The Preliminary Study of Traffic Impact Analysis for Developing Countries in Southeast Asia

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Abstract. Traffic Impact Analysis (TIAs) is an effective way to identify traffic generated by new developments in transportation systems so that it can reduce the impact of heavy traffic on the construction of new land. The traffic impact analysis model that has been developed in developed countries is very helpful in dealing with the problem of transportation disruption caused by development. Analysis of the impact of traffic in the development of new land uses is very influential in making a policy to overcome traffic congestion in developing countries such as Indonesia, Malaysia, The Philippines, and Thailand. There were two categories of nations with substantial differences in motorization rates: Sri Lanka, India, Nepal, Philippines, Pakistan, Indonesia, and Thailand have faster motorization rates than the rest of the world. The priority in analyzing the impact of traffic on the development of new land uses is used as a guide for the government in overcoming traffic congestion caused by development.The traffic impact analysis (TIAs) is designed to address traffic congestion and to improve the level of service (LOS) in new land-use developments. The problem faced by developing countries in overcoming traffic congestion at this time is that they do not have standard guidelines such as land-use models and planning implications in traffic impact analysis. Currently, a country like Indonesia does not have standard guidelines that can be applied in traffic impact analysis. So, it is necessary to provide a better traffic impact analysis that can be applied to reduce traffic congestion which is very bad for the surrounding network transportation, and to improve road services caused by the use of new land.

Keywords: Traffic impact analysis · Traffic congestion

1 Introduction

In Traffic Impact Analysis (TIAs) is critical to understanding how a proposed development will impact the surrounding transport network. TIA aims to assess the impact of new land-use developments on all aspects of the transport network. Therefore, by offering transport and land use planning, practitioners' knowledge of technological advances

H. Badioze Zaman et al. (Eds.): IVIC 2021, LNCS 13051, pp. 342–349, 2021.
https://doi.org/10.1007/978-3-030-90235-3_30

will make important development decisions that are more effective, low cost, and time-efficient. Transportation, social and environmental aspects will be considered during development planning.

The main factor which influences the traffic impact analysis is the development of new land which causes traffic congestion in every developing country. Therefore, it is necessary to develop standard guidelines in traffic impact analysis. There are some fundamentals differences in the countries' policymaking. The differences are presented in the policy-making of transportation conditions, land use, culture, and the surrounding environment. Standard guidelines have to be developed to determine the level of service (LOS) of new land development. To determine the level of service, supporting data is needed from traffic congestion, generation and attraction, traffic demand volume, traffic capacity, land, road length and width, and population density.

Traffic impact analysis (TIA) proposes a new method to enable regional accessibility of the proposed land use development project, this method is able to measure the impact of small-scale projects on the transportation system. In TIA development, special events would also be considered by the researchers. For example, The Federal Highway Administration (FHWA), proposes a special event TIA approach, and the approaches are designed similar to the TIA requirements for a planned development (Wang et al. 2019). Although there are many different TIA guidelines in most countries, the flexible limits for TIA transport impact analysis are not well reached through guidelines, or even in practice (Cooley et al. 2016).

In this case, the level of service (LOS) is one of the most frequently used congestion measurements, which is specifically intended to measure traffic congestion and assess the operational efficiency of the existing road network (Jolovic et al. 2021).

2 Related Work

The prerequisite to evaluate the TIA induced by traffic congestions is based on the evaluation indicators on two objects: land use and planning implication. Generally, the level of service (LOS) has been used to measure the operating conditions of transportation system elements for a long time and has been adopted by the Highway Capacity Manual. In line with the Highway Capacity Manual, the LOS ratings of transportation system elements range from A (best) to F (worst, or failure). Considering the data availability and comparability, we utilize the v/c ratio (v is hourly traffic demand volume and c is the capacity) to determine the LOS of roadway section and anticipating traffic congestions (Wang et al. 2019). Recent guides to TIA practice promote multimodal LOS analysis and the adjustment of trip generation rates based on local data. (Combs et al. 2020).

2.1 The Relationship Between Traffic Density and Congestion

There are three types of the density of traffic conditions: light, medium, and heavy which have a relationship with the level of perceived congestion density for the three traffic conditions showing the same tendency (Khoo and Asitha 2016). Figure 1 shows the relationship of the perceived traffic congestion level with density for three types of traffic conditions (i.e. light, medium, and heavy).

