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RESEARCH ARTICLE

Accomplishing environmental sustainability as an ethical responsibility; evidence from entrepreneur engineers in Sri Lanka

Praneeth Wijesinghe[*1], Thesara Jayawardane[1] and Sarath Dasanayaka[2]

[1]Department of Industrial Management, Faculty of Business, University of Moratuwa, Sri Lanka.
[2]Department of Management of Technology, Faculty of Business, University of Moratuwa, Sri Lanka.

Abstract: Sustainability and entrepreneurship are two concepts widely discussed in the contemporary world. Nowadays, the concept of sustainability is merged with entrepreneurship and directs entrepreneurs into a sustainable entrepreneurial journey. Many engineers have started entrepreneurial ventures, majorly in technology disciplines in Sri Lankan and international context, which are not adequately studied in the literature. Hence, the authors have designed an exploratory study on entrepreneur engineers' ethical practices in Sri Lanka, employing grounded theory approach. The present study investigates how entrepreneur engineers in Sri Lanka accomplish environmental sustainability as an ethical responsibility. Data were collected from purposively sampled fifteen entrepreneur engineers in Sri Lanka by conducting face to face semi-structured interviews. Voice recorded interviews were transcribed verbatim and analysed following grounded theory techniques with the support of NVivo software. The analysis has revealed that entrepreneurial engineers who participated in this study had a higher personal commitment to environmental sustainability while trying to accomplish sustainability by educating, introducing novel methods, planting trees, system optimisation, reusing, and recycling. Orientation towards sustainability has affected the entrepreneurial performances of a few of them too. Emerging entrepreneur engineers can utilise the findings of this study to contribute further to environmental sustainability through their business operations while achieving business success. Further studies can be conducted to expand the knowledge base of entrepreneur engineers' sustainable entrepreneurship while identifying profitable ways of establishing sustainable practices based on the findings of this study using qualitative and quantitative techniques.

Keywords: Entrepreneurs; engineers; Sri Lanka; sustainability.

INTRODUCTION

The never-ending utilisation of resources by humankind has pushed everybody to think about future generations' requirements. As responsible citizens, everybody should consider the well-being of the forthcoming generations while fulfilling their current needs. Consequently, the term 'sustainability' had created various conversations in society for a few decades. Like sustainability, 'entrepreneurship' is also widely discussed in society even before 'sustainability'. As a major force contributing to the country's economic development, entrepreneurs perform a significant role in society. In such a situation, the stress on sustainability can be identified as a significant turning point for entrepreneurs throughout the world. Since entrepreneurs utilise various resources to achieve their business objectives, adopting sustainable practices can be considered a more outstanding contribution to society, especially for future generations. In the international context and in Sri Lanka, there are many successful entrepreneur engineers. Mr Mukesh Ambhani in India and Mr Mark Zuckerberg in the United States are two famous billion-dollar entrepreneurial engineers in the international context. Their successful entrepreneurial journeys have ended up making them billionaires (McFadden, n.d.). Although not in the billion-dollar capacity, Sri Lankan entrepreneurial engineers have also achieved various success levels. Not like others, entrepreneur engineers tend to exploit technological opportunities for businesses (Thiranagama, 2015). Engineers can be considered an

[*]Corresponding author (praneeth@is.ruh.ac.lk http://orcid.org/0000-0001-5746-9510)

expert group of professionals in various technical fields and are trained for sustainability practices. In such an environment, engineers should have a higher ethical responsibility to achieve environmental sustainability through their deliverables. In exceptional cases where engineers have become entrepreneurs, their obligation to contribute to sustainability is not abandoned. As entrepreneurs, they have the full authority to take necessary actions to promote sustainable practices within their firms. In a situation where the whole world is moving towards environmental sustainability, it is a timely requirement to investigate the sustainable practices adopted by entrepreneurial engineers in Sri Lanka and its implications for their entrepreneurial practice to fulfil ethical responsibility. Disclosing the findings of this investigation to society will create benefits in various ways, like enhancing the body of the knowledge and guiding all entrepreneurs and policymakers in Sri Lanka to create a sustainable environment.

LITERATURE REVIEW

Sustainability

The term 'sustainability' has a history of nearly 300 years, and it was initially used in areas like forestry. For the first time in the literature, Hannß Carl von Carlowitz had used this concept in his book *Sylvicultura Oeconomica*. He emphasised that if anybody wishes to protect the forest for long term usage, they should not harvest more woods than the forest can produce. This concept was used in the forestry area (Fischler *et al.*, 2014). However, sustainability or sustainable development has become a significant policy issue in the contemporary world for a few decades. In 1987, the Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Herkert, 1998). This definition is widely used in society. Additionally, Brundtland commission has defined this concept more elaborately "In essence, sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations." (Fischler *et al.*, 2014). Over time, this concept has got increasing attention from various players at the national and international level.

Sustainability itself has three components as environmental, economic and societal sustainability. It has identified that whatever the things that humankind does in this world have implications on these three components (Mensah, 2019). Existence of the future generations depends on the balance of the implications created by the present society on these three interrelated components. Economic sustainability can be described as a system of production that fulfils current consumption levels without damaging future requirements. Economic sustainability in company perspectives is the initial approach followed by any company for long term survival. It can manage capital, stock and funds in the forms of tangible and intangible assets (İyigün, 2015). Empowerment, accessibility, participation, cultural identity, notions of equity, and institutional stability support social sustainability (Mensah, 2019). According to İyigün (2015), social sustainability in company perspectives means managing one's business operations considering the stakeholders' requirements while adhering to its value system. Most people assume that the sustainability concept is limited to environmental sustainability. However, it is only one component out of the three. Mensah (2019) emphasises that environmental sustainability is related to the natural environment and maintaining the natural environment more productive and resilient to assist human life. Major concerns associated with this are harvesting the natural resources not faster than its regeneration and releasing the waste materials faster than its absorption to the earth. According to İyigün (2015), environmental sustainability directs companies to operate without hurting the environment and generating over-dose emission. According to Khalili (2011: p. 19), goal of the sustainability in the business perspectives is increasing the long- term shareholder and social value, while decreasing industry's use of materials and reducing negative impacts on the environment. Since the world is more business oriented, it is no surprise to define sustainability in business perspectives.

