Highway Interchange Simulation

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ABSTRAK

Penyelidikan ini mewakili kajian kes untuk mengaplikasikan simulasi lebuh raya simpang bertingkat terhadap laluan kenderaan dengan menggunakan pemeriksaan model, tafsiran dan meningkatkan praktis trafik di Malaysia. Langkah pertama adalah dengan membina rajah proses implimentasi untuk simulasi model trafik dan menentukan urutan berdasarkan kuantiti kenderaan. Kedua, perkiraan masa untuk proses implimentasi proses dan pengawasan, kawalan aliran trafik yang mana mewakili tiga lebuh raya simpang bertingkat. Akhir sekali, lebuh raya simpang bertingkat, iaitu (dari Skudai ke Johor Bahru) perlu menghabiskan kitaran waktu trafik. Tambahan lagi, parameter penting untuk membina proses simulasi adalah kuantiti kenderaan, bilangan laluan dan faktor masa. Oleh itu, data kajian kes diperolehi dalam dua peringkat: (i) semasa waktu pagi dan (ii) semasa waktu petang. Demikian, data dikumpul melalui pemerhatian. Kepentingan aliran trafik dalam negara membangun dijelaskan sebagai analisis asas masa, di mana pelengkap kitaran masa projek lebuh raya di kira berasingan dengan menggunakan perisian *Witness* (2001). Keputusan yang diperolehi adalah bergantung kepada kuantiti kenderaan untuk setiap lebuh raya simpang dan jangka masa mengaplikasikan simulasi.

ABSTRACT

This paper presents a real case study endeavor to apply highway interchange simulation distribution of vehicle movement by using modeling to review, assess, and improve the current traffic practices in Malaysia. First, building the implementation process diagram for a traffic modeling simulation and determine the flow sequence with vehicles quantity. Secondly, Time measurement for implementation processes and monitor, control the traffic flow which presented in three interchanges. Finally, the interchanges are presented from (Skudai to Johor Bahru) that needed to finish the overall traffic cycle time. Furthermore, the important parameters to build the simulation processes are vehicles quantity, lanes number and time factor. Therefore, the case study data were obtained in two stages: (i) during the morning period and (ii) during the evening period. Consequently, the data were collected with observation. The importance of traffic work flow in a developing country was clarified as time-based analysis, in which the completion cycle time of the highway project in the overall duration to vehicles were calculated separately by using Witness (2001) software. As a result the output is depended on the quantity of vehicles for each interchanges and time period by applying the simulation.

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CHAPTER 1

PROJECT OVERVIEW

1.1 Introduction

Recent and continuing growth in Malaysia has resulted in increased demand for travel on urban freeways across the country. Many freeways are operating under congested conditions throughout much of the day.

Congestion has not only grown over the past two decades, it has become more volatile as well. Congestion levels are never the same from day-to-day on the similar highway because the varieties of traffic-influencing events that influence congestion. Because travel conditions are so untrustworthy on congested highways, travelers must plan for these problems by leaving early just to avoid being late. This means additional time out of driver's day that must be devoted to travel – even if it means getting somewhere early, that's still time we could be using for other productivity. Commuters could be late for work or after work schedule, business travelers could be late for meetings, and truckers could incur extra commitment by not delivering their product on time. And all because of unreliable travel conditions.

Assessment of the available data on congestion and highway usage over the past decade leads to the conclusion that congestion is getting worse. Highway usage has grown at two percent per year and is expected to continue doing so. On highways that are already congested, any additional traffic leads to a disproportionately higher

Traffic congestion on highways is becoming an ever more critical problem in countries all over the world. One approach to undertake congestion could be the construction of new roads to enlarge the capacity of the traffic infrastructure. This approach is very costly and it is often not possible due to environmental or societal constraints. In addition, it can only be executed on the longer term. So there is a need for another, short-term solution. This short-term solution existing controlling traffic in such a way only that congesting is solved, reduced, or at least delayed. Currently the traffic situation without monitoring it is by using video.

Highway interchanges serve two primary functions. as the sole entry and exit points connecting freeways to nearby communities, and they provide access to freeway users' services – fuel, food and lodging. Tracks of land near freeway interchanges are accessible to a wide region and have become highly desirable locations for diverting traffic congestion. The convergent land development demands of the multiple functions of serving highway users, shoppers, and employees have produced traffic volumes that have often grown faster than the forecasts upon which the design of interchanges has been based, resulting in congestion and safety problems. Interchange congestion and safety problems are often exacerbated by the proximity of freeway ramps to driveways and access roads, resulting in conflicting turning movements that have to be managed by signals and access management within restricted rights-of-way. Responding to freeway interchange congestion requires a variety of improvements, such as signalization, widening of cross roads, and new turn lanes at freeway ramps. The ability to expand interchange capacity is often financially constrained by intensely developed abutting property.

