Traffic Engineering and Traffic Management

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My task is to bring before you some of the traffic engineering measures that can be adopted to tackle this problem of energy losses or improve energy usage. Therefore, it is a relatively 'micro' problem But nevertheless, it is a significant proportion of the macro problem. If we can get our traffic to flow more smoothly, we can improve the road fuel efficiency.

Owing to time constraints, I have to limit myself to a few applications but I would like to say that there are numerous applications in traffic engineering that one has to look into; and I hope some of them will be taken up during the discussion.

Speed and Capacity

When we talk of traffic the first thing we have to look at is speed. As you can see here the fuel consumption is very much dependent on the average operating speed of your vehicle. A lot of the vehicles that are used in Sri Lanka have efficient fuel operation from 40 km/hr. to around 80km/hr. Therefore, that is the kind of operating speed that we must design our highways for. But if we look at our urban highway network, we are operating in the region of between 20 - 30 km/hr. average speed. This is why we have mounting congestion costs and energy losses in the urban area. Our intercity routes are better in the sense that they are operating around the 40 - 50 km/hr. range or maybe 35 - 50 km/hr. So a lot of the problem is in the urban area and lot of that is caused not by the poor pavement structures but because there are too many vehicles and we do not have the capacity for these vehicles to pass. So the first thing is that when we are designing a road we must know what kind of speed we must design that road for. So too much speed is not good and at the same time if we provide a road that does not have the required capacity we can assume that in a few years we will have a congestion problem and the nett result will be lower speed and higher fuel consumption.

MANAGEMENT

The next thing about operating speed is traffic management measures. When traffic management fails we again have problems of congestion. When I refer to traffic management, what I would like to emphasize is the matching of the demand for the road and the supply that is available. Therefore, measures (perhaps even national measures) need to be taken to match the two. For example, if we just enter an infinite number of vehicles on a very finite system the nett result is that we are going to have congestion and energy losses.

So therefore we must have a good understanding as to what our urban systems can cope with, and therefore enter only the permissible number of vehicles onto our system. What type of vehicles we enter is also important, because if we enter only cars we will find that 80% of our people will not be able to get about and attend to their normal business. But on the other hand if we permit high occupancy vehicles we will find that our speeds will increase because less capacity on our roads will be utilized. So these traffic management measures, perhaps even traffic management policies have to be taken in maintaining operating speeds on our roads.

Land use

The third aspect is the land use allowed. We see road side land use on both our urban road network as well as our intercity networks. Roadside development as we call it is actually mostly negative development. It actually does more harm than good. In fact there are enough examples that one can quote from. I will just take the most recent irritation for me personally - grape sellers at Dehiwela Mount Lavinia. Those who buy grapes add to congestion each time they do that. We can estimate the kind of impact that has on energy. Because I travel so much on Galle Road, I did some study taking my average speed on different sections of Galle Road. Fortunately I had the travel speed on this section before the grape sellers came and it was easy to observe it after they came. It dropped from 35km/hr to 31 km/hr 4 Km/hr. *(See graph next page)*

The 4 km reduction in speed is translated to an increase in fuel of 10 litres per thousand vehicles. And the Galle road in that section will have about 50,000 vehicles per day. Therefore, the nett excess consumption is (15 x 100) i.e. about 500 litres per day. ☞

☞ And if they do survive for 1 year then we can estimate 300 x 500 litres per year. And that is the amount of fuel the country has to spend because of this activity.

A. Energy in Design Speed & Speed Management

- The operating speed of highway is extremely contributory ot the energy consumption rate

Example: Grape vendors at Dehiwela - Mt Lavinia

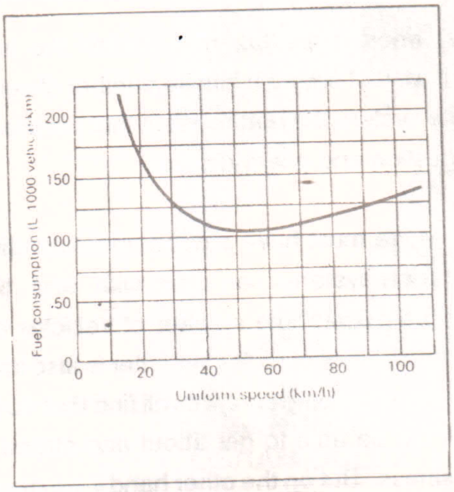

Figure 1

The operating speed is based on

- Design Speed
- Traffic Management Measures
- Land use allowed

10/- per litre of fuel will be in the order of Rs 2,000,000/- per year. There are about 100 grape sellers there, so the cost of allowing one seller is around Rs. 20,000/- per year. Therefore, I don't know what kind of development we are talking about. If we are thinking of providing employment I am sure there are cheaper ways of doing so. We can estimate all of these things, if we want to, and show the impact these kinds of negative development methods have on energy consumption.

