THE FATALITY INDEX OF PUBLIC TRANSPORT (EXPRESS BUS) IN MALAYSIA

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By

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This project report is submitted as part fulfilment for Master Degree of Highway & Transport Engineering

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Abstract of project report presented in fulfilment of the requirement for the Master Degree of Engineering

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NURSITIHAZLIN BINTI AHMAD TERMIDA

November 2006

Supervisor: **Professor Ir. Dr. Radin Umar Bin Radin Sohadi**

Faculty: **Engineering**

Until now, there is no research or study being conducted to establish the fatality index of public transport in Malaysia especially for express buses. For now, we only know the total accidents in our data storage involving public transport in Malaysia. Hence, this study has been conducted to develop the safety index of public transport (express bus) in Malaysia. It is important to know the safety index of public transport (express bus) in this country as compared to other developed countries since express bus is one of the main modes for long distance transportation in Malaysia. Besides, when the fatality index is obtained in this study, it could be used as a guideline or reference to improve the safety level of public transport (express bus) in Malaysia. The data analysis in this study is done using Mileage Deaths Rate Method (MDR) and the measurement unit is in passenger kilometres travelled (PKT). Thus, the fatality index is stated as per billion PKT which has been used by Department for Transport of United Kingdom. In this study, the fatality index of public transport (express buses) in Malaysia is 0.000009 per billion PKT as

compared to the fatality index in the United Kingdom which is 0.4 per billion PKT for the year 2005. It shows that the use of express buses in Malaysia is much safer than the United Kingdom.

Abstrak laporan projek dikemukakan sebagai memenuhi keperluan untuk Ijazah Master Kejuruteraan

INDEKS KEMATIAN BAGI PENGANGKUTAN AWAM (BAS EKSPRES) DI MALAYSIA

Oleh

NURSITIHAZLIN BINTI AHMAD TERMIDA

November 2006

Penyelia: **Profesor Ir. Dr. Radin Umar Bin Radin Sohadi**

Fakulti: **Kejuruteraan**

Kini belum ada kajian atau penyelidikan dijalankan untuk membuktikan indeks kematian bagi pengangkutan awam di Malaysia terutamanya bas ekspres. Kita hanya mengetahui jumlah kemalangan dalam data simpanan yang melibatkan pengangkutan awam di Malaysia. Oleh hal yang demikian, kajian ini dijalankan untuk membangunkan indeks keselamatan bagi pengangkutan awam (bas ekspres) di Malaysia. Adalah amat penting untuk mengetahui indeks keselamatan pengangkutan awam (bas ekspres) di negara ini berbanding dengan negara-negara maju yang lain memandangkan bas ekspres merupakan mod pengangkutan jarak jauh yang utama di Malaysia. Selain itu, setelah indeks kematian diperolehi dalam kajian ini, ia boleh dijadikan sebagai panduan atau rujukan untuk pembaikan ke atas pengangkutan awam (bas ekspres). Analisis data dalam kajian ini dilakukan menggunakan Kaedah *Mileage Deaths Rate (MDR)* dan unit pengukuran adalah dalam *Passenger Kilometres Travelled (PKT)*. Oleh hal yang demikian, indeks kematian dinyatakan sebagai *per billion PKT* seperti yang telah digunakan oleh Jabatan Pengangkutan di

United Kingdom. Dalam kajian ini, indeks kematian bagi pengangkutan awam (bas ekspres) di Malaysia ialah 0.000009 *per billion PKT* berbanding dengan indeks kematian di United Kingdom iaitu 0.4 *per billion PKT* bagi tahun 2005. Ini menunjukkan bahawa penggunaan bas ekspres di Malaysia jauh lebih selamat dari penggunaan di United Kingdom.

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The development of this project report required the cooperative effort of many people. My deep appreciation goes to Prof. Ir. Dr. Radin Umar Bin Radin Sohadi, my project supervisor who contributed in many important ways by giving such a useful advice and guidance during this study.