However, with the rapid increase in the world population and industrialisation, the environment is badly treated (Khalili, 2011). Careful use of resources such as education, land, and other industries is substantial in current scenarios to achieve economic development simultaneously coupled with environmental sustainability. Education is the most crucial resource since it is the tool that guides everybody on the sustainable use of other resources wisely (Schumacher, 1973: p. 54). However, the extent to which industries adopted sustainable practices is not sufficient presently, emphasising the need for systematic education on sustainability. Hence, another policy agenda related to sustainable development came into action focusing on human development goals. United Nations has introduced 17 goals that interlinked each other in 2015 to achieve a more sustainable future for all (THE 17 GOALS, 2020). One hundred ninety-three countries have adopted these goals to achieve them by 2030 to foster economic growth, ensure social inclusion

and protect the environment. Although there are many counter-arguments on sustainable development goals, most institutions worldwide have changed their policy agendas in line with these goals. The studies are carried out at various levels to investigate the implementation of strategies to achieve these seventeen national and international levels throughout the globe (Sachs *et al.*, 2019). However, environmental sustainability cannot be implemented within a country without the support of the government. Countries like Singapore have successfully achieved environmental sustainability through environmental friendly constructions called green buildings via the Singapore government's policy-level support through various legal & regulatory mechanisms, financial incentive schemes, and risk-sharing programs (Han, 2019). Countries like Sri Lanka who are still struggling to accomplish environmental sustainability, can learn from Singapore's policy-level decisions.

Entrepreneurship

Entrepreneurship has created a greater interest among various groups of people working in different sectors in society such as business, academic, political and technology. Various scholars have given many definitions for the terms "entrepreneurship or entrepreneur" during the past few decades. Joseph Schumpeter, an Austrian economist and a famous theorist in entrepreneurship, defined an entrepreneur as a "person who reforms or revolutionises the pattern of production by exploiting an invention or, more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way, by opening up a new source of supply of materials or a new outlet for products, by reorganising an industry and so on" (Schumpeter, 1934: p. 132) Peter Drucker who is a famous management consultant has defined the entrepreneur as a "person who always searches for change, responds to it, and exploits it as an opportunity" (Drucker, 1985: p. 28). Global Entrepreneurship Monitor (GEM) report defines entrepreneurship as "any attempt at new business or new venture creation, such as self-employment, a new business organisation, or the expansion of an existing business, by an individual, a team of individuals, or an established business" (Brenkert, 2002).

Similar to the numerous definitions, there exists a large number of theories explaining various aspects of the entrepreneurship phenomenon developed over time. Innovation is a crucial feature in entrepreneurship. Joseph Schumpeter's innovation theory of entrepreneurship highlights the requirement of an innovative step in business activity. Innovation theory emphasises that there should be novel and innovative steps in the components like products, production procedures, market, supply chain, and management functions (Schumpeter, 1934). However, Schumpeter has neglected the risk-taking behaviour of entrepreneurs, although he discussed innovation.

Further, Needs Theory proposed by psychologist David McClelland describes three basic motivating needs of any person as the need for power, need for affiliation and need for achievement. McClelland and his colleagues have identified that people demonstrating a strong desire to achieve something have a higher possibility of becoming entrepreneurs. Entrepreneurs as high achievers take calculated risks while performing the activities as business person while putting themselves entirely into the business until it becomes successful (Ricketts, 2006; Chepurenko, 2015). Another significant theory related to entrepreneurship is the risk-bearing theory of Knight. In that theory, Knight has highlighted that entrepreneurs have to undertake risk if they want to generate profits from their work. Profit is the primary reward for any entrepreneur for undertaking risk (Ricketts, 2006). The economic theory of entrepreneurship identifies that entrepreneurs are carrying out entrepreneurial activities expecting economic gains. Profit motive directs entrepreneurs to exploit novel business opportunities. A preferable economic environment further reinforces entrepreneurial development (Chepurenko, 2015). However, all these theories have various limitations specific to them. It shows that scholarly contribution to the entrepreneurship domain is still developing and on-going all over the world.

Engineers

Engineers are leading professionals who provide service to society using mathematics, natural sciences, engineering knowledge, and practical experience. According to Accreditation Board for Engineering and Technology (ABET), an engineer is a person who applies knowledge of the mathematical and natural sciences gained by study, experience and practice with judgment to develop ways to utilise, economically, the materials and forces of nature for the benefit of humankind (ABET accreditation, 2020). However, their efforts are often underappreciated due to the various levels of risks associated with engineering work (Qureshi & Nawab, 2013). According to the Washington Accord, a multilateral agreement between bodies responsible for accreditation or recognition of internationally recognised engineering degree programs, a graduate engineer should have 12 graduate attributes. Environment & Sustainability, and Ethics are two crucial attributes among them. Hence, engineering undergraduates are

educated and trained to be competent in sustainability and ethics during their degree programs. Major state universities offering engineering degree programs in Sri Lanka are accredited as per the Washington accord requirements and working hard to inculcate these attributes within their undergraduates. As per the graduate attribute 'Environment and Sustainability', a graduate engineer should understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development. Similarly, as per the graduate attribute 'Ethics', a graduate engineer should be capable of applying ethical principles and commit to professional ethics and responsibilities and engineering practice norms (The Institution of Engineers Sri Lanka - Accreditation of Engineering Degrees, 2013).

