed in the text. Such discussion would enable a better understanding of the actual situation than disclosed by the figures in the table.

- (3) *The text should attempt to interest the data collected in the particular research project in the context of other studies and background knowledge of the subject.*

The experience and knowledge of the report writer is very important in interpreting the findings of the research project in a broader context of other studies and related knowledge. Such background knowledge could enrich the quality of the report greatly.

Let me again illustrate the types of contributions a writer could make. He could relate the data to previous research findings. The data could be related to the economic and social context of the time of research. Economic facts

and quantitative data generated by the research project could be related to sociological and cultural factors and realities. Policy implications of the research finding could also be discussed.

These discussions in the text would bring out the significance of the research far more than if only the data are presented. The intellectual quality and wide experience and perspectives of the writer would indeed be the most important factor determining the quality of the textual presentation.

5. Tabular Presentation

There are several advantages in the tabular presentation of data. The main advantages are :

- (a) Conciseness in presentation
- (b) Clarity and ease in reading
- (c) Comparability—the rows and columns enable easy comparison.

Basic Requirements of a Table

The tables should be constructed so as to bring out these advantages of the tabular form. The following basic requirements of a table must be kept in mind.

- (1) The table with its title should be self-explanatory. It should not be necessary to read the text to understand the contents of the table.
- (2) The title of the table should contain all the relevant dimensions contained in the table and yet be brief. Year or Period of Data should be stated. E.g: District-wise Distribution of Population by Sex, Sri Lanka 1980.

Not.—Distribution of Population or District-wise Distribution of Population or Sri Lanka Distribution of Population by sex.

- (3) Units of measurement must be indicated clearly, as for example whether figures are in Rupees or Dollars, Metric Tons or Long Tons or Cwts., whether figures are numbers or percentages.
- (4) Column and row headings should be concise, brief and unambiguous.
- (5) Figures in series should be in columns. Comparable data in rows.

E.g:

In thousands		
Year	Cars	Motor Cycles
1975	6,210	4,111
1976	6,315	4,711
1977	6,400	5,848
1978	6,501	7,111
1979	6,800	8,999
1980	7,645	10,801

The columns indicate the numbers of vehicles each year for six years, the rows permit comparison of Cars and Motor Cycles in each year.

- (6) Where figures in the table are from other sources or derived from other tables, the source should be indicated at the bottom.
- (7) When unfamiliar terms are used these should be defined in footnotes.
- (8) Extensive ruling should be avoided. Spacing of columns and rows should be planned so as to accommodate these in the available space. If possible there should be uniformity in the width of columns. Remember that printed tables are more flexible to accommodation in available space than typewritten tables.

Hints on Tabular Presentation

1. Figures which are to be compared must be placed in immediate juxtaposition. By such placement of figures the reader's attention is drawn to a particular comparison rather than another. Consider the following two tables with the same figures.

Table 1
Sex and Age Distribution of Population, Sri Lanka 1972 & 1979

Age Groups Years	In Thousands			
	Male		Female	
	1972	1979	1972	1979
0 — 4	857	964	830	936
5 — 14	1,691	1,900	1,634	1,841
15 — 49	3,197	3,594	3,057	3,443
50 — 60	578	650	472	532
65 and over	296	333	249	278
Total	6,619	7,441	6,242	7,030

Source : Registrar General's Dept.

Table 2
Sex and Age Distribution of Population, Sri Lanka 1972 & 1979

Age Groups	In thousands			
	1972		1979	
	Male	Female	Male	Female
0 — 4	857	830	964	936
5 — 14	1,591	1,634	1,900	1,841
15 — 49	3,197	3,057	3,594	3,443
50 — 64	578	472	650	532
65 and over	296	249	333	278
Total	6,619	6,242	7,441	7,030

Source : Registrar General's Dept.

In Table I the comparison is between males in 1972 and 1979 and females in 1972 and 1979. In Table II the comparison is between the sexes in each of the two years. Therefore the juxtaposition of the same figures in different ways highlight different issues. The comparison in Table I is an analysis of the changes in the population of each sex in each age group in the two years. Table II is useful for an analysis of the sex ratios in each year.

2. Several types of comparisons and analysis could be facilitated by the use of ratios (percentages being the most popular), averages, cumulative figures and other computed relationships. These could be incorporated in the tables themselves in additional columns.

3. Do not overload your tables. Too many figures in a table could distract the reader and not enable him to see the important figures. If there are too many variables, it is better to construct separate tables.

4. A common error that should be avoided is the ambiguity of end values in class intervals. The class intervals should be as in Tables I and II above and not 0-5, 5-15, 15-50, 50-65 and 65 and over where the values of 5, 15, 50 & 65 could be in either of two class intervals. Where comparisons are made it is better to have class intervals of the same size.

5. Where placing the percentages is useful but separate columns and rows would make it cumbersome, percentages could be placed in paranthesis or brackets. It is however important to be clear of what total the figure is a percentage.

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Maps, Diagrams and Graphs

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1. Introduction

The results of research have to be presented in a meaningful and readily understood manner. If a researcher manages to convey to the reader what the researcher himself understood from the study concerned it is a mark of good scholarship.

Several techniques can be used to present the produced data of research studies. One technique is literary description. Data can also be presented in the form of tables. The other technique is to present data diagrammatically, graphically or pictorially. The technique to be chosen depends on the nature of the information, the purpose of the presentation and the type of readership at whom the study is aimed. In the rest of this lecture I shall make some observations regarding the use of maps, diagrams and graphs as techniques of data presentation.

2. Objectives

Quantitative data are analysed with one or more of the following objectives in view. Sometimes the researcher is interested in observing the nature of fluctuations and the degree of variability in a given series of data. The purpose of the study may be to discover a possible secular trend in the variable. Attention may also be focussed on the relationship between two or more variables. The data can also be analysed to observe possible deviations from a norm, such as the mean, median or mode. The objective of the researcher may be to find out the concentration or scatter of the values pertaining to the particular observation. It is also possible to observe patterns of variation in space. A researcher may wish to ascertain the frequency of occurrence of a particular value. Having processed and tabulated the data it is sometimes possible to use maps, diagrams and graphs to present the information with a view to bringing out one or more of the features mentioned above.

3. Maps

A map consists of presenting data in a diagram which contains or represents a region, a country or an area with a definite boundary and an orientation. Any pictorial representation having these characteristics is a map.

The presentation of information by means of maps can be divided into two broad categories. One is a qualitative representation which is called, 'chrochromatic' map without precise quantitative data. For example information provided in land-use maps or maps showing the distribution of vegetation fall into this category. In these no exact measurements are given. For instance, in land-use maps the distribution of the different types of crops are just marked without reference to the actual acreage.

There are two types of maps used in the quantitative representation of data. One type is the 'isopleth' map and the other is the 'choropleth' map. In isopleth maps we identify the locations having the same value and join them with a line. Thus these maps show not only the pattern or the spatial distribution but also its spatial quantitative variation. Maps showing rainfall and temperature distribution are examples from physical studies. In socio-economic studies, for example, if we want to show homogeneous regions in relation to variables such as per capita income, employment, or the cost of production it is possible to mark the locations where the same value is obtained and by joining all such points with an iso-line it is possible to indicate the variations of values over space.

In choropleth maps the quantitative average values of a variable are given in relation to some given area, usually an administrative unit. For example, the average yield per acre for a crop or the density of population per square mile can be calculated for an administrative unit and shown on a map.

4. Diagrams

Diagrams are those representations which use certain geometrical shapes such as bars, circles and so forth. The most commonly used diagrams consist of bar diagrams, wheel diagrams and flow charts.

Bar diagrams can be of two types, vertical (column) bar diagrams and horizontal bar diagrams. Column bar diagrams are particularly popular in the presentation of weather and climatic data. In such instances the columns are usually drawn without allowing for an interval between two columns. Horizontal bar diagrams are mostly used to present socio-economic data. For easy comparison horizontal bars can be constructed either in a pyramidal arrangement or in pairs sitting side by side to each other. Data on demography, export-import trade and so on can be presented in this manner.

