K. M. G. N. S. Kumara[1], P. V. M. Kumarasiri[2] and K. S. Weerasekera[3]

[1, 2 & 3]Department of Civil Engineering, The Open University of Sri Lanka

METHODOLOGY FOR JUSTIFICATION OF OVERHEAD PEDESTRIAN CROSSINGS USING SPEED CHANGE CYCLES

INTRODUCTION

When a vehicle is traveling at its cruise speed, if the speed is interrupted due to change of road geometry, road features or any road event (such as lane reductions, presence of road intersections, interruptions due to pedestrian crossings etc.), it will decelerate to a minimum speed (which even can be a complete stop) before accelerating back to its original cruise speed. It can be said that a vehicle undergoes a speed change cycle which leads to a difference in travel time and Vehicle Operating Cost (VOC) for traveling the distance of the speed cycle at the original cruise speed versus reduction of speed through the speed cycle.

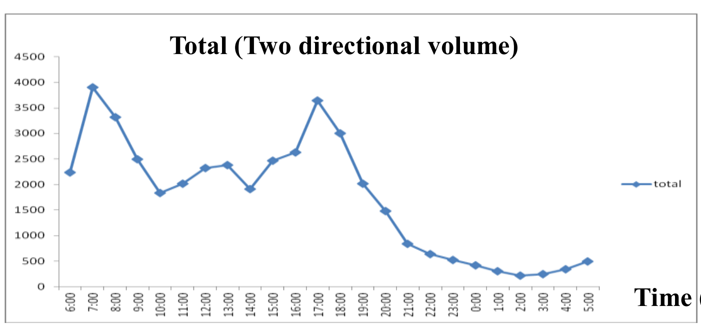
The study location was selected in front of the Malabe Campus of the Sri Lanka Institute of Information Technology (SLIIT) along the Malabe - Kaduwela road with an Average Daily Traffic (ADT) of 39,800 vehicles per day. At this location, traffic flow is constantly obstructed by the existing pedestrian crossing at the entrance to the Malabe Campus of SLIIT. This is a straight stretch of road consisting of minimum disturbance to traffic except for heavy pedestrian crossing movement that takes place in the location. With this very high ADT value, reduction and regaining the speed of vehicles may cause additional VOC and also increase travel time, higher accident risk, increase in vehicular emissions etc. finally causing huge additional cost to the national economy annually. Hence the additional cost for more fuel and oil consumption, wastages of tires, wear and tear of mechanical parts, additional travel time etc. could be quantified. As a solution, a safe overhead pedestrian crossing structure is designed and the construction cost is compared with the savings from the reduction in travel time and VOC, and finally, the construction of the structure is justified by carrying out a cost benefit analysis.

METHODOLOGY

Step1: Traffic survey

Firstly, traffic flow pattern around the study area was measured. Vehicles were counted manually on both directions at 15 minute intervals. Two directional vehicular flow for 24 hours is as shown in Figure 1. Peak hours were identified as; morning peak from 7:00 to 8:00am, mid-day peak from 1:00 to 2:00pm and evening peak from 5:00 to 6:00pm.

2-directional vehicles (Nos)



Time (hours)

Figure 1 – 24 hour vehicle distribution

Step2: Pedestrian survey

Secondly, pedestrian crossing flow around the study area was measured. A pedestrian count at the entrance to the SLIIT was done at 5 minute intervals throughout the day, in order to identify the pedestrian peak hours. Two directional pedestrian crossing flow is as shown in Figure 2. Pedestrian crossing peaks were identified as; morning peak from 7:45 to 8:45 am, mid-day peak from 12:45 to 1:45 pm and evening peak from 4:55 to 5:55 pm.

