ROAD SAFETY ANALYSIS ON COMMUTING ROUTE: IPOH TO UTP

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CERTIFICATION OF APPROVAL

Road Safety Analysis on Commuting Route: Ipoh to UTP

by

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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ABSTRACT

There are several routes of Ipoh-UTP trip for UTP staffs commuting to work. This research considers two major groups of staffs which are the academician, administration and support staffs. However, they tend to choose the routes that suit their personal concern very well. Alternatives of the routes and elements such as distance, travelling time, fuel consumption, ease of driving and facilities located along the road are the factors affect the decision making. During decision making process, a set of alternatives representing the possible choices is evaluated. The objectives to be achieved drive the screening of possible alternatives and determine their overall evaluation. The criteria are the yardstick for the objectives and specify the degree to which each alternative matches the objectives. By using Multiple Criteria Decision Making Method (MCDM) specifically under Multi Criteria Analysis (MCA), the attributes performance and preference of decision makers are combined to establish the overall merits of each option and highlight the best solution. The most popular routes identified were through the Ipoh-Jalan Lahat-UTP, Ipoh-Falim-UTP, Ipoh-Simpang Pulai-UTP and Ipoh-Bandar Botani-UTP. The road safety element of the most preferred route will be investigated by analyzing the accident trend along the route. The outcome of the project would be a rank of routes from the most preferred to least preferred one for UTP staff commuting to work and accident mitigation actions proposal to the local authority to improve the safety of the most preferred route.

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CHAPTER 1
INTRODUCTION

1.1 Project Background

Road Safety Analysis is a process to identify traffic movements and the road users which will be the target of corrective treatments. Knowledge and experience in traffic engineering, traffic management and road safety will be combined to derive a suitable development of countermeasures at accident prone area.

Every day, people make decisions. Most decisions come naturally. Some decisions are a little harder, because they have a lot of alternatives with different criteria and have more important consequences. Selecting the best route for commuting to work is an example of a decision making process which is worth some attention because its affect the daily life of a person in terms of time consumed, fuel consumption, road safety and ease of driving.

There are several routes for return trip from Ipoh to UTP for UTP staffs commuting to work. They tend to choose the routes that best suit their personal interest. Alternatives of the routes and criteria such as travelling distance, fuel consumption, facilities, safety and ease of driving are among the factors affect the decision making. Hence a proper way to evaluate these criteria within the alternatives is needed. The method chosen to help the author select the best alternative is by using the Multiple Criteria Decision Making Method (MCDM). The objective of the research reported are to find the best way to rank the alternatives according to their performance and doing road safety analysis on the most preferred route.

1.2 Problem Statement

The numbers of accidents of State route are increasing every year. These are the roads used by people to commute to work on daily basis. They are exposed to road hazards such as accidents due to poor road conditions, driver's bad attitude and others. Road Safety Analysis can help reduce accidents by identifying accident prone areas and proposing effective counter-measures.

1.3 Objectives

- To determine accident prone locations on commuting route from Ipoh to UTP
- To identify the preferred route for UTP staff
- To perform Road Safety Analysis on the most preferred route
- To recommend counter-measures

1.4 Project Scopes

The scope of this project is to gather all information along the road alternatives. The travelling time is obtained by using the common practice in traffic studies. All the road furniture along the alternative had been identify and analyzed in road safety aspect using the Road Safety Audit guidelines. Several trips along the alternative at the peak hour had been made to get the data related to fuel consumptions of the vehicle and ease of driving. All the information obtained had been analyzed by using MCA to evaluate the alternatives.

CHAPTER 2
LITERATURE REVIEW

2.1 Transportation

Transportation is an essential element in the economic development of a society. Without good transportation, a nation or region cannot achieve the maximum use of its natural resources or the maximum productivity of its people. The history of transportation illustrates that the way people move is affected by technology, cost and demand. (*Traffic & Highway Engineering*, 2002, p.13). In order to evaluate the best route from Ipoh to UTP, the author will consider elements such as the types of vehicle, travelling cost, distance, safety, time lagging and other factors relevant in term of transportation specifically to move people from one point to another point.

2.2 Rational Model of decision-making process

The fundamental concept of various models of individual and organizational decision-making behavior is ***rationality.*** The conceptual origins of the term rationality can be traced back to the philosophy of Rationalism which asserts the superiority of intellect over empirical experience (Encyclopedia Britannica 1974). Simon (1957) argued for replacing the concept of rationality, built into the classical model of decision-making, with the principle of ***bounded rationality.*** According to this principle, individuals and organizations follow a satisfying decision-making behavior, based on search activity, tomeet certain aspiration levels rather than the optimizing behavior aimed at finding the best decision alternative. In his more contemporary work Simon (1978, 1979) presented the concept of ***procedural rationality*** which means the effectiveness of decision support procedures in search of the relevant decision alternatives. The procedurally rational model of decision-making process distinguishes the following four steps that are generally appropriate for a structured approach to decision situations (McKenna 1980):

1. ***Problem definition:*** a discrepancy between the present state and the desired state is recognized as a need. That need is formulated as a problem calling for decision.
2. ***Search for alternatives and selection criteria:*** the feasible alternatives (potential problem solutions) and criteria for evaluating the alternatives are established.
3. ***Evaluation of alternatives:*** the impacts of each alternative on every evaluation criterion are assessed.
4. ***Selection of alternatives:*** alternatives are ordered from the most desirable to the least desirable and either the top alternative is selected or the group of more desirable alternatives is retained for further evaluation.

In this project, step 2 had been done by using Google Map from the internet application while step 3 and 4 had been done by using the Multiple Criteria Decision Making (MCDM) method specifically the Multiple Criteria Analysis in Definite software. The combination these two methods with proper analysis and relevant data, the outcome of this project surely convince the people to change their daily route to the most efficient route in terms of all aspect.

2.3 Road Safety Analysis

Road Safety is a global problem although the numbers of fatality rates are decreasing in our country nowadays. According to JKJR Statistic for 10 years from 1998 until 2007 it shows that the Malaysian government target to achieve 4 road accidents death per 10,000 vehicles by 2010 is already achieved by the year 2006. But then the total number of accident causing death has consistently been above 6000 since 2003. Due to this alarming figures, the government has launched the Road Safety Plan 2006-2010 in March 2006 with the objectives to reduce fatality rates from 4 to 2 fatalities per 10,000 registered vehicles, 10 fatalities per 100,000 population and 10 fatalities per billion vehicles kilometer travelled (VKT) by year 2010 (Ministry of Transport, 2006). Table below shown the details;

Table 1 : Road Accident Data for 10 years

TAHUN	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Jumlah Kemalangan Injuri	55,693	53,063	50,200	50,506	47,823	50,864	47,080	39,716	29,258	27,645
Kemalangan Ringan	37,885	36,886	34,375	35,973	35,236	37,415	33,413	25,928	15,596	13,979
Kemalangan Parah	12,068	10,383	9,790	8,684	6,696	7,163	7,444	7,600	7,375	7,384
Jumlah Kematian	5,740	5,794	6,035	5,849	5,891	6,286	6,223	6,188	6,287	6,282
Indeks Kematian (10,000 kend. Berdaftar)	6.28	5.83	5.69	5.17	4.9	4.9	4.52	4.18	3.98	3.7
Indeks Kemalangan (10,000 Kend. Berdaftar)	230.9	224.7	236.3	234.6	232.7	233	237.4	220.6	216.1	216.1
Bil. Kenderaan Terkumpul	9,141,357	9,929,951	10,598,804	11,302,545	12,018,291	12,819,248	13,764,837	14,816,407	15,790,732	16,812,440
Bil. Pemandu Terkumpul	7,191,419	7,585,363	7,956,414	8,327,261	8,640,235	9,049,311	9,500,27	9,928,238	10,351,332	11,836,136

Of all modes of transport, transport by road is the most dangerous and most costly in terms of human lives. Although extensive efforts had been made in many countries in reducing both risk and the absolute number of accidents, the present number of accidents is still far too high in most countries. Improved road safety is achievable if suitable safety targets in respect to time frame, as well as ambitiousness are adopted. According to Elvik, R. in his journal entitle "Accident Analysis and Prevention", he pointed that the best performance in road safety was achieved by countries with highly ambitious quantified targets.

Towards vision 2020, our country may be adopted a road safety program to aim to achieve zero deaths and serious injuries on the road. The European Union countries with the best road safety records, such as Sweden, the United Kingdom and the Netherlands, were the first to set quantified targets to reduce the number of victims to derive maximum benefit from potential improvements in road safety from increased knowledge, accumulated experience and technical progress. It is broadly accepted that targeted road safety programs are more beneficial in terms of effectiveness of action, the rational use of public resources and reductions in the number of people killed and injured than non-targeted programs.

In order to achieve such ambitious target, the analysis of accident problems activity should be boost up to a new level of practice. The road accidents rate can be reduce through the implementation of Hazardous Road Locations Program. Diagram below shown the phase involve in the program.

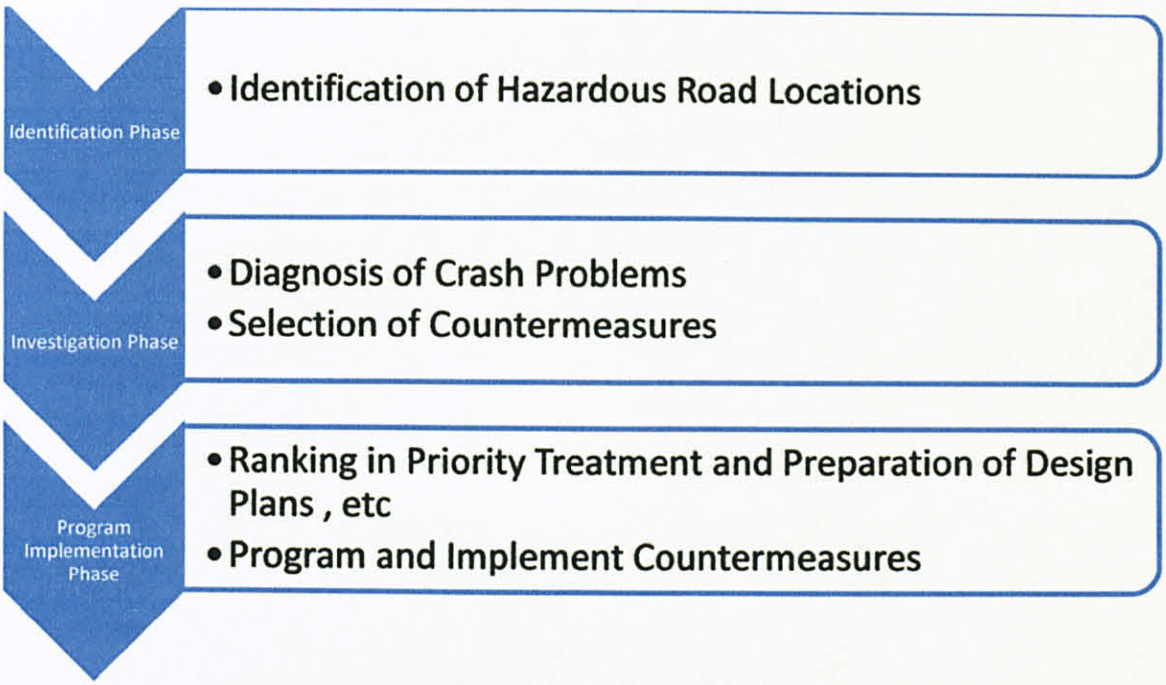


Figure 1 : Hazardous Road Locations Program

As for this project, the author uses the Multiple Criteria Decision Making Method to evaluate the several alternatives from IPOH to UTP. The case study is focusing on the most preferred route being used by the UTP staff. The exact location of the hazardous location area had been determined by seeing the trend of the accident data along the route. After the 'Black Spot' or high accidents area is identified the author follows the Investigation Phase as mention above to arrive at the correct program and implementation of countermeasures.

