Analysis of Road Infrastructural Audit Along Jalan Batu Pahat- Kluang Malaysia: A Case Study

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Abstract: Road infrastructure is one of the main factors determining the level of safety road transport system. Installation of good and complete infrastructure components along the road would reduce the rate of accidents from happening. Accidents are the most undesirable things happen, but no doubt every year, millions of road users were killed and injured due to road accidents. Therefore, the authorities should take steps to create a program that will periodically monitor, restore and also do the improvement on road infrastructure to ensure that the road infrastructure is able to function properly, thus helping to reduce the rate of accidents in Malaysia. The main goal of this study was to analyze the audit road infrastructural along F050 route which is from KM 7 to KM 28 based on Road Safety Audit. Several methods were used to obtain data such as observations and research, accident statistics and simple statistics. Through these methods, the data were analysed by using average index, HIRARC and simple statistics. From the analysis, it was found that the road infrastructure level in the study area was less satisfying. Besides that, research results show that the level of risk due to road infrastructure gradually increases at certain places. Hence, the authority should be play more important roles to conduct maintenance and improvement on road infrastructures that poses high risk of accidents to ensure the safety of road users. It is hoped that through continuously this research it will provide sufficient information to public and researches to curb with the ever growing road accidents.

Introduction

Road transport is the main infrastructure in developing countries like Malaysia. Roads that complemented by impeccable road infrastructure are able to function well and provide guarantee safety of road users. Road infrastructure can be defined as the basic facilities, services and installations needed for the functioning of transport on highway, roads, and streets [1]. Even, the elements of road infrastructure was built and equipped along the Route FT050 a question still be arise whether it was constructed according to the standard that be determined by the Jabatan Kerja Raya (JKR) which able to function properly or not. Referring to this issue; the main thing that will be linked when the road infrastructure does not capable to serve well is the safety of road users. As commonly known, accident became a major concern to road users on Route FT050 because the percent of mortality and serious injury was increased from year to year [2]. Where, road accidents have been listed as the ninth most common cause of death in 1990 and are estimated to be the third most common cause of death by 2020 [3].

However, many lives could be saved and many accidents avoided if the existing road infrastructure was managed according to the best practice of safety engineering. For instance mentioned in the Inland Transportation Service consultation paper, appropriate new signals at junctions can reduce the risk of fatal side impacts by up to 75%; pedestrian crossings at dangerous junctions can be lead to a potential reduction of the risk of collisions with vulnerable users by up to

85% [4]. Regarding to this problem, desirable for a developing country as in Malaysia to react quickly in ensuring the safety of road users are in a comfortable situation. Therefore, the road infrastructures should be designed and maintained in accordance with the standards and specifications that be determined by the Jabatan Kerja Raya (JKR). By this, the analyses of road infrastructural audit along Jalan Batu Pahat – Kluang were implemented to assist in producing a better road infrastructure and safe for road users. To answer and prove that the problem at FT050 route could be solved, several objectives have been determined as follow;

(a) To identify the types of road infrastructure constructed along Jalan Batu Pahat – Kluang.
(b) To determine and critically analyse the road infrastructural audit findings along Jalan Batu
(c) To conduct correlations between different types of road infrastructures, road accident statistics and community surveys.

The scope research is along the route FT050 where is focused on KM 10 to KM 24 which is from Kawasan Perindustrian, Sri Gading to Parit Haji Ali, Parit Raja. The audit level of infrastructure that be done refer to the Road Safety Audit (RSA) and Arahan Teknik Jalan (ATJ). Methods used in conducting this study are research and observations, questionnaires and interviews. The implementation period of this study will be carried out within 10 months.

According the some literature reviews being conduct, road safety audit can be defined as a formal examination of road safety in the planning, design and construction of road projects, as well as the features and operation of the existing road by independent and qualified examiners, to identify any potential features not safe or operating settings that can affect the safety of any road user [5]. Figure 1 briefly describes each stage of the road safety audit in Malaysia.