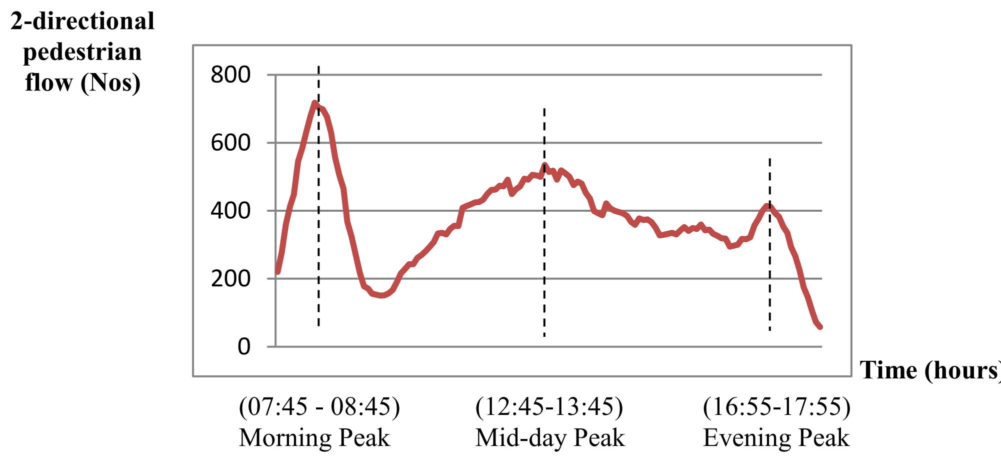


Figure 2 – Two directional pedestrian crossing flow

Step 3: Traffic volume study

As per two directional traffic volume, 7 time slots were selected to carry out the speed profile study as indicated in Figure 3. The study analysis was carried out under the following assumptions. It was assumed that vehicular flow pattern and vehicle composition at the study location is the same for all 7 days throughout the year. It was also assumed that flow pattern changes due to weather changes and the peak hours would not vary. Seasonal variation of traffic at the study location has been ignored.

To generate average speed profiles the time slots were taken as follows (see Figure 3):
6.00am - 8.00am, 8.00am - 9.00am, 9.00am - 12.00 & 1.30pm - 3.30pm, 12.00 - 3.30pm, 3.30pm - 6.30pm, 6.30pm - 10.00 pm and 10.00pm - 6.00am.

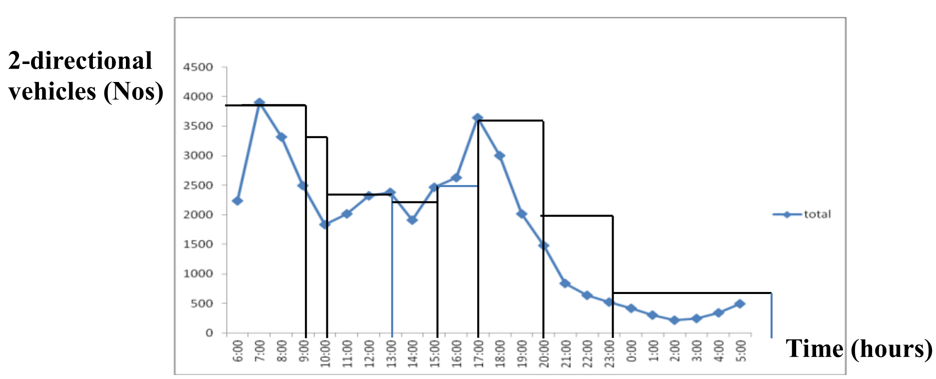


Figure 3 – Time slots based on two directional traffic

Step4: Speed measurements

As shown in Figure 4, either side of the existing pedestrian crossing was divided into 10m sections for taking speed measurements. Speeds of random 25 vehicles (from all vehicle categories) were measured in every 10 m road segment. In addition, the average speed was measured 100 meters away from the pedestrian crossing along both sides. Average speed variation for all categories of vehicles during each time slot (for both directions) was recorded and corresponding speed profiles for each time were drawn.

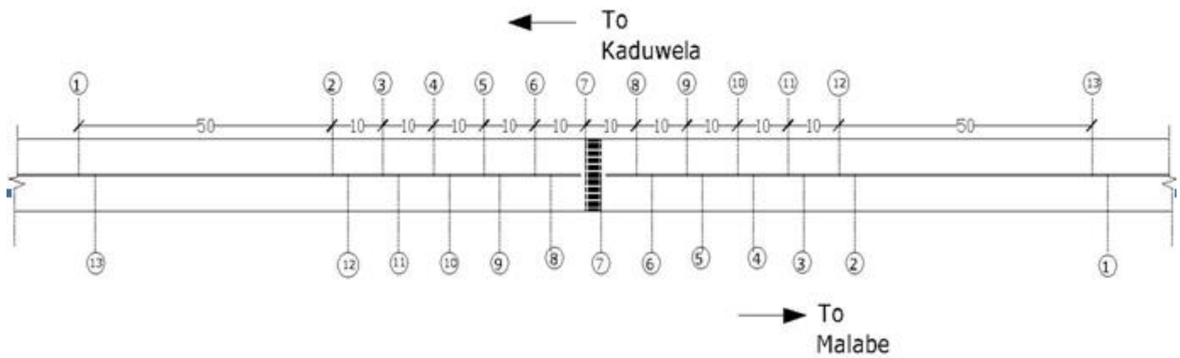


Figure 4 – Speed measurement locations

Step 5: Determination of additional vehicle operating cost (VOC) and additional travel time for a speed change cycle

The additional vehicle operating cost for speed change cycles of each vehicle category were taken by using the VOC tables obtained from NZ Transport Agency's Economic Evaluation. Within the selected time slots additional VOC for each vehicle class were computed for both directions. Hence total additional VOC values per day (due to speed change cycle) for all classes were computed.