I would like to thank all the management and staff in 40 local express buses companies for their cooperation and kindness by giving me a permission to collect all the related data and information for this study.

Much appreciation goes to Royal Malaysian Police (*PDRM*), Malaysian Road Safety Department (*JKJR*), Malaysian Road Transport Department *(JPJ)* or Commercial Vehicle Licensing Board *(LPKP)*, who provides supporting related data needed in this study.

I acknowledge and recognize the support of my family and friends especially to Mr. Kamal Hidhir, who provided emotional support during this study and preparation of this report.

AUTHENTICATION

This project report entitle,

THE FATALITY INDEX OF PUBLIC TRANSPORT (EXPRESS BUS) IN MALAYSIA

By

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13 . 12 . 2006

(Prof. Ir. Dr. Radin Umar Radin Sohadi)
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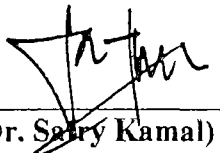

27 . 12 . 2006

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DECLARATION

I hereby declare that the project report is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

NURSITIHAZLIN BINTI AHMAD TERMIDA

Date: 17 NOVEMBER 2006

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LIST OF ABBREVIATIONS

ATSB	Australian Transport Safety Bureau
DFT	Department For Transport of United Kingdom
DOT	Department Of Transport of United State
ETSB	European Transport Safety Council
EU	European Union
FHWA	Federal Highway Administration of United State
HDCs	Highly Developed Countries
IIHS	Insurance Institute for Highway Safety
JKJR	Malaysian Road Safety Department
JPJ	Malaysian Road Transport Department
KLMT	Kuala Lumpur Mass Transit
LPKP	Malaysian Commercial Vehicle Licensing Board
MDR	Mileage Deaths Rate
PDR	Population Deaths Rate
PDRM	Royal Malaysian Police
PKT	Passenger Kilometres Travelled
PMT	Passenger Miles Travelled
RDR	Registered Deaths Rate
SI	Standard International Measurement of Units
STS	Scottish Transport Statistics
TRL	Transport Research Laboratory
TSGB	Transport Statistics Great Britain
UK	United Kingdom
US	United States of America
VKT	Vehicle Kilometres Travelled
VMT	Vehicle Miles Travelled
WHO	World Health Organization

CHAPTER I

INTRODUCTION

Public transportation industry in Malaysia is expanding to meet population's demand which has increased year by year. Currently, buses, taxis, trains and airplanes represent the major modes of public transportation in Malaysia. However, the main mode of long distance transportation in Malaysia is express buses because it is cheaper and affordable.

Types of Public Buses

There are two types of public buses in Malaysia which are express buses with air conditioned and regular buses which are known as local buses. These two types of buses are used to carry passengers from Kuala Lumpur to any major cities in peninsula Malaysia. In East Malaysia, such as Sarawak and Sabah, these kind of buses carry passengers between the major cities within their states through the local road systems since there are no highways or expressways connecting them unlike in peninsula Malaysia. The express buses with air conditioned are used as a research subject in this study.

Benefits of the Use of Public Transport

Public transport has its own importance to the country. Nowadays, many countries agreed to introduce the use of public transportation among their citizens in order to avoid congestions in major cities due to the presence of private vehicles.

According to the article of Integrated Urban Transportation System by KLMT (2005), Kuala Lumpur is one of the most car-dependent cities in the world. Public transportation in this city of nearly two million people comprises only 20 percent of total motorized travel as compared to 62 percent in Manila, with the total population of 10.2 million and 80 percent in Hong Kong, with the total population of 6.5 million. As a result, the road congestions and street-level pollution in Kuala Lumpur have increased.

Nowadays, one of the integrated transportation strategies to address the issues of urban congestions and environmental concerns are to promote the use of public transport. Therefore, it is important to improve the public transport systems in Malaysia in order to encourage people to use the public transport instead of using the private vehicles for their own safety and other related health and environmental hazards.