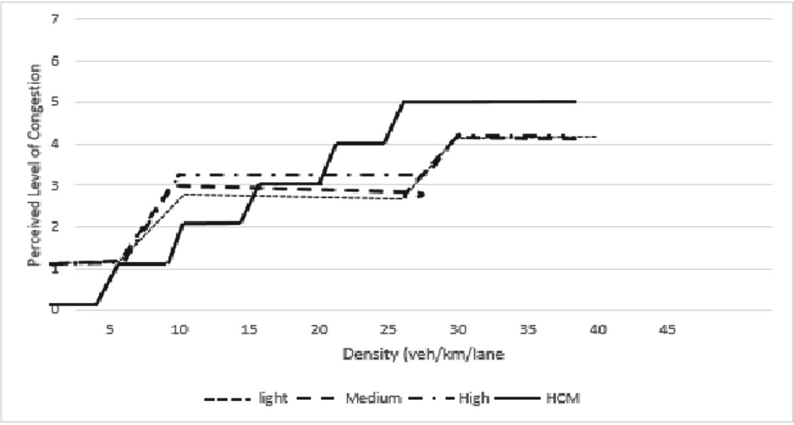

Fig. 1. Perceived congestion level vs density

In general, drivers feel a high level of congestion when travel speed is low, besides that drivers are more sensitive to travel speed during heavy traffic conditions (Senbil et al. 2007; Khoo and Asitha 2016). Figure 2 shows the relationship of perceived congestion level with speed.

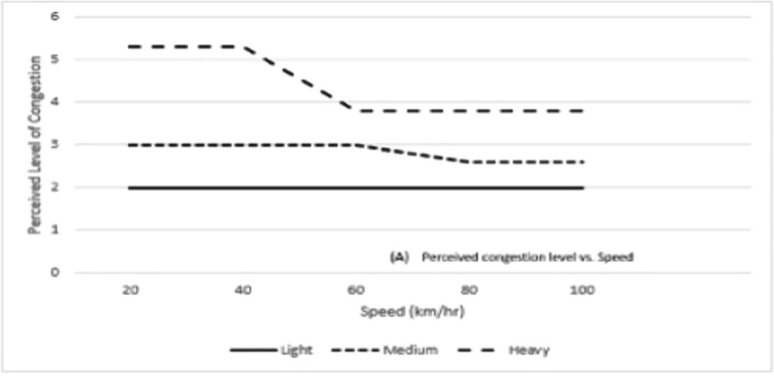

Fig. 2. Perceived congestion level vs speed

Drivers are more sensitive to changes in density compared to traffic flow and speed when evaluating traffic congestion levels. The reason is that when the density increases, the drivers' freedom to maneuver (e.g. change lanes) becomes limited and driving becomes less comfortable (Khoo and Asitha 2016). Figure 3 shows the relationship of perceived congestion level with traffic flow for three traffic conditions (i.e., light, medium, and heavy).

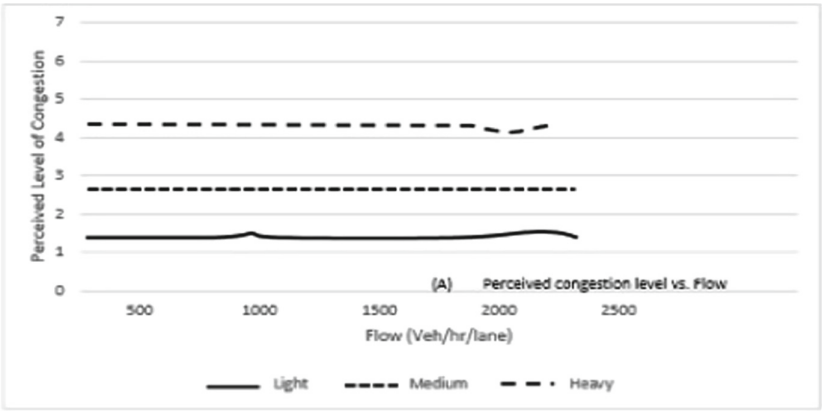

Fig. 3. Perceived congestion level vs flow

2.2 Guidance Framework for Traffic Impact Analysis (TIA)

Methodological frameworks and workflows in analyzing the impact of construction traffic during special events are designed according to traditional TIA but differ due to different goals and concerns. The analysis process must be closely combined with the data and the planned special event management (Wang et al. 2019). In general, data collection, traffic request requests, and evaluation are the main steps of TIA project construction during special events. However, the process does not last the same as a traditional TIA. The detailed steps are shown in Fig. 4.

3 Improper Traffic Impact Analysis

This is the initial stage where the overall research planning is carried out by identifying problems, determining research scope, conducting a literature review, and finding how to overcome traffic congestion using traffic impact analysis (TIA) development on new land and guidelines results. Theories and concepts in the research field will be explored and analysed. The analysis will be applied in developing countries in Southeast Asia.

This research collects and analyses the primary and secondary data. The source of primary data is speed data, traffic inventory data, estimated future traffic values, traffic forecasts, and respondent selection. Secondary data is used to be integrated into the analysis data process. Secondary data is the data that was obtained from the ministry of transportation officials, the ministry of public works office, and the central statistics agency.