Wheel diagrams can be used either individually or in groups. They could be drawn in such a way that both the overall magnitude of the different variables as well as the constituent parts of a given variable could be compared simultaneously. For example, suppose one wants to show the asweddumized area of paddy under major irrigation, minor irrigation and rain-fed conditions in each of the twenty two districts in Sri Lanka. Then twenty two wheel diagrams can be drawn with the size of each wheel diagram varying according to the area under paddy in the district concerned and each diagram showing in proportionate terms the three types of paddy land in the district in question.

Flow charts can be used to indicate simultaneously direction of flow as well as the magnitude of flow. Direction is indicated by drawing a line with an arrowhead and by adjusting the length and/or the thickness of the line it is possible to show the relative magnitude of the quantity which flows in that direction. For example, if we want to show the migration pattern between Colombo and the surrounding area it is possible to show this by means of a flow chart.

Flow charts are also used to demonstrate intra-organization and inter-organization relationships. There are several advantages in this technique. The respective responsibilities or functions of groups and individuals and their inter-relationships can be specified.

The direction of authority can also be conveniently shown. Sometimes it is also possible to include some data (e.g. strength of individual units or organizations of various wage levels) and descriptive notes in the chart.

Before I end this section it should be mentioned that it is sometimes useful to represent data by incorporating diagrams into a map. For example monthly rainfall data in the different districts can be shown on a map where a bar diagram for each district is drawn within the district boundary.

5. Line Graphs

Line graphs can be sub-divided into three main categories. Simple line-graphs where only one line or curve is drawn to show the change in any given series of data constitute the first. Second, the polygraphs where a number of lines or curves are drawn to represent different variables. Thirdly, the land graphs where along with the change in the total quantity that is represented by the graph we also show its constituent elements on the same graphs.

Some line graphs represent time series data. In such instances the convention is to represent the time period on the horizontal axis and the values of the variable on the vertical axis, and plot the points on the graph.

Some line graphs are scatter graphs where we try to show the relationship between two variables. It makes no reference to a time period as such. Very often when the points are plotted it is found to be a scatter and not a line. Scatter graphs are especially useful as a means of preliminary verification of possible relationships between variables before a researcher attempts more sophisticated methods of analysis such as regressions.

Semi-log paper can be used for line graphs when it is necessary to compress the vertical scale to manageable proportions. Semi-log graphs are also useful to indicate the rate of growth of a variable.

6. Some Rules to Observe

When presenting data by means of maps, diagrams and graphs there are certain rules and conventions to which the user must adhere. Firstly, if it is a map, an orientation which indicates the north must be clearly shown on the map. Secondly, whether it is a map, diagram or a graph, the presentation should be given in a frame to make it visually striking. Thirdly, where necessary a scale must be indicated. A scale can be presented in three ways. It can be a statement such as, say, 'one inch on the map represents one mile'. Alternatively, it could be shown either as linear scale or a representative fraction. Fourthly, maps, diagrams and graphs must have definite and clear titles conveying what they attempt to show. Fifthly, a legend may be required to explain signs, symbols and letterings used. Sixthly, the source of data must be stated. Seventhly, the lettering and numbering must be clear. Letter and number sizes can be varied so that due attention can be focussed on more important captions by means of relatively bigger-sized letters and numbers. Finally, when colouring is used, as in maps, various shades of the same colour must be used to indicate the different gradations of the same variable, and different and contrasting colours to represent different variables.

Reference

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PART VII

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Retrieval of Information: The Literature Search

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1. Introduction

The ability to use your own library and to exploit its resources to the full is an essential prerequisite for any meaningful research and if the library is a good one—like the library at the University of Peradeniya—it may go a long way in providing the researcher with a knowledge of the literature in the field. Still it is not enough to know merely how to use the library of the institution you are attached to, for the publishing world has grown so much today that no one library could possibly possess all the books written and published all over the world even in just one field of study.

Therefore researchers have to be able to find out what documents have already been published in his field of study in the form of books, articles in scholarly journals and the like—irrespective of whether they are available in his own library or not. This knowledge has to be periodically up-dated to keep in touch with literature being published while the research is going on. This is what is termed a literature search and there are a number of tools available for the purpose.

2. Bibliographies

One of the most important of the tools which may be used in the literature search is the bibliography. A bibliography is a list of books pertaining to a given topic or field of knowledge. Bibliographies are of many different types. Some are a simple listing of books arranged alphabetically according to the author. Except in a bibliography covering a very narrow area of study or a short time span this kind of bibliography is less useful than a classified bibliography which makes it easier for the user to find out the material he is interested in.

A bibliography may be comprehensive or select. A comprehensive bibliography includes all material published on a particular subject or field without excluding any items that the compiler may think would be of little use. This type of bibliography has its uses, for it presents the researcher with a complete list of publications and lets him decide what would be more useful from his point of view. On the other hand a select bibliography would present him with a much easier task of a smaller list of works already screened by a bibliographer. However, here the danger is that items which may be of value to the researcher might have been dismissed as unimportant by the compiler who had a different set of norms and objectives. Then again a bibliography may be annotated. An annotation is a note which gives information about the contents of an entry in the bibliography. Annotations may be descriptive or critical. Usually a critical annotation is more useful than a descriptive one but again it depends on the expertise and the point of view of the

compiler. Bibliographies may limit themselves to books published during a certain time span and may be designed for a certain kind of user. Therefore the proper utilization of bibliographies depends partly on some knowledge about the aims and standards of the compiler as well as of the scope of the bibliography.

3. Types of bibliographies

Bibliographies can be divided into—

1. National bibliographies
2. Country bibliographies
3. Subject bibliographies.

A national bibliography is a complete listing of books published in a country on any subject. A national bibliography has a number of advantages. They are reasonably comprehensive. Moreover, they are published regularly—e.g. *The British National Bibliography* (BNB). This is published weekly and classified by subject, with author and title indexes. There are monthly, quarterly, annual and five-yearly cumulations. Therefore researchers can find out what has been published in Britain on his subject for the last, say, 20 years, while also keeping a check on current publications since full descriptions are given, i.e. author, title, place of publication, publisher, date, pagination, price etc. It is possible to use the BNB to request librarians to order books as well.

However, national bibliographies are not usually annotated and are a mere uncritical listing of all publications. Other examples of national bibliographies are *Ceylon National Bibliography*, *Indian National Bibliography* and *National Union Catalogue of the USA*.

In contrast, a *country bibliography* is a comprehensive listing of all publications regarding a particular country irrespective of whether the works were published in that country or elsewhere. We have an excellent example of such a work for Sri Lanka in H.A.I. Goonetilleke's *A Bibliography of Ceylon* published by Inter Documentation Company, Zug, Switzerland. This is a comprehensive bibliography and has been developed as a continuing work with annotations, both descriptive and critical, attempting to guide the scholars to the more valuable publications. It is classified according to a scheme devised by the compiler but has numerous cross references and a good author index. It is an indispensable starting point for all research workers on Sri Lanka and the later volumes appear to be better annotated than the original two-volume work.

Finally there are the *subject bibliographies*. As the title indicates these bibliographies cover particular subject areas. Sometimes the area covered may be very wide, e.g. *International Bibliography of Social Science*, Tavistock Publications, prepared by the International Committee for Social Science Information and Documentation. This appears in four parts—Sociology (since 1951), Politics (since 1952), Economics (since 1952), and Social and Cultural Anthropology (since 1955). Entries for the volumes are obtained

from many countries and include articles selected from over 25,000 periodicals. Its continuous publication for 25-30 years has made it a good source of recent research publications but it is usually about 2 years behind time.

Some bibliographies are limited by area though they cover wide subject fields, e.g. *The Asian Social Science Bibliography*, Vikas Publication House Delhi edited by N. K. Goit. This is a classified and annotated bibliography but it takes a long time to appear in print (e.g. the volume for 1967 appeared in 1974). The annual bibliography appearing in the *Journal of Asian Studies* (Ann Arbor) is another example. Other subject bibliographies may be more limited or specific in the subject scope, e.g. *The Annual Review of Anthropology* published by the Stanford University Press provides a regular survey of the literature on anthropology classified by subject divisions.

