HAZARDS IDENTIFICATION AT BUS INTERCHANGES IN KUALA LUMPUR

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Abstract

Bus is one of the main alternatives of mass public transportation in Kuala Lumpur as it is cheaper and has better coverage area than its counterparts such as Light Rapid Train (LRT) and commuter train. Thousands of people use the bus interchanges around Kuala Lumpur to reach their destinations. In this paper, hazards at these bus interchanges are identified to prevent or, at least to minimize the number of accidents that might occur as well as to reduce health problem. Five bus interchanges were selected for this research; the Hentian Puduraya, Klang Bus Stand, Hentian Putra, Mydin Bus Stand and Hentian Duta. The main objective of this research is to study the level of safety awareness among the management of the bus interchange and also the public. This research is conducted using several methods, which includes observation, checklist, questionnaire and interviews with safety personnel. From the result, it was found that most users of these bus interchanges are aware of safety aspects and this might be due to an increasing level of education. Hazards that might occur at these bus interchanges have also been identified and several suggestions to prevent or minimize these hazards have been made.

Keyword: Hazards, Bus interchange, Safety, Mass public transportation and Awareness

1. Introduction

Increasing urban population and development has resulted in a rapid increase in public transport on the roads. Existing bus interchanges are often inadequate to meet the growing needs. This results in crowded terminals and frequent numbers of accidents during boarding and alighting. A study done by Skjöt-Rasmussen [1]

and Kirk et al. [2] reported that about one-third of all bus injuries originate from boarding and alighting at bus interchanges. Adding to this, results from ESBOS [3] for city buses in Austria showed that boarding and alighting were the causes for about one-third of fatal injuries.

Public mass transportation is one of the major methods of transportation used by the public in Kuala Lumpur other than private vehicles. Bus is one of the main alternatives of mass public transportation as it is cheaper and has better coverage area than its counterparts such as Light Rapid Train (LRT) and commuter train. Most studies were concerned with other modes of transportation, such as railway but not on bus interchange. Salim, N. and Abdullah, S. [4] identified the possible major hazard at Central Station Kuala Lumpur, a transportation hub for LRT and train, where the study found that old building would serve higher rate of hazards compared to newer building, as risk associated will increase over time.

Thousands of people use the bus interchange around Kuala Lumpur to reach their destinations. Bus interchanges studied for this research are the interchange stations where more than five buses stopped at a time to take or drop passengers. These interchanges are Hentian Puduraya, Klang Bus Stand, Hentian Putra, Mydin Bus Stand and Hentian Duta. The safety aspect of the bus interchange is an important issue as it deals with life of thousands of people. Thus hazard identification at these bus interchange is a must to prevent or at least minimize the number of accidents that might occur. Works concerning the safety of commercial vehicles by Peterson [5] concluded that human factors, vehicle factors, road factors and environmental factors determine the accident risks. Chaterjee et al. [6] stated that human error is commonly recognized as the major factor contributing to commercial vehicle accident.

Bus interchange management plays a massive role in ensuring the bus interchange is safe for the public. Based on a national survey of transit agencies, TCRP Synthesis 21, there are seven strategies which are most effective and widely practiced among terminal bus operators [3]. Listed in order of importance, these strategies are: technological aspect, such as video and closed-circuit television (CCTV) surveillance; uniformed officers on foot; employee involvement in conflict resolution and crime reporting; education and information; community outreach; and plain cloths officers.

Bus interchange is usually constructed in the heart of the city where people can easily access it. Usually the construction is undertaken by the government; however, at times a private transportation company may handle the whole project where in this case, two out of five bus interchanges that have been selected are managed by UDA Mall Sdn. Bhd; a private transportation company, while the other three are managed by the Kuala Lumpur City Hall (DBKL). A study in UK by Parkhurst et al. [7] on the strategic environmental assessment for bus interchange concluded that the locations for bus interchange must be planned thoroughly using an environment assessment method to lessen the negative impact of the interchange to the environmental, social and economic sustainability to a certain area.