The diagnosis of crash problems at black spot area can be divided into two phase. The first phase is the in-office analysis of accident data and secondly the on-site inspection and observations of traffic behavior.

The in-office analysis is often carried out prior to visiting the site, but it is always an advantage to be familiar with the site and the general traffic conditions prior to starting any analysis. Several information required for the analysis are details of the accidents at the site including the copies of Police accidents reports (POL27 Form), Plans of the existing road layout, Traffic volume and composition data.

The accident data should be readily available from the data bank, maintained by the government authority that had it. Using the micro-computer accident analysis program (MAAP), the accident investigator can produce various accidents tabulations and frequency distributions for the site in question. These are useful in identifying the extent of the accident problem at a site and establishing the relative seriousness of the situation compared to other sites in the region. They are also valuable in identifying patterns of accident occurrence related to factors such as time of the day or day in week or month of the year, or if several years of data is available, variations in accident numbers from year to year.

A site inspection is an essential activity in the investigation of an accident black spot. In practice it is often necessary to make more than one visit particularly if it is a complex site for which detailed plans of the road are not available. Sometimes it is desirable to make an initial site inspection early in the analysis period and then follow up with a more detailed site inspection when information from the outcome MAAP program are available.

In addition to the physical features at the site, the inspection must consider the actual traffic operation. In this respect, the 'in-office' analysis may indicate a pattern of accidents or accidents types at particular times of the day or days of the week. Where this is the case, it is desirable if not essential, to arrange the site inspection so that traffic operation during these periods can be observed.

2.4 Multiple Criteria Decision Making (MCDM)

MCDM consists of two categories which are multiple attribute decision-making (MADM) and multiple objective decision-making (MODM) (Cohon 1978, Hwang and Masud 1979, Hwang and Yoon 1981). MADM is concerned with choice from a moderate/small size set of discrete actions (feasible alternatives), while MODM deals with the problem of design (finding a Pareto-optimal solution) in a feasible solution space bounded by the set of constraints (Colson and De Bruyn 1989). MADM is often referred to as ***multiple criteria analysis*** (Teghern *et al*. 1989) or multi criteria evaluation (Nijkamp *et al*. 1990, Voogd 1983), whereas MODM is viewed as a natural extension of mathematical programming, where multiple objectives are considered simultaneously. Figure 1 below shows the several methods of MCDM.

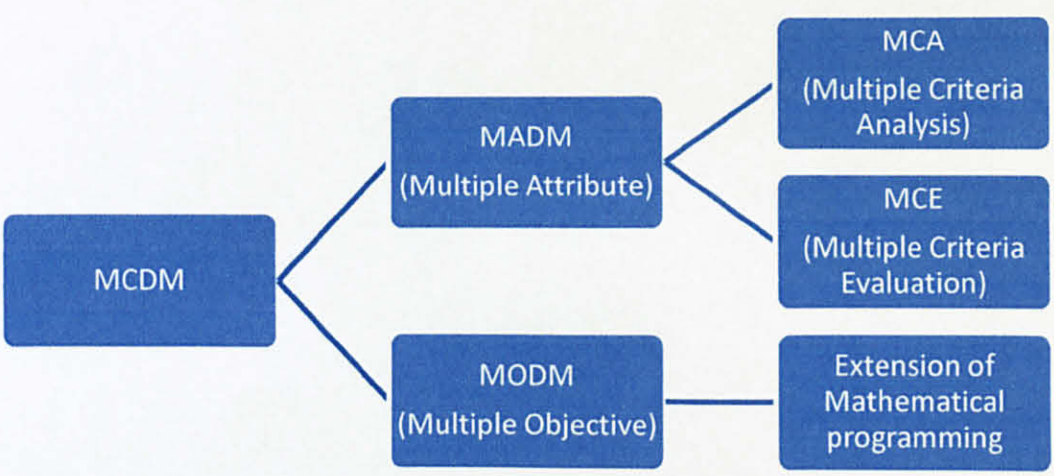


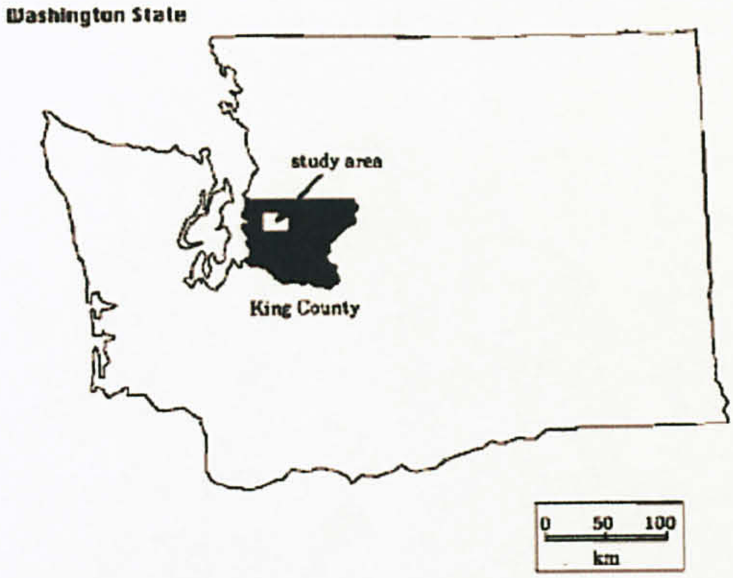
Figure 2 : Multiple Criteria Decision Making Methods

Hong and Vogel (1991) identified five different choice strategies used by decision-makers (DM) that can be matched with characteristic of different MCDM techniques. The choices include:

1. Screening of absolute rejects: elimination of clearly dominated alternatives as the first step before any further choice deliberation.
2. Satisfying principle: the DM will consider all the alternatives that satisfy conjunctively or disjunctively the minimum performance levels.
3. First-reject: the DM wants to use exclusively the conjunctive elimination rule to reject all the alternatives that do not attain minimum threshold values.
4. Stepwise elimination: the DM narrows down the choice, re-evaluating the set of remaining alternatives every time one of the alternatives is eliminated.
5. Generation of linear ordering: the DM wants to generate a ranking of alternatives from the most preferred to the least preferred one.

An example of implementation of these strategies is illustrated in this route selection problem described in Jankowski and Richard (1994). This example has some similarities in the author project in terms of evaluating several route alternatives with certain criteria and producing the rank of selection according to its performance.

The Seattle Water Department (SWD 1988) studied various alternatives for selecting a route for a new section of a primary water transmission line for the City of Seattle and its purveyors in King Country, Washington (See Figure 2).



Source from Seattle Water Department (SWD 1988)

Figure 3 : Study area for a water transmission line in King County, Washington

The proposed alternatives were all located within the environmentally sensitive Snoqualmie River Valley region, making this an appropriate example of the multi criteria decision problem. In the initial study, conducted by the Seattle Water Department, the alternatives were identified with a manual, suitability mapping approach. In the verification study conducted by Richard (1992) a GIS-based approach was used. The decision criteria included: total cost (TOTALCOST) estimated for each route alternative, the amount of public right-of-way (ROWACRES) falling within the alternative right-of-way, the reliability criteria including the normal daily traffic volume of roads (VEH-DAY) which fall with and parallel the alternatives' rights-of-way, erosion hazard areas (ERSACRES), landslide hazard areas (LNDACRES), seismic hazard areas (SEIACRES), and the environmental criteria including the area of wetlands (WETACRES) and the length of stream segments (STRMLEN) falling within the alternatives' rights-of-way. The additional criterion included in the analysis was the length of alternative (ALTLEN).

The conjunctive selection rule, representing the 'first reject' strategy, was applied to reduce the initial set of pipeline route alternatives. The choice rule included a combination of technical, land use, topographic, geological, and economic constraints that had to be satisfied by the alternatives. The six alternatives that passed the conjunctive selection rule are listed in table 1 together with the decision criteria and criterion scores.

The six pipeline route alternatives can be ordered from best to worst applying the choice strategy 'generation of linear orderings'. One variant of this strategy that uses criterion utility functions for expressing criterion score preferences and weights for representing preferences on criteria can be implemented by the Multi-Attribute Utility Tradeoff System technique-MATS.

Table 2 : Six conjunctively selected alternatives with the decision criteria and criterion scores

ALT.NAME	ROWACRES (acres)	ERSACRES [acres]	SEIACRES (acres)	LNDACRES (acres)	WETACRES [acres]	STRMLEN (m)	VEH.DAY (cars)	ALTLEN (km)	TOTALCOST [$ millions]
ALT1	70·27	6·24	15·7	4·91	5·71	502	8200	12·38	27·1
ALT2	53·25	10·05	12·76	4·03	5·07	206	8200	11·83	25·2
ALT3	15·28	13·76	15·00	5·22	1·09	1347	4900	25·57	23·6
ALT4	34·54	13·53	16·12	4·78	0·86	883	6300	9·88	24·4
ALT5	35·35	12·03	22·53	13·85	6·52	675	7240	37·05	24·7
ALT6	29·78	9·36	16·28	3·44	6·91	191	8200	8·1	15·6

MATS, implemented as a stand-alone, interactive computer program that runs on DOS-based microcomputers (Brown *et al.* 1986), requires the decision maker to enter first decision criteria and to define a numeric scale for every criterion by entering a maximum and minimum values. Next, with the help of program's interrogation/specification mode, the utility functions are derived by the user for every criterion. A criterion utility function describes how much utility is received from each value of the criterion score. The utility values are normalized and range in the interval (0, 1).