Current Annotated Bibliography of Dutch Expansion Overseas edited by Gerard J. Telkamp in the *Itinerario* is a fine example of a classified, annotated subject-bibliography but it does not extend to cover material written from outside the Netherlands by non-Dutch sources. Single-volume or multi-volume bibliographies covering more specific fields can be found in plenty: e.g. A. Ajaeghu, *Africa Urbanization: A Bibliography*; H. A. I. Goonetilleke, *Coins and Currency*. Some subject bibliographies cover only a certain type of material, e.g. Joseph Schulman's *Doctoral Dissertations on Asia*.

Lists of theses are very important, for one of the nightmares of every research worker is the possibility that someone might work on exactly the same problem and produce his thesis before him. Works to consult in this respect are as follows.

(1) *Index to theses accepted for higher degrees by the Universities of Great Britain and Ireland* (London). This is arranged in broad subject category with a more detailed subject index and an alphabetical list of authors. It is usually published about two years after the theses are presented.

(2) *Dissertation Abstracts International (A)—Humanities and Social Sciences* : (University Microfilm, Ann Arbor) This has been published since 1938 and covers 350 academic institutions in North America and is better designed, for it provides not merely titles but abstracts of doctoral theses and is carefully cumulated. There is an invaluable cumulative index to the first 29 volumes of the series called *Retrospective Index* published in 1970 in 9 volumes, and almost all theses presented to Universities in the USA since 1861 are listed in the *Comprehensive Dissertation Index 1861-1972*. Ann Arbor, 1974.

Other bibliographical tools that cover current research : *The Asian Studies Association of Australia Review* gives a listing of theses in progress or completed in Australian Universities. The *Sri Lanka Research Bulletin* lists on-going research projects by scholars working in Sri Lanka. *The Progress Report of the Marga Institute* lists research work completed and in progress as well as projects formulated for the future.

4. Printed Catalogues

Another major tool which may be used in the literature search is the printed library catalogue. The difference between a bibliography and a catalogue is that while the former usually represents a listing of books irrespective of where they happen to be located—the catalogue represents a collection deposited in one or in a collection of libraries. The printed catalogues of some major libraries in the world are often used as instruments for finding out what books have been published in a particular area, e.g. *The General Catalogue of Printed Books to 1955 of the British Museum* published in 1965 runs into 263 volumes and is supplemented by 5 yearly cumulations. This is a very useful work because of the great comprehensiveness of the British Museum Library, but this is an author catalogue and is thus of limited value in locating books on subjects. This is only partly remedied by the *Subject Index of Modern Books acquired since 1881* published by the same institution.

Catalogue of the New York Public Library—Oriental Collection, G. K. Hall, 1960
16 Vols. First supplement 8 Vols.

Library of Congress Catalogue : (Books : Subjects) This appears in quarterly issues with annual and semi-annual cumulations and can be very useful as the accessions to the Library of Congress are extensive.

Trade Catalogues : These often provide the quickest way in providing information on current publications. Each publisher issues a list of books that are in publication or will be issued shortly. In addition *British Books in Print : A reference catalogue of current literature* (Whitaker) and *Books in Print* (Bowker) provide information on the publications in UK and the USA.

The Bookseller : The Organ of the Books Trade was first established in 1958 and is published by the Booksellers Association in London. This gives advanced information of books published in the U.K. This is a very useful guide for both selection for libraries and to the individual scholar.

Guides to Journals and Newspapers : Since journals and newspapers are a little different from monographs in that they may contain a variety of information on many unrelated topics in one issue, they need special guides. We will first deal with journals. In many areas of the social sciences one of the most important sources of information on recent research is the journal literature. There are a number of obstacles to the exploitation of journal literature. Of these I will mention three here. The first is the enormous size of the available literature. The second is the scattering of articles on a topic among a great many different journals. The third is the problem of locating a journal which is not available in one's own library.

There are over 5,500 Social Science journals available today. Therefore, it is extremely difficult to locate articles on a subject field of your choice among these journals and these will certainly not be discovered by browsing among a library's limited collection of journals.

On the existence of journals the standard reference work is *Ulrich International Periodicals Directory*. This publication lists over 55,000 periodicals in print (on both social science and sciences) by subject and title. There are other listings limited to a country, e.g. *Guide to current journals*. But periodicals appear and fail frequently, they change their titles often and change frequency of publication. The *International Social Science Journal* provides a way of keeping track of new journals in the social sciences. The list provided in this is selective, but includes all journals likely to be of interest to academics. This journal also lists the current and projected social sciences programmes of Unesco.

To find out the contents of journals there are various *bibliographical services* provided by libraries as well as commercial organisations. There are *indexing journals* which comprise lists of bibliographical references arranged by subject headings in alphabetical order. *Abstracting journals* also provide bibliographical references together with an abstract or summary of essential facts, theories or facts presented in the articles. Academic libraries now issue photo-copies of contents pages of periodicals. There is a very popular *Current Contents in Social and Behavioural Sciences* published commercially by the Inst. for Scientific Information, Philadelphia. *The Union Catalogue of Serials* and *The National Union Catalogue*, also provide information on periodicals.

The British Union Catalogue of Periodicals of the world, from the 17th century to the present day in British libraries arranged under title. For Sri Lanka we have the *Union List of Periodicals in Social Sciences and Humanities* published by the National Science Council.

Newspapers are a significant source of current and historical information for many social scientists. Unfortunately the newspapers do not take the trouble to compile subject indexes to their past contents. *The Times (London) Index* is an exception to this. This has been published since 1906. The American Association for the Advancement of Slavonic Studies publishes the index to *Pravda* on a monthly basis, with annual cumulations. This service started in 1975.

The lack of an index to newspapers is compensated by the publication of the *British Humanities Index* (Library Association, 1962 +). This indexes *The Times*, *Guardian*, *The Daily Telegraph*, and also such journals as the *Economist*, *Political Quarterly*, *Economic Journal*, *Sociological Review*, etc.

Events and issues which are recorded in newspapers are incorporated into digests; among these, the best known is *Keesings Contemporary Archives*, a weekly diary of important world events with index continually kept up-to-date (1931 +). *The African Record : a fortnightly digest of African events* (1962) and the *Asian Recorder : a weekly digest of Asian events* (1955 +), both published by the Recorder Press, New Delhi, are modelled on Keesings.

Finally, useful bibliographical information can also be had from the book reviews in *Times Literary Supplement*, *Sunday Times*, *Guardian*, *Daily Telegraph*, *New York Review of Books*, *London Review of Books*, *Times Higher Educational Supplement* and book reviews in learned journals.

Reporting, Interpretation and Generalization: A Historian's Perspective

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Research writing in the social sciences is not as simple as it sounds. If you look at the handbooks that introduce you to research techniques in the social sciences they will tell you to consult your sources, test them and satisfy yourself about their authenticity. Then once you are reasonably satisfied that your facts are accurate you have to assemble them and prepare your report giving at the same time clear references. This is sometimes called the 'historical method' (a method which has a remarkable antiquity.) But today historians are beginning to doubt whether there is anything called a 'historical method'. I need not go so far as to agree with that but there is a point in it because the method of the historian is rather different from, say, that of an accountant or even a lawyer. When an accountant or a lawyer sets about his task he proceeds on certain time-tested lines. They have a number of methods for a variety of purposes and each has a procedure. A systematic mode of proceeding from question to answer and of suggesting remedies for difficulties. What they have in common is the procedure can be repeated. But with the historical method you cannot repeat it. I do not think that two historians work alike. I would go so far as to say that there are as many methods as there are historians. In other words, in so far as the historian is concerned, method is only a metaphor to say that he is trying to be rational, resourceful, imaginative and conscientious. These are four qualities which are extremely difficult to acquire. But this is more or less what a person means when he says that he is adopting the historical method in tackling a particular problem.

Some American universities and schools, we are told, teach their pupils composition. In some of these schools, there is a practice which some people find rather deplorable but it has its advocates. You are simply told to get, say, a novel from Conrad and repeatedly copy, say, the first fifteen pages. The idea is that in this process you learn something of style, of technique of writing. But I think there are easier and less dreary methods of learning to write a report. The important thing I want to emphasise is that when you write prose you have to be simple as possible in your language and avoid jargon as far as possible. If this sounds very twentieth century, let me assure you that what I was giving you now was a summary of something written in the year one hundred and sixty A.D. by a Roman historian called Lucien in a treatise called *The Way to Write History*. The fact of the matter is that there is nothing remarkable in resorting to jargon. In fact, the clever person will do without jargon. The freer you are from jargon, the more effective you are in preparing a report because the purpose is to communicate your ideas to make people understand what you are saying and not to confuse them. If your purpose is to confuse others, then by all means resort to jargon.