The additional travel time for a speed change cycle is the difference in travel time for traveling the distance of the speed cycle at the original cruise speed from reduced speed through the speed cycle. The road user values are used to produce travel time values for uncongested and congested traffic conditions. Hence with the help of speed change cycles, savings on VOC and travel time were computed on annual basis due to the construction of the overhead pedestrian crossing.

Step 6: Design of the overhead pedestrian crossing

Based on the pedestrian survey results the overhead pedestrian crossing structure was designed. The span of the structure was decided based on the designed carriageway width of the road for a projected traffic for 20 years from now. The width of the structure was determined according to the forecasted pedestrian volume after the same period of time for a Level of Service (LOS) of C (Highway Capacity Manual, 1985). Vertical clearance was decided based on RDA standards (RDA, 1998). Design of the structure was done as a combination of pre-stressed and reinforced concrete.

Step7: Cost estimation

As described in step 5 the total additional VOC per a typical day for all vehicle classes as they undergo a speed change cycle due to the existing pedestrian crossing was computed. At the same time, for the same speed change cycle, additional travel time per day for all vehicle classes was determined (NZ Transport Agency). The total cost for additional travel time for all vehicles classes was calculated by considering the annual income of different road users. The additional cost on the system (due to total cost for additional travel time, total cost for fuel and oil wastage, total cost for tyre wastage, total cost for maintenance and repairs, and total cost for depreciation per day) can be computed on annual basis. Then by predicting for future time periods by taking in to account the traffic growth rate in Colombo district the final total cost was computed.The construction cost of the overhead pedestrian crossing was computed separately.

Step 8: Economic evaluation

By comparing the various methods available for economic evaluation, Internal Rate of Return (IRR) method was selected to conduct the economic evaluation of this study. The IRR is the discount rate which makes the discounted future benefits equal to the initial outlay. In other words, it is the discount rate which makes the stream of cash flow to zero. IRR was picked to carryout the analysis after considering all the merits and demerits of the other available economic evaluation methods.

RESULTS AND DISCUSSION

Total cost of the project and cost saving from the new structure are as follows:

Total construction cost of project (as per year 2012)	=	Rs.124, 000,000
Cost saving from additional VOC (per day)	=	Rs. 59,260
Cost saving from additional travel time (per day)	=	Rs. 38,165
Cost saving per year 1 (Rs. 59,260 + Rs. 38,165) x 365	=	Rs. 35,560,125 → (Rs. 35,560,000)

Expected IRR of this project is 13.4% and it should be compared with the minimum rate of return applicable to make an investment decision. The proposed overhead pedestrian crossing will cost 124 million rupees in 2012 and it is expected to save 35.56 million rupees per year over the next 5years. Hence it can be seen that the construction cost could be recovered in less than 5 years

CONCLUSIONS AND RECOMMENDATIONS

It was shown that the best possible way to ensure reduced VOC and safe travel along this road stretch for commuters was by constructing a new overhead pedestrian crossing. The proposed width of 2 meters of the overhead crossing structure will serve the forecasted pedestrian volume at a reasonable LOS, even twenty years from now. At present capacity of Malabe - Kaduwela road is not adequate, and improvement is needed to overcome the anticipated future traffic congestion along this road section by improving up to 4 lanes. With suggested improvements initially the LOS of the road will improve considerably, but in twenty years time it will reach the present level of service of the road if present traffic growth rates persist. As the IRR of this investment exceeds its cost of capital (10% - 12%), the project can be undertaken. This project is considered to be profitable and execution of the project is justified.

REFERENCES

The NZ Transport Agency's Economic evaluation manual, volume-1, www.nzta.govt.nz.

Highway Capacity Manual (1985), *Special Report 209*, Transportation Research Board, National Research Council, Washington, D. C.

Road Development Authority of Sri Lanka (1998), Geometric Design Standards of Roads.