Based on the framework of the analysis, the data process consists of various formats and types that will be carried out in the performance of evaluating the network of the road before or after construction. The results of the analysis can be used as guidelines for developing countries. This is used by the government as consideration for decision-making. Implementation of traffic impact analysis (TIA) is an analysis of road network performance in evaluating traffic congestion. Selecting the problems obtained from the evaluation includes recommendations and implementation that are the responsibility of

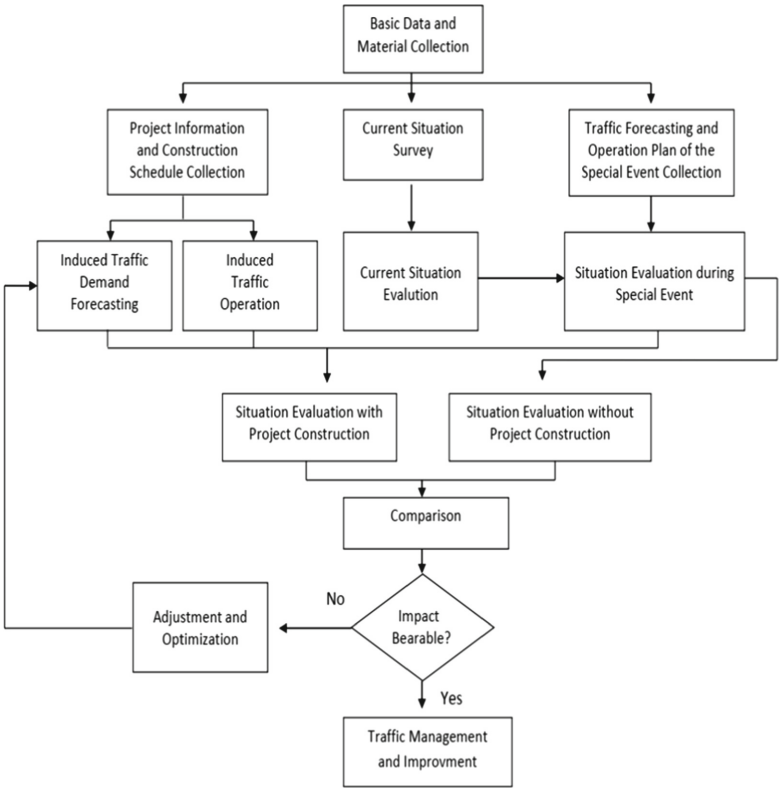

Fig. 4. Traffic impact analysis process of project construction during planned special events.

the government, monitoring, and evaluating plans to be implemented as well as providing appropriate guidelines in traffic impact analysis (TIA) in developing countries in overcoming congestion. Figure 5 shows the flow of traffic impact analysis (TIA) in studying the factors that caused of improper TIA in Southeast Asia developing countries.

3.1 Service Level Evaluation Criteria (LOS)

A prerequisite for evaluating the impact of extra traffic caused by project construction during a special event is the definition of evaluation indicators on two objects: road sections and intersections. As is known, the level of service (LOS) has long been used to measure the operating conditions of transportation system elements and has been adopted by the Highway Capacity Manual (Wang et al. 2019). We provide evaluation criteria for LOS of road sections and intersections for project construction caused by traffic impacts during special events in Table 1.