I began my talk by more or less suggesting that there is not anything called a 'historical method'. Instead I would use the term 'a historian's approach' to a problem. Looking through all the guide books that I have been referring in the last few weeks to prepare this lecture, I found one in which a very well known historian, talking of the historian's approach to the social sciences, said that any decent report had to have four particular qualities. They are narrative, chronology, concreteness and memorability. In other words, in telling the historian how to prepare a report he insisted first of all that history is a narrative or a story. Interpretation is more often than not optional and there are some historians who have lived without interpretation. The story of course, is intended as the truth, and it gives particulars of change within time and space.

The second quality is concreteness. That is, you begin with events, incidents or with data. Indeed, in terms of most reports the whole question is 'what happened ?'

Memorability is rather more complicated, because it has two meanings. One is, 'it is worth remembering', the second is 'capable of being remembered'. Both these meanings are essential in preparing a report. There are no clear limits as to what one person or another will deem worth remembering. Yet it is also evident that no one would want all the facts even if it was possible to collect all. So the two meanings point to one, a certain selectivity and second, to an intelligible pattern in your writing. Quite often, especially as a social scientist, you will be confronted with a situation in which you have a mass of data and information, and you are called upon to give it a certain order and coherence. There is no point in taking a chaotic situation and trying to be as faithful as possible. You are expected to select facts and try to put your ideas together in some cohesive order.

As historians we know one thing. No one expects mathematical precision from us. But sometimes social scientists in allied fields believe that mathematics performs the same role today that religion performed a few centuries ago. There is no virtue in mathematics of that sort and, I would add for myself, no virtue in religion of that sort. But your purpose is to select and to matter, put it together. At this stage, I would like to remind you of a saying from Bernard Shaw, which is important to social scientists. He said 'chaos has no statistics, it has only statisticians'. Of course, I am not suggesting that you should not consider the bulk of the data before you. It is simply that this encyclopaedic ideal of all the facts is self-defeating. It is self-defeating for a historian or any other social scientist.

Next you come to the question of interpretation. Here, as all good scientists should, you need to have a look in the dictionary. The Concise Oxford Dictionary (New Edition) gives two meanings to the word 'interpretation'. One, stretched out at great length says "Expound the meaning of (abstruse or foreign words, writings, dreams etc.) make out the meaning of; bring out the meaning of; render, by artistic representation or performance ;" and so on. So you have a fair idea of what the word 'interpretation' means.

In practice what interpretation means is this. You have through the exercise of intelligence and diligent research collected a lot of facts. These facts by themselves will not amount to anything more than a certain amount of order imposed on chaos. It must include an interpretation of the facts, because a framework of facts is not enough in a report. To get a coherent story out of these disconnected pieces of separately recorded information, it requires critical and imaginative powers of a very high order. When that is done there will be a number of difficulties. You have to attribute causes and explain events.

If the meaning of an event is to be short, an attempt must be made to set out the possible pattern for a whole period. Now complications arise. For example, consider a historical analysis of the twentieth century. As you approach modern times the framework of facts will become closer knit and more massive. There will be a great body of corroborative history, more records will survive. But the fact is that there are large gaps in all this. Some documents will be invented. Some documents will be destroyed. Some decisions will be taken over the telephone. In this sort of situation interpretation becomes a much more difficult exercise. It should, on the face of it, rather be easier, because at least if you live in contemporary times, you know the reputation of the persons who prepared those documents. Nevertheless, it presents very awkward difficulties. There are whole areas which are neglected, despite the seeming immensity of the material that you have.

How would you fill these gaps? Fill them with myths or theory? The first of course is not available to a historian. It may be possible for a sociologist. But the second aspect of it is a rather more attractive proposition. But what I would say is that as apprentice social scientists, trying to make your way into research, you have to make absolutely certain that everything that passes for history, political science or any other social science should bear a close relationship to a provable fact. It is better to say in your essay or your paper that there is a gap and I would merely point to the existence of this gap than to say that this is what I think has happened, if you do not have evidence to back you.

The interpretation of history can never be a mere catalogue of facts alone. But any interpretation which makes use of facts is open to challenge and falsification. Those which rely on obviously dubious facts and do not take into account facts which are known and could be found out, are misleading and deceptive.

As you know historical research is going on most of the time and new facts are being constantly discovered which often makes old interpretations impossible to retain. Historians are constantly probing and re-interpreting what were once recognised to be accepted facts. Any historical concept which has not been adjusted to the most recent research will cease to be satisfactory. To put it differently, times change and with time, views change and outlooks change. The changed outlooks alter the appearance and therefore the meaning of some part of the past.

The appearance and meaning of a picture or a scene change according to the angle from which the picture or the scene is viewed. It is the same with history and allied subjects. As the angle of vision changes, the appearance and meaning of historical facts change. Accordingly a re-writing of history from a new point of view becomes necessary.

The problem of historical generalization is a slippery and evasive subject which has a great deal to do with things like philosophy, from which I normally flee. But in view of the fact that this has been introduced here, I will merely indicate why some historians now do not accept the term 'generalization' in the sense in which it was accepted thirty years ago. I will merely say that it is difficult to agree on what a generalization is. Nor is it particularly profitable to try to distinguish generalizations from other kinds of historical propositions. A generalization was ordinarily conceived to be a statement broader than some other statement. But the term 'broader' is relative. All statements are in a sense generalizations. But some which are commonly and as a matter of convenience, referred to by this designation are broader than others. Even the distinction between factual statements and generalizations becomes really a philosophical problem and among historians it is a matter of controversy whether general laws are really useful in historical study.

To show you how complicated the problem is, I will explain what happened, when I tried to get a definition of the word 'generalization'. The concise dictionary, I thought, was not good enough. So I went to the marvellous thirteen volume Oxford English Dictionary. It had about six pages on generalization. It had a definition which would have suited anybody. This I thought was not satisfactory when I had to speak only for thirty minutes. Therefore, I consulted the Shorter Oxford Dictionary which had almost one page on it. But the complication was still there. So I went back to the Concise Oxford Dictionary which sets out the meaning of 'generalize' in this form—"reduce to general laws ; form into a general notion ; give a general character to ; call by a general name. 2. infer (law, conclusion) by induction ; base general statements on (facts etc). 3. (Math and Philos) express in general form, extend application of and so on. What is really means is that even the compilers of the Oxford Dictionary have given up in despair. The result is that some historians have now shifted their focus away from generalization to generic statements. This may appear to be an exercise in semantics, but it is not.

A generic statement for purposes of this discussion is simply a statement about common characteristics of behaviour of individual people, events or things. It is an ugly word but from all points of view rather better than generalization. I will refer to two generic statements made use of by historians when they discuss the past and the present. The simple and the most obvious is one which divides history into periods. The conventional division used to be ancient, mediaeval and modern, which no historian now accepts in that form at least. But in historiography, periodisation is necessary and historians have evolved new divisions. In other words people have moved away from one set of generic statements to a new set of generic statements, which, hopefully will yield new insights.

The second area of generic statements is much more difficult. That is a statement which involves personality, be it a nation, race or class. For example, today Great Britain is a nation. But you cannot use the phrase to imply that certain things happen in Great Britain over several centuries, because Great Britain is, in terms of history, something of recent evolution. The use of the word generic term German in relation to the twentieth century can be even more confusing because it could mean either the Federal Republic of Germany or the German Democratic Republic or indeed Austria. These are illustrative of the problems caused by common seemingly innocent generic terms.

I wish to conclude my lecture with just one piece of advice. If you are trying to be a social scientist of any quality, the most important thing to do is to immerse yourself in the reading of the standard classical works on your subject. That will give you some idea of the way in which a work of scholarship should be approached and handled.