Following the specification of criterion score preferences through the criterion utility functions the user is asked to define the preferences regarding the decision criteria. The decision criteria preferences are derived through the series of trade-off questions in which the user is asked to evaluate the relative importance of one criterion versus the other criterion. The decision criteria preferences are then quantified into standardized weights that sum to 1.0. In the next step the user enters the names of decision alternatives and the criterion scores. MATS use the following aggregation function to calculate the final score for each decision alternative:

$$S_i = \sum_{j=1}^{J} Uf_j(c_{ji})w_j$$

where:

S_i = final score for alternative i.
c_{ji} = criterion score for criterion j and alternative i
Uf_j = utility function of criterion j
w_j = cardinal weight of criterion j.

In the water pipeline route selection problem the following criterion weights, consistent with preferences stated by a citizen advisory committee (Richard 1992), were used:

Table 3 : Criterion weights

Criterion	Weight
ROWACRES	0·130
ERSACRES	0·057
SEIACRES	0·057
LNDACRES	0·057
WETACRES	0·053
STRMLEN	0·027
VEH_DAY	0·053
ALTLEN	0·284
TOTALCOST	0·284

The ranking of six alternatives based on standardized final score values calculated by MATS are presented below:

Table 4 : Alternatives with final score values

Alternative	Final score
ALT6	0·821
ALT4	0·638
ALT2	0·572
ALT3	0·543
ALT1	0·478
ALT5	0·270

The sensitivity analysis of the solution, facilitated by MATS, revealed that the alternative route ALT6 was firm in the first position. It would take a significant improvement in the total cost of the second-ranked route (ALT4) or a simultaneous improvement in values of at least four other criteria, in order for ALT4 to tie ALT6. Another variant of the decision strategy 'generation of linear orderings' incorporates the DM'S priorities only in regard to decision criteria. This variant can be implemented using, among others, a MCDM Weighted Summation technique. In this example the Best Choice program (Nagel and Long 1989) was used to rank the alternatives ALT1 through ALT6. Best Choice requires the user to enter names of alternatives, decision criteria, the measurement units of criteria, and weights for each criterion. The criterion scores for each alternative are then entered into a decision matrix with alternatives represented by rows and criteria by columns. The program analyzes data by converting scores to percentages in order to deal with the multidimensionality of data, and a summary score is computed for each alternative. Negative (cost) criteria are handled simply by placing a negative sign in front of the criterion scores, or by taking the reciprocal of the criterion scores. The sensitivity analysis in Best Choice allows the user to see how much the criterion score or the criterion weight must change to alter the results of the analysis.

The ranking of six alternatives based on final score values calculated by Best Choice, using the same criterion weights as in MATS, is presented below:

Table 5 : Alternatives score rank

Alternative	Final Score (%)
ALT6	25·27
ALT4	18·03
ALT3	16·59
ALT2	15·26
ALT1	14·17
ALT5	10·90

The final ranking obtained from Best Choice is very similar to the ranking obtained from MATS. This can be explained by the same type of aggregation function used in both programs, and by the fact that utility functions derived in MATS were nearly linear. The final ranking might have been quite different if the utility functions were concave or convex.

There are also many others example of using Multiple Criteria Analysis in ranking alternatives. Paolo Ferrari (2001) in "A method for choosing among alternative transportation projects" and E.Abdi, A. Darvishsefat, Z.Mashayekhi, J. Sessions (2009) in "A GIS-MCE based model for forest road planning" produce a rank of alternatives for their outcome. Based on these research paper, it shows that using MCA in evaluating alternatives have been commonly used in the various field.

CHAPTER 3
METHODOLOGY

There are two important part of this project. The first one is finding the best alternative route from Ipoh to UTP and the second part is the road safety analysis along the route. In the first part, there are three main steps in finding the best alternatives from Ipoh to UTP which are formulation of discrete set of alternatives, the formulation of the set of criteria, and the evaluation of the impact of each alternative on every criterion. After that, road safety analysis begins with data collection, in office analysis, on-site inspection and lastly proposed countermeasures.

3.1 Identifying Alternatives

The road alternatives from Ipoh to UTP had been identified by:

- Map from the internet
- Survey form

Map from the internet

This is the easiest method to get the map with detail information. By using Google Maps, all the routes had been identified. The interface that provides information for getting directions from one place to another enhanced the process of finding the routes. Besides that, this image is captured from the satellite and the data from here is reliable.

Survey form

The survey form consisted of questions about the user route choice and justification of the selection, vehicle type and elements that affect their ease of driving. The survey had been conducted to all UTP staff that commuting to work from Ipoh to UTP.

3.2 Criteria formulation

The criteria that had been recognized important by the author are travelling time, fuel consumption, road safety and ease of driving. According to the survey being done, it shows that these criteria affect most of their decision on selecting the route to commute to work daily. By using the data from the survey form and several experiments, appropriate value had been assigned to each criterion for data analysis in MCDM.

3.3 Evaluation of the data

The data had been evaluated by using the appropriate MCDM method. Due to a lot of methods available in the decision making process, the researcher used the most suitable method. Basically, the general steps in MCDM are shown in Figure 4 below. The Seattle Water Department (SWD 1988) project on selecting the best route for a new section of a primary water transmission line for the City of Seattle and its purveyors in King Country, Washington is the most similar situation for this project.

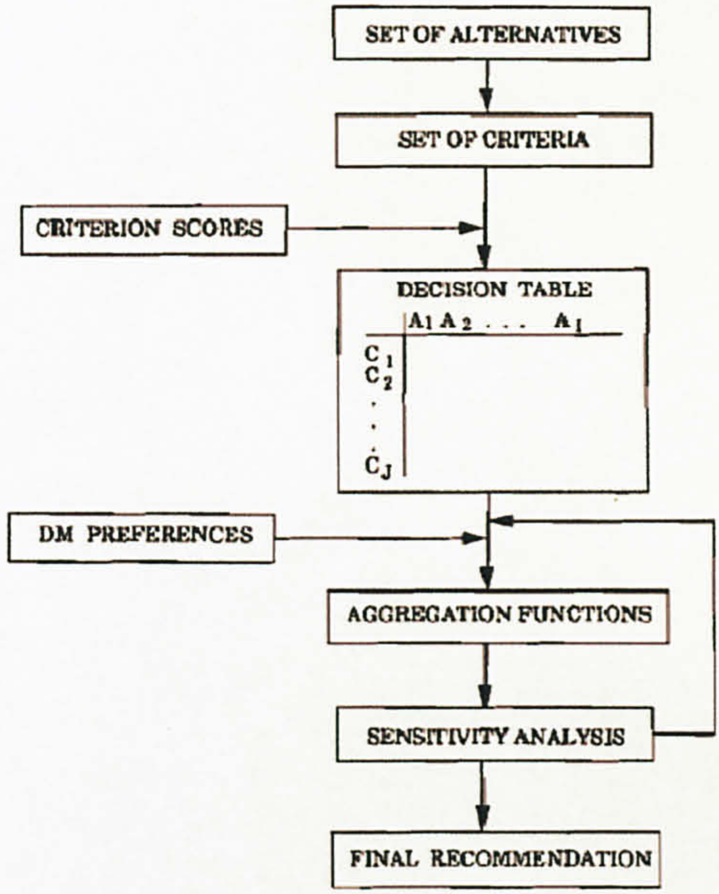


Figure 4 : A General Model of MCDM

3.4 Road Safety Analysis

The accident data had been taken from the Ipoh Police department. From the data given, the author had identified the most frequent area of accident and done some site investigation. Any accident mitigation action needed at the area being proposed based on one of transportation engineering guideline which is the Interim Guide on Identifying, Prioritizing and Treating Hazardous Locations on Roads in Malaysia. Below are several items that need to be check on site;

- Are accidents being caused by the physical condition of the road or adjacent property, and can the problem be eliminated or corrected?
- Is the 'blind' corner or restricted sight-line at a junction responsible? If improvement is impossible, can steps be taken to warn drivers.
- Are existing signs, signals and markings performing the job or which they were intended? Have conditions at the site changed since the devices were installed? Are replacement needed? Could the devices be causing accidents rather than preventing them?
- Is traffic properly channeled to minimize conflict?
- Would accidents be prevented by the prohibition of any single movement such as right turn at a minor road?
- Could some of the traffic be diverted to other (safer) streets where problems are unlikely to be transferred?
- Are night time accidents out of proportion to daytime accidents, thus needing special night time protection, eg. Reflectorised signs, street lighting or traffic signals?
- Are there any particular times of the day (or days of the week or year), or weather conditions when accidents are common?
- Do conditions indicate the need for additional levels of law enforcement?

CHAPTER 4
RESULT & DISCUSSION

4.1 Multiple Criteria Analysis

In the first part of this project, the author has collect all the data that is needed in order to do the multiple criteria analysis to evaluate the routes from IPOH to UTP. The table shown below is the result of the data collection;

Table 6 : Detail of four selected routes from IPOH to UTP

No	Routes / Criteria	Distance(km)	Time(min)	Fuel Consumption	Ease of driving	Facilities
1	IPOH-FALIM-UTP	31.7	30	57.06	a	2
2	IPOH-BANDAR BOTANI-CW-UTP	35.1	37	63.18	b	1
3	IPOH-SIMPANG PULAI-CW-UTP	37.3	39	67.14	c	6
4	IPOH-LAHAT-MENGELEMBU-UTP	28.8	25	51.84	d	7

To evaluate the ease of driving, the author actually does the MCA process within it to evaluate the ease of driving of each route. By using the detail shown in table 6 and 7 below, which are the information extracted from the survey form, the author produce the rank of route from the most convenient in term of ease of driving to the lowest score route.