Public transportation also offers the largest opportunity and the most efficient means for making major strides in environmental quality awareness without involving direct government regulations, especially as seen in the urban and densely populated suburban areas with the worst pollution.

Shapiro *et al.* (2002) found that, the direct environmental benefits of public transportation come primarily from two factors. Firstly, public transportation systems burn less fuel on a per person/ per mile basis and therefore produce less pollution. Secondly, the diesel fuel and electrical power used in public transportation systems are less polluting, unit-by-unit, as compared to the use of gasoline in most private automobiles, SUVs, and light trucks.

Other benefits from the use of public transport such as buses and rail facilities are reducing overall travel fatality risk compared to the use of autos or private vehicles. This has been agreed by Halperin (1993) where the individual interested in reducing travel risk will use surface mass transport. The society interested in reducing overall travel fatality risk, will encourage the making and use of buses and rail facilities, and discourage the building of new roadways or the increased use of autos.

Hence, in view of the need of a safe transport system, it is important to maintain and enhance this mode of passenger transport. Due to this, the study must

be done to develop the safety index of public transportation (express buses) in Malaysia since the accidents involving express buses in this country is on the rise. By knowing the safety index of public transport (express buses), it can attract more passengers to use the public transport. If the results obtained in this study is better than the safety index in developed countries, this will give more advantage and confidence to the passengers to switch over to the use of public transport.

According to the Malaysian Road Safety Department (*JKJR*) Director, Suret Singh (2005), in Malaysia accidents involving express buses reached an unprecedented average of 406 cases a month in 2004. Bus accident figures rose from 1,963 in 2003 to 4,874 in 2004. Based on the source from the Royal Malaysian Police (PDRM 2005), the total number of accidents involving express buses increased almost 2.5 times from 2003 to 2004. In the year 2004, accidents involving buses contributed 2.2 percent of total accidents (Figure 1) in Malaysia (JKJR 2005, 2006). This is a worrying phenomenon since express bus is the main mode of long distance transportation in Malaysia.

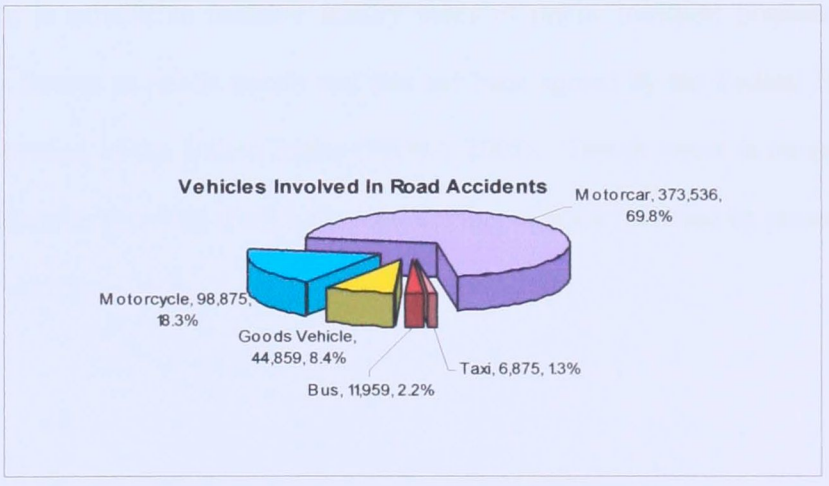

Figure 1: Vehicles involved in road accidents in the year 2004 in Malaysia.

Fatality Index

There are many types of road accidents and one of them is fatal accident. Fatality is defined as a person who is killed and killed is defined as casualties. These casualties sustained injuries which caused death less than 30 days after the accident (TSGB 2005). According to Oxford Minidictionary 3rd Edition (Hawkins 2004), index is defined as a figure indicating the current level of prices and etc. compared to a previous level. In this study, the fatality index of public transport (express buses) in Malaysia is obtained in comparison to other developed countries.