Technical Aspects of Writing

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University of Peradeniya

1. Introduction

My lecture will start with some assumptions which have dictated its position at the tail end of this seminar. It will be assumed that the research topic has been chosen, that the research work has been done and that the major conclusions are already in the researcher's mind. It is also assumed that the researcher has obtained some facility in expressing his ideas. At this stage you come to the problem of acquiring some knowledge over the technical aspects of writing. By the technical aspects of writing I mean the rules for writing footnotes or making a bibliography and possibly even correcting proof copies of the publishers. These aspects and the details relating to them may seem very boring and tedious, after the excitement of formulating the hypothesis, conducting a survey and so forth. But a good piece of work in terms of research and conclusions can be marred by inattention to the technical details.

Since the whole exercise in proof reading is combination of information and of patience, what I will do is merely to circulate a copy of proof readers marks (see Annex 1) and hope that you will read the marks and develop patience. I will, however, deal at length with footnotes and with the preparation of a bibliography.

2. Footnotes

Let me first take the case of footnotes. There are two basic kinds of footnotes. Firstly there are source footnotes, which give the source from where you have obtained information or from where you have obtained a quotation. Source footnotes are also those which may refer the reader to a further source of information. This kind of footnote can be distinguished from the explanatory footnote, which gives additional information which though it may not be related to the main theme you are discussing, may still be of interest to the reader. I will give you an example of an explanatory footnote from a book called the *Facets of Ceylon History. The Letters of J. Peiris*, written by Michael Roberts. The name of C. Don Bastion is incidentally mentioned in the text. In a footnote, the author says Bastion (1852-1921) was a Sinhalese novelist and journalist. Born in The Pettah, he settled in Karagampitiya, Dehiwela and carried influence in the locality. He was the proprietor and editor of 'Dinapatha Pravurthy'. Now this has nothing to do with Roberts' main theme. But he has found this information and thought that it may be of interest to the reader. So it is mentioned in a footnote.

It is easier to talk about the format of a footnote, and types of footnotes rather than as to when to use them and the extent to which they should be used. Nevertheless I would prefer to centre the discussion on the latter aspects because it is useless to know how to construct a footnote, if you do not know when and how to use it and how it can

be misused. It is a little difficult to lay down a set of common rules for the use of footnotes for this depends on the kind of report, article, paper or book you are writing. But for people who want to write a report based on research, the source footnotes are indispensable. They are indispensable because you have to acknowledge the source from which you got the information in order that somebody can check on it and find out whether you have reported correctly or whether you have misinterpreted the evidence. But even here the use of source footnotes can be limited. There is no need, in my opinion, to sight footnotes for well known and accepted facts or information. For example, you may not have to give a footnote to prove that there was an election in 1956. This is accepted or generally known, at least in Sri Lanka. However, if you are working on a new theme which has not been written on before, you may need to substantiate many of the things you are stating because they may not be familiar to your readers. If you are writing something that has been explored before, then you might well be able to cite an authoritative source, a source which states certain conclusions which you accept, and thus dispense with a lot of footnotes which you might otherwise have to present.

There is much greater debate in the case of explanatory footnotes. One extreme argument is that if there is something which is not important enough to be put in the text, then it does not deserve to be entered at all and that excessive footnotes distract the reader from the main arguments in the text. At the other extreme certain scholars illustrate many things in the text with long explanatory footnotes so that often the space taken by footnotes in a page is much longer than the text. I do not think anybody can dictate to you which method to adopt or whether you should compromise between the two. There have been very good books written without any explanatory footnotes and there have been excellent books written with a lot of explanatory footnotes. Much would depend on the kind of topic you have chosen and the amount of information that you have obtained. I think that, by and large, explanatory footnotes do have a place in most studies. You can use them to define some of the terms used in the text, and to place some bits of information which cannot conveniently be woven into the narrative.

In the case of an article in a periodical, footnotes are normally numbered consecutively. In books footnotes are numbered separately in chapters. Some scholars have adopted the practice of having separate footnote numbers for each page. But that could cause problems because normally an article would go through many drafts and, in retyping, often there is a change in the way the text is arranged. Thus a lot of confusion can be created about the numbers of the footnotes.

Let us now look at the format in which a footnote should be arranged. There are many manuals available which discuss the format of footnotes. But the differences given in the manuals are actually very marginal and I think you can adopt a system of your own if you so wish, as long as the system gives the necessary information and as long as you consistently adopt the system. In Annex 2, I have given examples of footnotes. The first time a book is cited in a footnote, as you will find in example 1, you need to give full and complete information. The only exception is where you have a bibliography at the end when you might be able to shorten the reference in the footnote. But under normal circumstances when you are writing a paper, you have to give the author, the title of the

book, the publication data and the pages or chapter referred to. The abbreviation pp. is used to denote the word 'pages' (singular = p) and c. or ch. (plural = chs.) to denote a chapter. You should also note that in the footnote normally the author's name is given in its proper order unlike in the bibliography. In a bibliography, you would have, for example, MYRDAL, Gunnar whereas in the footnote (see footnote 1, you would have the normal order in the name. The second format is an example where a pseudonym is used. E. J. Thompson is a pseudonym as in example 3.

When a work is more important than the author, as in the case of an encyclopaedia or a dictionary, you would normally enter it under the title of the work as in example 4. If the title page does not give the author whose name is known to you then you can put the name of the author within brackets as in example 5. In the case of multiple authors, they should all be listed as in example 8, unless the number of authors or editors exceeds three, in which case, as in example 9, you say J. W. Winston and others, to keep the footnote short.

The name of the editor of a collection of essays is often given before the title as in example 6. But when a work written by one person is edited by another, as in example 7, you give the author's name first, then the title and then the editor's name. The same rule applies in the case of translations. There are a number of rules relating to the entry of a title. The complete title is given in the original spelling, even though the original title may have spelling mistakes. The words in the title are capitalised except the articles and propositions within it. That is 'in' 'a' and 'the' are not capitalised unless they are found at the beginning of the title. Often as a convention the last word of the title is capitalised.

Names of all books, monographs and journals are given in italics and therefore should be underlined in your typed script. When there is a sub-title, the sub-title is joined to the title by a colon, as you will find in example 1.

The place of publication must be given, and if it is not clear where the place is as in example 1, you can give the state in which the place of publication is located—New Haven, Connecticut. Normally the city is given in the anglicised form—for example you have Kandy and not Mahanuwara.

If some information is lacking, it is normally indicated. For example, in example 2, in example 2, you will find (n.d.). This means that the date of publication is not recorded. If you have (n.p.) as in the example 3 it would mean that the location of publisher is not known.

If there is a re-print or a new edition, this should be mentioned as in example 7. If a book is not yet published, you can always give the title of the book, the author and so on, and say forthcoming and refer to the pages, if the page numbers are known. If you want to refer to a number of pages following your reference, you can say *passim* (every here and there) as in example 8.

Sometimes you have out of print books re-printed photographically and in such cases scholars often cite the original edition as well as the second edition. When a book is published in hard back and paper back, you should always mention the kind of volume you have used because sometimes the pagination is different. In the case of multi-volume works normally the page reference is preceded by the volume number.

If a book has been cited once subsequent references in later footnotes can be shorter, as in the example 11—Myrdal *Beyond the Welfare State op.cit.* *Op. cit.* means that it has been cited before. If in the next footnote you want to refer to the same book, it is not necessary to write it all over again. But as in example 12, you can write '*ibid*' and give the page numbers. That means you are referring to the same book as above. However, you do not start with *ibid* at the beginning of a chapter in your book. If you wish to compare something you have said in the text with that of another work you can use, as in example 13, the abbreviation of which means (compare) (Latin=*confer*).

Now I would like to turn to articles in journals where you have the same format. For instance, in example 13, the author's name is given first, the title of the article next and then the name of the journal underlined, followed by the series, the volume number, the number of the part, then the data of the journal and the pages. In the case of popular magazines and newspapers, as in example 14, the title of the article is given first followed by the name of the publication underlined, the date of publication and the page number. Example 15 refers to an article published not in a journal but a collection of essays. Here the name of the author of the article is given first, followed by the title of the article, title of the book, editor's name and then the usual publication details.

Example 16, 17 and 18 illustrate references to unpublished manuscripts. All three indicate the author and nature of the manuscript, the date of production and the depository or library where the manuscript can be found.

