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The Future of Human Mobility

Special Issue:

Road Safety

PREFACE

Dear Readers,

Welcome to the first issue of volume 3 of our online-peer-reviewed International Journal of the Society of Transportation and Traffic Studies. Four issues of the journal are published annually.

It is fitting and timely that the first issue of this year journal focuses on road safety, as we are now in the UN Decade of Action for Road Safety 2011-2020. The goal of the decade is to significantly reduce the number of global deaths on the road, currently stand at some 1.3 million annually.

This issue contains 5 papers covering wide geographical regions from Taiwan to Vietnam to Thailand and Malaysia, and important topics in road safety. Two papers discuss the development of accident database which is the starting point for the planning of effective strategies and actions to deal with crashes and their consequences. One study was for the state of Johor Bahru, Malaysia, and the other for Thailand. A paper on urban road safety describes the safety situation for Ho Chi Minh City in Vietnam, practical solutions were also proposed. A practical paper focuses on in-depth crash investigation of bus accidents in Malaysia. The final paper presents the relationship between pedestrian fatal accidents and their characteristics in Taiwan.

We trust you will once again find these papers informative and useful.

Pichai Taneerananon
Professor
Chair of Editorial Board

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DATABASE DEVELOPMENT OF ROAD TRAFFIC ACCIDENT CASE STUDY JOHOR BAHRU, MALAYSIA

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ABSTRACT:

This study is to develop a database system for the road traffic accident (RTA) by the rescue operation. In Malaysia, there are four cores involving in dealing with accident database, such as (1) hospital; (2) police; (3) fire and rescue; and (4) the civil defense. Thus, this paper aims to integrate the data from these four sources. Available data are classified hierarchically based on their share characteristic and integration established by identifying the integrated data from mapping to the target data. The data available is used by the head of department and staff from emergency provider which they can be viewed and query. The data integration used to enhance the cooperation between emergency providers according to accident data. The development of database uses Visual Basic Program and Microsoft Access. Hopefully the modules can assist the providers to improve their emergency service and also can be used for other research to reduce the fatalities of road traffic accident

KEYWORDS: accident database, emergency providers, data integration

1. INTRODUCTION

Emergency Response Systems (ERS) are used by providers to assist for responding to an emergency situation. The goal of the ERS are to facilitate clear communication; to improve collaboration between providers; to improve the efficiency and effectiveness of decision-making; and to manage data for preventing or at least for mitigating information overload (Murray, E. 2007).

Since the last decade, Malaysia has economic expansion and growth in population, economy, industrialization and motorization. The population has increased at an average growth rate of about 3% per year. The increase has been led to a consequent raise in the number of road accidents. In addition, a new road safety was set up to specifically plan, coordination, implementation; and evaluation of intervention for the road safety in the country (Law et al. 2005). Malaysia recently reduces the fatality rate to 3.4 deaths per 10,000 vehicles (RSDM 2011) (see Figure 1 and 2).

Road traffic accidents (RTA) and road traffic injuries (RTI) become the major problems in socio-economic and public health. Nik Hishamuddin et al. 2007 found that the accidents place the top ten of principal causing deaths in government hospital. From data analysis, number of accidental injury increases every year, however, number of victim sustained by severe injuries is declined. In addition, even there are some efforts to avoid the road accident, number of death is still unchanged over the years. Its can be concluded that response of the emergency provider and the public cooperation yield the poor result.

The numerous efforts have been made by Malaysian Government to improve the road safety to achieve the target. And, the advanced road accident database systems are required to better help for road accident causation. The quality of database can influence the road accident. This paper intends to improve the collection data and to create the coordination among emergency providers.

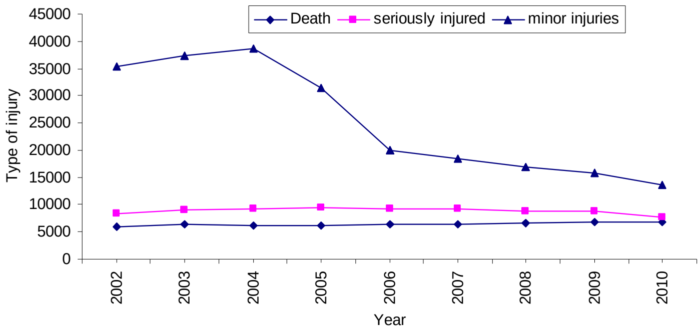


Figure 1 Type of injury

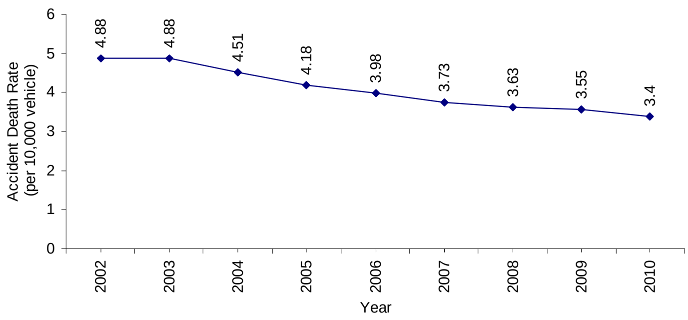


Figure 2 Road accident deaths per 10000 vehicles

2. RTA DATABASE

In Malaysia, the ERS is not totally developed. There are three cores involving in dealing with emergencies services, such as: (1) the fire and rescue; (2) police; and (3) ambulance. Actually, the aim of three providers is to prevent loss of life and damage with the high demand of time response. There is not coordination among providers to handle the road accident. Some additional providers (civil defense department and a volunteer organization) assist the three main providers (Figure 3). In addition the main problem of handling the road accident was developed using own database. Recently, Malaysia should upgrade the emergency response systems.

Government of Malaysia has been developing The Malaysian Emergency Rescue Services (MERS) 999 to handle the road accident system. However, this project including the Computer Telephony Interface (CTI), Computer Aided Dispatch (CAD) and GIS should see the realization. The MERS999 system will definitely help greatly for improving the response time and efficiency of emergency services. The upgrading and efforts to integrate various providers are very important steps which should be looked seriously by Malaysian Government in ERS project. One of the major limitations of ERS in Malaysia is deficiency integration between providers during an emergency situation. There is no uniform communication for dispatching and data sharing for the entire country. Therefore the system should discover a combination of all providers to supervise the systems. The cooperation starts using the construction for RTA database systems.

Since 1991, there is one established Microcomputer Accident Analysis Package (MAAP) to manage accident data using the road accident form POL27. The continually accident data available from the Royal Malaysian Police (RMP) and the new version using Windows based, they called as Computerized Accident Recording System (CARS). These system was use to maintain and make a system of cross-tabulation analysis providing for general road accident statistics (Law et al. 2004; Hizal Hanis H & Sharifah Allyana, 2009).

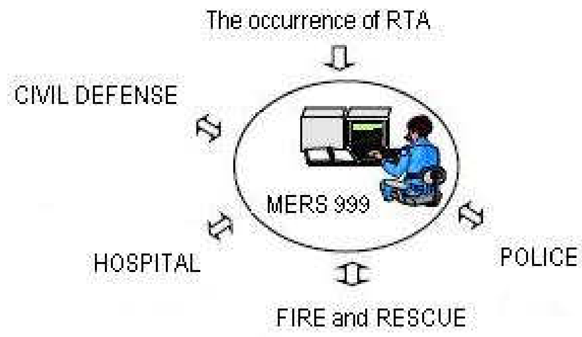


Figure 3 Typical ERS systems in Malaysia

From the research made by Choy, et al. 2007 shows that the Malaysian Road Traffic Injury Surveillance System (MRTTISS) is applicable only for local hospital. The systems provided a data entry, storing, retrieving, editing and saving the road traffic injury data. Although there is an existing system to capture road accident data, the system was not aimed to establish a RTA database system and it has not been fully implemented. This is only applicable for the current system structure database from police and the database is not obtained from other providers such as hospital, fire and rescue, and civil defense. Other providers have no the proper database system and several of them uses the hard copy. Therefore, the accident data are often kept just for recording purposes rather than using it as a source of information data accident. Thus, a system of database should be available in the attempt to combine the database on the RTA in order to analyze an accident.

However, the compilation has involved several issues, especially for the data quality problem. Data integrity and checking probably has not been conducted since it has no similarity to RTA cases. Therefore, a new system is needed to address the issue of data compilation as well as for data analysis. For the early step, a construction of data collection and analysis has been developed by using RTA database structure in order to improve the effectiveness and efficiency of emergency services management in Johor Bahru study area.

2. METHOD

2.1 Requirement Analysis

Each provider has RTA database which is obtained by the emergency work. Currently, the police database has been only adapted to digital copy since there is the existing database of CARS. Other providers have no any digital data system causing they do not support for the RTA database. The database is created to help for identifying the road accident, using the combination variety of database from providers. This concept is suitable for application centralized systems for study area. The construction of systems should provide the facilities to providers to record their data for RTA database and have capability to view as a report and query back their own data. The data can be used for the further study if required and to handle an emergency situation plan.

2.2 Data

Data is one of the major problems to RTA research in Malaysia. The shortcomings of RTA data are widely acknowledged throughout the country. Unfortunately, nearly one of the completed sources of accident data is provided by the police from POL27 form. To develop the RTA database, there are four main data sources principally (police; hospital; fire and rescue; and civil defense) used in this research. The RTA database from a provider excepted by the police database should be input manually from hardcopy into the systems. Instead of a lot of data, the data from end of 2008 until early 2009 can be used only for the purpose of construction of RTA database. This study considered only about RTA occurred within the Johor Bahru area. The data is also selected only an important data relating with RTA. The data are structured into different type of tables before they will be created the similarity identification in order to make the data more manageable and easy to retrieve (Kowtanapanich, et al. 2007). The variables such as location, date and time are used as the similarity of the analysis Despite of RTA data from several providers cannot maintain the records in digital copy. They also have no a standard forms such as what the police data. In addition to develop a RTA database, data integration between police, hospital, fire and rescue and civil defenses can be used as a database (Figure 4).

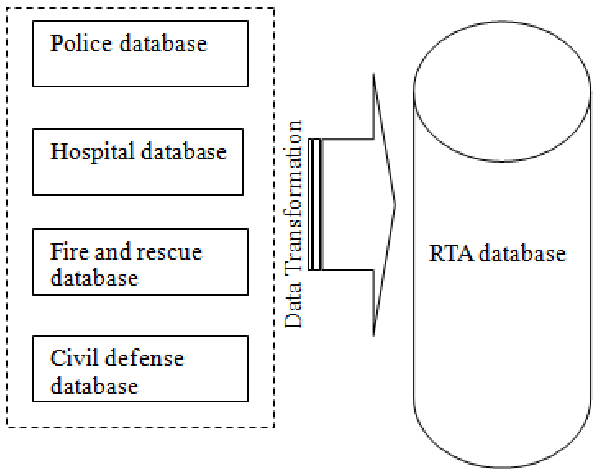


Figure 4 Development of RTA database

2.3 Database Design

The accident database coming from RTA in study area are key-in according with their providers database format and store in different set of database before integration for RTA database. Database usually contains the information about the general accident info, callers, vehicle and driver, victims, type of treatment and location info (Table 1).

Data collected from each case of RTA is difficult to incorporate if there is no variable acting as the key to link between the data. Difference case of RTA uses a report number and can be applied easier for executing. For certain RTA database is not used as a report number, for a time, date and location will use to facilitate the combination of RTA data. In addition, some of the data cannot be combined because of missing data. Since the providers collect the data according to the standard operational procedure themselves. The different of collecting data from each provider is the important problem for the data link. In the future, each provider should develop the data link in one standard from MERS999. This study tries to extend only the combination data, not for the linking data. All data is incorporated in the systems developed using Visual Basic and Microsoft Access. Furthermore, the data analysis can be used for GIS in subsequent research such as blackspot analysis (Saffet E., et al. 2008).