Whatever the option pursued to mitigate interchange area congestion, an overarching need is to take a longer-term view of planning interchange capacity and managing interchange areas, including integrated management of access and land

development. Even in circumstances where land development and traffic trends can be predicted with relative confidence, resource constraints can preclude building to meet long-range needs. Consequently, the issue is to allow for flexibility to facilitate expansion and, at the same time, to better manage traffic growth to mitigate the need for expansion. Balancing these issues over time is the essence of interchange planning and management.

Simulation is today effective tool used for reproducing and analysing a broad variety of complex problems, difficult to study by other means that might be too expensive or real dangerous. This powerful tool is now of current use. The democratisation of new data processing techniques and the coming of inexpensive powerful computers have supported this move. Thus, it is in a favourable context that the interest for traffic simulation increased. Whether they are transport institutes, training centers, universities or car manufacturers, many research centers are active today in the field.

1.2 Problem Statement

In the last few years, Malaysia has experienced a dramatic increase of the number of the vehicles, as well as state of Johor, which leads to the problem of the congested interchanges of the highway.

The time spent by the vehicles in the interchanges between Skudai and Johor Bahru will be increased as a direct result of the increasing of the numbers of the vehicles. The total time spent by the vehicles in the interchange can be calculated if any of the lanes of the interchange breakdown, by using the simulation. Congestion results in a higher traffic density (and lower speeds) during a longer time and thus the total time spent will increase with an increasing level of congestion.

1.3 Objectives

The objectives of this master project are:

- Find the traffic flow capacity for the interchange using real measurement.
- Simulate the junction with or without the traffic light.
- Find the maximum time for the traffic light to avoid the congestion using the simulation breakdown.

1.4 Scope of Study

The scope of this study is focused to selecting and forming the systematic logistic workflow process in overall traffic projects. The purpose of this study is to determine whether the ways in which logistics management can provide value for traffic process better, faster, and cheaper. The study will also seek criterion for a good logistics vision statement is that it should provide the road map for how these two goals are to be achieved especially in reducing the overall transportation period as the follow:

- Taking the three junctions to get the variation and simulation using witness 2001.
- To explain the deference between the simulation models and the traditional methodologies.
- To visualize the traffic simulation models that include a real-time animation of traffic flow results with alternative traffic scenarios.
- Ability to model the traffic workflow and observe the effect of changes on one lane of the highway to the performance of the process.
- Ability to model the effects of quantity vehicles on the performance of the highway. This includes simple queuing situations, such as short turn lanes, as well as more complex situations, such as ramp meters and the queuing of vehicles from a signalized intersection into an adjacent intersection.

- Making references to relevant books, journals and other sources, as well as conducting literature study on logistics of transportation management and its applications are performed in the first stage of the research. The second stage involve a modeling and simulation using the (Witness, 2001) technology. The implementation like this technology allows the users to monitor and reduction on time and cost for traffic management project. The third stage of the study in the analysis of the results. The final stage ends with the writing of findings and conclusions, Figure1.1