Table 7 : Ease of driving element in each selected routes from IPOH to UTP

No	Routes / Criteria	Road Hump	Traffic Light	U.Intersection	Poor Road Condition	Petrol Station
a	IPOH-FALIM-UTP	1	10		1	2
b	IPOH-BANDAR BOTANI-CW-UTP	9	13			1
c	IPOH-SIMPANG PULAI-CW-UTP		15			6
d	IPOH-LAHAT-MENGELEMBU-UTP		19			7

Table 8 : Weightage of each element in ease of driving

	Weight
Traffic Light	0.555
Poor Road Condition	0.307
Road Hump	0.079
Unsignalized Intersection	0.059

Table 9 : Decision Making Preferences on the high ease of driving element

	Decision Making Preferences
Traffic Light	0.56
Poor Road Condition	0.31
Road Hump	0.08
Unsignalized Intersection	0.06

Table 10 : Weightage of each element in the routes evaluation

	Total	**Perspective : Distance**	**Perspective :Travelling TIme**	**Perspective : Fuel Consumption**	**Perspective : Facilities**	**Perspective : Ease of driving**
Distance	0.27	0.5	0.125	0.125	0.125	0.125
Travelling Time	0.25	0.125	0.5	0.125	0.125	0.125
Fuel Consumption	0.2	0.125	0.125	0.5	0.125	0.125
Facilities	0.06	0.125	0.125	0.125	0.5	0.125
Ease of driving	0.22	0.125	0.125	0.125	0.125	0.5

After all the weightage have been identified, the process of MCA produces the result shown below;

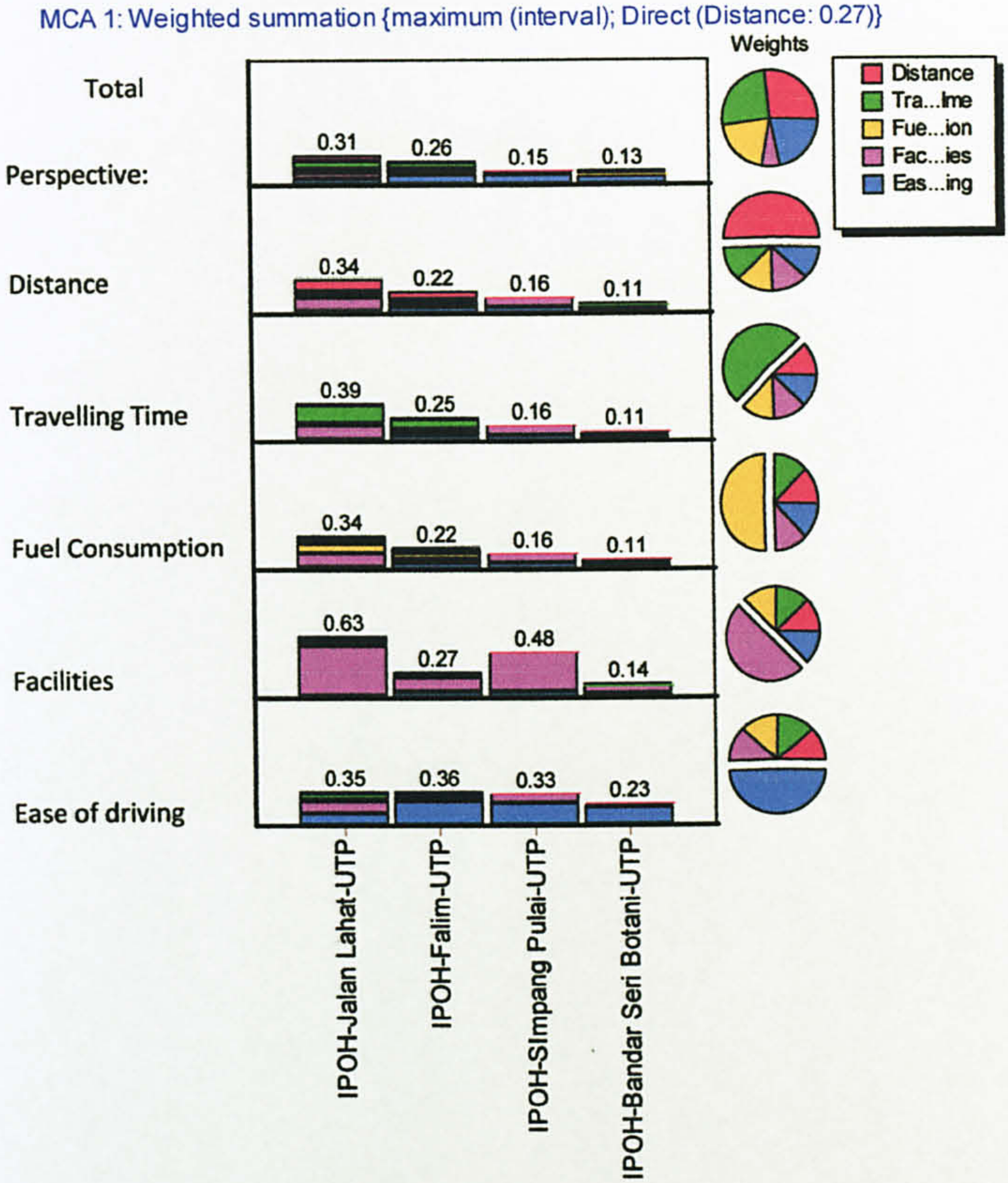


Figure 5 : Rank of alternative routes from IPOH to UTP

4.2 Road Safety Analysis

From the analysis it is found that the most preferred route from IPOH to UTP is the route with the highest total score of 0.31 which is Jalan Lahat (Refer Figure 5). Because this is the most preferred route, the author proceeds to do the road safety analysis along this route. This is being done to make sure the project have some significant value for the people that using the road. By the data collected from the police department, the author manages to find out the black spot along the route

Black spot are the accident prone area that will affect the road safety element in a route. There are two black spot that have been identified by the author by analyzing the accident data in location perspective. Table below show the detail of the analysis;

Table 11 : Accident Location Analysis

No.	Location along Jalan Lahat	Year	
		2008	2009
1	ACS	5	8
2	BUKIT MERAH	29	33
3	SEKOLAH MEMANDU	14	15
4	TNB	6	14
5	BULATAN KACANG	15	11
6	JALAN LAHAT	44	40
7	JALAN LAHAT-FALIM	46	34
8	T/L PASAR BORONG	9	3

From this table it is found that Bukit Merah area shows the highest accident increment compare to others area from 2008 to 2009 with four total of death accident. The junction nearby futsal sport planet and junction nearby Kg. Bukit Merah are the accident prone locations within Bukit Merah area. The exact places of these locations are shown by the coordinate value of the accident data (Refer Figure 6). The accidents occurred here increased within the range of 25 to 50 percent and therefore it is a need to do some mitigation action to counter the problem.

Table 12 : Black spot along Jalan Lahat

	Longitude	Latitude
Location 1	101 03.663	4 34.472
Location 2	101 02.546	4 32.877

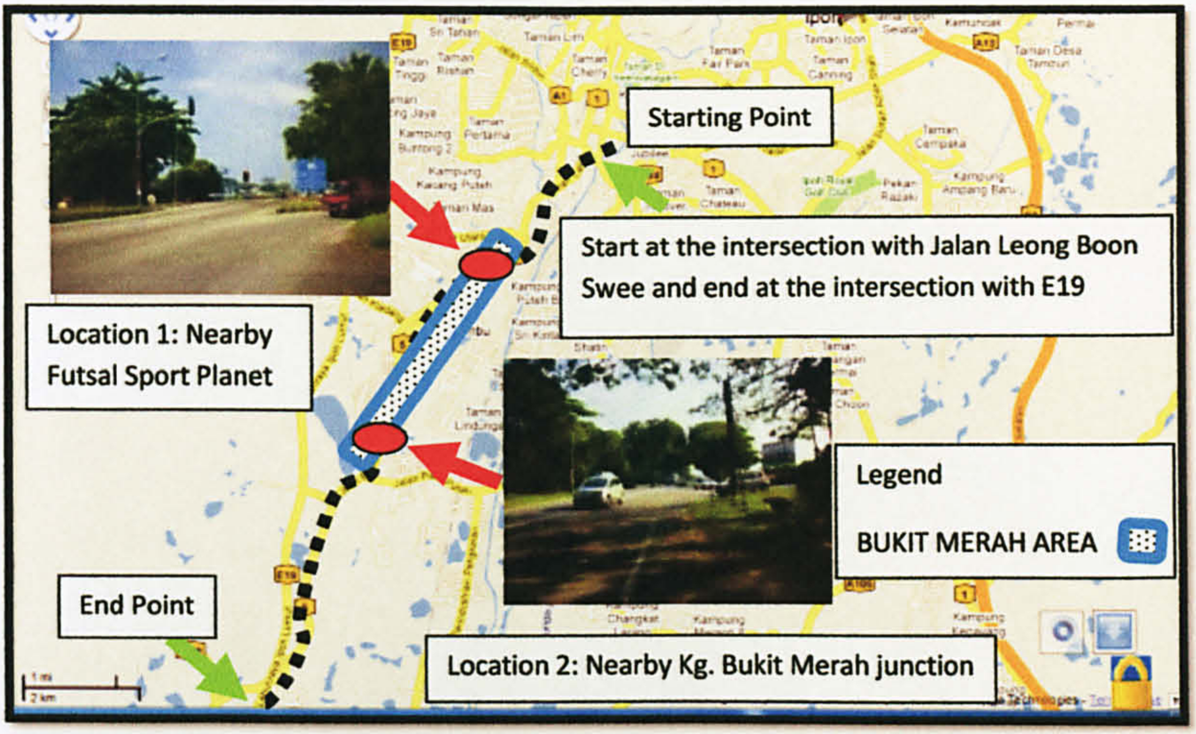


Figure 6 : Map of the Jalan Lahat stretch

The author proceeds to investigate more the black spot location by doing the detail investigation at the area. Below are some of the pictures taken during site inspection at both of the location to find out the issues related to the road geometry;

Table 13 : Road Geometry issues at the black spot area

Location 1	Location 2
 Crocodile cracks on the road	 The marginal strip are not properly maintaned

Below the list of item that need to be identify during site inspection taking from Interim Guide on Identifying, Prioritizing and Treating Hazardous Locations On Roads in Malaysia. By answering these questions, it helps the author doing the road safety analysis.

Table 14: Road Safety Checklist

Question	Answer
Are accidents being caused by the physical condition of the road or adjacent property, and can the problem be eliminated or corrected?	Yes. The problem can be eliminated by improving the road pavement and maintaining the current road furniture at the junction.  Location 1
Is the 'blind' corner or restricted sight-line at a junction responsible? If improvement is impossible, can steps be taken to warn drivers.	No.
Are existing signs, signals and markings performing the job or which they were intended? Have conditions at the site changed since the devices were installed? Are replacement needed? Could the devices be causing accidents rather than preventing them?	The current condition of the signals and marking need to be improved.

	 Location 1
Is traffic properly channeled to minimize conflict?	No. There is no provision for right turn to enter the Kg. Cina at Jalan Bukit Merah.  Location 2
Would accidents be prevented by the prohibition of any single movement such as right turn at a minor road?	No
Could some of the traffic be diverted to other (safer) streets where problems are unlikely to be transferred?	Some warning sign need to be installed along the road approaching the junction to avoid the vehicle entering it with high speed.

	 Location 1
Are night time accidents out of proportion to daytime accidents, thus needing special night time protection, eg. Reflectorised signs, street lighting or traffic signals?	Yes. There is no street lamp provided.  Location 2
Are there any particular times of the day (or days of the week or year), or weather conditions when accidents are common?	From the data analysis done in office it shows that most of the accidents occur in the evening and at night. More than half of the accident is between 2pm until 12am.
Do conditions indicate the need for additional levels of law enforcement?	No.