3. APPLICATION DEVELOPMENT

Since the RTA data mostly are obtained from the hard copy, the application is started from the development of data entry and the data can be combined into the Meta data. All providers input the data accordingly their format. They also can edit, query and print report within their own database (Figure 5). Firstly the form of database entry was developed before the database integration process. Data integration from providers can be produced containing the Meta data of RTA. Then the application will be developed from the available database for query, viewing and creating a report. A different module is developed for the head of department including staff. This is for protecting the confidentiality of data from manipulation process. The head of department have an access for the whole database from providers. The staff uses only the general access. For application the systems effectively, the interface is designed by the suitability of every provider application.

Table 1 Traffic accident variable list

Factors	Data Component	P	H	F	C	Factors	Data Component	P	H	F	C
General Accident Info	Report no.	x			x	Victims info	Victims name				x
	State code	x			x		Victims address				x
	District code	x					Victims id no.				x
	Office code	x	x		x		Victims sex				x
	Month	x	x	x	x		Victims age				x
	Hour	x	x				Victims race				x
	Day of week	x					Victims injury	x			x
	Time receive call		x	x	x		No. of victims				x
	Time action starting		x	x	x	Treatment	Type of treatment		x		x
	Time departure (loc)		x	x	x		Medical Services		x		
	Time departure (base)		x		x	Location	Name of road	x		x	x
	No. vehicle involve	x					Type of road	x			
	No. vehicle damage	x					Kilometer post	x			
	No. drivers killed	x					Latitude	x			
	No. drivers injured	x					Longitude	x			
	No. passenger injured	x					Route name	x			
	No. pedestrian injured	x					Landmark		x		
	No. Pedestrian killed	x					Zone			x	
	Accident severity	x		x			Map code	x			
	Road type	x					Type of location	x			
	Road condition	x					Type of area	x			
	Weather	x			x		Direction	x			
Caller	Caller name		x			Extra info	Animal info				x
	Phone no.		x				type of ambulance		x		x
	Address		x								
Vehicle and driver	Vehicle damage	x									
	Vehicle model				x						
	Vehicle color				x						
	Registration no.				x						
	Vehicle c.c				x						

Remark
P-Police **H**-Hospital **F**-Fire and Rescue **C**-Civil defense x - the attribute data is available

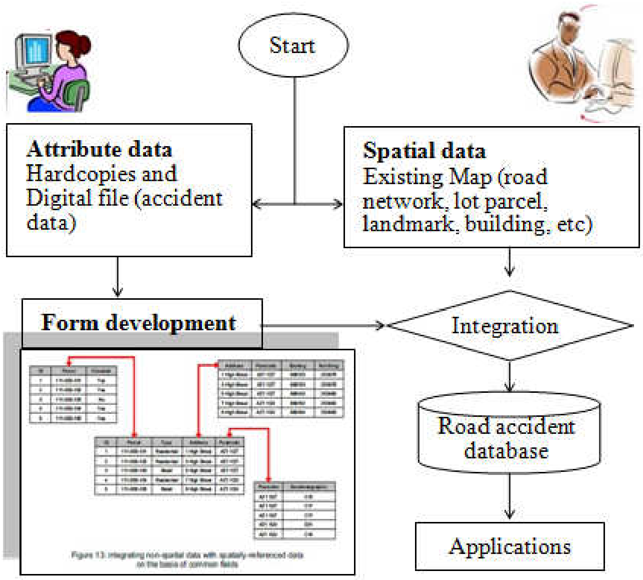


Figure 5 Data application process

3.1 Modules for provider staff

Each provider staff can use the system by input data, editing, viewing and creating the report. This process uses the access password. Figure 6 shows the interface menu for Hospital Sultanah Aminah, one of the providers involving with emergency road accident. From the main menu, an input menu, find data, back and exit menu is developed. From input data menu, a submenu is created the data input menu for dispatcher data and pre-hospital data. The back menu uses to proceed to other providers and exit menu for exit from the systems. Figure 7 shows the similarity form of data input from dispatcher unit, trauma and emergency. Accident variable data is input according to RTA cases followed by variable listed in Table 1. Only the staff from each provider allows conducting input the data. They also can edit the data and a given password before they use the systems. Currently the process can incorporate with the existing data. For the next time, the data entry should input directly after or during the RTA occurred. It requires to facilitate data from each provider and to create a similarity of data. After data input and data integration are completed, the users can view the query/find menu to obtain the data about the RTA in their own database only (Figure 8). Later on, the query/find menu display only a database table and willing to create an accident report.

Figure 6 Hospital data input interface

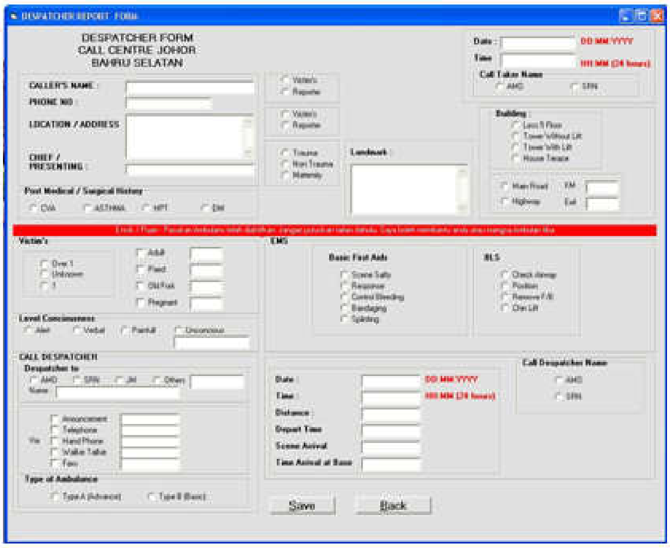


Figure 7 Data input for hospital dispatcher

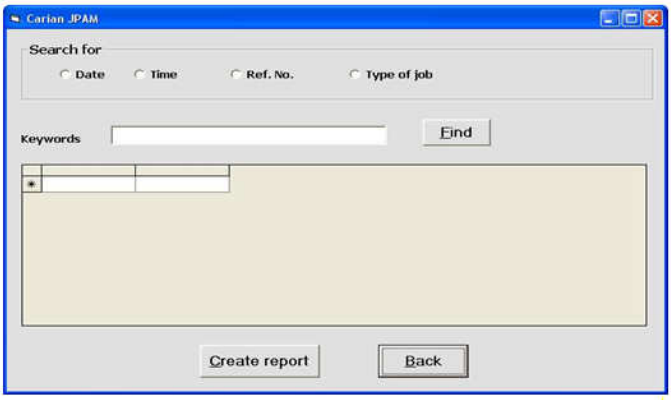


Figure 8 Query of hospital data

3.2 Module for the head of department

The advantages of this database are the capability of accessing from the other provider database by their head of department. The data is useful for the provider to provide a report for their emergency plan. The function of accessing database to the head of department menu shows in Figure 9. The password system is developed to protect the menu and the database.

By this menu as shown in Figure 9, head of department has to select the special menu to access all database from each provider. Then head of department can search the specific data from database. If the head of department select 'All provider' menu, it can make some query and statistic accident from all provider following the uniform variable (time and date). In addition, accident location from the police data to determine the blackspot using GIS. Figure 10 (a and b), shows the map of blackspot according to the level of ranking. However, this study can support the advanced research.

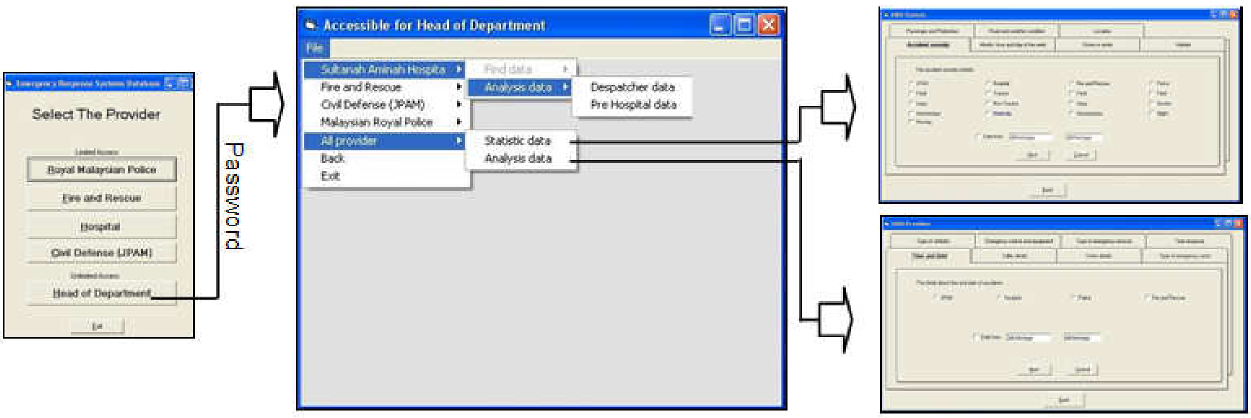
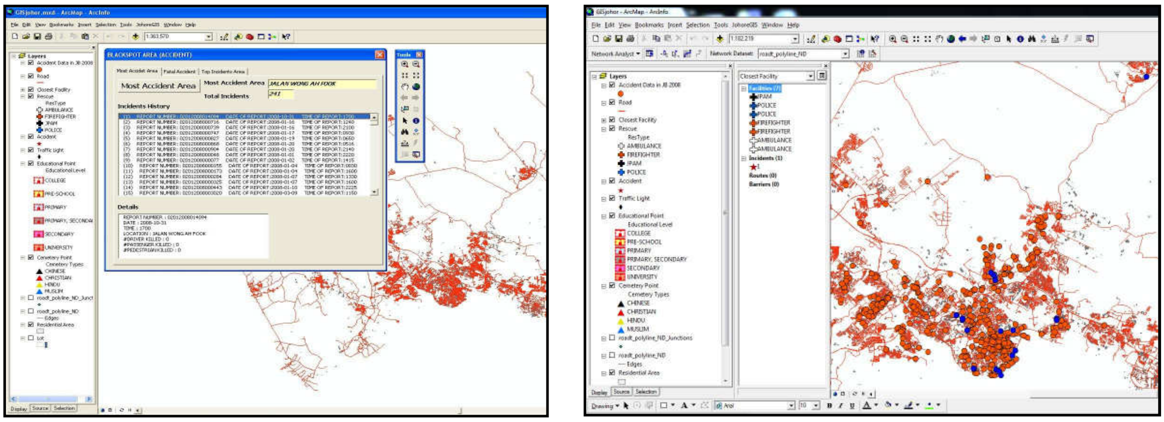


Figure 9 Menu for head of department accessing



(a) (b)

Figure 10 Blackspot finding using GIS

4. DISCUSSION

The results of the development of RTA database are able to provide and serve as the source of plan for emergency response in the study area. The development of RTA database has resolved also the issue of existing RTA database and can be used for further analysis system. Functionality in RTA database such as the enhanced data tabulation can help the emergency provider to setup their proper database compared with the hard copies. From the head of department accessing database, they can plan the strategies for reducing the severity of accidents and optimally reduce the number of accidents and fatalities.