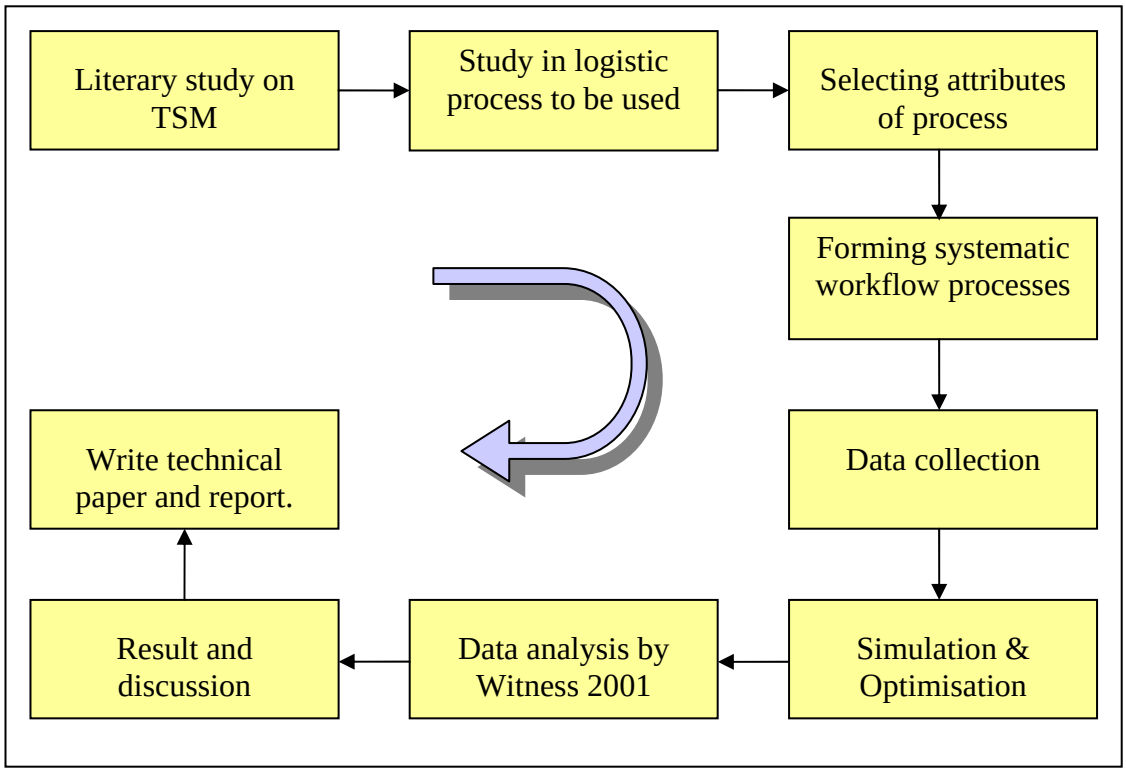

Figure 1.1: Research flow

1.5 Significant of the Study

There are some recommendations to be taken under consideration, especially for traffic management studies by using simulation, and they are:

- In future research, PCE (passenger car equivalent) should be taken under consideration as a parameter in the simulation models.

- Gap (the distance between two following cars) also should be taken in consideration in building the models.
- The journey time on the highway between Skudai Johor to Johor Bahru can be reduced.
- The wasted time during this journey can be avoided by solving the congested problem in the interchanges on all the way between Skudai Johor to Johor Bahru.
- Proposed simulation model in this study can be applied in the planning of transportation projects especially the logistic process of organization work flow and the execution at the transportation projects.
- Propose alternative models for organization and to monitor and control the process.
- Optimum work flow process in achieving a good overall journey time can be calculated from the proposed model.
- In the traffic modeling field such as in simulation modeling, platoon dispersion detail would provide increased accuracy in traffic arrival distribution.

REFRENCES

1. R. J. Salter and N . B . Hounsell Third Edition (1996) “Highway Traffic Analysis and Design”.
2. C.S. Papacostas and P.D. Prevedouros SI Conversion by Othman Che Puan SI Edition (2005)“*Transportation Engineering and Planning*”.
3. T. Bellemans, B. De Schutter, and B. De Moor, “*Models for Traffic Control*,” Journal A, vol. 43, no. 3–4, pp. 13–22, 2002.
4. Todd Litman and Victoria Transport Policy Institute (2006) “*Smart Transportation Investments Reevaluating the Role of Highway Expansion for Improving Urban Transportation*”.
5. Hiroshi Inose and Takasahi Hamada (1975) University of Tokyo Press. Translation edited by Edward C. posner “Road Traffic Control”.
6. Dr. Charles Harrell, Dr Biman K. Project Leader, Dr. Royce O. Bowden, Jr.(2004) second edition “*Simulation Using Pro-model*”.
7. Panos D. Prevedouros PhD jams Watson and Jerry PhD “*Tests of Simulation Models FREQ, KRONOS, Integration and VISSIM in Replication Congested Freeway Flow*”.
8. JamesG.Strathman, ThomasJ.Kimpel, Paul Leistner, KennethJ.Dueker,“Effects of Comprehensive Plan Amendments on Interchange Traffic in Oregon”.
9. Donald R.Drew (1968) “Traffic Flow Theory and Control”.
10. Viera K. Proulx " Traffic Simulation: A Case Study for Teaching Object Oriented Design".
11. Slobodan Guberinic , Gordana Senborn , Bratislave Lazic 2008 "optimal traffic control".
12. Alexis Champion, René Mandiau, Christophe Kolski "Traffic generation with the SCANeR II.
13. Fang Clara Fang and Lily Elefteriadou 2006 "Development of an Optimization Methodology for Adaptive Traffic Signal Control at Diamond Interchanges".
14. Qiang Meng; Hooi Ling Khoo2; and Ruey Long Cheu 2008 "Microscopic Traffic Simulation Model-Based Optimization Approach for the Contraflow Lane Configuration Problem".