Based on Asian Road Safety Conference Report, fatality index is the number of deaths per road accident (Radin Umar 1993). It shows how much better or worse the vehicle's death rate in the year's analyzed (IIHS 1994). In this study, the chosen unit for the fatality index of public transport (express buses) in Malaysia is passenger kilometres travelled (PKT) or passenger miles travelled (PMT). This is because the PKT unit is suitable to measure fatality index of public transport (express buses) which is known as public transit and this has been agreed by the Federal Highway Administration of the United States (FHWA 2005). Transit travel is measured by passenger miles travelled (PMT), the total number of miles travelled by passengers in transit vehicles.

The benefits from this fatality index comparison are the establishment of targets to aim for as a guideline to improve the current facilities. In order to select achievable targets in long term, it must be compared with developed countries such as United Kingdom, Australia, United States of America and others. This is because, the developed countries known for the lowest fatality rates in the world compared to the developing countries in Asian Region including Malaysia. Based on the state of World Health Report by World Health Organization (WHO 1995), external causes such as accidents and violence accounted for about 4 million deaths, or some 8 percent of the total, again mostly among adults. Developing countries have nearly four times the number of deaths from these causes compared to the developed world.

The developed country chosen as a comparison in this study is United Kingdom. According to Road Safety Minister of Great Britain, Stephen Ladyman, Britain has one of the best safety records in the world with a substantial drop in the number of people who died on Britain's road (DFT 2005).

PROBLEM STATEMENT

Until now, there is no research or study being conducted to establish the fatality index of public transport (express buses) in Malaysia. Due to this, the entire Malaysian citizens did not know how safe the express buses in their country are compared to other developed countries. The improvement on public transport

(express buses) in Malaysia should be given more attention and the fatality index obtained in this study could be used as a guideline or reference. Presently, the available data storage being kept by the Royal Malaysian Police (PDRM 2005) shows only the total number of accidents and deaths exclusive of the safety index especially for express buses (Figure 2) and there is an increase in the total number of accidents involving express buses each year (Nor'aishah 2005). Hence, in-depth study needs to be done to develop the safety index for any travel modes in Malaysia in order to gauge how much better or worse the vehicle's death rates were in the year's analyzed.