3. Bibliographies

A bibliography generally reveals the author's knowledge of his chosen subject. A bibliography of a good research article or monograph must contain a representative sample of the latest works on the subject. The bibliography can be especially important in the case of dissertations where examiners usually scan them to assess the candidate's familiarity with the field of study.

In certain types of research writings such as seminar papers a separate bibliography is an optional, whereas in certain other types such as dissertations it is an essential. In general, most books, monographs and articles written on academic subjects carry a bibliography.

The normal practice is to include in the bibliography all the articles, books and other similar materials to which reference is made in the text. Sometimes a bibliography can contain titles which are not mentioned in the text but this is usually done only in instances where the author wishes to supply the reader with a comprehensive bibliography on the subject under discussion.

The format of a bibliography can vary considerably depending on the type of material that has to be included. The simplest case is a consolidated bibliography where all entries are listed in alphabetical order according to the names of the authors. However, a bibliography which is lengthy and includes a variety of sources can be usefully divided into appropriate sections. Published and unpublished sources can be listed separately and each in turn can be sub-divided depending on the material to be listed. For example, in the section containing publications, journal articles and books can be listed separately and in the section on unpublished sources, archival material and dissertations can be listed separately. When archival material from more than one depository is used it may be helpful to list the material from each depository separately.

Sometimes authors like to number the entries in the bibliography, and in the text refer to the sources by their respective numbers. Alternatively, the year of publication can be referred to in the text together with the name of the author. In such instances, if there is more than one entry from one author, the usual practice is to attach an alphabetical subscript (e.g. A.B. Perera, 1977a ; A. B. Perera, 1977b) to distinguish them from one another.

In 'literature survey' type of articles or monographs which attempt a comprehensive review of the existing knowledge on a given topic, sometimes the bibliography is annotated.

4. Conclusions

Finally, as young scholars who are about to embark on research careers you should bear in mind one important point. A piece of writing which pays proper attention to the preparation of footnotes, a bibliography and other technical details usually indicates a disciplined mind and dedicated scholarship.

References

Barzun, Jacques and Graff, Henry F. *The Modern Researcher*, Third Edition. New York, Harcourt Brace Jovanovich Inc., 1977.

Chang, Sidney H. Lloyd, Shavon F. and Yoshino, Ronald W. *Method and Form for Paper Writing : A Manual*, Revised Edition, Taipei, By the Authors, 1978.

ANNEX I

THE PROOFREADER'S MARKS AND THEIR USE

MESSAGE TO PRINTER	MARK INDICATION IN TEXT	CORRECTED TEXT
Remove letter or word.	He read the boook.	He read the book
Insert letter.	't She wrote a leter.	She wrote a letter.
Insert space.	# We wenttogether.	We went together.
Change to capital letter.	B Pam asked bill.	Pam asked Bill.
Change to lower-case.	lc Do You know him?	Do you know him?
Wrong font (type face)	uf He mixed them up	He mixed them up
Broken letter. Replace.	X Clean your type.	Clean your type.
Inverted letter. Turn.	9 It must be wrong.	It must be wrong.
Reset in italic type.	ital Don't do that!	Don't do that!
Reset in roman (regular).	rom What can it be?	What can it be?
Reset in bold-face (dark).	bf The word was nor.	The word was nor.
Reset in small capitals.	sc The sign said Stop!	The sign said STOP!
Transpose.	tr but enough world and	but world enough and
Insert period.	o Such is life.	Such is life.
Insert hyphen.	/=/ Mr. Wycliffe Jones	Mr. Wycliffe-Jones.
Insert comma.	/, That's all folks.	That's all, folks.
Insert apostrophe.	^v Dont look now.	Don't look now.
Insert quotation marks.	^v^v Eureka, he said.	"Eureka," he said.
Insert inferior figure.	^ Water is HO.	Water is H ₂ O.
Insert superior figure.	^v E=MC^	E=MC ²
Insert question mark.	? What's going on here.	What's going on here?
Paragraph.	¶ done? [Now we must	done? Now we must
No paragraph.	n. ¶ decided. Then they	decided. Then they
One-em space.	□ □ Call me Ishmael.	Call me Ishmael
One-em dash.	/M/ had if only because	had--if only because
Move as indicated.	□ □ Move it to the left.	Move it to the left.
[move left move right]		
Close up space.	⊖ They had a break up	They had a breakup.
Let stand as is.	stet Which one did it?	Which one did it?
Straighten type.	= Type can shift a bit.	Type can shift a bit.
Query to author.	⊙ A word overlooked.	A word was overlooked.

ANNEX II

EXAMPLES OF FOOTNOTES

1. Gunnar Myrdal *Beyond the Welfare State : Economic Planning and its International Implications*. New Haven Conn., Yale University Press, 1960. pp. 47-50.
2. (Edward Morris) E. J. Thompson *The Economy of Johbra*. Kuala Lumpur, Academic Press. (n.d.) p. 81.
3. Sparataous (pseud.). *World Revolution*. (n.p.) Ziff-Davis, 1962. p. 36.
4. *The World Almanac and Book of Facts 1980* ed. by George E. Delury, New York, Newspaper Enterprise Association Inc., 1980. p. 87.
5. (W. Wiswan) *The Urge to Slander*. New Delhi, 1971 (p. 13).
6. K. Indrapala, ed., *The James Thevathasan Rutnam Felicitation Volume*. Jaffna, The Jaffna Archaeological Society, 1975. (Released 1980) p. 32.
7. Thomas Pires, *The Suma Oriental of Thome Pires*. . . . trans. & ed. by Armando Cortesao, London, Makluyt Society, 1944. Reprint edition. Oxford University Press, 1972, 2 Vols. Vol. I. p. 37.
8. Barrie M. Morrison, M.P. Moore and M. U. Ishak Lebbe (editors) *The Disintegrating Village : Social Change in Rural Sri Lanka*. Colombo, Lake House Investments, 1979. *passim*.
9. James W. Winston and others *The Economy of Zambia*. Revised Edition. London, C. Hurst, 1980. p. 86.
10. Fernao de Queyroz *The Temporal and Spiritual Conquest of Ceylon*. translated by S. G. Perera. Colombo, Ceylon Government Press. 1930. 2 vols.
11. Myrdal *Beyond the Welfare State op. cit.* p. 84.
12. *Ibid.*, p. 114.
13. cf. K. M. de Silva "A Tale of Three Constitutions, 1946-8, 1972 and 1978" *The Ceylon Journal of Historical and Social Studies, New Series*. Vol. II, No. 2, June-December 1977, pp. 1-17.
14. "Poland's Race Against Time" *Newsweek* 1 Sept. 1980. p. 18.

PART VIII

Field of Research	<i>Page</i>
1. Choice of Field of Research — <i>G. H. Peiris</i>	259

Choice of Field of Research

G. H. PEIRIS

University of Peradeniya

In this lecture if you expected me to suggest topics for research I am afraid you will be disappointed. Such an exercise, if undertaken, will be counter-productive for several reasons. First, the social sciences encompass a very wide range of disciplines. There may be some whose knowledge covers a relatively wide span in the spectrum of social sciences. Nevertheless no individual or no manageable group of individuals can or should pretend to be able to suggest topics of research to others.

My second reason is that there is considerable diversity among those who comprise the present audience. They vary from each other in academic training, talents and capabilities, interests, inclinations and objectives. To such a diverse audience it is not possible to generalise. What could be prescribed for one person may not be appropriate or relevant to another person.

My third and most important reason of all is that the idea of an individual prescribing or suggesting possible areas of research to a group of others or even to an individual runs counter to my perception of what research is and what research should be. The only exception to this rule would be those who are doing research in a particular area because their job demands it.

Selecting a subject for research is like selecting a spouse. There are many parallels. Undertaking the task of giving advice to another on the choice of a research subject would be like someone advising another whom to marry. Extending this analysis a little further, I would like to recognize four interrelated qualities, if the researcher is to be successful and productive.