Ethics is also an essential aspect for engineers, as graduate attributes highlighted. Professional engineering associations in the international context like The Institute of Electrical and Electronics Engineers (IEEE), The American Society of Civil Engineers (ASCE), The National Society of Professional Engineers (NSPE) have introduced code of conducts for their member engineers to guide them in the professional practice (Poel, 2000). In the Sri Lankan context, The Institution of Engineers Sri Lanka (IESL), as the apex body for professional engineers in Sri Lanka, also has introduced a code of ethics for its member engineers. There are eight main clauses in the IESL code of conduct. The third clause is devoted to guiding engineers on sustainability. It emphasises the requirement of assuring sustainability as "engineers shall be committed to the need for sustainable management of the planet's resources and seek to minimise adverse environmental impacts of their engineering works or applications of technology to protect both present and future generations" (The Institution of Engineers Sri Lanka - Code of Ethics, 2013). IEEE and ASCE code of ethics also highlights this clause as an important aspect of engineering practice (Hansen & Zenobia, 2011). Hence, it is clear that engineers are guided from their undergraduate period to work on sustainability by including it as one of the graduate attributes of professional engineers. Moreover, professional engineers have an ethical responsibility to uphold sustainable practices when in professional practice.

Sustainable Entrepreneurship

As the whole world moves towards sustainability, entrepreneurs also adopt sustainable practices within their business territories and become sustainable entrepreneurs. Sustainable entrepreneurship has the characteristics of sustainable development and entrepreneurship (Spence, Gherib & Biwole, 2011). After reviewing the extensive literature, Shepherd & Patzelt (2011: p. 137) have defined sustainable entrepreneurship as "Entrepreneurship which focuses on the preservation of nature, life support, and community in the pursuit of perceived opportunities to bring into existence future products, processes, and services for gain, where the gain is broadly construed to include economic and non-economic gains to individuals, the economy, and society is known as sustainable entrepreneurship". Entrepreneurs have the freedom to consume resources as they wish for their entrepreneurial business operations (Drucker, 1985). Famous economist Amartya Sen's views on sustainability apply to entrepreneurs as well due to present tendencies of consumption patterns that are not sustainable with economic freedom (Sen, 2013). Hence, sustainable entrepreneurs should adopt sustainable consumption patterns.

Although numerous studies have focused on sustainable entrepreneurship during the last two decades with the popularisation of the concept of sustainability, the field is still ambiguously defined and controversial in findings (Fellnhofer, Kraus & Bouncken, 2014). Using a quantitative research design, Vuorio, Puumalainen & Fellnhofer (2018) have conducted a study to investigate the drivers of entrepreneurial intentions in sustainable entrepreneurship employing a sample of university students from three European countries. They have found that attitude toward sustainability and perceived entrepreneurial desirability enhance sustainability-oriented entrepreneurial intentions. Hoogendoorn, Zwan & Thurik (2019) have found that sustainable entrepreneurs realise extra-institutional barriers in terms of a lack of financial, administrative, and informational support at business start-up than regular entrepreneurs from a study conducted over 33 countries. However, there is no significant difference in risk attitudes and perceived financial barriers between sustainable entrepreneurs and regular entrepreneurs. Lüdeke-Freund (2020) has investigated the applicability of business models in sustainable entrepreneurial ventures while aligning sustainability innovations on the one hand and the influence of environmental contingencies, barriers, and stakeholders from the sociotechnical context on the other hand. Lüdeke-Freund (2020) concluded how business models could help commercialise sustainability innovations while emphasising the necessity of conducting future studies to identify the barrier for sustainability innovations empirically. A study conducted in South Asia paying significant attention to Sri Lanka has identified that women entrepreneurs can work as essential personnel in promoting sustainable practices in economic, social

and ecosystems (Ambepitiya, 2013). Another qualitative study conducted in Sri Lanka suggests that organisations' sustainability practices have been affected by long-term survival requirements and other institutional factors such as coercive and mimetic pressures. Cost difficulty acts as a barrier to organisations' efforts to achieve maximum sustainable performances (Rajapaksha & Rajapakse, 2017). They further recommend carrying out studies to investigate why organisations face problems and how organisations adapt to such issues.

Entrepreneurial Engineers and Sustainability

Pretheeba (2014) has discovered that entrepreneurial intention among engineering undergraduates are higher than the business and management undergraduates in Sri Lanka. Thiranagama (2015) has concluded, after conducting an empirical study focusing on entrepreneurial engineers and accountants in Sri Lanka, that there is a higher tendency of engineers to exploit a technological business opportunity related to their field of specialisation. Further, Thiranagama (2015) has recommended conducting more systematic studies focusing only on the entrepreneurial engineers in Sri Lanka to identify hidden insights of entrepreneurial practice specific to engineering professionals. Successful entrepreneurial engineers have written even textbooks in the international context to guide engineers to become successful entrepreneurs (Goldberg, 2006; Guardia, 2016). However, when reviewing the existing research literature on entrepreneurial engineers in Sri Lankan and international context, it was apparant that the knowledge's inadequate nature has led to the rising confusions when demarcating the differences between regular entrepreneurs and entrepreneurial engineers. Entrepreneurial engineers are well educated, and most of them are even having various post-graduate qualifications in the areas they are interested at (Guardia, 2016).

Moreover, they closely deal with exploiting technological opportunities as new business ventures (Heijden, Brinkman & During, 2009). Code of ethics published by various engineering professional bodies create various impacts on entrepreneurial engineers' business practices which is also an under-investigated area in the literature, confirming the difference between regular entrepreneurs and entrepreneurial engineers. In such a situation, investigating the sustainability practices adopted by entrepreneurial engineers in the Sri Lankan context, which is considered a significant clause in the code of ethics, is a timely requirement to contribute the body of knowledge empirically and theoretically. Hence, this study aims to enhance the understanding on how entrepreneurial engineers in Sri Lanka accomplish environmental sustainability as an ethical responsibility towards society and its implications on their entrepreneurship practice.