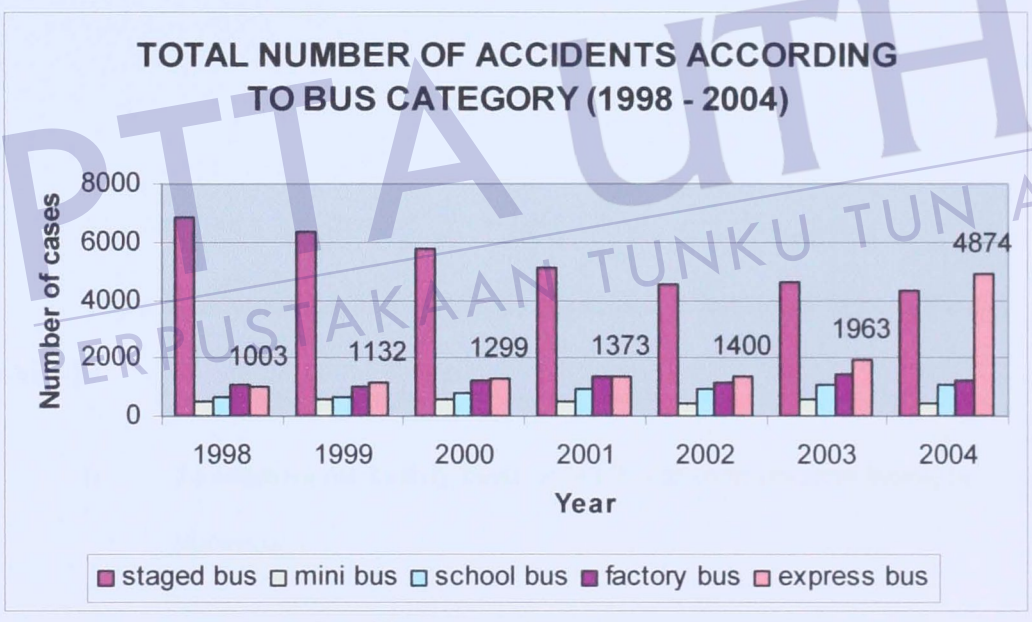

Figure 2: Total number of accidents according to bus category from year 1998 to 2004 in Malaysia.

RESEARCH QUESTION

Based on this research title, there are two research questions needed to be answered at the end of this study as follows:

i) What is the fatality index of public transport (express buses) in Malaysia?

ii) How safe the public transport (express buses) in Malaysia as compared to other developed countries?

OBJECTIVE

There is only one main objective in this research that needs to be achieved, which is:

i) To establish the fatality index of public transport (express buses) in Malaysia.

THE IMPORTANCE OF THE STUDY

There are many importances of this study and the main one is to develop the safety index by establishing fatality index of public transport (express buses) in Malaysia and compares it to other developed countries. As such, the actions can be done in upgrading and improving the safety level of public transport (express buses) in Malaysia if the fatality index shows the negative results as compared to other developed countries. Besides, in future, the public transport can be one of the most important solutions to decrease the traffic congestions and street-level pollution especially in urban and major cities in Malaysia. This has been done by developed countries such as the United states of America. Their citizens have realized the importance of public transports role in their countries. So it is important to develop the safety and fatality index in order to encourage people using express buses rather than private vehicles.

Since there has been no study being done regarding this topic, the findings in this study which is to establish the fatality index of public transport (express buses) in Malaysia could be used as a reference or a guideline for any researchers to expand the use of fatality index in their study for more details in future.

SCOPE OF STUDY

There are some limitations that need to be followed in this study. This study is only limited for public transport which focuses on express buses in Malaysia. The fatality index obtained from this study is to be taken for comparasion purposes with other developed countries such as the United Kingdom. The data obtained and used in this study is only for the year 2005.

DEFINITION OF TERMS

1. Fatality According to TSGB (2005), fatality defines as a person who is killed and killed defines as casualties who sustained injuries which caused death less than 30 days after the accident.

2. Index According to Oxford Minidictionary 3rd Edition (Hawkins 2004), Index defines as a figure indicating the current level of prices and etc. compared to the previous level. In this study, the fatality index of public transport in Malaysia obtained is compared to other developed countries.

3. Fatality index According to Asian Road Safety Conference Report (Radin Umar 1993), fatality index is the number of deaths per road accident. In this

study, the chosen unit for the fatality index of public transport (express buses) in Malaysia is passenger kilometres travelled (PKT).

4. Passenger kilometres travelled According to the TSGB (2005), passenger kilometres travelled is the total distance travelled annually by passengers by all modes of transport.
(1 passenger kilometre is equal to 1 person travelling 1 kilometre).

5. Mileage Deaths Rate (MDR) MDR is generally defined as fatalities per 100 million vehicle miles, reported annually. MDR calculates deaths per mile of vehicle travel (Halperin 1993).

6. Registered Deaths Rate (RDR) RDR is defined as annual fatalities per 10,000 motor vehicles (Halperin 1993). The RDR method does not take the passenger as the item in a calculation and it is normally making the risk comparison of vehicle where the unit is in per vehicle, for example, fatalities per airplane or fatalities per bus.

7. Population Deaths Rate (PDR) PDR is defined as annual fatalities per 100,000 people in the population. PDR reports the number of fatalities from a particular cause relatively to the number of people then living. It is generally reported annually, for the population of a politically designated territory, or a subpopulation thereof. The units are in annual deaths per 100,000 population (Halperin 1993).