With the RTA database, accident data will be fully utilized and will not be used only for record keeping. Furthermore, with having a digital database system can help to solve the delay in data entry, thus enabling fast access to the data. With the development of RTA database, it is possible for its functionalities to be further expanded. For example, the next research has currently to extend continually road accident analysis from the RTA database. Correlation between four sources of database can be made and an advanced study can be carried out. In addition, the existing of MRTTISS has been developed to provide an injury data, and the integration with CARS can be made easier to enhance the development of RTA database. For further study, this data expect to be used for various link of emergency data, especially for accident and injury data (Anna et al. 1993), it can be analyzed by GIS (Saffet et al. 2008, Zhuon et al. 2003) using the black spot analysis and statistic accident (Isabelle et al. 1999)

5. SUMMARY AND CONCLUSION

The result of the RTA database system in Malaysia has shown that accident data can be used as the primary source for emergency response plan and applicable for the accident situation. This system is aimed to increase the efficiency of emergency services in Johor Bahru area. The integration series of data come from various emergency providers. The application of the system can be used largely between the providers; they will cover the coordination and the improvement of their service for road accident. It would be more advantage if it is conducted with the integration RTA database and GIS. And, finally the application of the research optimally decreases the fatalities of accidents.

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REALITY OF URBAN ROAD SAFETY IN HO CHI MINH CITY AND SUGGESTED SOLUTIONS

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ABSTRACT:

This paper is intended to provide an overview of the reality of urban road traffic safety in Ho Chi Minh City, Vietnam and to give a brief description of the suggested solutions to such reality. First, the collection of statistics on the infrastructure, vehicles and accidents is done. Then, these statistics are categorized as well as analyzed so as to lay the foundation fo r the suggested solutions.

KEY WORDS: road safety, road accidents, safety planning

1. INTRODUCTION

Ho Chi Minh City is the biggest city in Vietnam, located in the southern part of the country. This is a city of motorbikes and poor traffic safety. More particularly, road traffic safety is one of the most serious problems in this city. The reality of this problem can be felt in different aspects including great numbers of accidents with considerable death tolls and costly damages, and traffic congestion of high frequency. These facts result from a number of factors, such as poor traffic infrastructure, low awareness of road users and high density of vehicles due to urbanization and overpopulation. The traffic problems above are supposed to lead to various negative consequences, namely, human loss, damage to vehicles, traffic congestion as well as other potential consequences. So far, there have been a number of policies on urban road traffic set up by the local government. However, not much effectiveness has been seen in term of road traffic safety. Therefore, it is necessary to have a closer look at the issues in order to launch practically satisfactory solutions to the situation.

2. REALITY OF ROAD NETWORKS AND REGISTERED VEHICLES IN HO CHI MINH CITY

The main road networks in Ho Chi Minh City as shown in the Figure 1 consist of

2.1 ROAD NETWORKS

National roads managed by the central government, intercity roads and urban roads managed by the local government. A system of ring roads has been planned. A portion of this road system is under construction. Ho Chi Minh City has 3,654 named roads with a total length of 3,413 kilometers and a total pavement area of 24,300,000 square meters.

However 69.3% of these roads have a width of under 7.0 meters. The road density is 1.9 km/km^2. There are 1,350 intersections and roundabouts, 120 of which are located on 75 main urban road and intercity roads. Most of these 120 intersections are at-grade and of low traffic capacity; only 9 which are under construction are grade separation. The station system consists of 5 coach terminals with a total area of approximately 15.8 ha and a capacity of 27.9 million passenger per year; 01 main bus station located in the center of the city with a total area of 0.22 ha; 03 lorry stations located on the ring road system with a total area of 3.8 ha; and 07 taxi stations with a total area of 3.3 ha. Generally, the station system is small in number as well as area, occupying 0.1% of the urban area. Most of terminals are located in inner city regions and have limited area, leading to chaos and giving rise to traffic congestion.

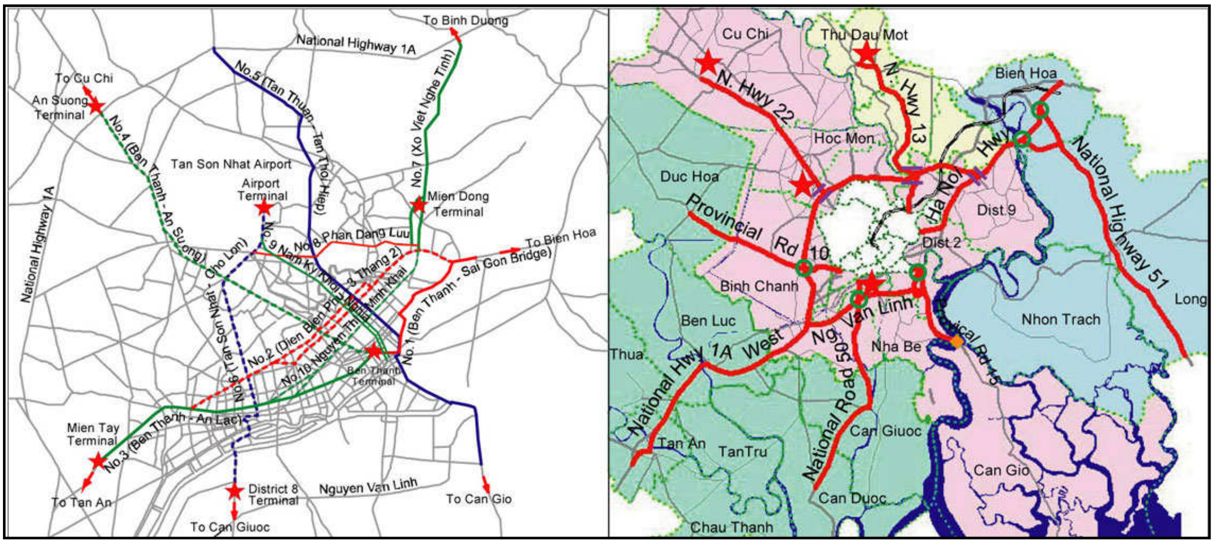


Figure 1 Road network and terminals in Ho Chi Minh City (HCMC)
Source: JICA (2005) - HOUTRANS

2.2 REGISTERED VEHICLES

There are currently approximate 4.8 million vehicles in HCMC, approximately of 10 percent of which are cars operating on the streets. Each year, the city sees an increase of 10 percent of the existing vehicles, which means approximately 120 additional cars and 1,200 motorbikes per day. Statistics of the period from 2000 to 2010 points out that the rate of increase in vehicles seems to surpass the rate of population growth. This fact can be seen in Figure 2 with the reference to the trends of vehicle density. The density of motorbikes (the number of motorbikes per 1,000 persons) in HCMC is rather high in comparison with that in other cities of Vietnam's neighboring countries. In 2000, Vietnam's density of motorbikes was ranked sixth in Asia; and in 2005, it was ranked third, after Taiwan and Malaysia. With this upward trend, in 2010 the density of motorbikes in HCMC reached its peak: 645 motorbikes per 1,000 persons as showed in Figure 3.

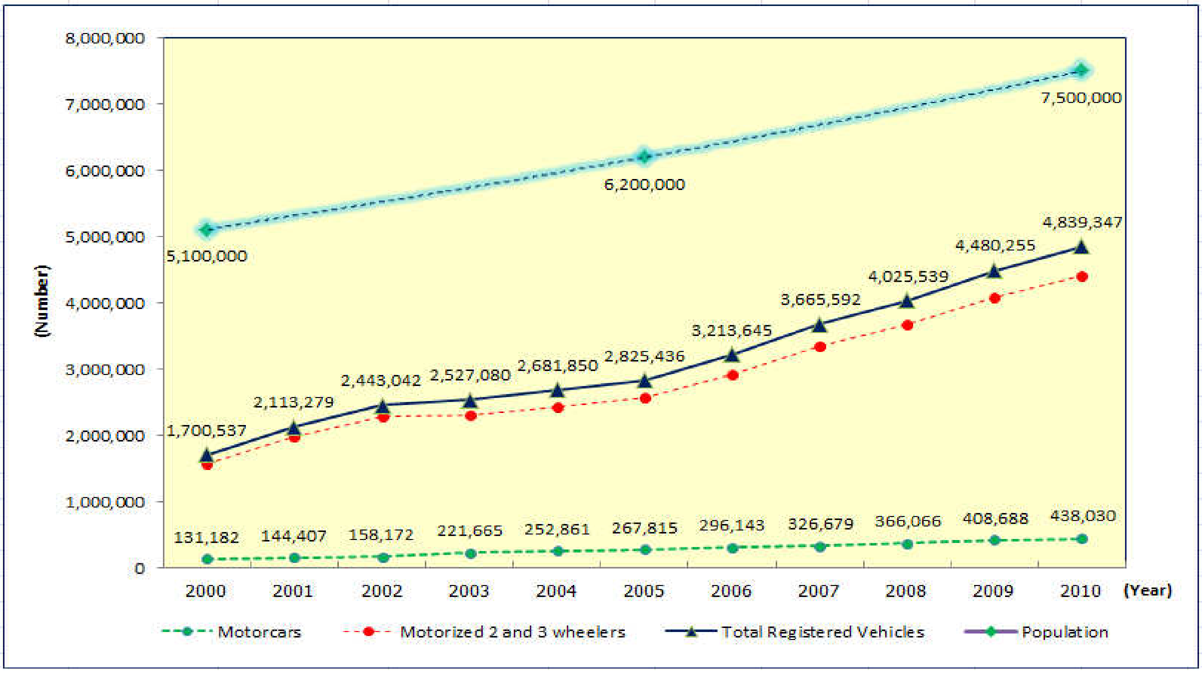
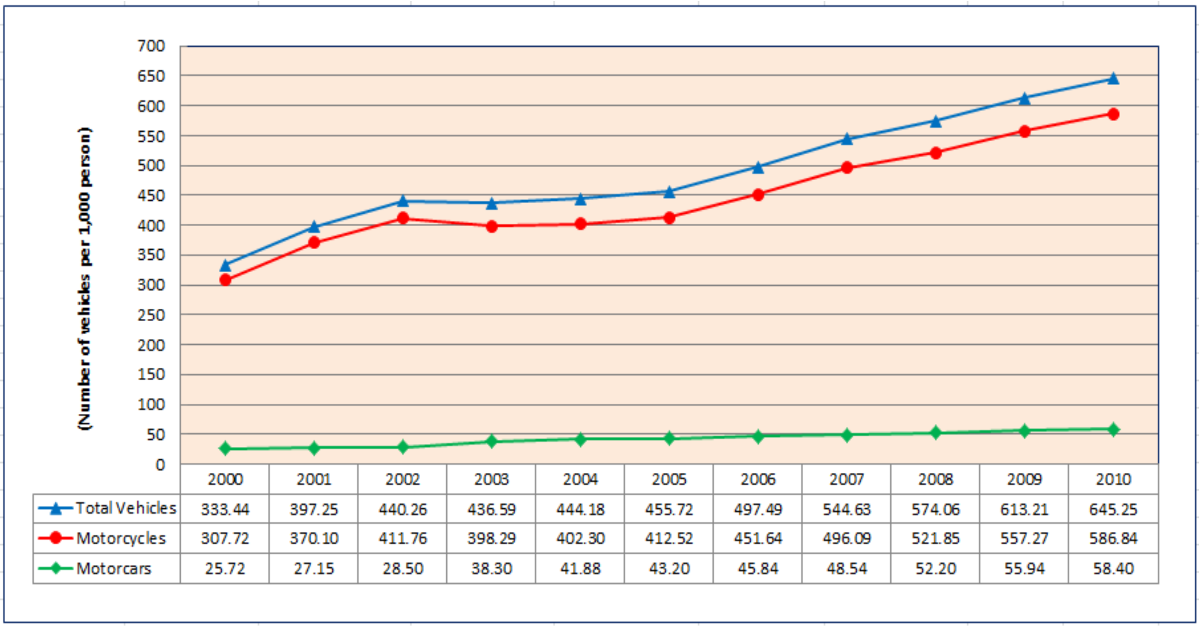


Figure 2 The trend of registered vehicles and population in HCMC (2000 – 2010)
Source: HCMC Department of Transport and Public Works



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Vehicles	333.44	397.25	440.26	436.59	444.18	455.72	497.49	544.63	574.06	613.21	645.25
Motorcycles	307.72	370.10	411.76	398.29	402.30	412.52	451.64	496.09	521.85	557.27	586.84
Motorcars	25.72	27.15	28.50	38.30	41.88	43.20	45.84	48.54	52.20	55.94	58.40

Figure 3 The trend of Vehicles, Motorcycles, and Motorcars per 1,000 persons in HCMC
Source: HCMC Department of Transport and Public Works

3. ROAD ACCIDENTS IN HO CHI MINH CITY

3.1 THE TREND OF ROAD ACCIDENTS IN RECENT YEARS

The number of road accidents in the city slightly decreased in the period from 2003 to 2010. However, the number of casualties was still high, approximately 900 cases per year as shown in Figure 4. According to statistics reported by Ho Chi Minh City Traffic Police, in 2010 there were 1071 fatal road accidents with 885 cases of casualty and 9,676 non-fatal road accidents with 469 cases of serious injury and 9,651 cases of medium injury and light injury. These accidents together caused damage of different levels to 14,394 vehicles as shown in Figure 5.