The same set of question is being used on location 1 and location 2. Each of the location has their own problem related to certain question. But in terms of no issue they have some similarities. It is found that there are no same problems indicated at both locations. For example both locations did not have any problem with 'blind' corner or restricted sight-line at a junction, the need to prohibition of any single movement to reduce accident and both conditions indicate that there is no need also for additional levels of law enforcement. Any suitable mitigation actions according to the answer above will be proposed to the local authority for the improvement of the road.

4.3 Proposed Mitigation Action

There are several actions should be taken by the local authority to rectify the problem at the black spot areas. Below are the lists of item that need to be done;

- Maintain the road geometry condition (road pavement)
- Maintain the road furniture condition (road marking & signage)
- Install street lamp along the area
- Provide enough provision for vehicle at the junction

With this few actions, the accident happens in that area are expected to be reduce in the future. The local authority should always maintain all roads which are under their supervisions and be more proactive to overcome road safety issues.

CHAPTER 5
ECONOMIC BENEFIT

Road Safety Analysis from IPOH to UTP is a case study project. The economic benefits of the research are to reduce any cost related to the accident. According to the accident costing report published by ADB-ASEAN Regional Road Safety Program, if all road accidents in Malaysia are taken into consideration, with the value or RM 1.2 million being adopted per road accident fatality the estimated total road accident cost for 2003 is RM 9.3 billion (2.4% of GDP). Table below show the cost of accidents in 2003;

Table 15: Cost of Accidents

Type	Frequency	Value (RM million)	Cost (RM million)
Fatal Injury	6,282	1.2000	7,538
Serious Injury	9,014	0.1200	1,082
Minor Injury	37,406	0.0120	449
Damage Only	254,504	0.0012	305
Total Road Accident Cost			**9,374**

Source: Malaysia data.

All the effort of the government in road safety aspect is aiming to reduce the number. Due to that, project such as Road Safety Analysis is worth to be implemented more frequently in the near future. The costs in doing the research are detailed out in the table below;

Table 16 : Cost of the project

No.	Item	Frequency	Cost (RM)
1	Road Study at all routes	2	100
2	Road Study at Jalan Lahat	2	60
3	Trips to IPOH Police Station	2	60
4	Trip to Kuala Lumpur	1	150
			TOTAL = 370

It shows that the cost of the research is about RM 370. The expense is mainly on the transportation aspect of the project. To be more specifically it is spend more on filling the fuel tank of the vehicle used. In order to study the possible routes and detail analysis along the most preferred route, several trips need to be made. Trips to IPOH police station is meant for road accident data collection and interview with the police officer about the project. Meanwhile trip to Kuala Lumpur is meant for discussion with several engineers in one of the engineering consulting firm to facilitate the project.

As for conclusion, with a small cost of budget, project such as road safety analysis will help a little bit to reduce the loss caused by the accidents happens in Malaysia. Due to that, the project is economically to be run in the future. Furthermore, it is important to continuously expense in education for the sake of next generation.

CHAPTER 6

CONCLUSION

There are several multiple decisions-making models for selecting the best alternative routes from Ipoh to UTP (round trip). From the research, the author have exposed to the practical way of doing research as well as build good rapport with others parties such as UTP staffs (lectures, technician & supporting staff), the government authorities, privates sectors and others. The outcome of this project shows that Jalan Lahat is the most preferred route from IPOH to UTP. In order to make sure this route is safe, the author proceed with the road safety analysis along the route. Several locations have been found to be the black spot areas which contribute to the accident along the route. By using the knowledge in transportation engineering, the author proposed some mitigation action to be taken by the local authority to improve the safety of the route.

http://www.waterforfood.org/gga/Lecture%20Material/SKSrivastav_GISOverview.pdf

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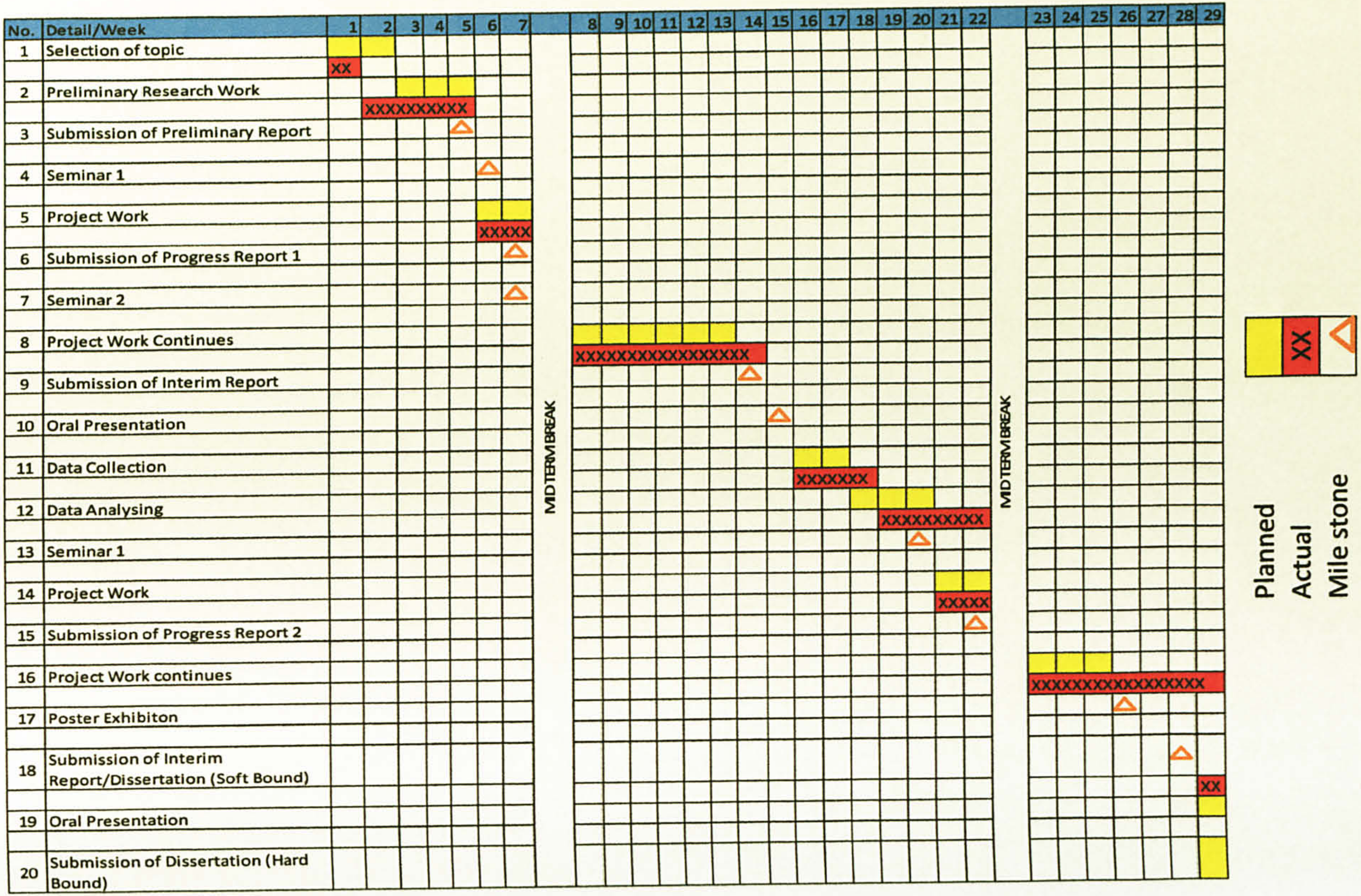
APPENDICES

Appendices A:

Final Year Project Gantt chart

GANTT CHART


No.
Detail/Week
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
1 Selection of topic
2 Preliminary Research Work
3 Submission of Preliminary Report
4 Seminar 1
5 Project Work
6 Submission of Progress Report 1
7 Seminar 2
8 Project Work Continues
9 Submission of Interim Report
10 Oral Presentation
11 Data Collection
12 Data Analysing
13 Seminar 1
14 Project Work
15 Submission of Progress Report 2
16 Project Work continues
17 Poster Exhibiton
18 Submission of Interim Report/Dissertation (Soft Bound)
19 Oral Presentation
20 Submission of Dissertation (Hard Bound)
MID TERM BREAK
MID TERM BREAK
XX
XXXXXXXXXX
XXXXX
XXXXXXXXXXXXXXXXX
XXXXXXX
XXXXXXXXXX
XXXXX
XXXXXXXXXXXXXXXXX
XX
Planned
Actual
Mile stone

Appendices B:

Survey Form

Questionnaire of Evaluation of the Best Alternative Route from Ipoh to UTP (roundtrip) using Multiple Criteria Analysis

INTRODUCTION

Dear respondents,

This research is for Final Year Project report. As a part of the research; I am distributing questionnaires to the person who are related to my target group. Your views and opinions are important for the research. Your response will help me with my evaluation of the best alternative route from Ipoh to UTP for UTP staffs commuting to work.

The questionnaire set consists of a variety of closed and open ended questions. Your participation is voluntarily. Your name will not be used in any reporting of the research and your privacy will be protected. Your answer will be reported and aggregated with other respondents.

If you have any enquiries regarding this survey procedure or wish to make suggestions, please contact the researcher.

Thank you.

Mohd Amin bin Harith
FYP I Student
HP: 013-5065928
Email: mohdamin87@gmail.com

THE PURPOSE of THIS QUESTIONNAIRE

1. To get the details about the target group
2. To identify the most selected routes from Ipoh to UTP (roundtrip)
3. To determine the priorities of criteria along the route from the respondents' view

Supervisor:
Miss Noor Amila bt. Wan Abdullah Zawawi
Lecturer
Civil Engineering Department
Universiti Teknologi PETRONAS

Mohd Amin bin Harith
FYP I Student
HP: 013-5065928
Email: mohdamin87@gmail.com

Please submit this survey form to your respective academic executive before 20th October 2009.

SURVEY FORM: Please tick your answer.

Section A: Background information.

1. Please state your gender.
   ☐ Male ☐ Female
2. How long have you been in service with UTP?
   ☐ Less than 5 years ☐ 5 to 10 years ☐ More than 10 years
3. Please identify your job group.
   ☐ Academic ☐ Administration & Support
4. Where do you currently reside? Please indicate your neighborhood area.
   ☐ Ipoh Neighborhood area: ______________
   ☐ Others Neighborhood area: ______________

If your answer others in Question 4, please proceed to Section C. Section B is optional.