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

The total number of public transport (express buses) on the road has increased and due to this, the total number of public transport (express buses) involved in accidents is on the rise. According to the data of Royal Malaysian Police (PDRM 2005), the total number of accidents involving express buses has increased almost 2.5 times from 2003 to 2004 (JKJR 2005, 2006). This figure shows that in this country, the accidents rate is increasing rapidly and in serious situations that need an immediate attention to address the problem. Therefore, it is important to develop the safety index of public transport (express buses) in order to improve or lower the accidents rate involving express buses in future.

Safety can be measured in many different ways. The number of people killed and injured provides a simple measure of the dangers of travel by a particular mode of transportation (DFT 1999).

Safety is one of the most important goals in the operation of the transportation system. Over the past three decades, transportation fatality rates have

declined in relationship to system usage, due in large part to safer cars, tougher police enforcement, and increasing use of seat belts, air bags, and child safety seats. However, in many accident categories, the actual number of accidents has increased because there are more people using the transportation system (FHWA 2004).

According to *JKJR* Director, Suret Singh (2005), in Malaysia, accidents involving express buses reached an unprecedented average of 406 a month in 2004. Bus accident figures rose from 1,963 in 2003 to 4,874 in 2004. However, based on Road Safety Council Meeting held in Kota Kinabalu, Sabah last year, death among express bus drivers and passengers have decreased for the last two years, where in 2004 (January – September) there were 47 deaths reported and between January to September 2005, there were 36 deaths reported (Nor'Aishah 2005). This figure is only for the data between January to September.

When focuses on public transport (express buses) in Malaysia, the accidents have increased year by year and this matter must be addressed to as soon as possible. This is what this paper is all about, which is to develop the safety index of public transport (express buses) in Malaysia by establishing the fatality index, which is one of the methods to measure the safety level of public transportation in Malaysia so that improvements and actions can be taken immediately.

Fatality index is the number of deaths per road accident (Radin Umar 1993). Fatality index is very useful to show how much better or worse this vehicle's death rate is in the year's analyzed (IIHS 1994). In conjunction to measure the fatality index, there are three main methods being used.

There are various approaches to calculating transportation risk. It broadly includes property damage and financial loss, narrowly, fatalities and injuries or still more narrowly, risks of death only. Three common measures used to calculate transportation risk are Mileage Deaths Rate (MDR), Registration Deaths Rate (RDR), and Population Deaths Rate (PDR) (Halperin 1993).

2.2 THREE COMMON MEASURES ON FATALITY RATES

There are three common measures on fatality rates and these are Mileage Deaths Rate (MDR), Registration Deaths Rate (RDR) and Population Deaths Rate (PDR).

2.2.1 Mileage Deaths Rate (MDR)

MDR is the travel risk measure and most widely used in the United States and the figures for average MDR are well-known. MDR is widely used in discussing the safety of various classes of roads.

MDR calculates deaths per mile of vehicle travel, it reports average annual fatalities per 100 million miles of passenger travel (Halperin 1993). MDR is generally defined as fatalities per 100 million vehicle miles reported annually.

In this paper, the MDR method is used in calculating the fatality rates and establishing the fatality index of public transport (express buses) in Malaysia. This is because, the MDR gives a per distance travelled approach to risk result which is relevant to the unit of fatality index chosen (PKT). It also takes the passenger kilometre age into calculation and can show the comparison of fatality risks among different modes of transportation. The example which was given by Halperin (1993), whereby two people both need to go twenty miles and one decides to travel by auto, the other by bus. The one using roadway/auto travel has a 70 times greater chance of dying on the trip than the one using the bus.