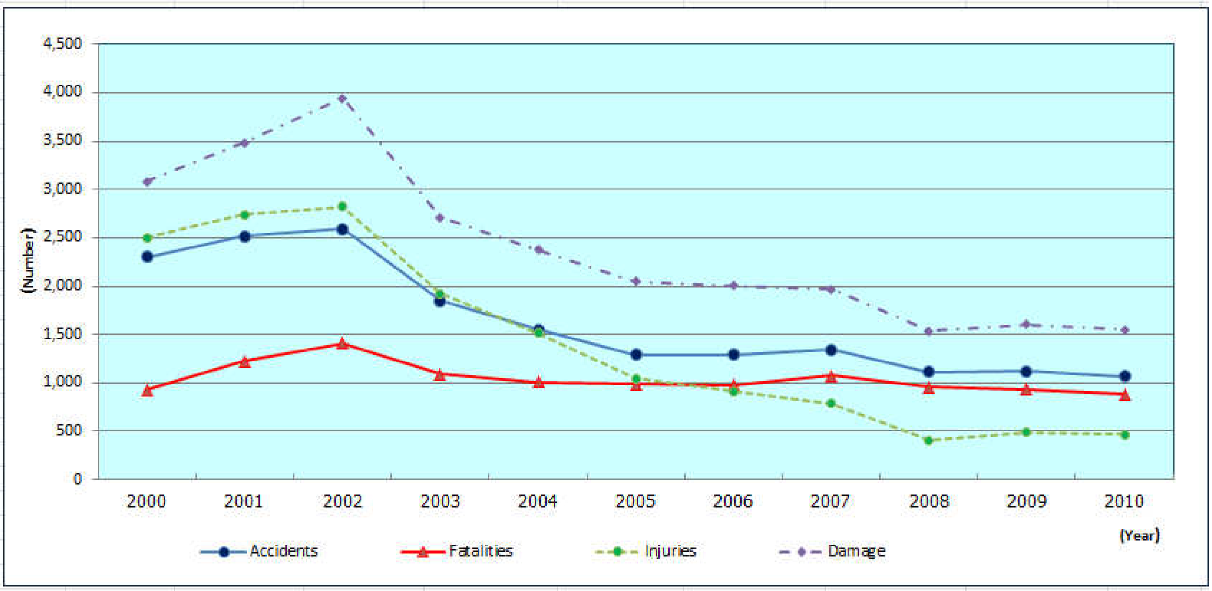


Figure 4 Road traffic fatalities in HCMC (2000-2010)
Source: HCMC Traffic Police

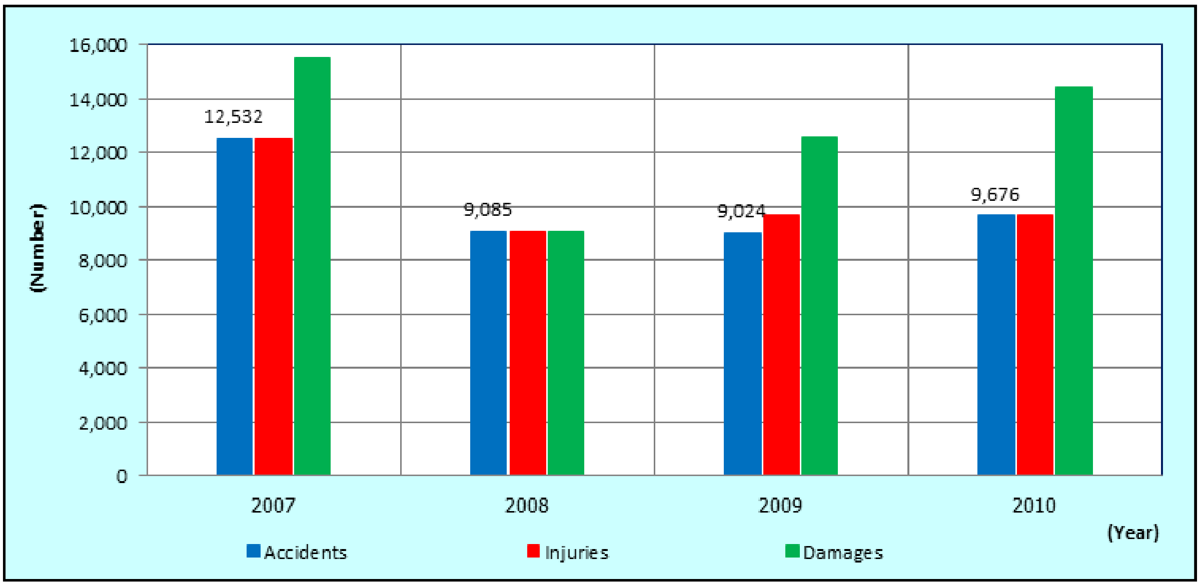


Figure 5 Non – Fatal Road traffic injuries in HCMC (2007-2010)
Source: HCMC Traffic Police

3.2 ACCIDENT, DEATH, AND INJURY RATE PER 100,000 POPULATIONS

The rate of road accidents gradually increased from 2000 to 2002, and slightly decreased from 2003 up to now as shown in Figure 6. However, the rate of accidents, deaths, and injuries per 100,000 persons was still high. The average rate of accidents in HCMC from 2005 to 2010 is 13.5 while the average rate in the 10 ASEAN countries is 10.2. The statistics were provided by ASEAN Development Bank (ADB) in 2003.

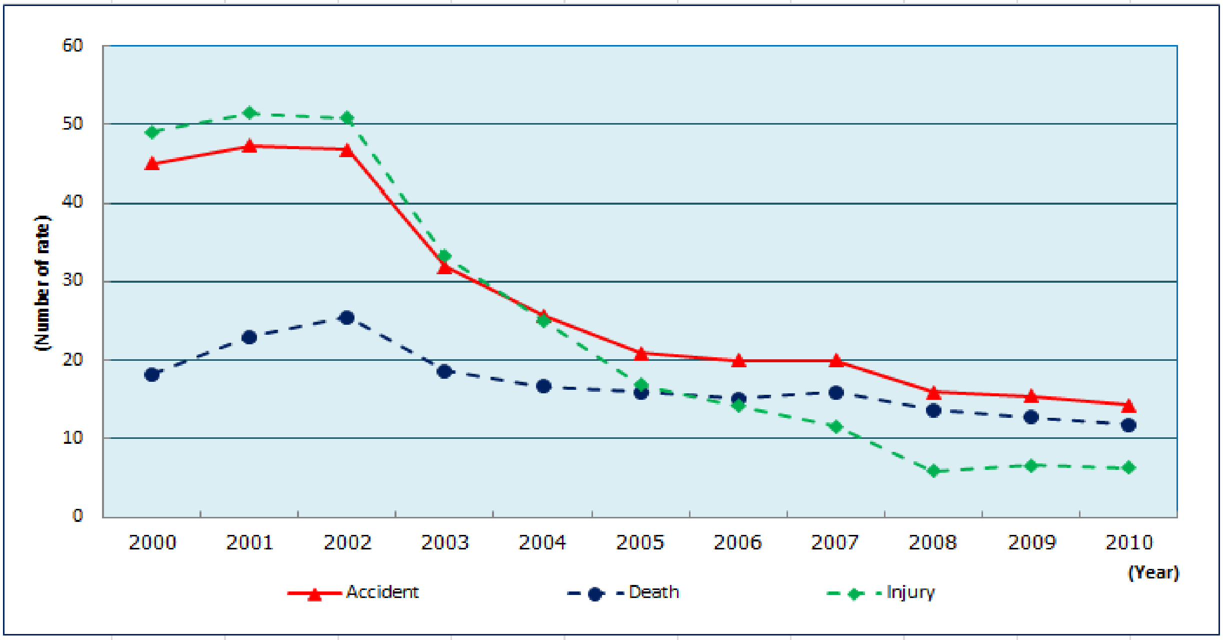


Figure 6 Accident rate, Death rate, and Injury rate per 100,000 populations in HCMC
Source: HCMC Traffic Police

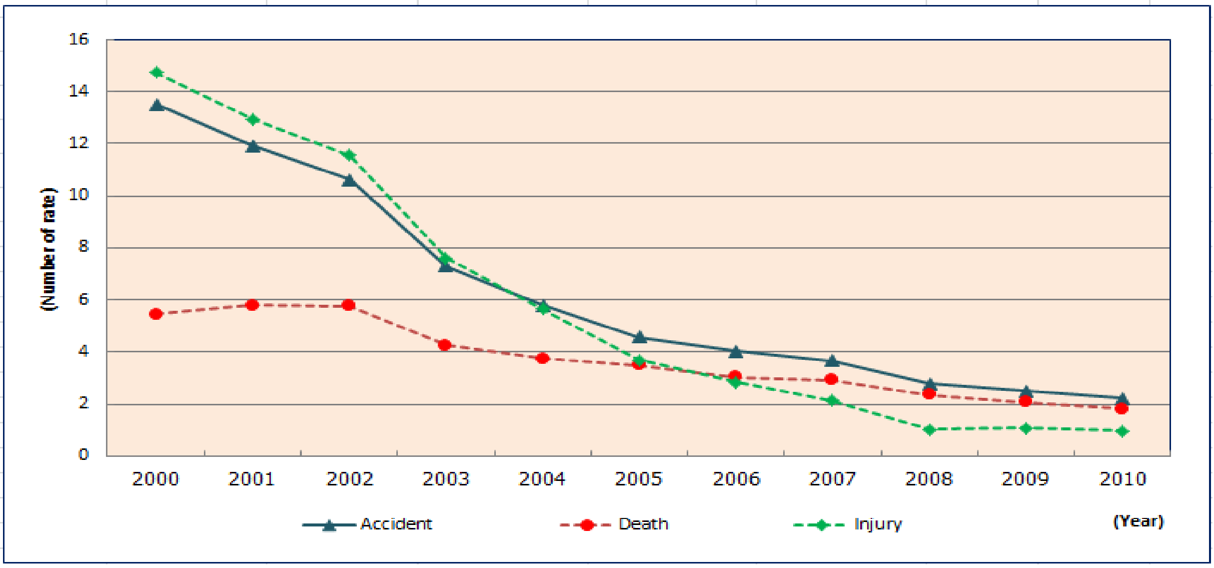


Figure 7 Accident rate, Death rate, and Injury rate per 10,000 vehicles in HCMC
Source: HCMC Traffic Police

3.3 ACCIDENT RATE PER 10,000 REGISTERED VEHICLES

The rate of accident, death, and injury per 10,000 registered vehicles slightly decreased from 2000 to 2010. However, the rate of death is still high and currently estimated at 20 as showed in Figure 6. ADB's reported in 2003 shows that the average rate of death per 10,000 vehicles in the 10 ASEAN is 10.35

4. ANALYSIS OF DATA ON ROAD ACCIDENTS

As categorized by Vietnam's Ministry of Public Security, there are four types of accident classified according to the level of the damage to human and property:

(1) *Fairly serious accidents*: This type includes accidents with serious injury at a rate of >30%, and with no cases of death.
(2) *Serious accidents*: This type includes accidents with 01 case of death.
(3) *Very serious accidents*: This type includes accidents with 02 cases of death.