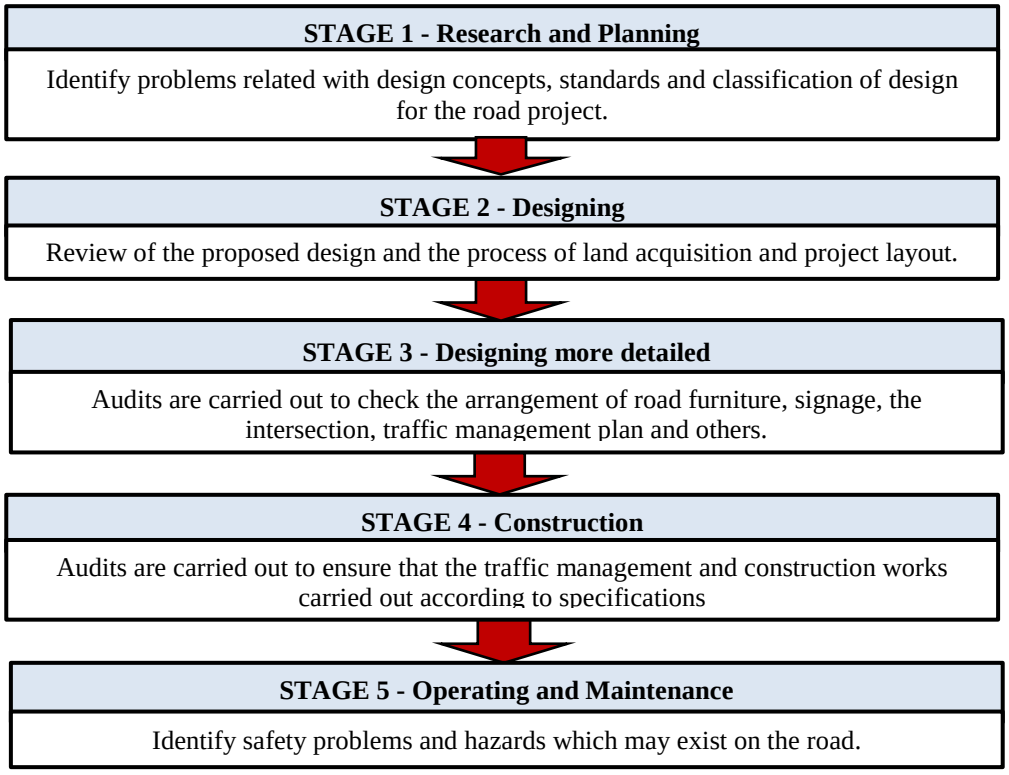

Figure 1: Road Safety Audit Stage in Malaysia
Source: (Samsudin, 2013)

Some elements of road infrastructure audit are studies on good road conditions can be specified when a road is designed according to the standards set by the relevant authorities. Road design standards made with regard to five main aspects namely functionality, economy, safety, comfort and aesthetic [6]. Construction and maintenance of a road should be guided by the standards provided by the Jabatan Kerja Raya (JKR) as examples road safety audit. Road infrastructure elements that are audited as follows:

(a) **Geometry of Road;** Road geometry are including of access control, horizontal alignment, vertical alignment, visibility, cross section and intersection [2]. Each element of road geometry was designed in accordance with the requirements of traffic based on specific standards recommended by JKR and AASHTO.

(b) **Traffic Signs;** The purpose of traffic signs is to help ensure the safe and informed operation of every road user on the highway. Traffic sign comprising three (3) categories which are guide signs, warning signs and regulatory signs. General design consideration on traffic signs are colours, letterings and borders, symbols, post and mounting and materials used as mentioned in ATJ 2E/87 [7].

(c) **Pavement Marking;** Road markings serve a very important function in conveying to road users information and requirements which might not be possible using upright signs. Several criteria must be taken into consideration in audit the road surface markings such as illumination, colours and dimension as mentioned in ATJ 2D/85 [7].

(d) **Street Lighting;** Major factor installations of street lighting are to improve safety of road users at night. Several factors should be considered in the auditing of existing street lights such as light pole location, rate of lighting and design of the lighting system as described in the Road Safety Audit (RSA).

(e) **Width and Road Shoulder;** Condition of the road width affects the vehicle speed limit in certain area [2]. Road width should be in line with the appropriate speed limit in an area. Road shoulder width generally is 3 meters for all structures road design. However, for certain situations there is a wide shoulder of the road classification outlined by Jabatan Kerja Raya (JKR) and REAM.

(f) **Road Barries;** Usually the specifications for road barrier systems are classified into three categories: permanent barriers, semi-permanent barriers and flexible barriers. Road barrier should have a height that is optimal for proper functioning refers to ATJ 1/85 [7].

(g) **Traffic Signal;** Traffic signals are a device that controls the movement of vehicles and pedestrian traffic. A few things in the installation of traffic control signals should be taken into consideration to ensure the efficiency of operations such as signal phasing, signal faces, appropriate signal installation and signal hardware as explain in the [5].

Research Methodology

The methodology of this study describes briefly the overview of the process and workflow involved in the study. To carry out the analysis of road infrastructure audits, several planning and statistics of the study were set as shown in Figure 2. Methods of data collection used in the execution of the study are observations, questionnaires and interviews. The analyses involved in this study are the average index analysis, statistical tools and HIRARC analysis.