The second thing I would like to say is that we cant always have uniform flow. Earlier I was talking about operating speed and we all know that if we can maintain a uniform operating speed then we have the near maximum fuel efficiency. But if we want to have road networks like that we will have to keep building more and more free ways, and be prepared to build more and more freeways until we have only half of our city left. So we will have to live with the kind of roads we have, having pedestrian crossings, and intersections and so on and so forth. But we must also know what such measures are going to cost us and how

B. Energy Losses in Deviations from Uniform Speed Flows - The pickup losses due to speed changes is a significant contribution to energy losses

Eample : Speed Humps on Reid Avenue

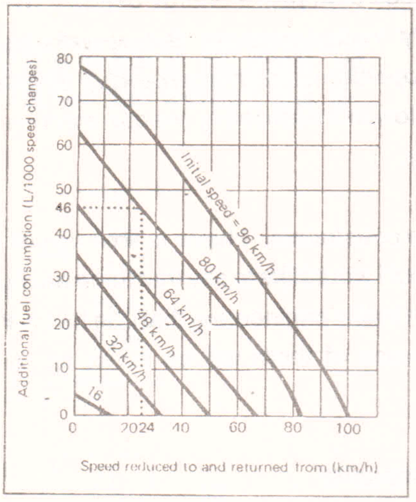

Figure 2

Some Occurrences -
- Road Humps
- Pedestrian Crossings
- Centre Median Openings
- Slow moving vehicles
- On-Street Parking
- Bus Stops

we can minimize those costs. Figure 2 gives us the pick up losses due to speed changes. We know that whenever there is an obstruction either total or partial to the free flow of traffic there is a speed reduction. There are number of traffic devices such as road humps, pedestrian crossings, centre median openings for the turning of vehicles, an assortment of slow moving vehicles, on street parking (both legal and illegal) bus stops (again both legal and illegal). Each of these incidents will cause the traffic flow behind that incident to reduce its speed and to regain its speed. Now each time that cycle happens there is a loss of energy. Let me take the controversial road humps on Ried Avenue and see what that costs in terms of Energy. We know what it costs in terms of human lives, let us look at energy. If we take an operating speed of 56 km/hr and the speed approaching the hump and over the hump to be 10 km/hr or so, your speed reduction would be 45. You are therefore losing 35 litres /1000 speed changes. On that road we can estimate around 20,000 vehicles a day meaning 700 litres of fuel per day. When multiplied by one year, we see that each hump or each pedestrian crossing will cost the country Rs. 2,000,000/- in fuel only- (twice as much actually for time wasted!). Therefore, we need to be clear as to what kind of traffic management measures we need. We do need to have safe pedestrian crossings but is this the answer? We need to have more and more efficient traffic management measures.

c. Energy Management at Intersections

Intersections are locations at which large losses in energy are occurred. Optimisation of Central Methods are necessary to minimize the losses. Eg: Signal Timing

The third largest delay is at intersections. We need to know where to have round abouts where to have traffic signals and where to have stop signs and so on. Right now we do not have a policy to determine what type of intersection needs what type of control. And that is very urgent. Even if you do signalize the exact timing is very important. And that is the problem with many of our signal light intersections. The timing is not exact and in fact here there is an example from a Canadian exercise where they showed how the timing (changing the red and the green) by a few seconds to match the traffic flow they can get something like 12% improvement in the traffic flow and a corresponding fuel consumption saving of 1013 litres per day. (A 5% saving). Similarly, we have to analyse each and every intersection because these are the things that add up to our total fuel bill. Then again we need to know what type of intersection to use and what type of signalisation has to follow. Just because you put a traffic signal that doesn't mean that the intersection is going to improve.

Finally let me very briefly name a number of possible areas

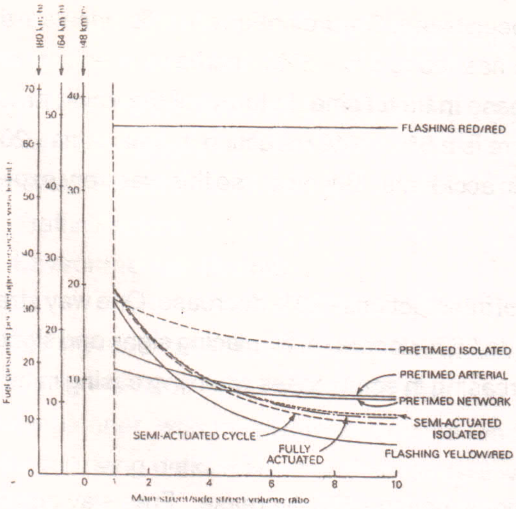

Figure 3

Table 1 : Estimate of Fuel Consumption Changes with Signal Timing Improvements

Total fuel consumption*(in litres) = [100.4(D) + 0.63(T)] x N

Where D = total distance travelled in kilometres T = total travel time in seconds, N = number of vehicles affected