4.1 TYPES OF ACCIDENTS

(4) Especially serious accidents: This is type includes accidents with 03 or more cases of death (within 24 hours from the time of accident).

The statistics from 2007 to 2010 show that more than 70% of the total number of accidents are serious accidents, leading to great loss of human and property. The detail of each accident type are showed in Figure 8.

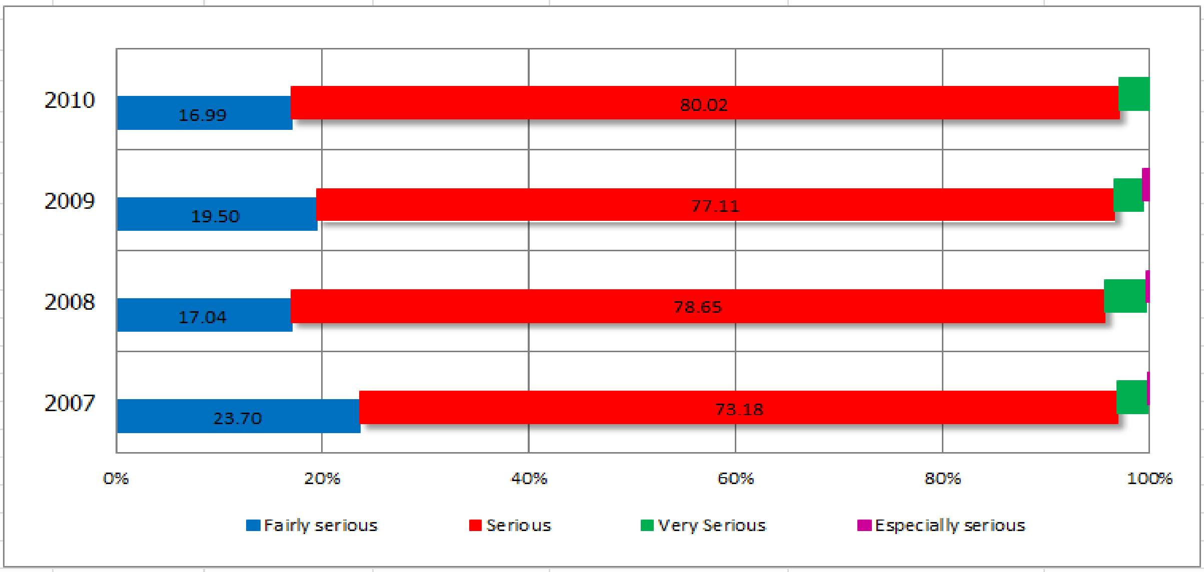


Figure 8 Traffic accidents according to level of damage
Source: HCMC Traffic Police

4.2 ACCIDENTS ACCORDING TO ROAD TYPES

Owing to heavy traffic with strong conflict between vehicles of different sizes and speeds, the percentage of road accidents happening on urban roads is relatively higher than that of accidents happening on sub-urban roads and national roads. The distribution of road accidents according to road types in the city in the period from 2008 to 2010 is illustrated as in the Figure 9.

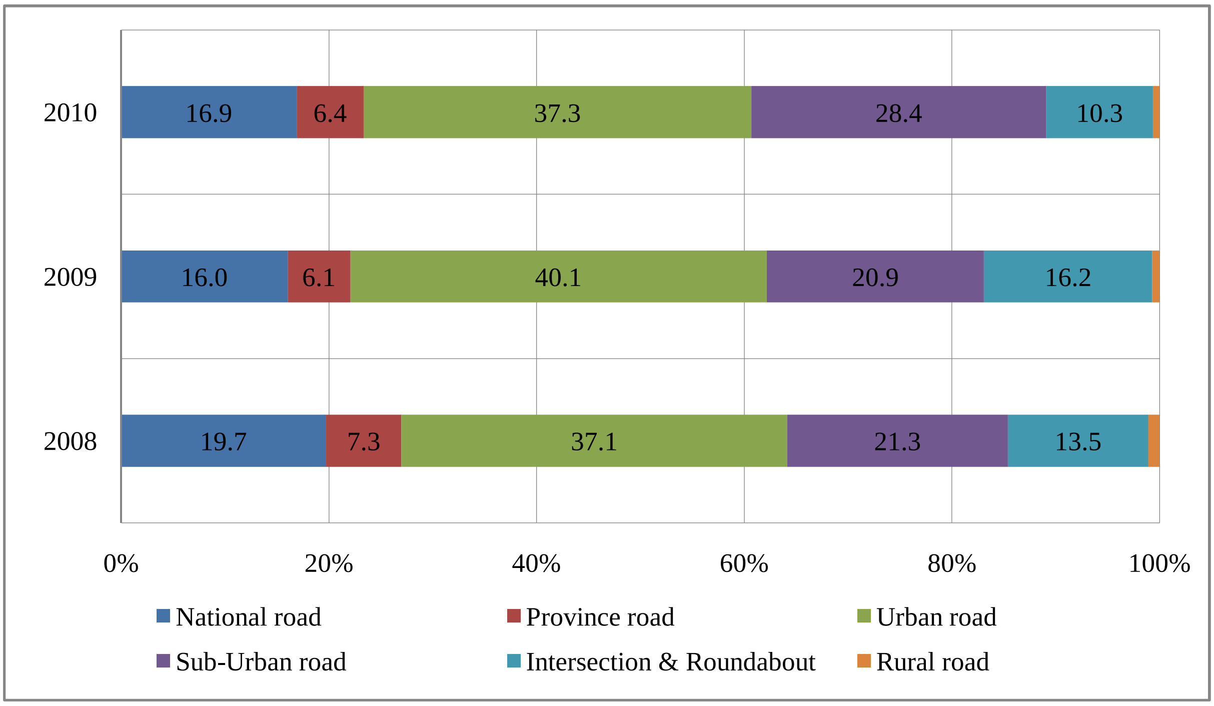


Figure 9 Traffic accidents according the type of roads (2008-2010)
Source: HCMC Traffic Police

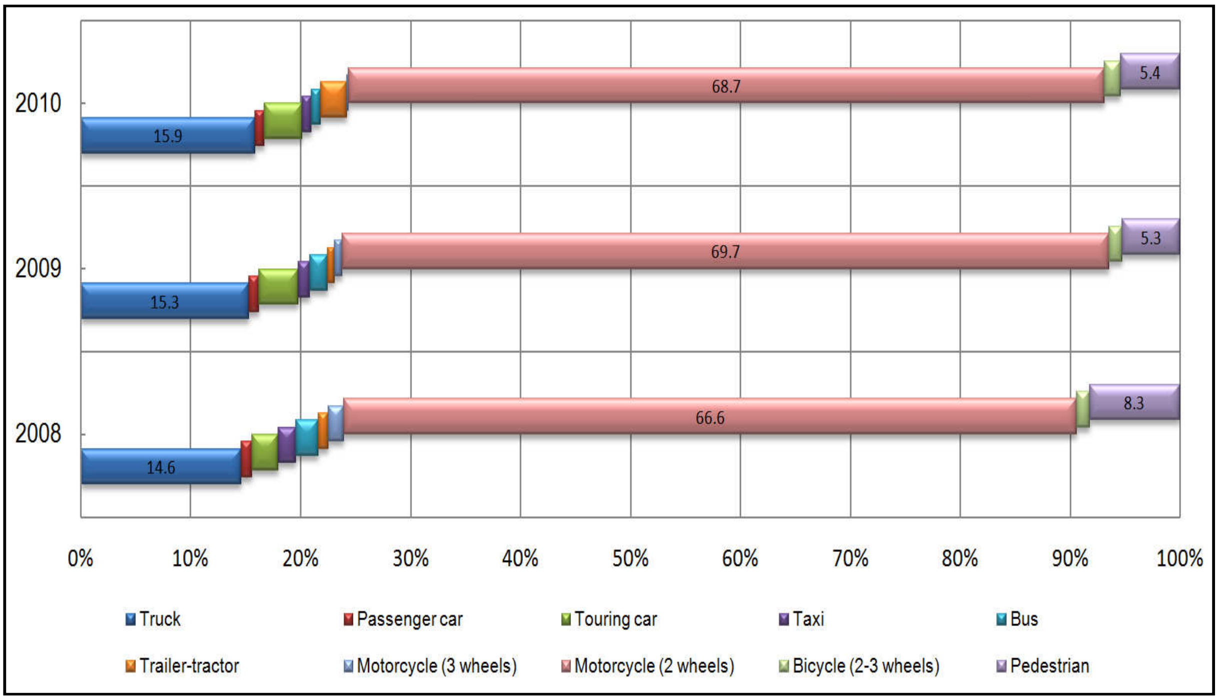


Figure 10 Road accident according to type of vehicles (2008-2010)
Source: HCMC Traffic Police

4.3 ACCIDENTS ACCORDING TO VEHICLES TYPES

The prominent feature of vehicle types in Ho Chi Minh City is that motorbikes account for 90% of the total number of vehicles. As a result, this type of vehicles takes up 90% of the road traffic capacity of the city. 70% of the road accidents are caused by motorbikes, 15% by taxis and 5% by lorries. The remaining 10% are caused by other types of vehicles such as trailers, buses, coaches, and so on. The distribution of road accidents according to vehicle types in the city in the period from 2008 to 2010 is illustrated as in the Figure 10.

4.4 ACCIDENTS ACCORDING TO CRASH TYPES

Most of the road accidents are crashes between motorcycles, accounting for a percentage of approximately 60%. Next comes, the case of between motorcycles and cars, accounting for a percentage of 18%. The remaining 22% are the cases of car-car accidents, motorcycle-pedestrian accidents, and so on. The distribution of road accidents according to crash types in the city in the 2010 is illustrated as in the Figure 11.