METHODOLOGY

The objective of this study is achieved from the data collected by authors for a still on-going major study on Engineering Ethics and entrepreneurial engineers in Sri Lanka. This section describes how the larger on-going study was designed, and the objective of this paper was achieved from that study. Authors have identified that the engineering entrepreneurship research domain is still under explored. Hence, exploratory research in which qualitative techniques are incorporated is best used on such occasions. (Cresswell, 2014). Moreover, such under-explored domains should initially investigate participant-led or bottom-up, in the sense that they allow participant-generated meanings to be heard, which were not heard previously in the scholarly literature (Willig, 2013: p. 89). Qualitative research methodologies facilitate participant-led or bottom-up studies. Suddaby, Bruton & Si (2014) also recommended carrying out more qualitative studies on entrepreneurship. Although Thiranagama (2015) recommended empirical studies on entrepreneurial engineers in Sri Lanka, nobody has conducted a comprehensive study focusing on them. Senadheera & Karunarathne (2016) also recommended future researchers extend their qualitative methodology to various entrepreneurs in Sri Lanka in different sectors, different disciplines or different professions to examine how they deal with the ethics and dilemmas. Hence, the qualitative approach for the major study on Engineering Ethics and entrepreneurial engineers can be justified.

Out of the available recognised qualitative research methodologies, constructivist grounded theory in sociology was selected. It allows the researchers to develop abstract theories from the findings of the gathered data without any influence of the existing literature (Charmaz, 2006; Willig, 2013). It can be considered as a suitable methodology for a field that lacks even empirical theories and is sensitive to the concerns of a group of persons who have not been adequately studied (Gibson, Horan & Billy, 2016). Face to face in-depth interviews were conducted with selected entrepreneurial engineers in Sri Lanka as the major data collection method for this study with the support of a semi-structured questionnaire (Charmaz, 2006). Interviews lasted for nearly one hour and conducted by the first author after visiting the interviewees' offices. All the conducted interviews were voice recorded after getting the consent of the interviewees.

Sample

Purposeful sampling, the recommended sampling strategy in the initial stage of the grounded theory and theoretical sampling in this study's later stages, was used (Mäkelä & Turcan, 2007; Willig, 2013). Therefore, entrepreneurial engineers who were having 'Chartered Engineer' status were selected purposefully as the sample to collect rich, meaningful data since they are having much awareness on Engineering Ethics than other categories of engineers due to a compulsory requirement to pass an examination on Engineering Ethics as a pre-qualification to be a chartered engineer (Professional Review Rules, 2018: p. 30). After completing interviews and their analysis concurrently for ten participants, five participants were selected and interviewed as per theoretical sampling criteria to refine the analysis on sustainability aspects (Birks, Hoare & Mills, 2019). The accurate sample size for a grounded theory study depends on the theoretical saturation of the analysis when no new categories and clues emerge from data (Charmaz & Thornberg, 2020). It was found that the analysis has reached the theoretical saturation with a sample of fifteen entrepreneur engineers with respect to the means of accomplishing environmental sustainability through their business operations. However, the main study is still on-going to investigate other aspects of the ethics of entrepreneur engineers in Sri Lanka.

Data Analysis

Voice recorded interviews were transcribed verbatim into Microsoft Word files after listening to them several times by the first author. All the identifiable factors revealed by the interviewees during the interviews were replaced with standard terms to secure their confidentiality. Further, all interviewees were given pseudonyms in transcriptions. Before commencing the coding process, each interview transcript was sent via email to the respective interviewee to get their feedback on the content's accuracy. Then, interview transcripts were analysed by comparing and contrasting to identify significant themes and categories, both common and distinctive, underlying in the participants' views on sustainability using NVivo software while the interviewing process was going on (Charmaz, 2006). Since data collection and analysis were carried out simultaneously, later stage interviews were directed by the previous analysis findings as per theoretical sampling criteria (Charmaz & Thornberg, 2020). Memos were further written to support the analysis process during the coding stages (Charmaz, 2006). During the analysis stage, the confusion that came across was clarified by consulting relevant interviewees whenever required as participant checking to ensure accuracy (Charmaz, 2006; Cresswell, 2014). Findings were further discussed with the other two authors of this paper and few industry experts to enhance this study's trustworthiness and credibility (Braun & Clarke, 2013). Further, all interviewees' company web sites were checked to find more evidence relevant to the analysis findings.

RESULTS & DISCUSSION

The assigned pseudonyms and demographic information of each interviewee are as follows.

Table 1 : Demographic Information of Interviewees

Pseudonym	Field	No of Employees	First Degree	Start-up Year
A	Irrigation Engineering	10+	Civil	1998
B	Chemical and Construction	30+	Chemical	2005
C	Highway & Transportation	30+	Civil	2009
D	Structural Engineering	30+	Civil	1998
E	Structural Engineering	20+	Civil	2012
F	Electrical Engineering	40+	Electrical	2013
G	IT & Cyber Security	27	Electrical	2006
H	Wastewater Treatment	50+	Chemical	2004
J	Building Services	40+	Mechanical	2015
K	Architecture/Structural Engineering	8	Civil	2001
L	Structural Engineering	7	Civil	2009
M	Engineering & Project Management	20+	Electrical	2010
N	Architecture/Structural Engineering	10+	Civil	2008
O	Electrical Engineering	200	Electrical	1982
P	Power Engineering	10+	Electrical	2003

Source: Prepared by authors

According to the demographic information, participants are running entrepreneurial firms that belong to the Small and Medium Enterprise (SME) sector, where the number of employees is less than 250. Most of their firms are having permanent and contract-based employees. Therefore, identifying the exact number of employees working in these firms was difficult. Selected interviewees perform in various fields, satisfying the requirement of maximum variations in the sample as per the grounded theory methodology (Birks, Hoare & Mills, 2019). Interviews revealed that they all have worked in engineering firms as employees before starting their entrepreneurial firms and that previous working experiences have supported them positively in entrepreneurial operations. These professionally qualified chartered engineers also have post-graduate qualifications. All participants who contributed to this study were male engineers, and researchers could not interview any female participant satisfying the sampling criteria.