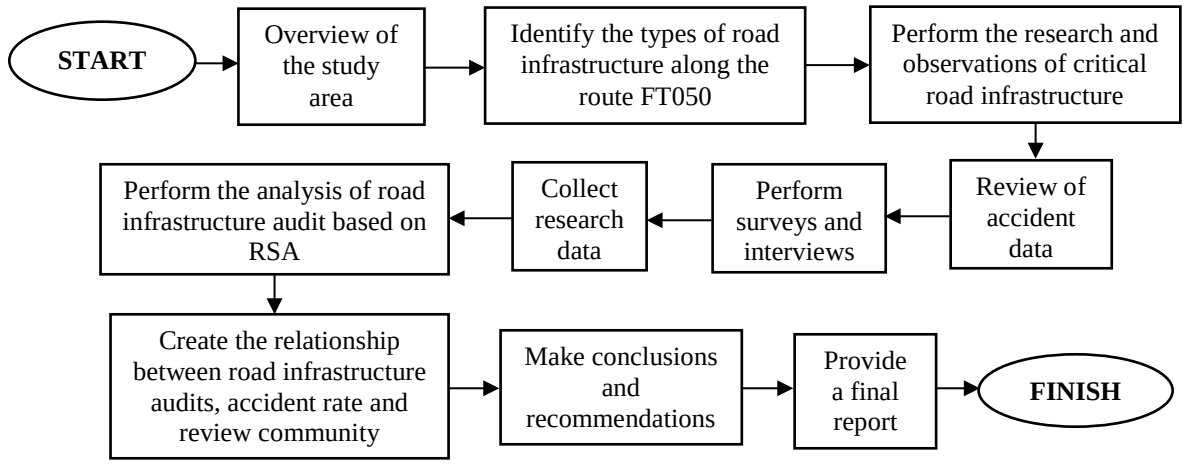

Figure 2: Workflow process

Method of Data Collection

Data collection is the primary data obtained in this research, which is collected directly from the individual and experienced researchers in the research topic. Data collection was conducted using observations and research methods on the location of studies, questionnaires and interviews.

(a) **Research and observation;** Research and observation were implemented to observe the state of weakness and lack of road infrastructure with the reference guided manual of the Road Safety Audit (RSA), Arahan Teknik Jalan (ATJ) and Geometric Design Guide Road.
(b) **Questinnare;** A questionnaire was used intended to obtain the practical data of real environment in the study location. A questionnaire method selected is a closed form. Questionnaires forms were distributed to 375 respondents based on resident population of Pt. Raja and Sri Gading which consists of road users along the FT050.
(c) **Interview;** An interview were conducted to organizations or individuals that is knowledgeable in the analysis of road infrastructure audits and road traffic accidents such as the Jabatan Kerja Raya (JKR), Polis Diraja Malaysia (PDRM) and the Jabatan Keselamatan Jalan Raya (JKJR). The purpose of this technique was carried out to obtain the views of the legal aspects, standards and road conditions along the route FT050.

Data Analysis Method

The methods chosen in this study to analyse data is by used the average index method, statistical methods and HIRARC analysis methods which appropriate to the objectives and scope of the study.

(a) **Average Index Method;** Average Index Method was calculated to analysis survey data by using equation 1, where ai is a constant that represents the weight of N, xi is a variable that represents the frequency of respondents N and N is a total respondents; 0,1,2,3,4. [8]

$$\text{Average Index, Xi} = \frac{\sum \text{ai xi}}{\text{N}} \quad (1)$$

(b) **Statistic Method;** Statistic methods were used to produce a pai chart, bar chart, graph and table to illustrate the results of the analysis of research more clearly and regularly.
(c) **HIRARC Method;** Hazard Identification, Risk assessment and risk controls are commonly known as HIRARC which this method enables an organization to manage the inherent hazards of their workplace more effectively [9]. However, other country also applied this guideline to analyze the factors of the accident on the road based on safety audit data [2].

Results and Discussion

Result from the analysis audit of road infrastructural, accident data and questionnaires along KM10 to KM25 will be presented through tables, charts, graphs and diagrams. Through the analysis of survey results for the overall function of each type of road infrastructure it can be stated that the majority of the 375 respondents less agreed with the function of road infrastructure along the Batu Pahat-Kluang.

Analysis of Audit Outcome

Based on this research an observation, HIRARC analysis was conducted to identify risks at every kilometers and every type of road infrastructure. This risk is assessed by considering the possibility of danger at every type of infrastructure available at KM10 to KM24. Figure 3 shows the results of

a risk analysis for each kilometer while Figure 3 shows the results of a risk analysis for each type of road infrastructure involved.