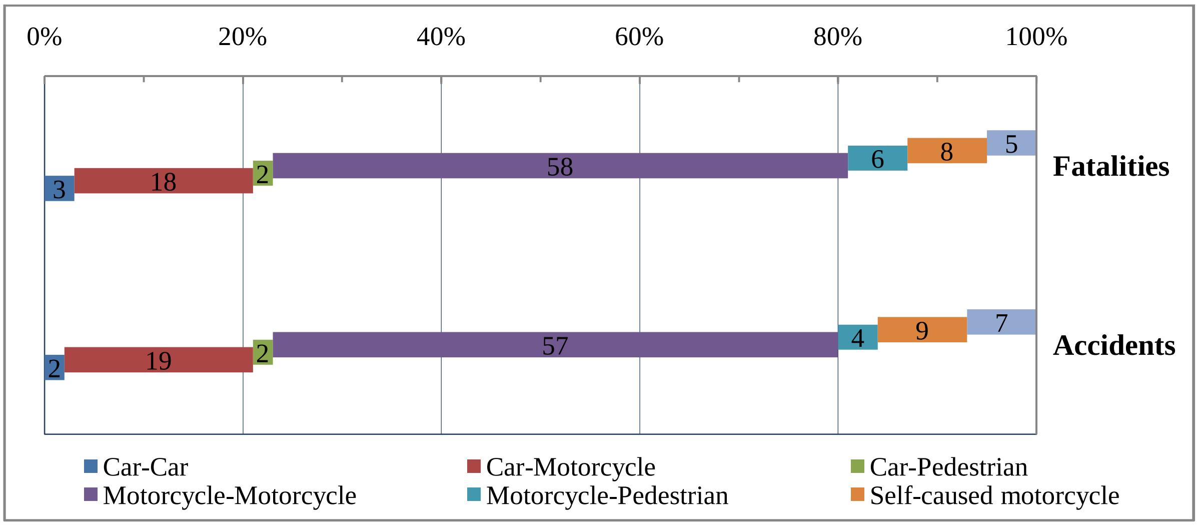


Figure 11 Traffic accidents according to crash types (2010)
Source: HCMC Traffic Police

4.5 CAUSES OF TRAFFIC ACCIDENTS IN HCMC

Statistical analysis suggests that of the 11 basic causes of accidents in HCMC, lane encroachment is the most common, accounting for a proportion of 22%. Next comes speeding, and ranked third is changing directions at wrong places. At the fourth position is irregular passing of pedestrians. The fifth position goes to using roads closed to responding vehicles. Most of these causes originate from road users' poor awareness of traffic laws and their morality. This is an important issue which point out that HCMC has a rather old road networks of poor quality which need upgrading and widening. Hopefully, research and analysis in coming stages will launch more practical and reliable findings about the causes of road accidents in HCMC. Figure 13 is added for the purpose of should be further considered so as to make better plans and establish more satisfactory solutions for traffic safety in HCMC. Details of the corresponding rates of the 11 most common causes of road accidents in HCMC in the period from 2008 to 2010 are showed in Table 1 and Figure 12. It is necessary to add an interesting idea that the 11 causes mentioned in Table 4.1 exclude the impact of the poor road traffic infrastructure in HCMC despite the fact that recent annual reports by HCMC Committee of Traffic Safety providing readers with the detailed statistics of causes of road accidents in HCMC recorded in 2010, a considerable proportion of which (accounting for 30% of the total number) has remained unknown up to now.

Table 1 Causes of road accidents in HCMC (2008 - 2010)

No	Cause of accidents	Proportion (%)		
		2008	2009	2010
1	Lane encroachment (a)	22.96	23.95	22.04
2	Speeding (b)	17.85	14.87	13.45
3	Changing directions at wrong places (c)	7.17	8.82	4.86
4	Irregular passing (d)	6.55	9.17	8.78
5	Using roads closed to responding vehicles (e)	2.96	4.36	3.36
6	Going through red lights (f)	1.43	1.51	0.84
7	Drunk driving (g)	1.08	1.96	0.28
8	Self-caused accidents (h)	3.59	3.74	4.01
9	Improper distance between moving vehicles (j)	2.51	4.01	2.99
10	Refuse to give way to other vehicles as required (k)	5.11	4.19	4.48
11	Pedestrians improper use of roads (l)	8.25	5.34	5.42
12	Other causes (unknown or under investigation)	20.54	18.08	29.51

Source: HCMC Traffic Police

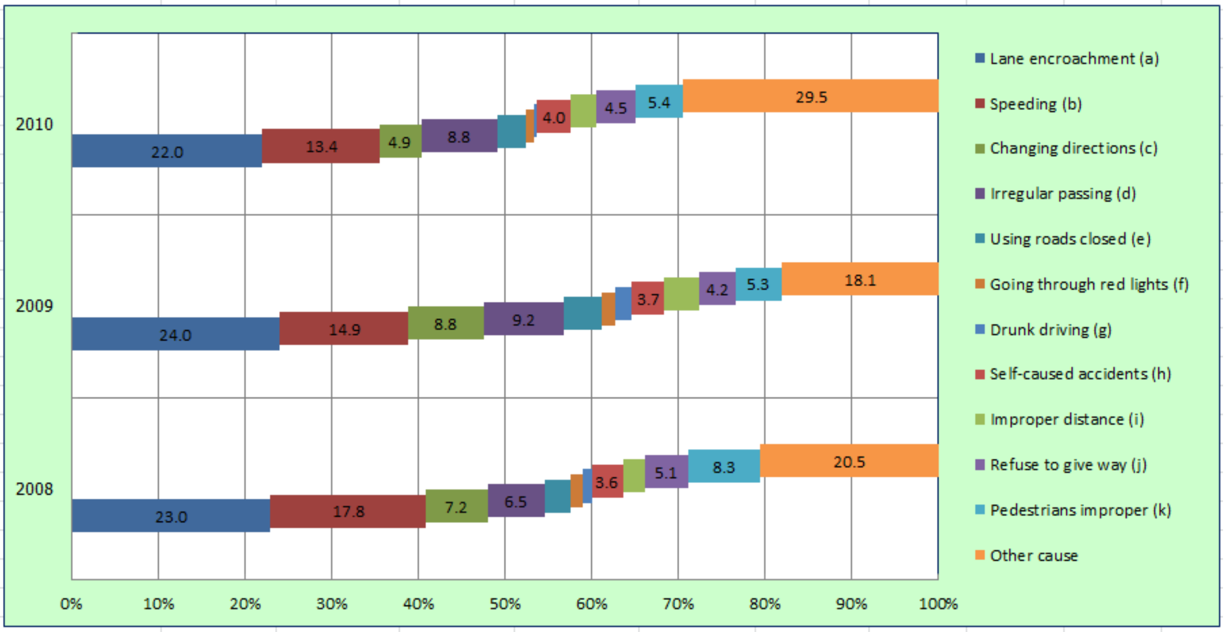


Figure 12 Causes of road accidents in HCMC (2008 - 2010)
Source: HCMC Traffic Police

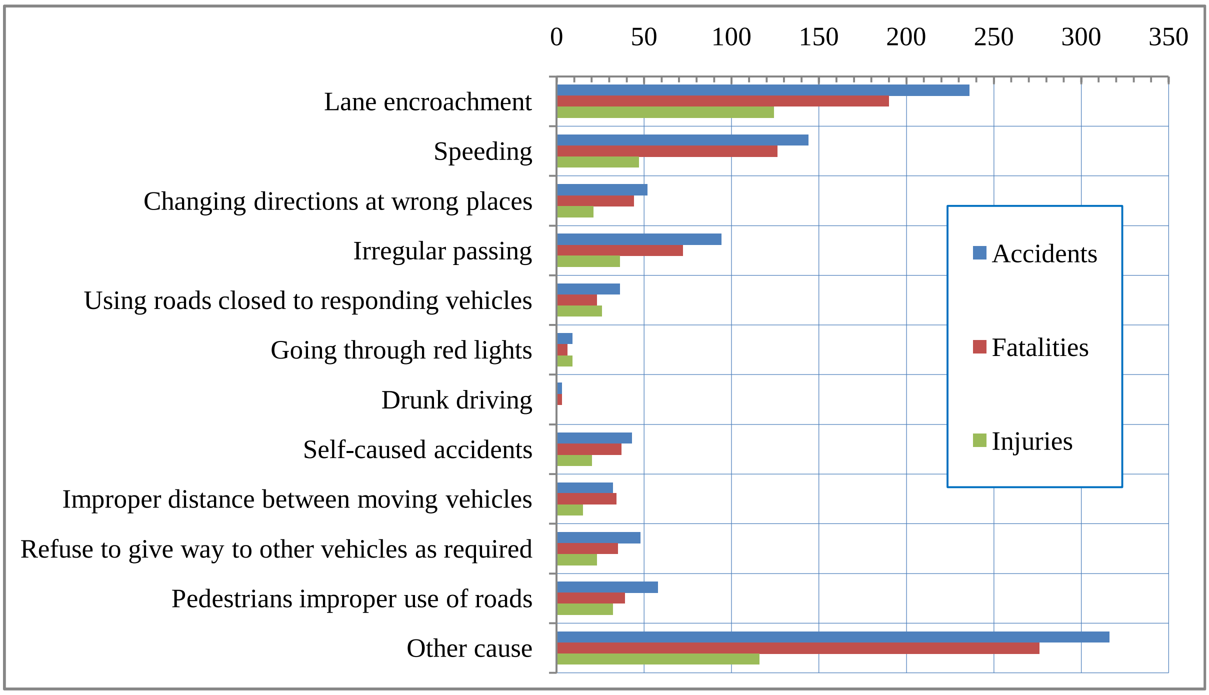


Figure 13 Number of accidents, casualties and injuries according to cause types (2010)
Source: HCMC Traffic Police

4.6 ACCIDENTS ACCORDING TO THE AGE OF ROAD USERS

According to the statistics for road accidents in 2010, most of the accidents are caused with the involvement of road users of the age between 19 and 40. The distribution of road accidents according to the age of road users in the 2010 is illustrated as in the Figure below. Figure 14 shows that most of cases of death and serious injury in road accidents in HCMC happen to people who are still at the age of labour. These people are often the breadwinner in their families and also the main labour force the society.

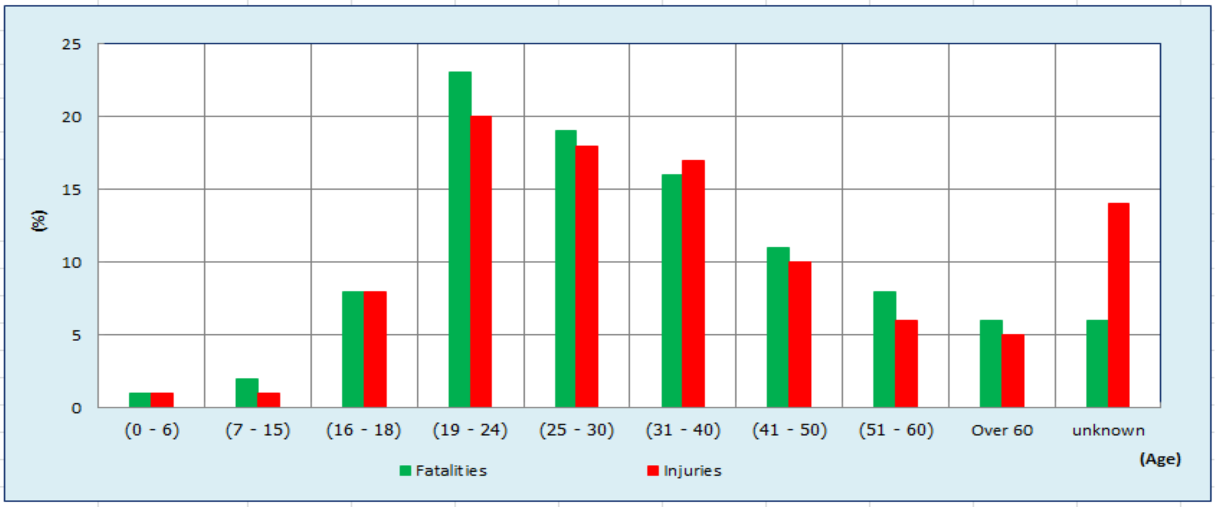


Figure 14 Traffic accidents according to age of road user in the year 2010
Source: HCMC Traffic Police

4.7 TRAFFIC ACCIDENTS ACCORDING TO GENDER

Figure 15 shows that approximately 80% of death cases in road accidents in HCMC happen to male road users. The combined analysis of Figure 14 and Figure 15 leads to the conclusion that the impact of road accidents can be felt with not only the surfacial loss of human and property which can easily be recorded but also with the potential loss of belief, of financial stability and educational support in the victims' families. Further considered, it can be seen that road accidents create potential social burdens both materially and spiritually.