1.1. Location background

The first interchange, Hentian Puduraya is situated at Jalan Tun Perak, Kuala Lumpur that is 100 meters away from a China Town. It was developed and currently managed by UDA Mall Sdn. Bhd. It is accessed by about 50,000 people a day with the peak hours are during 8 a.m. to 10 a.m. and from 4 p.m. to 6 p.m. It serves as a bus interchange for buses with the North, South, East Coast of Malaysia and Genting Highlands as their destinations.

The second interchange, Klang Bus Stand, also known as Pasarama Kota, is situated on Jalan Sultan Mohammed, just in the south of Central Market, a tourist centre, and is used by Klang Valley buses. It is situated only 50 meters from the Central Market LRT Station. It is accessed by about 2,000 users per day and the interchange is being managed by the DBKL.

The third interchange, Hentian Putra is situated opposite the Putra World Trade Centre (PWTC) and accessed by 1,000 users per day. It provides bus services to the east.

The fourth interchange station, Mydin Bus Stand is situated at Jalan Pudu and it is in front of the Mydin Supermarket. It serves buses with short distance destinations and is accessed by 2,000 to 3,000 people a day.

The fifth station, Hentian Duta was built by the UDA Mall Sdn. Bhd. and situated at Jalan Duta, next to the Hockey Stadium and Duta Tennis Court. It is used by 3,000 to 5,000 people a day with the peak hours are during the early morning and late afternoon. It was launched to minimize the crowd and traffic congestion at Hentian Puduraya.

1.2. Scope of study

Hazard has been defined as a real or potential situation that may cause unintentional injuries or deaths to people or damage to, or loss of, an item or belongings. Safety performance of each element can then be measured by evaluating the correspondent on-site hazard factor; with the decrease of its potential hazard, its safety performance improves.

Data obtained from this study were analyzed using the parametric tests, independent sample t-test and analysis of variance (ANOVA). A statistical multivariate analysis was performed by correlating historical accident data, directly collected on the field, with relevant intrinsic road factors and meteorological, traffic conditions. A significative (alpha < 0.05) degree of correlation was highlighted making reference to the several chosen parameters.

The main objective of the research is to study the safety awareness among the management of the bus interchange and also the public and to suggest upgrading of safety performance of the transportation sector especially at the bus interchange studied. Public perception and awareness toward safety at these bus interchanges is also studied and hazards that might occur are evaluated.

2. Methodology

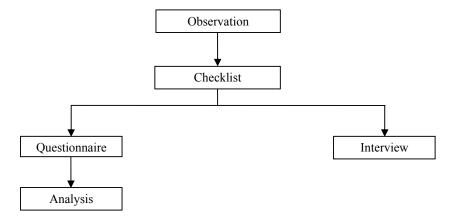The study consists of several steps as shown in Fig. 1 below.

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  │ Questionnaire│   │  Interview   │
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  │   Analysis   │
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Fig. 1. Hazards Identification Steps

2.1. Observation

Observation is the pre-evaluation technique as it is an important step and forms a foundation base in this study. From the observation results, information of the location and overall safety aspects can be identified. Preliminary results can then be concluded from this general analysis. This step involves with listing down all the hazards associated with the locations.

2.2. Checklist

A checklist analysis uses a written list of items to verify the status of the system or location. It provides a common basis for evaluating questionnaires and interview questions later on. The prepared checklist for this research consists of four components related to the management of bus interchange, which are emergency action aspect, security aspect, safety aspect and health aspect.

2.3. Questionnaire

Questionnaires are distributed among targeted group. The sampling method is based on a randomizing device that gives each individual chance of selection. In this research, the size of the sample for each bus interchange will be taken as 70, as this will produce a margin of error of no more than 10 percent. Typically, a larger size of sample will generate lower margin of error but due to lack of both man power and budget, a margin error of 10 percent will be tolerated. The data obtained from the survey is analyzed using a Statistical Package for Social Sciences (SPSS) Version 10.0. From the descriptive statistic, the mean score of each parameter evaluate from this questionnaire is determined. The results are then further evaluated in discussion section.

2.4. Interview

This step is intended to identify the location conditions or operating procedures that could lead to an accident and result in injuries, significant property damage or environmental and other health impacts. The interview is specifically aims at the management part of the bus interchange. It should be viewed as cooperative efforts to improve overall safety and performance of the bus interchange. The targeted person to be interviewed is the safety officer from each of the bus interchange.