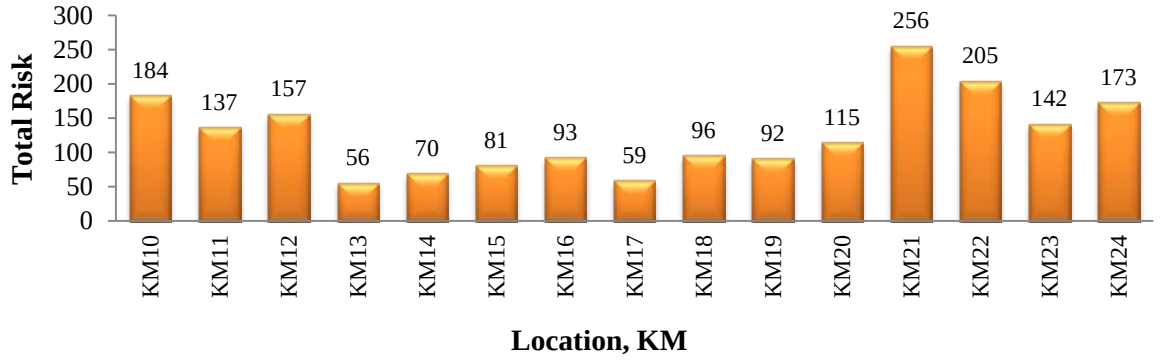

Figure 3: Total risk based on the location

Figure 3: Total risk based on the type of road infrastructure

Once the risks were identified, the risk classification was performed to give priority in order to take action and control measures appropriate to address the hazards that exist throughout the study area. Table 1 shows the classification of the level of risk priority based on the location and Table 2 shows the classification of the level of risk based on the type of infrastructure priorities.

Table 1: Classification level of risk priority based on location

No.	Location	Risk Classification		
		Low	Medium	High
1	KM17			
2	KM 10, 13-16,18-20,23,24			
3	KM11,12,21,23			

Table 1: Classification level of risk priority based on type of infrastructure

No.	Type of Infrastructure	Risk Classification		
		Low	Medium	High
1	Road surface, Pavement Marking, U Turn, Road Barrier and Street Lighting			
2	Sign Board, Road Side, Road Divider and Pedestrian Traffic Light			

The correlation between accidents and infrastructure

Figure 4 shows that the risk of road infrastructure and the number of accidents along KM10 to KM24 is directly proportional. Based on the analysis of the road infrastructure risk graph against the accidents rates, it can be concluded that the factors of road infrastructure can also be a cause of the accident.

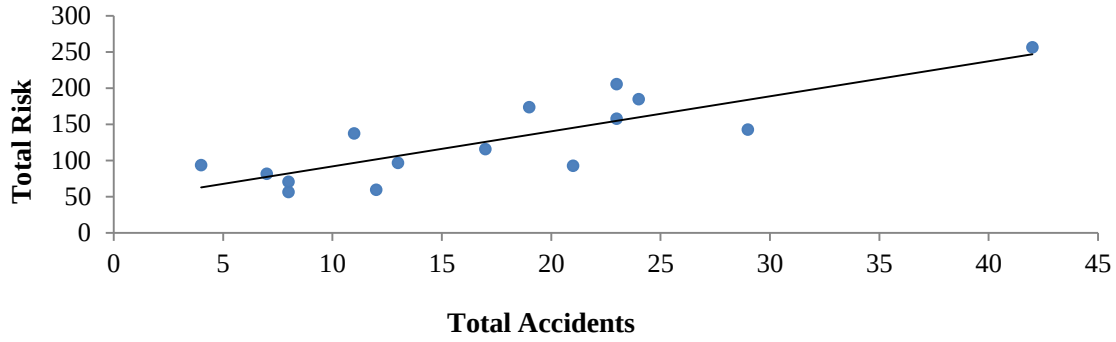

Figure 4: Graph of total road infrastructure risk against accidents

Conclusions and recommendations

As a conclusion, the entire objective of this study was achieved. Based on the results of the study it can be concluded that the level of road infrastructure along the Batu Pahat-Kluang route is still very risky and could contribute to accidents. Some measures should be taken so that the road infrastructure can be maintained at good condition so that rate of accidents can be reduced. Therefore, the authorities should play an important role in the improvement and maintenance of proper infrastructure and to produce the perfect road system. Audit of the existing road infrastructure is an important aspect of ensuring a safe and comfortable road usage. Through the research conducted some recommendation can be listed as follows;

(a) Several recommendation had been proposed to improvement road infrastructure along Jalan Batu Pahat-Kluang such as extended the road shoulder width for the provision of bike paths, performing periodic maintenance of road infrastructure, examines back the location of the pedestrian bridge and signal, ensure the street lights a fully functioning and make checking on the road barrier height.

(b) In future, the research can be improved by extending its research scope by taking into consideration human behavioral factors when auditing road safety. Besides that, the audit elements can be expanded by conducting a more precise audit on horizontal and vertical alignment, corner deflection rate, safe road widths, access control and U-turn curves.

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