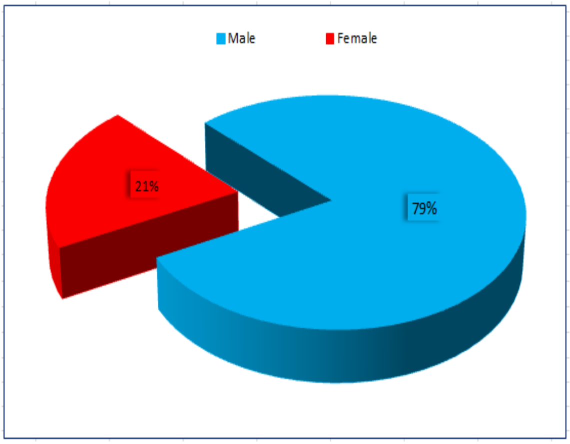


Figure 15 Gender distribution on road traffic fatalities in HCMC – 2010
Source: HCMC Traffic Police

4.8 TRAFFIC ACCIDENTS ACCORDING TO TIME OF THE DAY

An important point to consider is that road accidents in HCMC do not often take place during rush hour, but from early in the evening (19:00) until late at night (01:00) as shown in the Figure 16. During this period of time, there is not much traffic on the streets. Therefore, traffic patrol is done only at some important points. And accordingly, road users are more likely to break traffic laws, leading to road accidents.

5. GOVERNMENTAL POLICIES ON URBAN ROAD SAFETY IN HCMC

(1) development planning of traffic infrastructure

- Publicize and carry out the plan of traffic development in HCMC up to 2020 and the vision of post-2020 period;
- Plan and construct car parks, including multi-storey and underground ones;
- Widen and upgrade current road networks, construct metro routes;
- Construct more overpasses as well as underpasses, upgrade the system of traffic control equipment, especially at the black spots;
- Modernize the urban traffic control centers, apply the Intelligent Traffic System;
- Effectively manage the safety corridors of railways as well as roadways.

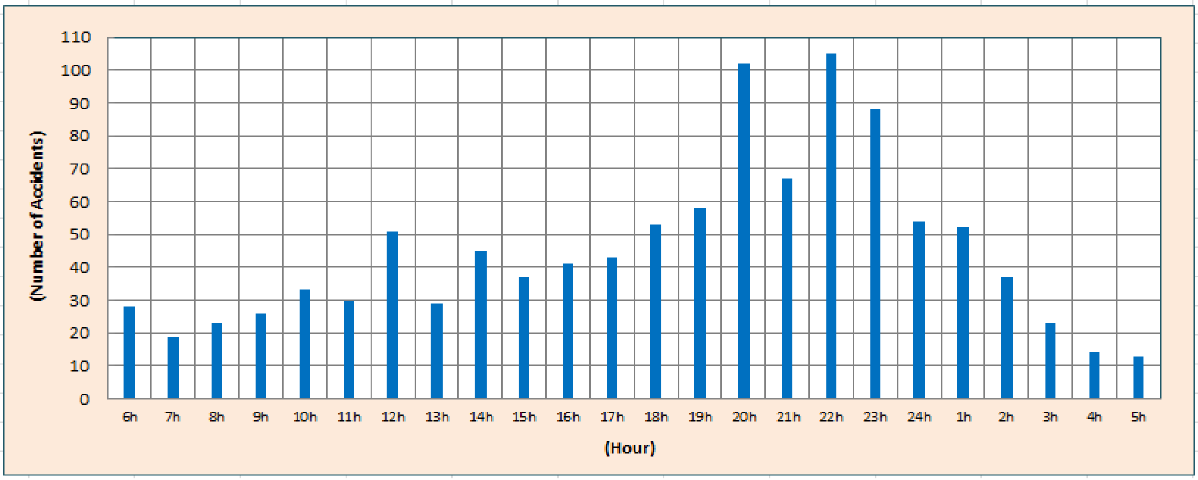


Figure 16 Traffic accidents according to time of the day in year 2010
Source: HCMC Traffic Police

(2) Relocate office buildings, universities, hospitals, ports, etc., properly.

(3) Raise traffic awareness by means of education, traffic culture campaigns as well as fines.

(4) Improve the system of public transport and encourage the use of public transport. Establish policies to limit the use of private cars and motorbikes in urban areas.

6. GOALS FOR ROAD SAFETY UP TO 2020

6.1 VIETNAM'S MISSION OF ROAD SAFETY.

Vietnamese government states in the Master plan of road safety, "The purpose of road safety development is to create a traffic culture with the spirit of humannity and without serious accidents."

6.2 VIETNAM'S GOALS OF ROAD SAFETY UP TO 2020.

(1) Reduce the number of casualties in road traffic by 50% in comparison with the statistics for road accidents in 2007.

(2) Improve the responsibility and function of traffic-related authorities. If necessary, establish new authorities as well as new regulations to maintain long-term traffic safety solutions.

7. SOME REMARKS ON ROAD SAFETY IN HCMC

- Records of traffic accidents are kept by The HCMC Traffic Police. Data of this kind are hand-printed rather than computerized. Therefore, it is difficult for this body of data to be collected and analyzed when needed.
- According to the statistics on traffic accidents provided by The HCMC Traffic Police, there has been a downward trend in road accidents in recent years. However, the total number of accidents is still a considerable number. If no satisfactory solution is developed, there will be negative consequences to the local socioeconomic status as well as human lives.
- Poor infrastructure engineering, weak traffic enforcement, and low driver awareness are the key causes of accidents.

8. SUGGESTED SOLUTIONS TO ENHANCEMENT OF TRAFFIC SAFETY IN HCMC

(1) Application of IT to traffic safety management:
Application of IT is done for the purpose of creating a database of traffic safety which is easy to access, collect, or analyze so as to facilitate the process of planning, building and developing the traffic system of the city.

(2) Road safety planning:
It is advisable to fully consider all the factors related traffic safety so as to make a satisfactory master plan of traffic safety with effective detailed plans and action programmes. In this way, it is possible to eliminate the current black spots of traffic safety and maintain a sustainable improvement of traffic safety in the city.

(3) Infrastructure improvement:
Traffic infrastructure should be modernized so as to improve its throughput capacity, reducing traffic congestion and accidents, facilitating the intercity transport.

(4) Enforcement:
A traffic education program should be widely carried out in order to raise road users' awareness of traffic safety. In addition, heavy fines should be strictly imposed on breakers of traffic laws in order to enforce their observance of traffic laws. Furthermore, more practical training courses in patrolling, monitoring as well as controlling traffic should be held for traffic police so as to improve their professional skills to meet the new requirements. Finally, a revised version of regulations on traffic safety should be accomplished to suit the reality of traffic situation in the city.

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IN-DEPTH CRASH INVESTIGATION ON BUS ACCIDENTS IN MALAYSIA

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ABSTRACT:

Road accidents involving bus is an alarming matter in Malaysia. National statistics showed that bus accident cases increased significantly with 48% between the year 2006 and the year 2008. Due to this reason, an in-depth study was performed to clearly identify the problems, investigate the characteristics of bus accidents in the country and determine critical issues highlighted from the investigated accidents. The data of bus accidents during the period of 2007-2009 was obtained from MIROS database of real-world crash investigation and used for the study. A total of 109 cases related to bus accident were analysed and related important issues were discussed in the paper. From the study, several issues that contributed to the high level of fatalities and severe injuries arising from accidents involving bus were identified crucial—failure of bus structure integrity, roadside hazard, lack of Safety and Health Environment Code of Practice (SHE COP) by the operators, and poor vehicle maintenance.

KEY WORDS: bus accident, accident characteristics, Malaysia

1. INTRODUCTION

Road traffic accidents and injuries are well-known problems in developing countries such as Malaysia. Statistics by the Royal Malaysian Police (RMP) show that the average number of fatalities due to road traffic accidents is around 6,365 for each year between 2006 and 2008. From the statistics, the major contributor for road traffic fatalities in Malaysia is motorcycle user which comprised 60% of the total fatalities and the number keeps increasing consistently with the number of registered motorcycles (RMP, 2008).
Furthermore, accidents involving commercial vehicles also increase significantly since 2000 (SHE COP, 2007). These statistics should not be taken lightly since the increase in accidents involving commercial vehicles is significantly alarming despite the fact that majority of road deaths are motorcyclists and car occupants. For bus, road traffic accident cases increase significantly with 48% between the year 2006 and the year 2008. Figure 1 shows the trend of road traffic accidents involving bus with respect to registered buses from 1998 to 2008 (Figure 1). While the number of traffic fatalities has shown a tendency to decrease over the last two years in Malaysia, the number of injuries tends to increase.

Even though the total number of bus accidents per year is comparatively low to other type of vehicles, but when an accident involving a bus occurred, it normally attracted attention from the public due to the severe nature of the accidents. For example, in year 2007, Malaysia was shocked by a catastrophic bus accident which had caused 23fatalities. Due to the severe nature of the bus accidents and very few studies being conducted on this issue in Malaysia, MIROS has taken the initiative to conduct a study to understand the characteristics of bus accidents in Malaysia and to highlight the issues by utilizing MIROS in-depth crash investigation data.

It is hoped that the findings from this study can be utilized by related stakeholders such as the RMP, Road Transport Department (RTD), and other related agencies as counter measures to reduce the resulted casualties from bus accidents. Furthermore, the results will help and support the government to implement the approved policy or related regulation.

2. MATERIALS AND METHODS

The source of data for the study was obtained from MIROS Crash Accident Reconstruction System (MiCARS) database. The database archives all accident cases investigated by trained crash analysts since the year 2007. This database is different from the RMP's database as it contains more detailed information on the crash scenes, the examined crashed vehicles and the victims' hospital records. Furthermore, based on the evidences, every investigated case was reconstructed in order to determine the possible scenarios during pre-crash, crash and post-crash, and the causes of crash. Figure 2 illustrates MIROS crash investigation's process flow, starting from notification stage until report writing.

For this particular study, only accident cases involving buses from years 2007 to 2009 were selected for analysis. In total, there were 109 cases. The first part of the analysis focuses on the overall accident characteristics which includes collision type, road type and geometry, weather and crash partners. Related accident cases of the total accidents cases were then used to identify safety issues related to bus transport in Malaysia discussed during the second part of this paper.

Figure 1 Trend of bus accidents and registered buses in Malaysia
Source: RMP, 2009

3. RESULTS AND DISCUSSIONS

3.1 Overview of crash characteristics

A finding from the MiCARS shows that 188 occupants from the crashes were identified to be fatally injured while 686 victims were either severely or slightly injured. These Figures accounted not only for the bus occupants but also for other parties involved in the accidents related to buses. The highest number of fatalities recorded was in the year 2008 since the number of investigation cases had increased 12% as compared to the previous year. Figure 3 shows the distribution of casualties based on the three year period.