The first of these is that the topic or the field of research must be capable of maintaining the sustained interest of the researcher. This depends both on the subject as well as on the perseverance of the researcher. Research in any branch of science, not only in social sciences, inevitably entails a great deal of routine, repetitive and painstaking work. Therefore it is desirable for the prospective researcher to consider whether his topic has the quality of being able to sustain his interest for a long period of time. There could be the counter-argument that the researcher might develop an interest in his subject as he goes on, just like in marriage, although at the start he would have little interest. Still I would maintain that when a person is adequately prepared to undertake research, he will be able to sense before he starts whether that topic is capable of sustaining his interest.

The second quality can be described by borrowing a term which is usually associated with my marriage analogy, namely 'compatibility'. A research topic must be compatible with the researcher's training and more importantly his talents and interests. For example, some may prefer long hours in libraries and archives, some may possess writing skills, and

others may be good at statistical work. The topic that you select for research, therefore, must be compatible with your talents, interests and inclinations. Here too, it is possible to say that these skills and talents can be acquired as you go on. But my opinion is that acquiring new skills is a time-consuming and a tedious process. More importantly, the scope for useful research in the social sciences is so vast that it is certainly easier to adjust the area of research to suit one's capabilities than to acquire capabilities to suit one's area of research. That is why I say that in the choice of a research topic, one must look for this characteristic of compatibility with one's own talents and interests.

The third important consideration that you must look for in your research topic is whether you can afford it in terms of facilities, funds, time and opportunity. The more obvious aspects of this require no further elaboration. But there is evidence in our own experience that the significance of affordability in the broadest sense of the term is not quite appreciated even by some experienced researchers. For example, in Sri Lanka there is the eternal complaint that not enough funds are made available for research or that official data are not accessible to local researchers. I am not suggesting that these are not serious constraints on research. But the point I wish to make is that even if we are to consider these problems as a part of a given and a unchangeable system, still there are enough areas of research to select from which are affordable.

Fourthly, the selected field of research must be capable of fulfilling the researcher's aspirations. This too is a quality that has parallels in my marriage analogy. To adopt a pragmatic approach, I would say that one of the questions that should be posed when selecting an area of research is, 'what can you expect from it?' This is a question which is rarely asked. Aspirations or expectations may vary from individual to individual, and in this, I do not see certain aspirations as being intrinsically superior to others. Your aim might be to get a Ph. D. or an M.Sc. or to satisfy your intellectual curiosity, or to make a contribution to solve a problem confronting the community. Obviously these aspirations are not mutually exclusive. With luck one may select a topic that fulfils all these aspirations but that would be unusual.

In conclusion I would like to recall the question that I raised at the beginning—"what topic of research should I select?". A researcher with good potential will be able to answer the question himself taking into account, among other things, the factors that I have discussed. One who is not capable of doing so should not aspire to a research career.

PART IX

Evaluation of the Training Seminar

Page

1. Report of the Course Director — *S. W. R. de. A. Samarasinghe*

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Report of the Course Director

S. W. R. de A. SAMARASINGHE

University of Peradeniya

1. Background

The idea to hold a Training Seminar on Social Science Research Methodology was first mooted by the Unesco and it also offered to help the National Science Council (NSC) of Sri Lanka with funding and the procurement of resource persons from abroad if the latter were to implement the proposal. The NSC accepted the project and the Unesco's offer of assistance and entrusted the Statutory Working Committee on Social Science Research (SSRC) the task of implementing it.

The SSRC under its Chairman functioned as the organizing committee. The University of Peradeniya was selected as the venue, and a three-member co-ordinating committee in Peradeniya was entrusted with the task of local organisation.

The dates for the Seminar (25 th August to 13th September 1980) were chosen partly with a view to avoiding a clash with University sessions. Given the fact that the initial decision to hold the seminar was taken in late June, this left relatively little time to complete the preparatory work. Indeed, it is conceivable that the quality and final outcome of the Seminar could have been further improved if a little more time was available for its planning. This would have been particularly true of resource persons, several of whom were unable to participate because of the short notice given.

2. Objectives

Briefly stated, the objective of the Seminar was to improve and build upon the knowledge of social science research methodology that participants might have had acquired in the course of their undergraduate careers and post-graduate study and research.

3. Selection of Participants

The selection procedure adopted was to call for applications by means of a notice in the national press, process and short-list the applications submitted, and select a pre-determined number (about 40). Given the fact that time was short, this was a reasonable procedure to adopt and, indeed, it is likely that about three-fourths of those who were selected would have secured admission even if the SSRC had adopted a more elaborate method. However, it is worth stressing that on similar occasions in the future

- (a) a prescribed form should be provided for applications (this was not done when the initial press notice appeared) ;
- (b) adequate information should be provided to applicants concerning the course content (in answer to a questionnaire a fair number of participants indicated that more information at the application stage would have been helpful) and ;

- (c) the final selection should be made only after an interview (rather surprisingly, more than half of those who answered the questionnaire (36) would have preferred an interview before final selection—perhaps because it would have given them a chance to obtain more information about the Seminar). An interview would have almost certainly eliminated the few who were very weak in English and consequently found the proceedings hard to follow.

4. Composition of the Seminar

The 41 participants came from the following institutions :

Universities ..	..	19
Central Bank ..	..	4
Research Institutes ..	..	2
Ministry of Planning ..	..	4
Other Government Departments ..	..	5
Other State-sectors ..	..	6
Private sector ..	..	1

They either held junior staff rank positions (e.g. Research Officers, Planning Officers) or were Assistant Lecturers in Universities.

The bulk of the participants had a social science academic background. Most had graduated after 1973 and were under 30. Very few had post-graduate qualifications or any significant research contributions to their credit. However, almost all claimed to have research projects in progress, some in relation to post-graduate degrees for which they were registered with local universities.

5. Length of Seminar

The consensus of opinion among the participants was that the Seminar period of three-weeks was just about right. Given the course content most participants found it to be a tolerable period to be away from home and work. While a shorter Seminar would have reduced the quantity of the course content and probably lowered its quality as well, a longer Seminar would have almost certainly failed to sustain the interest and enthusiasm of participants.

6. Course Content

Broadly speaking the course content divides itself into :

- (i) General, philosophical and theoretical ;
- (ii) Statistical and quantitative methods ;
- (iii) Computing ; and
- (iv) Field work.

The answers provided by the participants to a questionnaire administered to them at the conclusion of the Seminar suggest that most of them found in the Seminar what they expected to find at the time applications were first made. The overwhelming majority of participants were also generally satisfied with the course content. However, on both counts there were a few exceptions. These were mainly either those who had an unusually narrow and specialist research interest and academic background (e.g. Mathematicians interested in Statistical Techniques only) or those who had entertained the misconception that the Seminar was a course in Statistical Techniques.

It is quite evident that those whose research interests were limited to a narrow field should have been left out. However, it must be stressed that the value of a Seminar of this nature lies partly in encouraging inter-disciplinary thinking and research. Thus, a more homogenous group though helpful from a practical point of view would not have been necessarily desirable when broader academic considerations are taken into account.

7. Course Structure

In planning the course structure (sequence of lectures) of a seminar that consists of over forty lectures one is necessarily constrained by practical problems such as lecturers not being free on a given date, or, worse still, not appearing on the appointed day and this Seminar had its fair share of these. However, given such problems, a logical and smooth course structure makes an important contribution towards the success of a seminar. Broadly speaking, the programme for the Seminar was satisfactory. However, there was room for improvement. For example, there were a few days when about five or even six full-length lectures were crammed into a six or seven hour period, a situation which denied the Seminar an opportunity to discuss subjects adequately and also over-taxed the mental absorptive capacities of the participants. It also became evident that tampering with the planned programme should be avoided as far as possible, however expedient it may be.

Finally, while dwelling on this subject there is one general—should I say philosophical—point to be considered. The logic of the situation apparently suggested that the Seminar should first deal with the general and theoretical aspects of methodology, and then move on to quantitative techniques. However, this apparently logical sequence was broken by having had to accommodate one lecture on a general theme in the middle of the course on Statistics. On reflection this appears to have had the beneficial effect of breaking the monotony of the Seminar and also reminding the participants of the essential unity of the Seminar theme.