Grounded theory-based analysis has revealed the categories of personal commitment, sustainable practices and implications on entrepreneurship concerning environmental sustainability. The following sections discuss the above findings supporting narrative evidence from the interview transcriptions and information published on their company web sites.

Personal Commitment

All participants have demonstrated a positive commitment to achieving sustainability, especially in the environmental sector. As the leaders in their businesses, if they are not demonstrating the personal commitment towards sustainability, sustainable business culture cannot be inculcated within their business entities (Spence, Gherib & Biwole, 2011). Personal commitment to achieve something develops when a particular person believes that it is a worthy cause. Hence, it is better to know about entrepreneurial engineers' perception of sustainability. Engineer A has raised his voice as follows.

> "The supreme profit of any project is the health of mankind and the rest of the ecosystem. Because when the rest of the ecosystem is not healthy, automatically humanity dies. But, unfortunately, human beings assume that they are supreme and can control the rest of nature".

Though Engineer A has not used the specific term 'sustainability in his narrative, he has highlighted the relationship between the long term existence of human life and the rest of the ecosystem. He criticises the current practices of human beings, neglecting sustainable practices. A considerable number of people in society, including professionals, act in such a way of violating accepted sustainable practices (Manion, 2002). Hence, perception is an important matter in achieving sustainable goals as people who think they can control nature or use resources as they wish will not enact sustainable practices. Engineer A is a person who is passionate about sustainability. He has completed numerous engineering projects targeting environmental and community development through his entrepreneurial firm. It is evidenced by his company web site. Engineer E has stated that "from our side now, the industry is bit developed compared to those days, because now we think about the green aspects, sustainability, reducing the waste likewise. People now aware. Engineers also aware."

Similarly, engineer K has emphasised his perception of sustainability as "I respect sustainability". Nowadays, engineers have much more awareness of sustainability due to incorporating this concept in engineering education, Code of ethics, and other institutional policies (Qureshi & Nawab, 2013). Hence, engineer K's claim has further strengthened the claim that engineers are more aware of sustainability. It is a positive sign for a greener future.

Continuous development of environmental concerns has further led the entrepreneurial engineer's attention to sustainability. Although entrepreneurial engineers are business-minded, they have identified that the current direction towards which Sri Lankan society moves is not sustainable. Engineer A further highlighted, "you can see now this is a big mistake. What the hell is this development? You can't live in the city which is full of fumes; I mean polluted air. What is this development?" When looking at the current developmental activities, most of them badly damage society and the environment due to the uncertainty in predicting the consequences of innovative technological solutions (Dodds & Venables, 2005). People are using many sophisticated vehicles and machinery that were not available in the past to make their works more accessible. Unfortunately, the never-ending utilisation of machinery has created an unfavourable environment for all (Mensah, 2019). Therefore, engineer A questions the sustainability of the current development process. Inequalities in natural resources distribution have strengthened engineer H's sustainability orientation, who runs an entrepreneurial firm to purify wastewater. Engineer H highlighted, "In some areas of Sri Lanka, we have enough water. Nevertheless, in some areas like dry zone, we do not have enough water." The reuse of wastewater is a must

and encouraged (Dutta & Sengupta, 2014). Engineer H could exploit this requirement for a successful business venture. Though it is business-oriented, his website includes a list of innovative solutions that he can provide to purify water for the local and international industrial sector. His quality policy too focused on providing environmental friendly technological solutions for the customers.

Entrepreneurial engineers, as owner-managers of their business entities, have higher freedom for taking decisions and making judgements. If they are not committed to achieving something, their employees will not also work for that. Hence, personal commitment is required for any entrepreneur to achieve the targets. Engineer D explained, "I always make sure it is sustainable. Even if you see my office, you can see how sustainable it is. Even this building, this is a sustainable building". Engineer D's commitment toward sustainability was demonstrated in the above extract. He has considered sustainably maintaining his office; giving value to the proverb 'example is better than precept'. The first author of this article who visited his office to conduct the interview has observed what he was mentioning is confirmed with evidence. The building has the features for getting natural sunlight and ventilation, minimising electricity use for those purposes. The garden is full of trees and plants to create a natural environment. Since he has shown his commitment to sustainability from examples, there is a greater possibility to motivate his employees and clients to adopt sustainability. As social learning theory emphasises, society can learn and adopt sustainability even by observing and imitating engineer D's sustainable practices (Bandura, 1969). However, his website does not contain anything related to sustainability, as his firm focuses only on structural engineering services. He further added that "sustainability can happen in two ways. In your own life, you have to be a good example, that is number one. Then in practice, employee engagement is a crucial factor that supports any company to move forward in sustainable business practice. For employees to change their behaviour, they have to believe it is worth it. They have to understand and believe in the reasons for the change and identify what they need to contribute to environmental sustainability (Eccles, Perkins and Serafeim, 2012). Engineer D's practical approach is beneficial in promoting employee engagement within his firm to achieve environmental sustainability as much as possible.

Engineer J considers sustainability as an essential component in engineering practice. He exploits business opportunities by providing innovative green engineering services through his firm. He expressed his commitment as follows.

> "We are the persons who should take the lead to preserve this world while getting the knowledge more and more. Therefore, without considering these cost benefits actually, I decided to change our style and converted the whole office to make more and more greener designs. And that is one thing. It came from our heart."