3. Results and Discussion

3.1. Observation

Observation is conducted at the selected bus interchanges as a preliminary study to identify hazards; which could lead to accidents and health problems. From the observation made, several possible hazards are identified at different bus interchange. One of the hazards identified at Hentian Puduraya is the slippery step. Also it is noted that not all the drains at the Hentian Puduraya are properly covered. The platform has poor lighting system and also slippery floor. Obviously, these may cause accidents to the users. The ventilation system at the interchange is not satisfactory even though mitigation measures, such as installation of exhaust fan, have been taken. This may cause health problems especially to the most frequent users. This poor ventilation might be due to inadequate design of the closed building of the interchange. Other health hazard which could be identified is that the interchange is infested with pests. Implementing pests control measures and promoting clean waste management to the stalls and food court patrons in the interchange may overcome this health problem.

At Klang Bus Stand, the most noticeable health hazard is the poor ventilation system. Exhaust smoke and dust are accumulating in the area. The platform is also dirty and infested with pests. Besides health hazard, the platform also has poor lighting system and slippery floor. This may cause the occurrence of accidents to the users.

It is observed that Mydin Bus Stand has more hazards among the earlier bus interchanges studied. This might be due to the fact that there is no specific body which is responsible for its safety aspects. A management body should then be appointed to manage the safety of the bus interchange and its users.

On the other hand, Hentian Duta is the bus interchange with the least hazards observed. This might be due to its open building design where better ventilation can be observed, i.e. the exhaust smoke and dust are not accumulating in the interchange. This bus interchange is still new compared to the other bus interchanges. However, there are drawbacks at this interchange where security aspects are not properly emphasized compared to the Hentian Puduraya and Hentian Putra.

From the observation made, it was found that several hazards observed at the Hentian Putra are mainly due to human factor such as the floor is not clean properly but in general, this interchange has better ventilation system compared to the Hentian Puduraya, Klang Bus Stand and Mydin Bus Stand.

3.2. Checklist

The checklist results in Table 1 show that the Mydin Bus Stand does not have any safety aspects necessary for a bus interchange. This is because there is no specific body that is responsible for its management. In the aspect of emergency telephone, only the Hentian Puduraya has this facility in the form of intercom. Other bus interchanges rely on the personal mobile phone as the method of emergency communication. It is also observed that only the Hentian Puduraya has the facility of CCTV.

Table 1. Checklist Results.

Aspects	Bus Interchange				
	Hentian Pudu	**Hentian Putra**	**Hentian Duta**	**Klang Bus Stand**	**Mydin Bus Stand**
Fire extinguisher	Yes	Yes	Yes	Yes	No
Emergency door	Yes	Yes	Yes	Yes	No
Fire hydrant	Yes	Yes	Yes	Yes	No
Emergency bell	Yes	Yes	Yes	No	No
First aid	No	Yes	Yes	No	No
Emergency telephone	Yes	No	No	No	No
CCTV	Yes	No	No	No	No
Police booth	Yes	Yes (Only at certain time)	No	No	No
Security guard	Yes	Yes	Yes	Yes	No
Safety signboard	Yes	Yes	Yes	Yes	No
Anti slippage floor-toilet	No	Yes	Yes	No	-
Anti slippage floor-steps	Yes (Worn out)	Yes	-	No	-
Platform border (fence etc.)	Yes	Yes	No	Yes	No
Waiting area	Yes	Yes	Yes	Yes	No
Covered drain	No	Yes	Yes	No	No
Ventilation system	Yes	Yes	Yes	No	No
Lighting system	Yes	Yes	Yes	Yes	No
Roof	Yes	Yes	Yes	Yes	No
Dust	Yes	No	No	Yes	Yes
Flies, rats and other pests.	Yes	No	No	Yes	Yes

3.3. Questionnaire

The data obtained were analyzed using Statistical Package for Social Sciences (SPSS) Version 10.0. A statistical multivariate analysis was performed by correlating the bus interchange; with relevant intrinsic safety factors, perception, frequency and type of accidents traffic. From the descriptive statistic, the mean score of each parameter evaluated from this questionnaire was determined. This test was also used to indicate the significance differences between accidents and bus interchange, with respect to some parameters related to the causes of accident.