Section B: Commuting To Work

5. What is your daily commuting mode to work?
   Private vehicle: ☐ Car ☐ Motorbike ☐ Others: __________
   Public transportation: ______________

If you chose Car in Question 5, please proceed to Question 6. Otherwise, you may skip to Question 7.

6. Please identify the engine type for your car?
   ☐ 1.0cc car ☐ 1.3cc car ☐ 1.6cc car ☐ 2.0cc car ☐ Others:_________
7. Please identify the most common route that you take to come to UTP.
   - Ipoh-Falim-UTP
   - Ipoh-Lahat-Menglembu-UTP
   - Ipoh-Jalan Pasir Putih-UTP
   - Ipoh-Simpang Pulai-Clear Water-UTP
   - Ipoh-Bandar Botani-Clear Water-UTP
   - Ipoh-Kellie's Castle-UTP
   - Others :______________________

Mohd Amin bin Harith
FYP I Student
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Email: mohdamin87@gmail.com

8. How long do you take to reach UTP (approximately)?

☐ 20minutes ☐ 30minutes ☐ 40minutes ☐ 50minutes ☐ More than 50minutes

9. What time do you normally leave home for work?

☐ Before 7.00 am ☐ Between 7.00 to 7.30 am ☐ After 7.30 am

10. Which route do you take to go back home?

- UTP-Falim-Ipoh
- UTP-Mengelembu-Lahat-Ipoh
- UTP-Jalan Pasir Putih-Ipoh
- UTP-Clear Water-Simpang Pulai-Ipoh
- UTP-Clear Water-Bandar Botani-Ipoh
- UTP-Kellie's Caste-Ipoh
- Others :______________________

11. How long do you take to reach your house (approximately)?

☐ 20minutes ☐ 30minutes ☐ 40minutes ☐ 50minutes ☐ More than 50minutes

12. What time do you normally leave the office for home?

☐ Before 5.30 pm ☐ Between 5.30 to 6.30 pm ☐ After 6.30 pm

13. What is the main reason for choosing the route?

____

____

14. Have you experienced any accident along the road?

☐ Yes ☐ No

15. If yes, what was the cause of the accident?

____

____

16. What is your estimated fuel cost per week?

☐ <RM 50 ☐ <RM 70 ☐ <RM 100 ☐ More than RM 100

17. What are the factor(s) that affect your ease of driving?

☐ Traffic lights ☐ Poor road conditions ☐ Intersections

Others________________________

18. Do you usually stop at petrol stations along your way?

☐ Yes ☐ No

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Section C: Criteria Preferences in Route Selection

19. Please circle your preferences on the importance of the criteria below based on Seven-point Scale (adapted from Osgood, Suci and Tannenbaum, 1957).

Criteria	**Scale: 1-most important to 7-least important**						
Distance	1	2	3	4	5	6	7
Traveling time	1	2	3	4	5	6	7
Road Safety	1	2	3	4	5	6	7
Fuel Consumption	1	2	3	4	5	6	7
Ease of driving (Traffic light & Road Hump)	1	2	3	4	5	6	7
Facilities (Location of Petrol Station)	1	2	3	4	5	6	7

- Thank You for Your Kind Cooperation -

FINAL YEAR PROJECT I (VAB 4022)

Appendices C:

Multiple Criteria Analysis Report

This report was created by DEFINITE for Windows version 2.5.4.4.
Session: FYP 1 -second try [C:\Program Files\Definite\FYP 1 -second try.BSF]
Date: 12/10/2009 Time: 12:10:20 AM

Problem definition

Session:

C:\Program Files\Definite\FYP 1 -second try.BSF
FYP 1 -second try

Alternatives:

IPOH-Falim-UTP
IPOH-Jalan Lahat-UTP
IPOH-Bandar Seri Botani-UTP
IPOH-SImpang Pulai-UTP

Effects:

Distance
Type of scale: Ratio scale
Type of effect: Costs
Unit: KM
Travelling TIme
Type of scale: Ratio scale
Type of effect: Costs
Unit: Minutes
Fuel Consumption
Type of scale: Ratio scale
Type of effect: Costs
Unit: RM
Facilities
Type of scale: Ratio scale
Type of effect: Benefits
Unit: Units
Ease of driving
Traffic Light
Type of scale: Ratio scale
Type of effect: Costs
Unit: No.
Unsignalized Intersection
Type of scale: Ratio scale
Type of effect: Costs

Unit: No.

Road Hump

Type of scale: Ratio scale

Type of effect: Costs

Unit: No.

Poor Road Condition

Type of scale: Ratio scale

Type of effect: Costs

Unit: No.

Effects table:

	C/B	Unit	IPOH-Falim-UTP	IPOH-Jalan Lahat-UTP	IPOH-Bandar Seri Botani-UTP	IPOH-SImpang Pulai-UTP
Distance	C	KM	31.7	28.8	35.1	37.3
Travelling TIme	C	Minutes	30	25	37	39
Fuel Consumption	C	RM	57.06	51.84	63.18	67.14
Facilities	B	Units	2	7	1	6
Ease of driving						
Traffic Light	C	No.	10	19	12	13
Unsignalized Intersection	C	No.	0	0	0	0
Road Hump	C	No.	2	2	10	0
Poor Road Condition	C	No.	0	0	0	0

Graphs

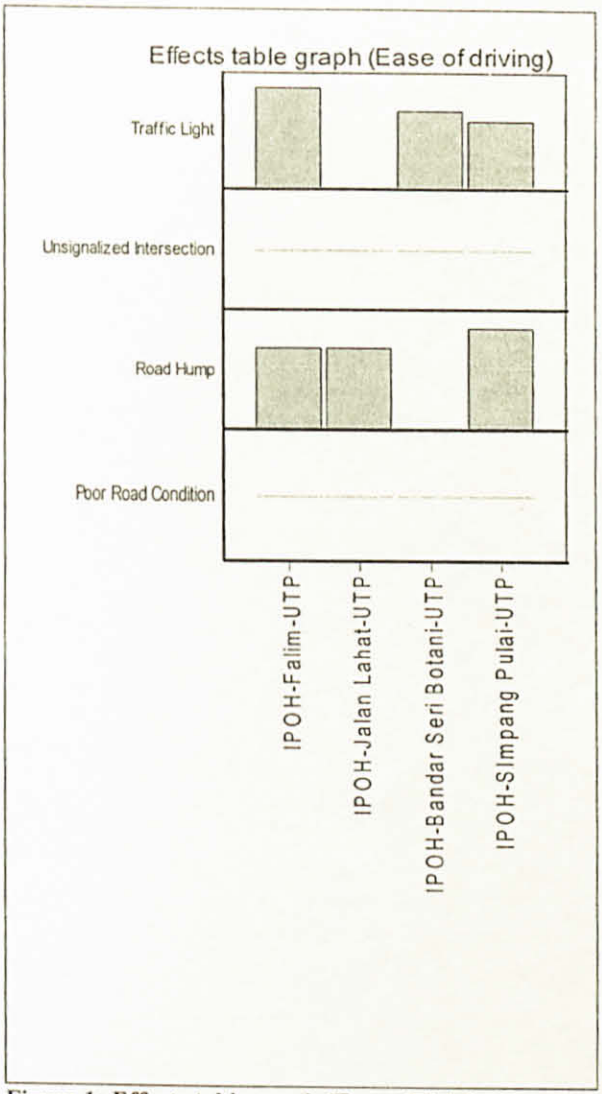

Figure 1: Effects table graph (Ease of driving)

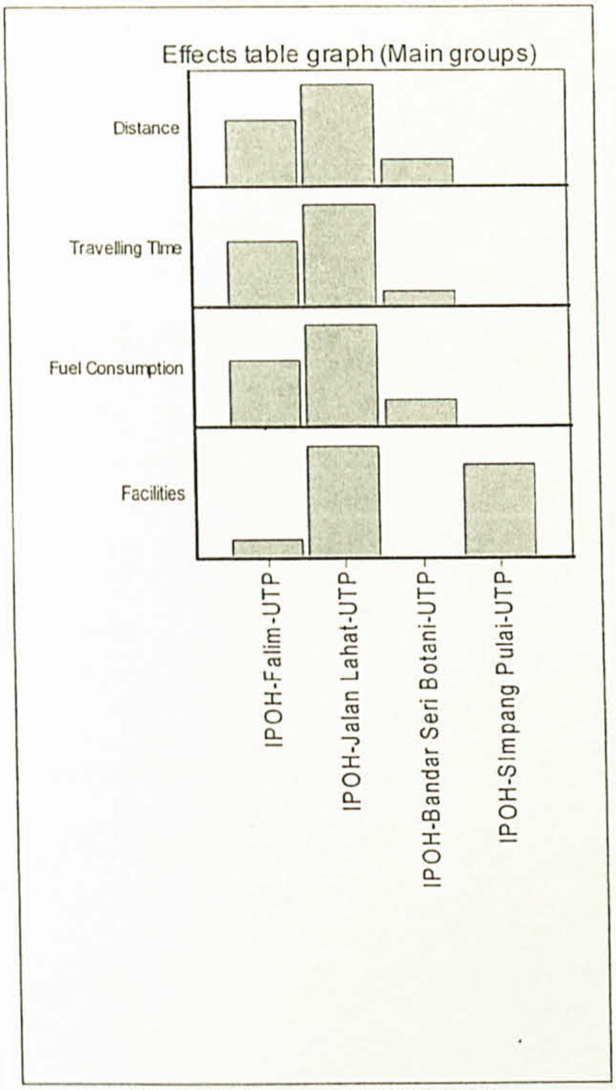

Figure 2: Effects table graph (Main groups)

Multicriteria analyses

Multicriteria analysis: MCA 1: Weighted summation {maximum (interval); Direct (Distance: 0.27)}

General information:

Name:

MCA 1: Weighted summation {maximum (interval); Direct (Distance: 0.27)}

Notes:

Method:

Weighted summation

Standardization:

Standardization settings:

	Unit	Standardization method	Minimum Range	Maximum Range
Distance	KM	maximum	0.00	37.30
Travelling TIme	Minutes	maximum	0.00	39.00
Fuel Consumption	RM	maximum	0.00	67.14
Facilities	Units	maximum	0.00	7.00
Ease of driving				
Traffic Light	No.	maximum	0.00	19.00
Unsignalized Intersection	No.	interval	-0.50	0.50
Road Hump	No.	maximum	0.00	10.00
Poor Road Condition	No.	interval	-0.50	0.50

Detail settings standardization:

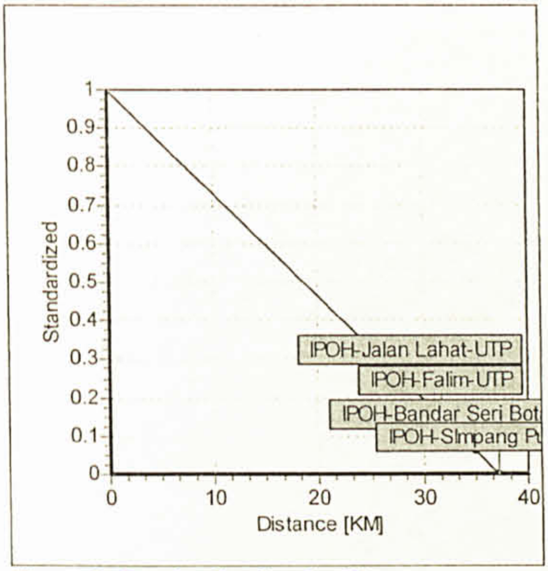

Figure 3: Standardization for Distance

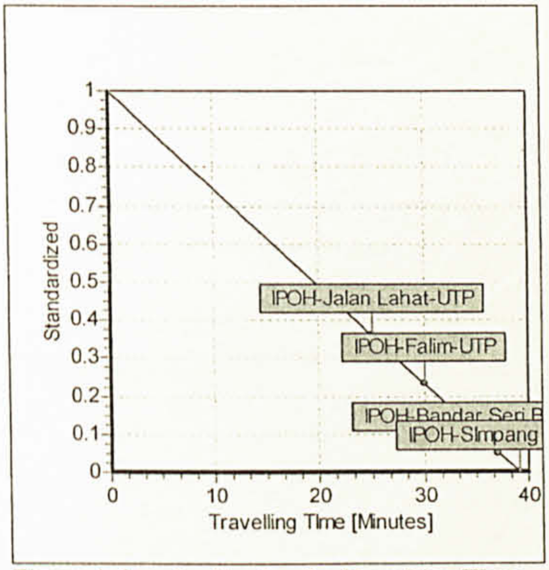

Figure 4: Standardization for Travelling TIme

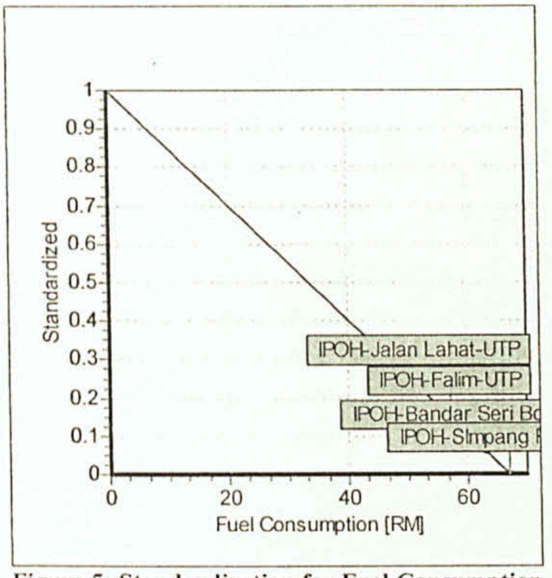

Figure 5: Standardization for Fuel Consumption

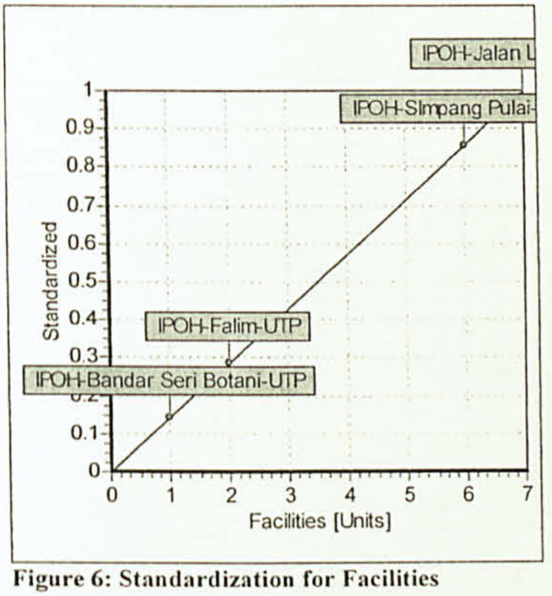

Figure 6: Standardization for Facilities

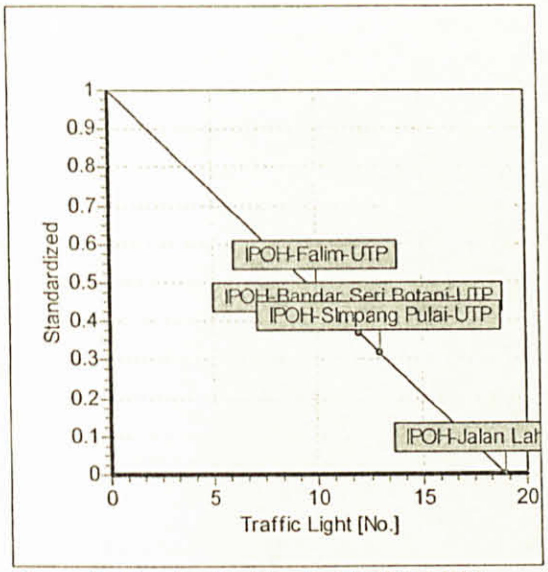

Figure 7: Standardization for Traffic Light

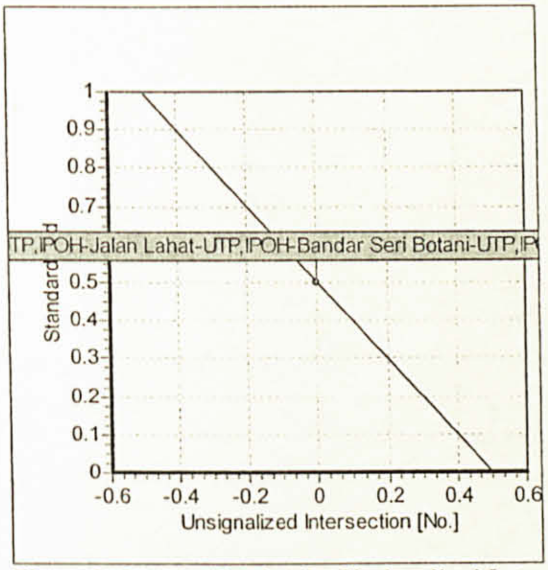

Figure 8: Standardization for Unsignalized Intersection

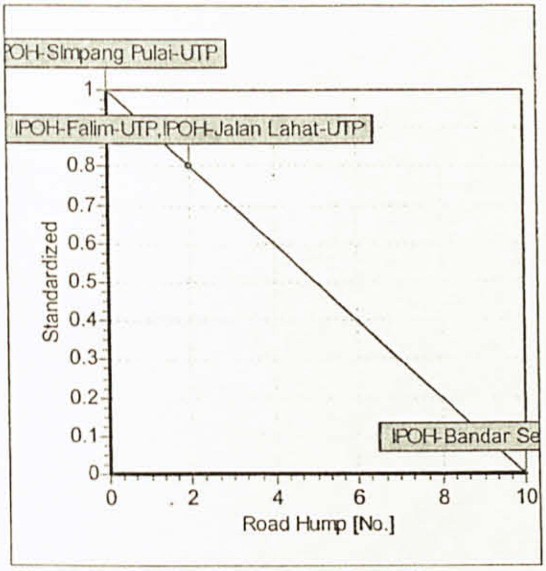

Figure 9: Standardization for Road Hump

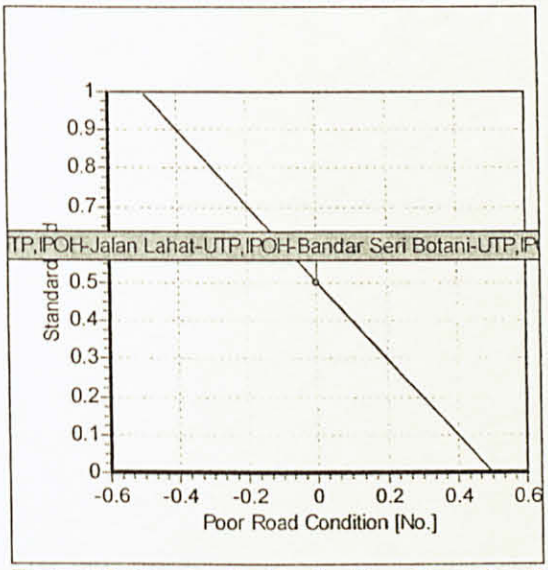

Figure 10: Standardization for Poor Road Condition

Standardized table:

	C/B	IPOH-Falim-UTP	IPOH-Jalan Lahat-UTP	IPOH-Bandar Seri Botani-UTP	IPOH-SImpang Pulai-UTP
Distance	C	0.15	0.23	0.06	0
Travelling TIme	C	0.23	0.36	0.05	0
Fuel Consumption	C	0.15	0.23	0.06	0
Facilities	B	0.29	1	0.14	0.86

	C/B	IPOH-Falim-UTP	IPOH-Jalan Lahat-UTP	IPOH-Bandar Seri Botani-UTP	IPOH-SImpang Pulai-UTP
Ease of driving					
Traffic Light	C	0.47	0	0.37	0.32
Unsignalized Intersection	C	0.5	0.5	0.5	0.5
Road Hump	C	0.8	0.8	0	1
Poor Road Condition	C	0.5	0.5	0.5	0.5

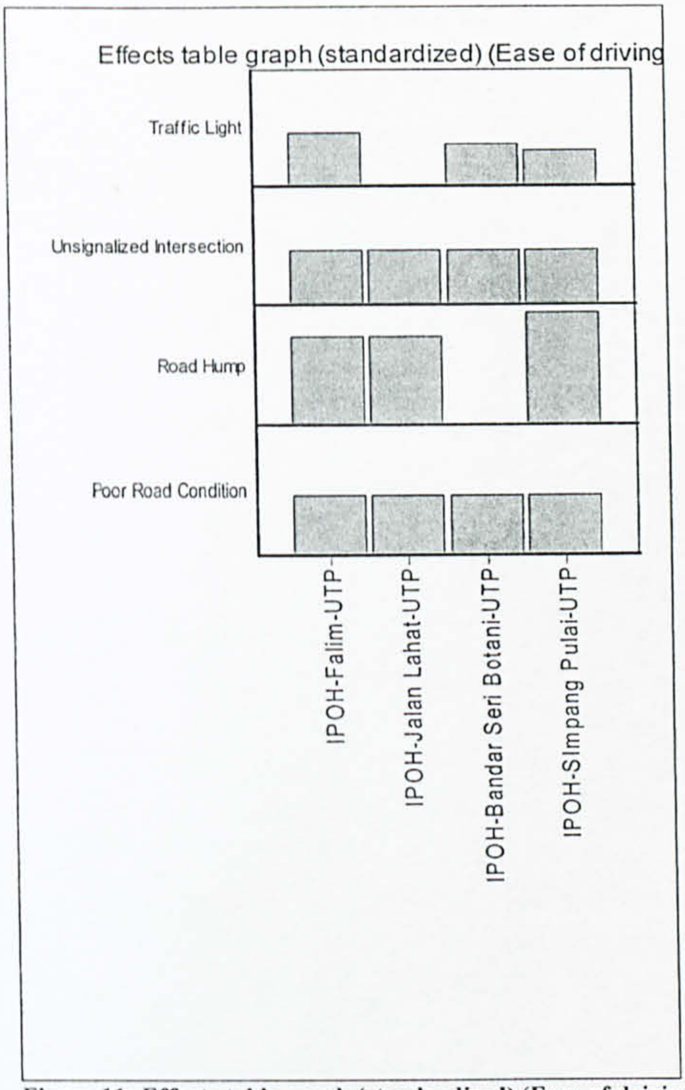

Figure 11: Effects table graph (standardized) (Ease of driving)