2.2.2 Registered Deaths Rate (RDR)

RDR is defined as annual fatalities per 10,000 motor vehicles. RDR does not lend itself to ready comparison of various modes of travel. The National Safety Council reports RDR for bicycles as well as autos, the auto RDR is 36 times that of the bicycle RDR. One could calculate fatalities per airplane or per bus, but not meaningfully. RDR does allow a comparison of fatality risk between cultures or governmental units, but this risk comparison is per vehicle, a choice of denominator which is not obviously meaningful (Halperin 1993).

The RDR method does not take the passenger as the item in a calculation and it is normally by including the risk comparison of vehicle where the unit is in per vehicle, for example, fatalities per airplane or fatalities per bus. So it does not suit the unit chosen for this study, which is PKT.

2.2.3 Population Deaths Rate (PDR)

PDR is a third widely reported value. PDR is defined as annual fatalities per 100,000 people in the population. It reports the number of fatalities from a particular cause relatively to the number of people then living. It is generally reported annually,

for the population of a politically designated territory, or a subpopulation thereof. The units are in annual deaths per 100,000 populations (Halperin 1993).

The problem with PDR is that it does not appear to be easily communicable to the public. For example, the average person, a risk of 25 per 100,000 may be incomprehensible. Dividing the PDR due to a particular cause by the PDR for the population as a whole gives jurisdiction to the percentage of people dying of a particular cause for the given year. For example, an overall PDR of 845 per 100,000 population for the U.S., for 1979, a PDR is due to what is termed accidents (roughly half being auto crashes) of 51 per 100,000, and thus a ratio of 6 percent. It is clear that the population appears twice, in the denominator of the overall death rate and in the denominator of the cause-specific death rate (Halperin 1993).

PDR is not a suitable method to be used in this study because it only reports the number of fatalities from a particular cause relative to the number of people then living. It means that PDR is only analyzed for certain particular cause and does not suit the unit chosen for this PKT.

2.3 FATALITY INDEX MEASUREMENT UNITS

There are many possible units to compare for any of several expressions of fatalities rate as follows (GTST 1998):

i) Fatalities per vehicle kilometre of exposure

ii) Fatalities per passenger kilometre of exposure

iii) Fatalities per hour of exposures

iv) Fatalities per number of trips

v) Fatalities per number of participants

vi) Fatalities per population regardless of individual exposure

vii) Fatalities per total number of accidents

2.3.1 Fatalities per Vehicle Kilometre of Exposure

Fatalities per vehicle kilometre of exposure are established using RDR method because it does not take the passenger as the item in the calculation and it is normally done to make the risk comparison of vehicle where the unit is in per vehicle. So this unit is not being used in this study.

Highway use is defined by vehicle miles travelled (FHWA 2005). It shows that this unit is only suitable for the usage of highway and it does not take into accounts about the total passengers.

2.3.2 Fatalities per Passenger Kilometre of Exposure

Fatalities per passenger kilometre of exposure are established using MDR method because MDR calculates deaths per mile of vehicle travel whereas deaths here mean the passenger. According to Australian Transport Safety Bureau (ATSB 2005), fatalities per passenger kilometre of exposure may provide the best cross modal comparison in terms of exposure. Due to the reasons, this unit is the most suitable for public transport because of the word passenger itself and the definition of public transport itself which carries the passengers to any destinations.

Passenger mile is a unit of measurement of the passenger transportation performed by a railroad during a given period, usually a year, the total of which consists of the sum of the mile travelled by all the passengers on the road in the period in question. Passenger mileage or passenger miles travelled are defined as passenger miles is collectively the total number of miles travelled by passengers on a railroad during a given period. Passenger Miles refers to the total distance travelled by all passengers in a public-transit vehicle on a single passenger trip. A five-mile commuter train's trip with a driver and 50 passengers would constitute as one vehicle

trip, 50 passenger trips, five vehicle miles or miles driven, and 250 passenger miles (Shapiro *et al.* 2002).