Table 2 shows the results of the Tukey test from the SPSS V10.0 analysis method.

**Table 2. Tukey Test (SPSS V10.0) for all Dependent Variables
with Location of Bus Interchange as Fixed Factor.**

Dependent variable	Sum of squares	df*	Mean square	F	P-value
Age	6.941	4	1.735	2.790	0.044
Sex	2.125	4	0.531	2.429	0.069
Race	0.000	4	0.000	-	-
Frequency	7.337	4	1.834	3.585	0.017
Location suitability	0.585	4	0.146	1.185	0.337
Sensitivity towards safety	0.292	4	0.073	0.894	0.480
Important factor causing accident	3.265	4	0.816	0.691	0.604
CCTV	2.115	4	0.259	3.909	0.011
Fire extinguisher	3.018	4	0.754	5.487	0.002
Police booth	4.718	4	1.180	9.611	0.000
Emergency door	3.094	4	0.774	4.843	0.004
Safety sign board	2.033	4	0.508	2.394	0.073
Fire hose	1.400	4	0.350	1.829	0.149
Safety alarm	1.466	4	0.367	1.523	0.211
Emergency phone	2.258	4	0.564	2.634	0.054
First aid box	3.228	4	0.807	4.389	0.007
Stairs are slippery & small	19.648	4	4.912	4.739	0.004
Improper bus parking	17.892	4	4.473	5.992	0.001
Floors are dirty & slippery	11.357	4	2.839	4.684	0.005
Dirty drains	10.494	4	2.624	2.764	0.046
Bad ventilation system	5.549	4	1.387	1.145	0.354
No clear platform boundaries	3.854	4	0.964	1.512	0.224
Unhygienic environment	8.879	4	2.245	2.591	0.057
Location where accident usually happen	5.454	4	1.364	1.046	0.400
Safety awareness at work place	0.201	4	0.050	0.594	0.670
Awareness method	7.787	4	1.947	1.588	0.203
Accident frequency	7.067	4	1.767	3.457	0.019
Type of accident	0.130	4	0.033	0.085	0.986

* df - Degree of freedom
  P-value - Probability value
  The *F* – statistic - A large ratio of the mean squares implies that the amount of variation
  explained by the dependent variable is large in comparison with the residual error [8].

Its main objective is to determine whether the parameters are significant or not. The benchmark value for significance (p-value) is that alpha should be less than 0.05 (alpha < 0.05). It is 95% certain that what was found in the sample is true of the population. From the table, it can be observed that only several parameters are significant by fixing location of the bus interchange as the fixed variable. Therefore, only the significant parameters will be further analyzed using descriptive statistic. In this case only the parameters of age and frequency of the users; existence of CCTV, fire extinguisher, emergency door and first aid box; stairs conditions; improper bus parking; floor conditions; drain conditions; accident frequency and overall satisfaction will be further analyzed.

Table 3. Mean Score for all Factors from Descriptive Statistic (SPSS V10.0).

| No. | Factor | Location (Score*) | | | | |
		H. Puduraya	H. Putra	H. Duta	Klang B.S.	Mydin B.S.
1.	**Age**	1.75	2.09	2.25	3.00	4.00
2.	**Frequency**	2.25	1.27	1.17	1.00	2.00
3.	**CCTV**	1.38	1.73	2.00	2.00	2.00
4.	**Dirty and slippery stairs**	2.63	1.18	2.08	3.33	4.00
5.	**Improper bus parking**	2.00	1.45	1.50	3.67	4.00
6.	**Dirty and slippery floors**	2.38	1.45	1.58	2.67	4.00
7.	**Fire extinguisher**	1.38	1.00	1.25	2.00	2.00
8.	**Emergency door**	1.38	1.00	1.42	2.00	2.00
9.	**First aid box**	2.00	1.27	1.33	1.67	2.00
10.	**Dirty drains**	2.25	1.55	1.75	3.00	4.00
11.	**Accident frequency**	3.50	4.00	3.67	2.67	2.00
12.	**Satisfaction**	1.75	2.45	2.58	1.00	1.00