Engineer N also has focused on delivering green engineering services to society, demonstrating his commitment to uplifting environmental sustainability. His company website has a separate page containing detailed information on green engineering services his company can offer. Engineers have a social and ethical responsibility to uplift sustainability in all aspects of society (Rahimifard & Clegg, 2008). As an engineer who has recognised that requirement strives hard to preserve the earth even without paying much attention to costs and benefits & his entrepreneurial works are greatly affected by green design concepts to improve sustainability. As evidenced by his company mission statement, his mission is to contribute to a greener, sustainable future.

Similarly, engineer K emphasised that "we have to take decision thinking about the country and the future, the whole society. That is the reason. Nobody gets the risk even. So, the entrepreneur should be going to a higher level." As engineer K highlighted, entrepreneurs also have a higher responsibility to consider society's well-being and the country without always extremely looking for profits. Billion-dollar entrepreneurs, including engineers in the international context, can significantly impact various practices in society (Goldberg, 2006). Though Sri Lankan entrepreneurial engineers lack that greater power to change society, they also can make a considerable impact on making policy-level changes to some extent. Hence, it is clear that all entrepreneur engineers who participated in this study demonstrate a positive commitment to sustainability. If any business entity requires to become sustainable in any aspect, leadership commitment should be there to inculcate the sustainable business culture within the firm as the first step of the sustainable journey (Eccles, Perkins & Serafeim, 2012). As identified from the study, entrepreneur engineers demonstrate their leadership commitment to environmental sustainability through their business operations. The code of engineering ethics and engineering education impact is instrumental in enhancing entrepreneur engineers' commitment to environmental sustainability. However, a previous study

conducted by Senadheera, Gamage & Karunaratne (2014) has identified that most Sri Lankan entrepreneurs generally tend to repeat unethical business practices due to ego-centric behaviour.

Sustainable Practices

Sustainable development will be impossible without fully supporting engineering practitioners (Qureshi & Nawab, 2013). Since the case is like that, entrepreneurial engineers' support for sustainable development is highly required. Entrepreneurial engineers have more authority to make decisions in their firms, unlike a typical engineer working for a company. Hence, they can practice a wide variety of sustainable practices within their firms targeting clients and society. Since the United Nations has declared 17 of sustainable goals to achieve by 2030, entrepreneurial engineers have many options to achieve sustainability (THE 17 GOALS, 2020).

Most entrepreneur engineers educate their clients to go for sustainable approaches. Even though sustainability is widely discussed at the policy level, the general public requires good education and motivation to adopt sustainable practices (Ambepitiya, 2013). Entrepreneurial engineers' efforts to guide their clients and the general public about sustainability are revealed in the form of the below-mentioned narratives.

> "I am promoting timber as a construction material because the embodied energy in timber is almost nothing, whereas when you talk about the steel, aluminium, and concrete it is very high. So, you know, we have to use sustainable materials and in the design as much as possible,"

As per the above narrative stated by engineer D, timber is much more sustainable than steel, aluminium and concrete. However, utilising excessive timber for human activities leads to reduced forest areas in the country. Therefore, many people believe that Aluminum, Steel or Concrete is more environmentally friendly since there is no damage to the forest. Scientifically, timber use is more sustainable and environmentally friendly than metals, as the timber's embodied energy is almost zero. If people are cutting down trees for their usage limitlessly without growing new trees sufficiently to cater to future requirements, the use of timber will not be sustainable. Engineer D disseminates his scientific knowledge for the betterment of society. Engineer H is also doing the same thing. He expressed it as "we always try to convince the clients, convince them to reuse the water because we make them aware of the importance of water and how difficult to get the water." These findings align with Amartya Sen's sustainable consumption concept, which is essential in achieving environmental sustainability (Sen, 2013). People give due respect to experts' opinions in most cases. Interview with engineer H revealed that many industries in Sri Lanka motivated to reuse wastewater by establishing treatment plants within their settings upon his explanations. It can be considered as excellent support for sustainability. Engineer A is taking efforts to make society more aware of the 'Circular economy', which is the most suitable economic model to achieve sustainability. He explained it as follows.

> "During the last century, we followed Linear Economics. It is becoming a failure because never-ending by-products right? It is spoiling the whole environment. Then they introduced, as a solution, 'Recycle Economics'. In that, you treat waste materials. As a result, countries like us are becoming a waste dumping ground for those days, as happened recently. So it is also not sustainable. The only solution is 'Circular Economics'. There is no waste at all."

Engineer A has published several articles in newspapers and conferences explaining the importance of adopting this concept. He has incorporated these concepts in most of the projects carried out from his entrepreneurial firm. As revealed from the narratives, entrepreneurial engineers try to educate their clients and society on sustainability whenever possible with their expert knowledge. These views further strengthen sustainable consumption in the present world's competitive economic struggle (Sen, 2013).

Engineers are designers, and it is one of the significant graduate attributes of a professional engineer (Passow, 2012). Entrepreneurial engineers also provide innovative designs for their clients' requirements as their business. They can optimise the designs to reduce the environmental impacts and energy consumption demonstrating that practice is also important, like preaching in achieving sustainability (Dodds & Venables, 2005). Optimising designs can be identified as another important practice followed by entrepreneurial engineers in Sri Lanka to achieve sustainability. Engineer F explained his practice as follows.

> "Since we are engaged in the consultancy work, you know that we are optimising designs. For example, if we are doing a design and if we are saving some materials, then that will be a something saved for the whole world, right?"

Proactiveness is very important for any engineering work as it is very difficult to change the things after completion. Later changes may cost various aspects like time, money and resources (Herkert, 1998). Including the sustainable aspects of the design itself while optimising is very important. As designers and problem solvers, engineers are the professionals who can do it cleverly more than anybody else in society. Engineer D also highlighted the same as "In the design also you have to do many precautions, steps could be taken to ensure the sustainability." Engineer P also optimises his engineering designs considering environmental sustainability.