Example

Arterial system 5km in length with 4 lanes, no parking, 15 intersections carries 24,000 vehicles/day

Average travel time prior to improvements = 560 s (32 km/h)

Assumed improvement in travel time = 12%

Resulting travel time = 493 s (35.8 km/h)

Base condition (poorly timed signals :

Fuel consumption

$$= \frac{[100.4(5) + 0.63(560)] \times 24\,000}{1000}$$

= 20 515 L/day

After condition (improved signal timings)

$$\text{Fuel consumption} = \frac{[100.4(5) + 0.63(493)] \times 24{,}000}{1000}$$

= 19,502 L/day

Reduction in fuel consumption

= 1013 L/day (4.9%)

Total savings at 50c/L = $506/day

that could be deliberated. I have taken as an example a summary of an exercise in Ontario of different measures that have been taken. Co-ordination of traffic signals in the city centre has led to 5% - 20% decrease in energy and 40% decrease in travel time. In terms of the environment as well there is a 5% - 20% reduction in emissions - 20% reduction in accidents. But ofcourse this was very expensive.

Widening of intersections - 20% decrease. One way street systems 5 to 25 % decrease. Replacing signs and signals again decreasing in some cases while increasing in other cases.

Improve signal timing - 6% decrease. Free way control- (not applicable to us), improved street signing & improved route identification is an important area. None of our intersections are properly signed and people have to go round and round trying to find their way. Turning movement restriction - reversible lanes - this concept was used on Galle road earlier, in this instance they say that reversible lanes do lead to 5 - 10% decrease.

Bus bays 4%, Cross walk replacement 10% decrease.

These are a number of areas which I will not go into detail because of time but which could be picked up for possible improvements.

D. Other Applications

Summary of Recommended Traffic Energy Management Measurers

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Measure	Potential applications	Potential impacts* Energy	Travel time	Emissions	Accidents	Risks and difficulties	Relative costs	Remarks
Coordination of traffic signals	Downtown networks and major arterials	5 - 20% decrease	Up to 40% decrease	5 - 20% reduction	Up to 20% reduction in accidents (40% reduction in rear end collisions)	—	Medium to high	Requires a systems design
Widening of intersections	Congested intersections	20% decrease	10% decrease	5% reduction	Reduction	Availability of property	Low to medium	—
One-way street systems	Downtown networks.	5 - 25% decrease	10 - 50% decrease	5 - 25% decrease	Reduction	Merchants' concerns Increased travel	Low to medium	—
Replacing signs and signals	Low volume intersections	2-way stop† decrease 4-way stop† increase	2-way stop† decrease 4-way stop† increase	2-way stop† decrease 4-way stop† increase	2-way stop† increase 4-way stop† decrease	Residents' concerns Potential increase in accidents	Low	Suitability depends on volumes
Improved signal timing	All signalized intersections	6% decrease	12% decrease	6% decrease	—	None	Low	—
Flashing of signals	All traffic signals	Potential decrease	Potential decrease	Potential decrease	Depends on control	Potential increase in accidents	Low	Low traffic volume operation
Freeway control	Freeways	8 - 10% decrease	20% decrease	8 - 10% decrease	31% decrease	—	High	—
Improved street signing	All intersections	Decrease	—	Decrease	—	—	Low	Reduces unnecessary travel
Improved route identification	Major highway routes	Decrease	—	Decrease	—	—	Low	Reduces unnecessary travel
Turning movement restrictions	Congested intersections	4% decrease	12% decrease	Decrease	Decrease	May cause additional travel	Low	—
Reversible lanes	Major arterials	8 - 10% decrease	25% decrease	Decrease	—	Merchants' concerns Access	Medium	Requires enforcement
Bus bays	Congested intersections	4% decrease	8 - 10% decrease	Decrease	Decrease	—	Low to medium	—
Crosswalk replacement	All crosswalk locations	10% decrease	6% decrease	—	—	Community reaction	Low	—

* The estimates of impacts are for specific applications during specific times and for traffic volumes affected, not for area-wide impacts. They should be considered as general approximations only, owing to variations in conditions among municipalities. See Appendix A for details regarding studies and projects on which the estimates are based

† Relative to a standard signalized intersection.