The calculation of passenger kilometres travelled that has been used by International and Analysis Department for Transport in United Kingdom is by taking number of passengers' tickets and average distance travelled and then multiply both figures to get the total number of passenger kilometres travelled (Anil 2006). The calculation method used by DFT of United Kingdom and the method used by Shapiro *et al.* (2002) is the same and this method also being used in this study.

The passenger transportation which is indicated in the definition of passenger mile means the transport which carries the passenger. Hence, the public transport can use this type of unit because it carries the passenger all the time. Shapiro *et al.* (2002) also stated that the passenger miles are so much related to public transit vehicle or public transport which relates to passenger. Passenger-miles for other modes of transportation are calculated based on actual passenger counts and recorded trip lengths. The passenger fatality rates can be interpreted as the risk a traveller runs of being killed, per million or billion kilometres travelled and this information relates to passengers.

This unit can also be used as a comparison among other modes and this has been done in developed countries such as in European Union countries (EU). Based

on Transport Safety Performance in the EU, rail and air travel are the safest modes per distance travelled, followed by bus. Bus travel has a 10 times lower fatality risk than car and air travel. Within the EU, the average flight distance has about the same fatality risk per passenger kilometre as that of train travel. Both are half as risky as travel by coaches (ETSC 2003).

2.3.3 Fatalities per Hour of Exposure

This unit of measurement was established using PDR because the fatalities are calculated for a particular cause of time (hour). So this is not suitable for this study.

2.3.4 Fatalities per Number of Trips

Fatalities per number of trips are not suitable for this study because they do not relate the passenger to the fatalities. They only relate the number of trips of the vehicles and were established using PDR method.

2.3.5 Fatalities per Number of Participants

This unit is related to passenger only and it is using the PDR method to establish the value because it is considering the particular cause which is only considering the number of participants. It does not take the kilometre age into calculation so it is not relevant to be used in this study.

2.3.6 Fatalities per Population Regardless of Individual Exposure

This is also established using PDR method and only considered on a particular cause of the population regardless of individual exposure, so it is not suitable for this study.

2.3.7 Fatalities per Total Number of Accidents

This unit is established using PDR method and only considered to a particular cause of the total number of accidents and hence, it is not suitable for this study.

2.4 CALCULATION OF FATALITY INDEX USING MDR METHOD

Passenger Miles refers to the total distance travelled by all passengers in a public-transit vehicle on a single passenger trip. A five-mile commuter train trip with a driver and 50 passengers would constitute as one vehicle trip, 50 passenger trips, five vehicle miles or miles driven, and 250 passenger miles (Shapiro *et al.* 2002). This calculation method that has been stated by Shapiro *et al.* also being used by The International and Analysis Department for Transport in United Kingdom where they are taking number of passengers' tickets and average distance travelled and then multiply both figures to get the total number of passenger kilometres travelled (Anil 2006). The calculation of PKT in this study is based on this method.

2.4.1 Calculation of Passenger Kilometres Travelled (PKT) of Samples

In this study, calculation of PKT of samples is obtained by using total kilometre age of each express buses data and also the total number of passengers using each express bus by taking the total number of passengers' tickets in the year analyzed. This formula is used because it is based on the definition of PKT by the Department for Transport of the United Kingdom (DFT 2005), passenger kilometres is the total distance travelled annually by passengers by all modes of transport. For example, 1 passenger kilometre is equal to 1 person travelling 1 kilometre.

PKT of samples = Total Kilometre age x Total Passengers

In this study, the samples are involving data of 40 local express buses company in Malaysia.

2.4.2 Calculation of Average Passenger Kilometres Travelled (PKT) in Year 2005

In order to calculate the average PKT of express buses in the year 2005, the PKT of samples has to be divided by the total number of express buses (sample) and the answer obtained is multiplied by the total number of express buses in Malaysia in the year 2005.

Average PKT of express buses in year 2005:

$$= \frac{\text{PKT (sample)}}{\text{Total number of express buses (sample)}} \times \text{Total number of express buses in Malaysia in year 2005}$$

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