8. Lectures on general, philosophical and theoretical themes

The answers to the questionnaire suggested that most participants thought that the time devoted to this aspect of the Seminar was reasonable and the quality of lectures good. However, almost none wanted most time devoted to these topics and indeed about one-third were of the opinion that too much time was devoted to them. In the point of view of one such participant, "The important point of the (sic) Research and Methodology is statistical methods. But you have given more attention to General, Philosophical and Theoretical Parts".

The failure on the part of a substantial minority of participants to grasp the fundamental importance of theory and conceptualization in social science research is unfortunate and, I dare say, to that extent the Seminar has failed to realize one of its objectives. The zeal to learn statistical techniques arises from the misconception that the hallmark of good social science research must be the inclusion of a few regression equations generated (preferably) with the help of a computer. This, as one lecturer (Dr. S. B. de Silva) emphasized is to sacrifice rigorous analysis for mere quantitative data generation. However, it is probably correct to assert that the Seminar succeeded in including a more balanced perspective of methodology in social science research in the minds of the majority of participants.

9. Statistical and quantitative techniques

Almost without exception participants lay great emphasis on the Seminar component on quantitative techniques. In general, those with a modest knowledge of mathematics and quantitative techniques found the course content useful and interesting. A few who had read mathematics and statistics for their degree found the course too elementary, and a fair number with a weak background in these subjects found it too advanced. Almost half the number who participated would have preferred to see more time devoted to Quantitative Techniques. Time and resources were not available for such an extension. Moreover, in a general seminar it would have imparted an imbalance to the course content. However, based on this experience one modification can be suggested for the future. In the case of technical subjects the participants should be graded in terms of their knowledge of the subject and, if necessary, several workshops must be conducted concurrently, one for each level or grade.

10. Computing

The participants were almost unanimous in acclaiming that the computing course was useful and that the lectures and instructions were of a high calibre. The lecturer concerned (Prof. J. A. Gunawardena) succeeded in making computer programming at an elementary level appear quite simple. Almost all participants also wished to see more time allocated to this part of the Seminar (only two days were made available). On reflection the programme would have been even more profitable if at least three or preferably four days had been allocated for computing.

11. Group Work in the field

The objective of Group Work was to introduce the participants to survey-type field work. The majority of participants found the experience useful. A few who had had some previous experience in field surveys did not find anything particularly novel. Many indicated that they would have preferred to spend more time on field work. However, here too the comments I made earlier with respect to availability of time, resources and balance in course content apply.

The Geography group under Professor G.H. Peiris (assisted by Prof. J.A. Gunawardena) which carried out a microsurvey of household firewood consumption deserves special mention. Without exception the participants (10) belonging to the group were

thoroughly satisfied with the work they did. Moreover, the survey concerned succeeded in collecting some data - crude as they may be - on household firewood consumption which have hitherto not been available in this country.

12. Resource persons

Almost all resource persons participated as scheduled in the sessions allotted. In the case of 6 lectures (out of a total of 48) the lecturers concerned made available a mimeographed copy of the full text to the participants before the lectures were delivered. Most other lectures were supported by handouts of varying length and coverage.

Although two foreign consultants were expected only one arrived. The uncertainty concerning Prof. S. C. Dube's participation - he eventually did not come - caused some disruption to the Seminar programme. It would have also been useful if the curriculum vitae of foreign consultants was made available by their sponsors at an early stage. However, the participants were highly appreciative of the contributions made by the foreign consultant who came, Prof. B. Ahmed.

13. Organization and Welfare

Almost all the participants indicated that they were happy with the general organization, seminar and accommodation facilities, and the food provided, at Peradeniya.

14. Free time

The majority felt that there was not enough free time. In retrospect it appears that it would have been better if the first week-end of the Seminar period, 30th and 31st August 1980, had also been left free.

15. Attendance

Attendance at sessions was very satisfactory averaging almost 90 per cent.

16. Overall evaluation

Almost all the seminar participants expressed that they benefitted considerably from the experience and that they felt more confident than before in undertaking a research project. Most indicated that they would strongly recommend a similar seminar to their colleagues.

17. Financial cost

Table 1 shows a 'full' cost budget estimate of the Seminar. A few salient points are worth emphasizing. First, the total local cost has been well within the original budget estimate and a substantial saving has been made on the estimated expenditure on foreign consultants. Second, a substantial saving has been made on the food budget (per capita expenditure on food per day was only Rs. 28.31 as opposed to Rs. 40/- provided for in the original budget). Moreover, the former figure does not take into account the extra meals - about 10 to 15 more in the case of lunch-supplied to Seminar personnel. Third, the free accommodation and seminar facilities (a relatively minor sum was spent on labour) provided

by the University of Peradeniya have made a major contribution towards keeping down costs. Fourth, mainly because of the close proximity of the seminar facilities, computer facilities, the Library and lodgings, to each other, we have succeeded in limiting transport cost at Peradeniya to a modest Rs. 3,000, half of which was incurred on the field trips. When field trips are excluded (and ignoring wages of the National Science Council driver) transport cost at Peradeniya amounts to Rs. 75.00 per day. (The relatively large number—19 out of 44—resource persons coming from the University of Peradeniya also helped to contain the transport bill ; see item 5(ii). Finally, the seminar cost per capita works out as follows :

Local— Rs. 1,585.00 per participant

Total (including expenses for foreign consultant) Rs. 2,154.00

18. Conclusions

The relatively minor shortcomings in the planning and execution of the project notwithstanding, the Seminar appears to have been a reasonable success in terms of the objectives it set for itself. Perhaps this seminar, being the first ever of its kind in Sri Lanka, will serve as a useful guide to the organization of similar seminars in the future.

It is too numerous to mention the names of all those who contributed in many ways towards making the seminar a success. To all of them I say a big 'thank you'.

TABLE I
TRAINING SEMINAR ON SOCIAL SCIENCE RESEARCH METHODOLOGY
A 'FULL' COST BUDGET ESTIMATE

<i>Local</i>	<i>Actual</i> Rs. cts.	<i>Estimated</i> Rs. cts.	<i>Imputed cost for services provided free</i>
1. Food ..	23,216.00	32,800.00	(Rs. 40 x 41x20)
2. Vice-Chancellor's dinner ..	2,018.00	2,000.00	(Rs. 20 x 100)
3. Accommodation ..	787.00		16,400 (Rs. 20 x 41 x 20)
4. Seminar (secretarial services & incidentals)	8,523.00	10,000.00	Seminar facilities
5. Transport ..		3,000.00	3 out of 4 vehicles by Peradeniya cost
(i) Peradeniya ..	2,686.00	3,600.00	only petrol & drivers wage Rs.800.00
(ii) Lecturers (Rs. 135x11xRs.270x6)	3,105.00	No provision	If hired (two days) cost would have to be at least Rs. 1,600.00
6. Trip to Sigiriya ..	1,567.00	do.	
7. Lecturers and Discussants ..	9,100.00	10,000.00	
8. Group Directors ..	3,500.00	5,000.00	
9. Honorarium for 3 Course Co-ordinators	6,000.00	6,000.00	
10. Others ..	5,000.00	No provision	
Expenses incurred by NSC (Administration, Organization, Transport Computer service etc.)			
11. TOTAL LOCAL COST ..	65,502.00	72,400.00 (70,000.00)	21,200.00
<i>Foreign Consultant</i>			
12. Travel ..	15,600.00	31,200.00	
13. Per diem (5 days) ..	3,680.00	14,720.00	
14. Honorarium (5 days) ..	3,520.00	14,080.00	
15. Total cost of consultants ..	22,800.00	60,000.00	
16. GRAND TOTAL (Local & Foreign)	88,302.00	130,000.00	21,200.00
<i>Sources of Funds</i>			
	Rs. cts.		
UNESCO ..	80,000.00		
NSC ..	10,000.00		
SSRC ..	40,000.00		
TOTAL	130,000.00		

Note—The total estimated local cost in the Budget Estimate circulated at the SSRC meeting on 01.08.80 was Rs. 70,000 . That estimate was changed in detail and also increased substantially at that meeting.

Costs of transcribing Seminar proceedings and other items of expenses connected with the planned publication are not included here.

source—Items 1 to 7 of actual expenditure from accounts submitted to the Accountant of the NSC by the Co-ordinating Committee. The others have been estimated.