Additionally, they have taken steps to conserve energy within their firms too. Conserving energy creates benefits in two aspects. As engineers, they support achieving the sustainable use of energy resources within their capacity while advising others to do the same. As entrepreneurs, it is profitable to themselves if the utility payments are less for their firms. Engineer D highlighted this as "my previous office was a four-storied building. The electricity bill was about two thousand rupees because of energy saving, we used only laptops, and many energy-saving steps were taken." Innovations in current technologies have offered numerous energy-saving options. Engineers are frontiers in developing and adopting these innovative options (Rahimifard & Clegg, 2008). Since laptop computers are more energy-efficient than desktop computers, engineer D and his employees are using laptops. Engineer G also explained his approach as "from our end, we do whatever the things possible. we make sure to switch off ACs and everything if it is not used in our office." These small scale steps can be considered as a valuable initiation taken in an individual capacity in a situation where Nijam & Nazar (2017) identified that Sri Lanka needs to focus more on energy and environmental issues to achieve sustainable development goals.

Reusing and recycling waste materials is another effective practice of entrepreneurial engineers in Sri Lanka. Reduction of waste materials is not possible always in engineering activities. Hence, engineers should reuse or recycle them as sustainability-oriented professionals (Dutta & Sengupta, 2014). Engineer D explained his previous work related to this as "we had to demolish two hotels to construct one hotel there. All the demolished materials were reused. It was not taken out from the site. We crushed it and reused." Engineers can find innovative methods to reuse waste materials. It can be considered their ethical and social responsibility towards the general public (Fleddermann, 2012). The use of demolished materials to construct a new hotel has saved existing natural resources for the future generation. Engineer G also highlighted that "we do whatever the things we can. We reuse discarded one-sided printouts again for the printing purposes. Such printouts are used for internal communications like things." Nowadays, a large number of trees are cut down for manufacturing stationeries. Out of them, A4 and photocopy papers are widely used in office works where a considerable wastage has happened. Engineer G's practice is a good approach for any person in society. Engineer H provides industrial solutions to recycle wastewater which can also be considered reusing and recycling.

As previously highlighted, trees are an essential component in balancing ecological sustainability. Deforestation has become a significant issue in achieving environmental sustainability with the current stage of development. Two entrepreneurial engineers have highlighted their practice of planting new trees for the environment as a part of their business activities. Engineer A planted trees whenever possible when carrying out his projects. He explained it as "We planted trees whenever we dredge streams. we never touched trees in the river banks like 'Vetakeiyya' (Pandanus). In addition to that, I planted trees, additional trees, right?" As an engineer who practices in the irrigation and water management sector, engineer A knows the importance of having various plants like Pandanus along the banks of the canals and rivers. In addition, his company web site contains evidence of tree planting activities previously carried out by engineer A. In a situation where most business people neglect their obligations to the environment, engineer A is a praiseworthy character in society. Engineer K also has a practice of promoting tree planting. He mentioned it as "I am always looking about the existing trees. I don't want to trim them even. If you are always in a compacted area, you will have a stressful mind no? So with trees, you can create a friendly, cool, calm and quiet environment." As an entrepreneur engineer in the field of housing, engineer K tries to balance the environmental sustainability and stress-free mind of the public. Maintaining a natural environment filled with many trees around a house eventually enhances the house owners' mind fullness and long-term success in personal and professional lives.

Innovation is not a novel term for both engineers and entrepreneurs (Drucker, 1985; Okokpujie, Fayomi & Oyedepo, 2019). Engineers can involve innovative findings which can be used to strengthen the sustainable approaches. As entrepreneurial engineers, few have suggested novel approaches. Engineer F has highlighted, "from the sustainable side, we will introduce whatever the new technology, green building, sustainable energy and energy-saving methods to our designs that based

on the client requirements." However, engineer F faces constraints when applying novel sustainable techniques with the client requirements. Sometimes clients are always not willing to adopt sustainable techniques. Therefore, he cannot incorporate all the possible sustainable techniques, including innovative techniques as clients' consent is required. It is a tremendous disadvantageous situation for achieving sustainable development goals. Dasanayaka *et al.* (2020) have identified that most commercialisation of new inventions in the Sri Lankan context is unsuccessful due to insufficient support from the external parties supporting engineer F's claim. As previously highlighted, entrepreneurial engineers themselves can educate their clients to some extent to adopt these sustainable practices. Engineer K has proposed the following approach considering the economic and social sustainability as "I mentioned that minimum land area should be ten perches in that instructions. Now six no? Change the regulations. Then anybody can construct a house with the environment." Engineer K highlighted that constructing a house covering the total land area is not a good approach according to the sustainable perspectives. Nowadays, it is challenging to buy suitable land for residential purposes closer to Sri Lanka's town areas. Hence, most people buy minimum land areas like six perches and build their houses covering the whole land area. However, it restricts the land itself to absorb the rainwater. He identified various socio-environmental consequences associated with this current practice and proposed to change the regulations on the minimum land area for residential purposes to ten perches.