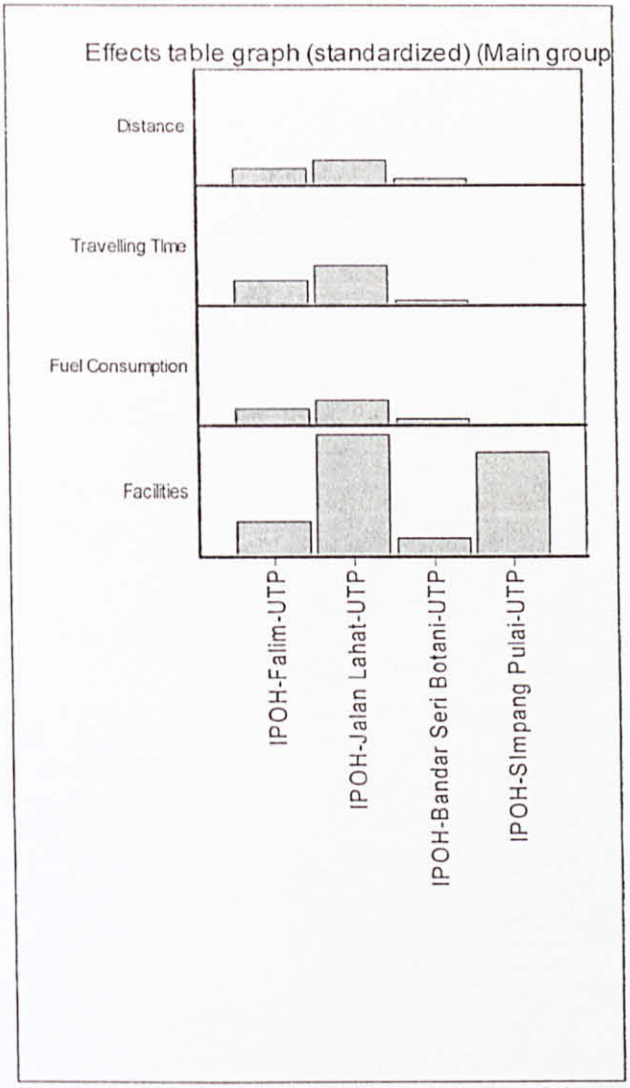

Figure 12: Effects table graph (standardized) (Main groups)

Weights:

Weights settings:

Group	Weights method
Ease of driving	Direct
Main groups	Direct

Weights settings for Ease of driving:

Method: Direct

	Weight
Traffic Light	0.554

	Weight
Poor Road Condition	0.307
Road Hump	0.079
Unsignalized Intersection	0.059

Weights settings for Main groups:

Method: Direct

	Weight
Distance	0.27
Travelling TIme	0.25
Ease of driving	0.22
Fuel Consumption	0.2
Facilities	0.06

Actual weights:

	Weight level 1	Weight level 2	Actual weight
Distance	0.27		0.270
Travelling TIme	0.25		0.250
Fuel Consumption	0.2		0.200
Facilities	0.06		0.060
Ease of driving	0.22		
Traffic Light		0.554	0.122
Unsignalized Intersection		0.059	0.013
Road Hump		0.079	0.017
Poor Road Condition		0.307	0.068

Weights perspectives:

	Total	Perspective: Distance	Perspective: Travelling TIme	Perspective: Fuel Consumption	Perspective: Facilities	Perspective: Ease of driving
Distance	0.27	0.5	0.125	0.125	0.125	0.125
Travelling TIme	0.25	0.125	0.5	0.125	0.125	0.125
Fuel Consumption	0.2	0.125	0.125	0.5	0.125	0.125
Facilities	0.06	0.125	0.125	0.125	0.5	0.125
Ease of driving	0.22	0.125	0.125	0.125	0.125	0.5

Results:

Results: MCA 1: Weighted summation {maximum (interval); Direct (Distance: 0.27)}

	Total	Perspective: Distance	Perspective: Travelling TIme	Perspective: Fuel Consumption	Perspective: Facilities	Perspective: Ease of driving
IPOH-Jalan Lahat-UTP	0.31	0.34	0.39	0.34	0.63	0.35
IPOH-Falim-UTP	0.26	0.22	0.25	0.22	0.27	0.36
IPOH-SImpang Pulai-UTP	0.15	0.16	0.16	0.16	0.48	0.33
IPOH-Bandar Seri Botani-UTP	0.13	0.11	0.11	0.11	0.14	0.23

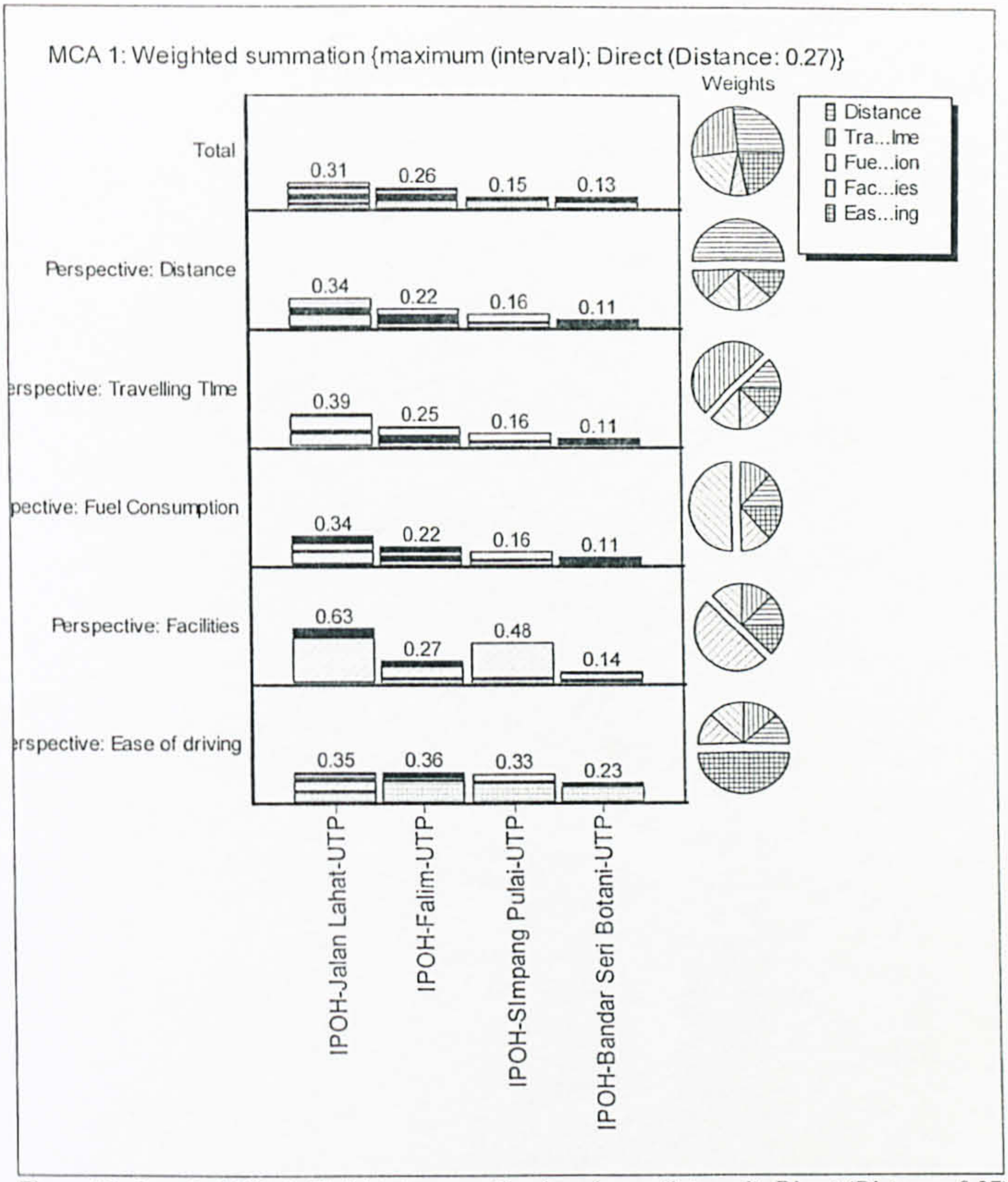

Figure 13: Results MCA 1: Weighted summation {maximum (interval); Direct (Distance: 0.27)}

Appendices D:

Accident Data Analysis

ACCIDENT DATA ANALYSIS

No.	Location along Jalan Lahat	Number of Accident per year		
		2008	2009	Indicator
1	ACS	5	8	increase
2	BUKIT MERAH	29	33	increase
3	SEKOLAH MEMANDU	14	15	increase
4	TNB	6	14	increase
5	BULATAN KACANG	15	11	reduce
6	JALAN LAHAT	44	40	reduce
7	JALAN LAHAT-FALIM	46	34	reduce
8	T/L PASAR BORONG	9	3	reduce

Black Spot area being focused in the project

Both locations at Bukit Merah;

	Coordinate		Total accident per year	
Location	E	N	2009	2008
location 1	101 03.663	4 34.472	79	59
location 2	101 02.546	4 32.877	10	5


Jalan Bukit Merah (2009)
4:48:00 AM
12:00:00 AM
7:12:00 PM
2:24:00 PM
9:36:00 AM
4:48:00 AM
12:00:00 AM
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33
TIME


Jalan Bukit Merah (2008)
4:48:00 AM
12:00:00 AM
7:12:00 PM
2:24:00 PM
9:36:00 AM
4:48:00 AM
12:00:00 AM
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
TIME