MULTI-CRITERIA DECISION MAKING FOR BUS TERMINAL ANALYSIS USING ANALYTIC HIERARCHY PROCESS (AHP)

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Introduction

Kandy is one of the highly urbanized cities in Sri Lanka. Inadequate road capacity, poorly maintained road network, high traffic growth rate, congested streets due to on-street parking, and inadequate off-street parking allocations have made a serious traffic issue to Kandy city (Senevirathne and Silva, 1999). Good-Shed bus terminal stands as the main bus hub for the central province. However, traffic is congested in-and-around Good-Shed bus terminal due to various reasons. Bus parking bays that are allocated at present were designed according to the past dimensions of busses. Recently many of the small dimensions were replaced by larger busses. Thus, the existing aisle widths are not suitable for present dimensions of busses. Further, some busses start with a reverse movement from the Good-Shed bus terminal. So other busses have to wait until those busses reverse and leave from the terminal. Besides, pedestrian pathways are occupied by the vendors. Due to that, pedestrians come to the road which causes heavy traffic congestion and make it highly uncomfortable for drivers. The few busses start with "U" turn movement; the resultant traffic shock waves due to the conflicts disturb the total flow pattern in-and-around the bus terminal. Moreover, the Good-Shed bus terminal area cannot be used effectively, due to unnecessary idling busses. Thus, this research has the objectives of analyzing the existing traffic flow pattern in-and-around Kandy Good-Shed bus terminal, develop alternative proposals to minimize the identified conflicts, and finally to prioritize the proposals with respect to certain criteria using a multi-criteria decision making system.

Methodology

Data collection was performed to identify the existing traffic condition in-and-around the bus terminal. Next, a set of criteria which constrain the use of alternatives were identified. The aim of the research was to use a multi-criteria decision making technique to prioritize the developed alternatives based on criteria. In that context, Analytic Hierarchy Process (AHP) invented by Saaty, 1980 was selected and the steps to perform the AHP operation can be described as follows;

Step 1: Establishment of a structural hierarchy

Step 2: Establishment of comparative judgments

Step 3: Evaluate the measurement of consistency

Step 4: Synthesis of priorities

Data Collection

Surveillance video was done to observe the traffic flow pattern and identify the traffic conflicts (i.e., diverging, merging, and oblique conflicts) in the Good-Shed bus terminal area. Video stations were selected such that the two videos overlap each other making the vehicle tracing easier. Further, registration number plate and classified volume count surveys were done to access the average vehicle speed and vehicle composition in peak hours. Besides, ground dimensions, parking bay sizes, and aisle widths at the Good-Shed bus terminal were measured.

Alternative proposals

Three feasible alternatives to eliminate the identified traffic conflicts were developed giving concern to a certain set of criteria; commencing delay, cost, and environmental feasibility. Details of both developed alternatives and criteria can be found in Table 1.

AHP decision making system

The hierarchic decision structure developed for the problem is shown in Figure 1.

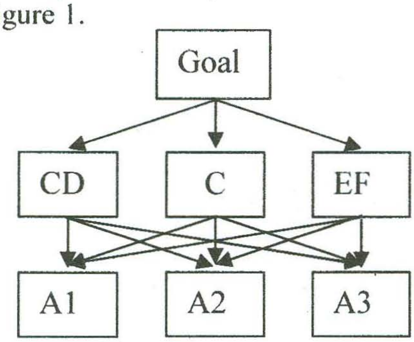

Figure 1 AHP decision structure

In order to give ratings to the alternatives, pair-wise comparison of alternatives should be done under each and every criterion. On the other hand to select the criterion that has much effect on the final goal is selected by doing a pair-wise comparison between criteria with respect to the final goal. Thus, the questionnaire prepared to collect data from experts in transportation field included two types of questions.

Type 1: Alternative comparison questions with respect to criteria

Type 2: Criteria comparison questions with respect to the final goal

Tables 2,3,4 show the comparison matrices for alternatives with respect to certain criterion and Table 5 shows the criteria comparison with respect to the final goal. Then prioritizing was done and most preferred alternative was selected (Table 6).

Conclusion

According to the criteria (i.e.., commencing delay, cost, and environment feasibility), "conflict minimization" is the best alternative among the three alternatives. It is obvious that the conflict minimization can be achieved by removing 'U' turn in Kurunegala bus halt and marking a guided route inside the Good-Shed.

References

Saaty T.L. (1980). The Analytical Hierarchy Process, McGraw-Hill, New York.

Senavirathne A. and Silva N. D. (1999). Transportation and Traffic, World heritage city of Kandy Sri Lanka, Conservation and Development plan, Central Cultural Fund, Pp. 251-253.

Table 1 Alternatives and criteria in the decision structure

Cluster	Elements	Description
Criteria	Commencing Delay (CD)	Effectiveness of an alternative in reducing the commencing delay
	Cost (C)	A measure of the financial cost associated with the alternatives (Capital Cost + Maintenance Cost)
	Environment Feasibility (EF)	The Environment Feasibility of implementing an alternative (e.g. - reducing environment pollution, noise control, etc.)
Alternative	Policy Changes(A1)	Introduce combined Private-Public bus time tables, Driver behavior changes, Time table changes, etc.
	Structural Changes(A2)	Removal of the gas filling station located in the middle of the bus terminal; introduce two slow moving tracks and two fast moving tracks near Good-Shed bus terminal.
	Conflict minimization (A3)	Propose best route to park and start the journey in side the study area, Remove and re-establishment of Kurunegala bus stand in different location to remove "U" turn movement.

Table 2. Relative priorities of alternatives with respect to commencing delay

CD	A1	A2	A3	weights
A1	1	1	1/3	**0.1924**
A2	1	1	1/4	**0.1749**
A3	3	4	1	**0.6327**

$\lambda_{max} = 3.0092$ CI=0.005 CR=0.008

Table 3. Relative priorities of alternatives with respect to cost

C	A1	A2	A3	weights
A1	1	3	1	**0.4160**
A2	1/3	1	1/4	**0.1263**
A3	1	4	1	**0.4577**

$\lambda_{max} = 3.0092$ CI=0.005 CR=0.008

Table 4. Relative priorities of alternatives with respect to environment feasibility

EF	A1	A2	A3	weights
A1	1	1/2	1/2	**0.1976**
A2	2	1	1/2	**0.3119**
A3	2	2	1	**0.4905**

$\lambda_{max} = 3.0092$ CI=0.005 CR=0.008

Table 5. Relative priorities of criteria with respect to goal

G	CD	C	EF	weights
CD	1	2	1	**0.4111**
C	1/2	1	1	**0.2611**
EF	1	1	1	**0.3278**

$\lambda_{max} = 3.0537$ CI=0.027 CR=0.046

Table 6. Relative priorities of criteria and alternatives

	CD (0.4111)	C (0.2611)	EF (0.3278)	Weight (Rank)
A1	0.1924	0.4160	0.1976	**0.2515 (2)**
A2	0.1724	0.1263	0.3119	**0.2071 (3)**
A3	0.6327	0.4577	0.4905	**0.5404 (1)**