Implications on Entrepreneurship

Few interviewees explained their concerns on considering sustainable approaches into their business practices. Entrepreneurs need profits to run their ventures (Drucker, 1985). Engineer J expressed his concern on profits and sustainability. "Profit in a sense, we have the self-satisfaction. The very first profit is that and financially actually that converting into sustainability do not make much profit to us. But, we are doing the correct thing by doing a minimum disturbance to the earth." Self-satisfaction is the critical factor that motivates engineer J to carry out his activities in a sustainable manner. Most of the time, sustainability is one of the engineers' significant obligations towards society (Fleddermann, 2012). Hence, engineer J is experiencing self-satisfaction from his work. However, sustainability approaches are not giving considerable profits for his firm. In SMEs, implementing sustainable practises is not financially viable (Rajapaksha & Rajapakse, 2017). Confirming that, engineer J gets lesser profits. Similarly, engineer E highlighted the difficulty of getting projects from the clients when he insists on incorporating most of the sustainable approaches in the client's project as they are costly to implement sometimes. He expressed it as "It is a bit difficult because we are not the only consultant in the building industry. So what clients try to do is try to meet their own requirements by moving to another consultant, neglecting our recommendations on sustainability." In perspectives of business, it can be considered as a loss of a business opportunity. Since entrepreneurs solely depend on their income to run the firm, sustainable orientation has negatively affected their business performance.

When the client is not having much knowledge on sustainability, they pay less attention to the recommendations of consultants' like engineer E. Perhaps; clients require additional financial resources to implement the recommended sustainable procedures. Hence, as engineer E highlighted, moving clients away from consultants like engineer E, can be observed. Clients will fulfil their requirements by meeting another professional who agrees to work according to their requirements. Therefore, some entrepreneurial engineers lose business opportunities which affect their entrepreneurial success. Engineer M highlighted his concerns as follows. "But some clients are not ready to accept sustainability at a cost actually. It is not free of charge. I mean you have to do certain investments for that and then certain clients are not ready to do that". Engineer N revealed his experiences as "we generally promote green building certifications. Most of the time, we will reduce our consultancy fee for green consultancy works to motivate the client to get the certifications. Sometimes, although we motivate, some clients are not adopting them because of the cost and other restrictions". It can be identified that the clients' unwillingness to adopt sustainable practices due to the higher cost associated with operationalisation is a significant obstacle faced by entrepreneur engineers in accomplishing environmental sustainability through their entrepreneurial operations in Sri Lanka. Even though Hoogendoorn, Zwan & Thurik (2019) have identified that sustainable entrepreneurs in other countries face extra financial difficulties in the start-up stages of their ventures, Sri Lankan entrepreneur engineers undergo financial difficulties with losing business opportunities consequently with sustainable practices. In this kind of situation, as Han (2019) highlighted, the Sri Lankan government can take policy-level decisions to grant an incentive scheme for both entrepreneur engineers and clients to choose more environmentally friendly solutions.

According to Schumpeter's innovation theory of entrepreneurship, entrepreneurial engineers are getting

the opportunities to work on sustainability innovations. As risk-takers, they can try to implement them in their business settings and exploit novel business opportunities from these innovations as the world is moving towards sustainability. Loss of business opportunities due to sustainable orientation is not a reason for entrepreneur engineers to demotivate and give up sustainable practices. They are highly achievement-oriented personnel in society. In line with McClelland's achievement theory, they can find innovative ways to realise their genuine commitment to sustainability, mainly to fulfil their ethical responsibility. Entrepreneur engineers in Sri Lanka can adopt business models identified by Lüdeke-Freund (2020) to commercialise sustainability innovations to attain environmentally sustainable business operations' competitive advantage to reduce the above-identified implications.

CONCLUSIONS & RECOMMENDATIONS

Environmental sustainability is not a novel concept for professional engineers. Nowadays, engineering degree programs have been designed while setting sustainability as one of the graduate attributes. Besides, engineers have an ethical responsibility to uplift environmental sustainability in society as guided by their Code of conduct. Data collected from fifteen entrepreneur chartered engineers in Sri Lanka following grounded theory methodology have revealed the following. Entrepreneur engineers aware of environmental sustainability and demonstrate a positive perception of that. They all have a personal commitment to establishing environmental sustainability within their firms and in Sri Lankan society. They are following some practices to enhance the Sri Lankan industrial sector's environmental sustainability through their business activities while educating their clients and the general public on sustainability where ever possible. They incorporate techniques like energy conservations, design optimisations, reusing and recycling waste materials, planting trees, and innovative sustainable technologies into their works, targeting their clients and society to fulfil the ethical responsibility of accomplishing environmental sustainability. Sustainable entrepreneurship is not always profitable for entrepreneur engineers in the Sri Lankan context as clients do not like to go for sustainable approaches at all times. However, entrepreneur engineers can work more on sustainability using their expert knowledge on engineering by doing innovations and taking more risks. It will help entrepreneur engineers in Sri Lanka to become significant figures in sustainable development. Moreover, the findings of this study can be used by emerging entrepreneurial engineers in Sri Lanka as a guideline to establish sustainability within their firms and society. Policy level decisions should be further taken to educate the various layers in the society on the significance and the value of environmental sustainability to implement them in the Sri Lankan context balancing the cost factor.

This study has several limitations to be noted. Gathering data only from male participants can be considered a significant limitation as researchers could not find any female entrepreneurial engineer with chartered engineer status in Sri Lanka during the study. Hence, results are not illustrating the views of female entrepreneur engineers. Further, the sample consisted only of entrepreneur engineers in Sri Lanka who have chartered engineer status because of the purposive sampling criteria. Therefore, this research does not contain other entrepreneur engineers' views who belong to various professional categories. Since this is qualitative study, findings also cannot be generalised to a larger population of entrepreneurial engineers.

Further studies can be conducted to expand the knowledge base of sustainable entrepreneurship concerning entrepreneur engineers as they can contribute massively to the country's sustainable development. Systematic studies can be conducted qualitatively and quantitatively to identify socio-economic factors that demotivate entrepreneurial engineers in adopting green thinking and sustainability. Determining the implications of sustainability approaches more broadly on entrepreneurial perspectives is also essential in today's fast-paced economic environment to propagate sustainability and other ethical practices among entrepreneurs to guide emerging entrepreneurs to achieve long term business success.

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