*where,

   factor no.1 (1= 15-20 yrs, 2 = 20-30 yrs, 3 = 30-40 yrs, 4 = above 40)
   factor no.2 (1 = daily, 2 = 2-3 times /week, 3 = less than 1 time /week)
   factor no.3,7,8,9 (1 = yes, 2 = no)
   factor no.4,5,6,10 (1 = very disagree, 2 = disagree,3 = agree, 4 = very agree)
   factor no.11 (1 = 4-5 times /week, 2 = 3-1 times /week,
            3 = 3-1 times / month, 4 = rarely)
   factor no.12 (1 = very bad, 2 = bad, 3 = satisfactory, 4 = good, 5 = very good)

From Table 3, it is observed that the mean age for the Hentian Puduraya users is 1.75 which means that most users are between 15 to 30 years old. This might be due to the fact that more students are using it. The Hentian Duta and Hentian Putra usually serve the users between the age ranges of 20 to 30 years old. However, at the Klang Bus Stand, the users are between the age ranges of 30 to 40 years. The Mydin Bus Stand serves mostly the users with age of 40 or above.

This might be due to the fact that the buses at this interchange are for short distance destinations and the users within this age range use the bus to escape traffic jams.

It is also observed that the Hentian Puduraya is the most frequent used bus interchange compared to the other bus interchanges. The least frequent is the Klang Bus Stand. This is due to the availability of other alternative ways to go to Klang such as train and also own transportation.

It can be observed that the Mydin Bus Stand is the bus interchange that does not have either CCTV, emergency door nor first aid box. In term of safety amenities, the Hentian Putra provides the most satisfactory output. In term of environmental conditions, the Hentian Putra has the lowest mean score where the environmental conditions are the best among the bus interchanges studied. The Hentian Duta and Hentian Putra have the least number of reported accidents compared to the other bus interchanges.

The users for the Hentian Duta have higher safety awareness compared to other interchanges' users while the users for the Klang Bus Stand have the lowest safety awareness. It is also observed that most users of the Hentian Duta are satisfied with the safety system of the bus interchange but not for the Klang Bus Stand and the Mydin Bus Stand's users. Therefore, the bus interchange should implement several measures to improve the safety systems such as providing better lighting system, CCTV to curb crime, better and clean bordered platform, etc.

Several suggestions are proposed to prevent or minimize the identified hazards at the bus interchanges studied. For example, good housekeeping should be ensured and routine inspection should be implemented so that floor is clean and dry at all time. The floor also should be tiled with suitable tiles so it would not crack easily. The stairs should be fitted with chequered steel plate or other non-slip surface and if the surface has worn out, it should be replaced. More lighting devices should be installed and managed at the bus interchanges.

3.4. Interview

The interview session was carried out with the responsible safety personnel for each of the bus interchange except for the Mydin Bus Stand since there is no specific body that is responsible for its management. Most of the personnel explained that the important factor that determined the suitability of a location to be developed as a bus terminal is that it must be an open area and not a multilevel complex. This is due to the fact that in a closed, multilevel bus interchange, the ventilation system is not good enough and the exhaust smoke tends to circulate within the building.

Respondents also mentioned that a bus interchange should not be in the heart of the city or commercial center to avoid crowd and traffic congestion. In term of security aspects, all of the bus interchanges have employed security guards to ensure the bus interchange is safe from crime 24 hours a day except at Mydin Bus Stand. In term of communication devices provided to the staff in charge of the safety aspects, they are facilitated with suitable communication equipments. Routine inspection is applied and good housekeeping is ensured.

4. Conclusions

The management and public perception and awareness towards safety at these five bus interchanges have been identified. From the research, it can be highlighted that most of the management team and users at these bus interchanges are aware about the safety aspects and this might be due to the increasing level of education.

Hazards that could lead to accidents and health problems at these five bus interchanges have also been identified. The most noticeable hazard is that some of the stairs at these bus interchanges are slippery and small. Even though some of them are constructed from chequered steel plate but they have worn out. Besides that, building design and age of the bus interchange structure also contribute to the increasing of hazards. Open building design of a bus interchange would decrease the health hazard, as exhaust smoke and dust do not accumulate around the bus interchange compared to close building design. As the age of the building of the bus interchange increases, the hazards associate also increase linearly.

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