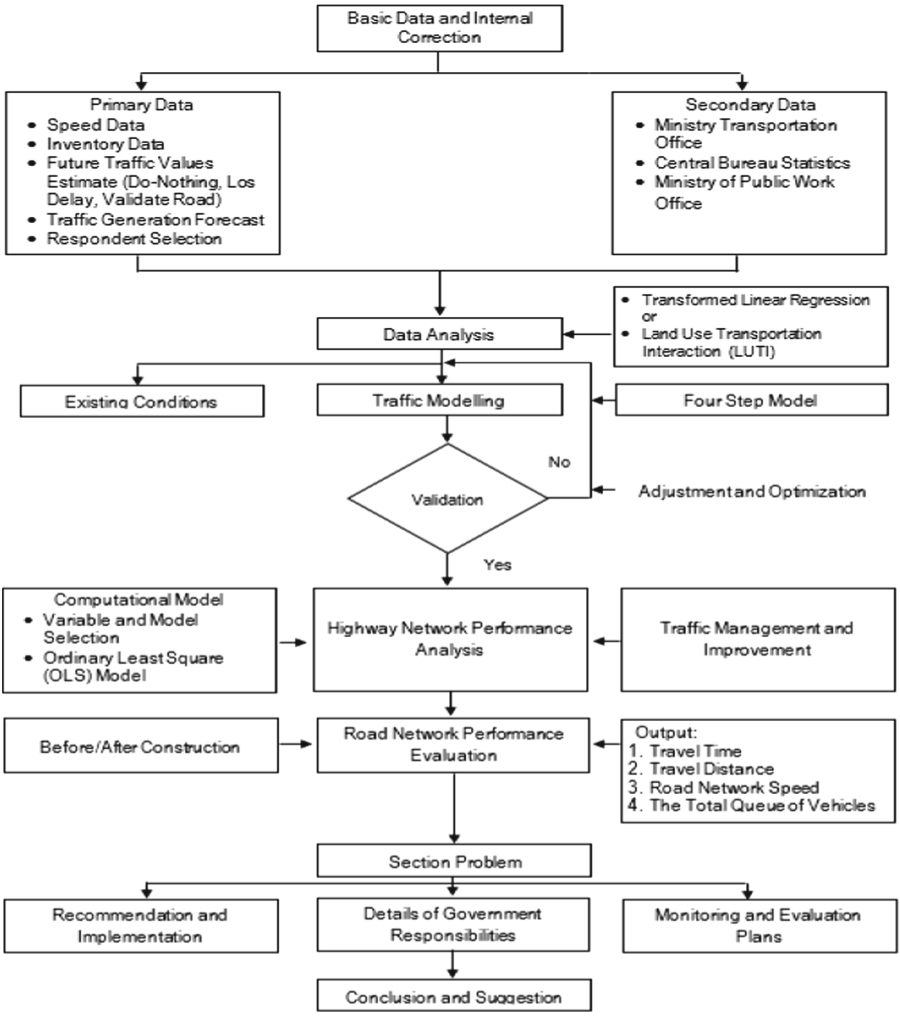

Fig. 5. Flow of analysis traffic impact analysis (TIA)

Evaluation criteria for construction project-induced traffic impacts during special events are suggested to determine impacts (see Table 2). The impact is significant if the LOS before (such as B) has an LOS after accounting for a construction project that is equal to or lower than the appropriate level (C or lower), and vice versa is not significant.

Table 1. Evaluation criterion for level of service.

Roadway section						
LOS	**A**	**B**	**C**	**D**	**E**	**F**
v/c ratio	v/c ≤ 0.27	0.27 < v/c ≤ 0.57	0.57 < v/c ≤ 0.70	0.70 < v/c ≤ 0.85	0.85 < v/c ≤ 1.00	v/c > 1.00
Intersection						
LOS	**A**	**B**	**C**	**D**	**E**	**F**
Average Vehicular delay (d, s)	d ≤ 10	10 < d ≤ 20	20 < d ≤ 35	35 < d ≤ 55	55 < d ≤ 80	d > 80
Note; LOS = level of service; v = hourly traffic demand volume; c = capacty						

Table 2. Critical impact evaluation criteria for traffic due to project construction during special events.

LOS without project construction	A	B	C	D	E	F
LOS with project construction	B	C	D	E	F	F
Note; LOS = level of service						

4 Discussion

This study is to provide accurate standard guidelines in the form of land use models and planning implications in traffic impact analysis (TIA). With the proposed guidelines in the form of existing models in the traffic impact analysis, it is hoped that they will be able to plan the transportation of a new city that can reduce traffic congestion. and predict future traffic both before and after development related to land use. The standard guidelines will be used as a determinant of government policy to make decisions in recommending development proposals on new land.

A traffic impact analysis (TIA) will have a good impact on areas that are still developing. It can also be used as a guide for developing countries in managing transportation to overcome traffic congestion. Traffic impact analysis is used as material for the government (policymakers) in making decisions on the development of new land that causes congestion.

The researchers further used traffic impact analysis in evaluating the development of land-use models and their implications for developing areas, and rearranging areas that previously had problems in traffic jams when development was carried out. The decrease in the level of road service (LOS) caused by the construction of new land causes traffic congestion. The standard guideline is expected to overcome and reduce traffic congestion.

5 Conclusion

Developed countries have well-managed transportation so that traffic congestion is not a major factor in development because those countries have already had a standard

guideline for traffic impact analysis (TIA) which is used as a policy determination in making decisions for new areas. Standard guidelines for traffic impact analysis (TIA) in developed countries cannot be used and implemented in developing countries in general. This is due to differences in transportation, population, land area, high levels of traffic congestion, vehicle growth, and the surrounding environment.

This study aims to provide standard guidelines with a new model for optimizing traffic impact analysis (TIA) in the development of new land developments and assisting the government in making policies to address traffic congestion problems that arise as a result of development in developing countries.

Acknowledgement. The authors would like to express gratitude to the National University of Malaysia (UKM) for providing the opportunity and funding under the Student Research Project Code TAP-K020558.

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