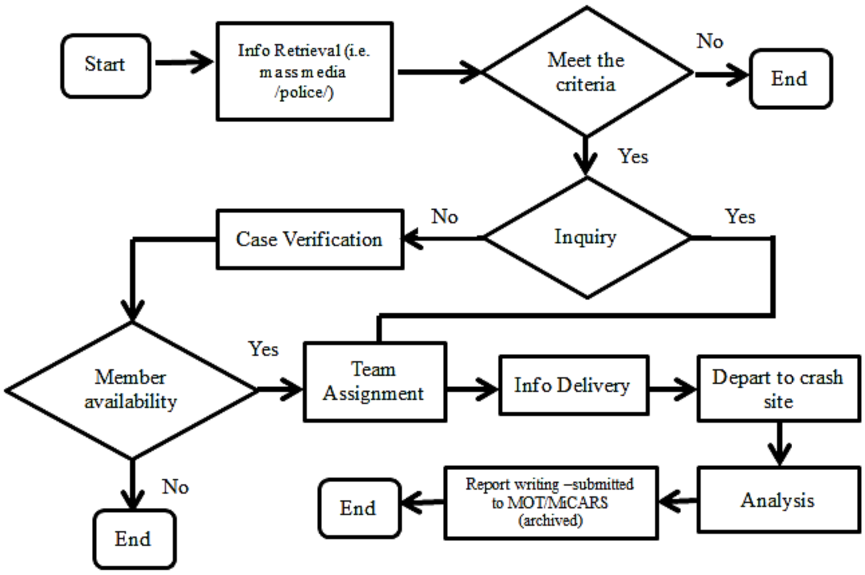

Figure 2 Process flow of MIROS in-depth crash investigation
Source: MIROS Crash investigation SOP, 2009

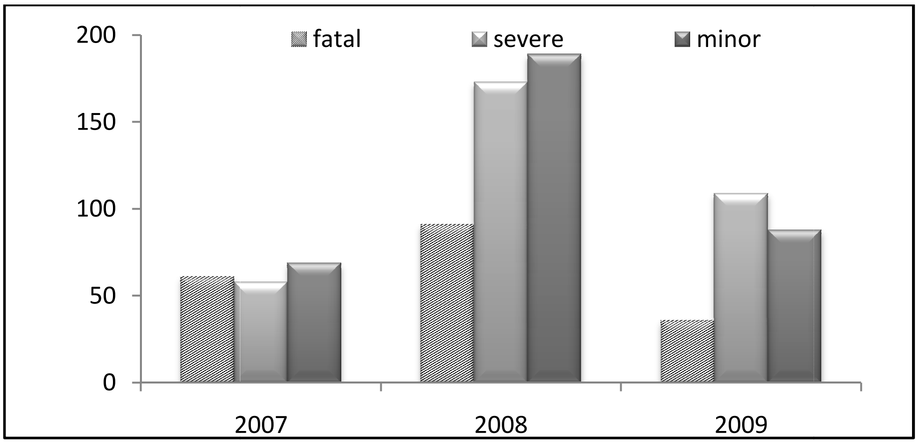

Figure 3 Casualties in accidents involving buses,
Which were investigated by MIROS from 2007 to 2009
Source: MiCARS, MIROS, 2010

Table 1 Characteristics of bus accidents based on MiCARS from 2007 to 2009

Attribute	Elements	N (%)
Type of bus	Express	58(53)
	State	26(24)
	Factory	9(8)
	Tourist	9(8)
	School	7(6)
Collision type	Head on	16(17)
	Side	12(11)
	Rear	21(19)
	Rollover	12(11)
	Multiple Event	20(18)
	Hitting object	27(24)
	Hitting pedestrian	1(1)
Road type	Expressway	53(47)
	Federal	27(25)
	State	27(25)
	City	2(2)
Road geometry	Straight	67(61)
	Curve	42(39)
Weather	Fine	67(61)
	Raining	29(27)
	Drizzling	11(10)
	Foggy	2(2)
Crash partner	Single	42(39)
	Motorcycle	8(7)
	Light vehicle	29(27)
	Heavy vehicle	11(10)
	Multiple	19(17)

Table 1 shows proportion of type of bus involved in road crashes that extracted from MiCARS. The Figure shows that the highest proportion of type of bus involving in accident is express bus with 53%. The high percentage is because accidents involving express buses attracted MIROS attention due to the number of casualties, which is higher as compared to other type of buses. The lowest type of bus from the crash investigation cases carried out by MIROS is school bus with 6%.The finding aligned with the pas studies that the long distance buses are the high risk of injury for bus occupant. It is due to high speed of traveling and this generally results in higher injury (Langwieder et al., 1985). Long distance bus is synonym with the middle and low-income basis in Malaysia. The demands on the buses increased during the festival such as Eid, Chinese New Year, Deepavali and others. Long distance travel, frequent trip per day and the geographical terrain in Malaysia road might be the factor led to driver fatigue thus resulted an accident. In addition, the easily accessible of the bus and their low cost compared to air transportation also a factor the bus is popular. For short distance buses, it has two difference configurations for passenger, seating and standing. In standing mode, probably passengers to get injured in accident are high. The result of previous study by Kirk et al. (2001) which concluded the cause of injuries among passenger is due of slip, trips and falls in the vehicle when accident happened. Also, study conducted in Great Britain showed 83% were injured on a road with 48km/h which commonly related to short distance buses (EBCOS, 2001).

In the three-year data collection, the highest type of collision recorded in MiCARS data was hitting object on or off-road with 24% cases followed by rear collision with 19% cases. Most of hitting object on or off-road cases were due to collision with barrier and tree. Rollover had less investigated with 11% cases. However, in term of second impact event, the rollover is the most severe event and recorded the most fatalities. Study done by Martines et al. (2003) showed that the rollover event consists 4% of bus accidents in Spain. The risk of fatalities in rollover is five times higher than any other types of bus accidents. Also, Rasenack et al. (1996) showed that 50% of passengers suffered severe injuries and 90% of all fatalities in Germany.

For road type, most accidents investigated occurred at expressway with 47% cases followed by federal and state with 25% cases respectively. This indicated that most of the cases occurred in high-speed areas whereby in Malaysia the expressway speed is 110km/h for light vehicle and 80 to 90km/h for heavy vehicle. Study done by Albertsson et al. (2005) in Europe revealed that the most bus accident occurred in high-speed areas contributed to many fatalities. Furthermore, most of bus investigated occurred at straight compared to curve road with 61% and 39% cases respectively.

In term of weather condition, 61% cases occurred during fine weather compared to bad weather (raining, foggy or drizzling) condition with 39% cases. Bad weather condition seems to give effect to the bus accident. It can affect the stability of bus especially in raining condition. Raining condition able create water ponding on the road cause the vehicle lost control if travel in high speed. In addition, raining condition can affect the coefficient of friction thus make the road become hazardous for travelling. Study conducted by Albertsson et al. (2005) based on the in-depth case discover that wind and slippery of road may affect the driving characteristics of the bus.

In addition, over the three years of data collection, MIROS has investigated 39% cases related to single bus crash which accounted the highest percentage among other crash partners. Nevertheless, bus collisions related to motorcycles are the lowest cases investigated with 7% cases. They were less investigated due to low fatality rate in the accident and most of fatalities involved motorcyclists.

3.2 Identified issues and recommendations

For this study, a few highlighted issues related to bus accidents were discussed in the following subsections. Structural integrity, roadside hazard, safety, Safety Health and Environment (SHE) and vehicle inspection were the regular issues involving buses in Malaysia. Therefore, several recommendations were proposed as a countermeasure.

3.2.1 Structural integrity

One of the main issues identified through the in-depth crash investigation is inadequate strength of the bus superstructure to protect passengers during rollover accidents. Based on MiCARS database, about 24 cases were involved with structural integrity problem. Even though the number of cases is low, the number of fatalities is greater due to the inability of the bus superstructure to protect the occupants.

For instance, in late 2007, Malaysia was shocked with a horrible bus crash which resulted in 23 fatalities. It was revealed that the major cause of death of the occupants is due to the collapsed of the roof structure that failed to retain the occupant survival space (Figure 4).

Retrofitting the rollover structure for old buses seems impractical for the bus industry in Malaysia due to the high cost compared to buying a new bus. Regulation compliance is the one of the factors that can relate with the bus road traffic accident in Malaysia. In terms of legislation, Road Transport Rules had been passed and enforced since 1959 and the act is applicable to all types of vehicle registered in Malaysia. As a member of Working Party 29 (WP29) since 2005, Malaysia has adopted the regulation into the Malaysia Road Transport rules.

Three regulations—R36 – Construction of large passenger vehicles, R66 – Strength of superstructure of large passenger vehicles and R80 – Seat for large passenger vehicles)—from the UNECE regulation were adopted in Motor Vehicle Rule (Construction and Use 1959). A grace period was given to coach builders to implement the adopted regulations as to avoid sudden burden to the coach builders and consequently, the customers in term of sudden fare increment.

In addition, corrosion is one of the factors that contribute to the weakness of structural integrity of the buses in Malaysia. MIROS in-depth investigation reveals that significant structural deterioration was observed in the six to 10-year group (33%) and in 28 percent from the 11 to 15 years age group (Azhar et al. 2010). Surprisingly, it is noted that the structural integrity issue could be a concern as early as in year four (Azhar et al. 2010). This factor may affect and reduce the bus structural integrity to withstand heavy accident impacts although it is only being used less than six years.

For example, in early 2007, a single bus accident occurred at one of Malaysian’s highways resulted in six fatalities and other victims had severe injuries. The accident happened when a bus ran off-road, punched through a guardrail before colliding with a tree stump and then overturned. This caused the entire roof to collapse and flatten the occupant cabin. Earlier inspection on the bus registration history revealed that the bus was already 16 years old. Hence, the bus structure was badly rusted (Figure 5). Besides that, instead of constructing a rooftop frame that is bonded together with the body of the bus, the manufacturer used welding technique to connect the pillars. Other factors included the mechanical fracture due to rust, and the decay of composite material (steel and wood) that formed part of the bus structure.

The corrosion on the bus might be due to the welding and jointing process during the construction stage. Wrong techniques and uncoated anti-corrosion on the bus structure may disrupt the material properties and may accelerate the corrosion rate. Since there is no regulation to assure the life of the bus structure yet in Malaysia, bus manufacturers have to play an important role to build safer buses that are competent to be used for a long period of time.

3.2.2 Roadside hazard

Roadside hazard such as the absence of barrier at ravine and lack of barrier's height are considered serious issues that led to catastrophic bus accident in Malaysia based on MIROS investigation. In the three-year data collection period by MIROS, there are 45 cases of accident caused by roadside hazard and mostly occurred at expressways.

For example, an accident occurred in December 2008 revealed that an absent of barrier caused the bus to plunge into the ditch (Figure 6). Ten fatalities were recorded in this crash while the rest of the passengers had severe injuries. The accident can be avoided if appropriate barrier was installed to cover the ditch and the bus would probably have minor damages instead.

Figure 4 Detached roof as a result of rollover crash

Figure 5 Severe corrosion on bus structure

Furthermore, nowadays double-deck or high-deck express buses are becoming a popular trend in transporting passengers especially for long distance journey. However, some of the cases investigated involving double-deck or high-deck buses show that the height of the current guardrail cannot tolerate with the height of the double-deck or high-deck buses.

Study conducted by Mohd Huzaifah et al. (2010) shows that fatal accidents in Malaysian's expressways are increasing every year whereby cases involving failure of guardrail design, installation and performance. With the appropriate speed, angle of impact, road condition and high of center of gravity, the current barrier can be a tilting point for this type of bus (high-deck or double-deck). Therefore, installation of safety barrier must be appropriately selected considering the barrier's performance capability, deflection characteristics including occupants' risks, site conditions, compatibility, life cycle costs, maintenance, aesthetic, environmental considerations and history of bus rollover accidents (Aqbal Hafeez et al, 2009).

For example, in 2009, a high-deck express bus was involved in a single vehicle crash. The crash occurred when the bus driver was believed to lose control of his bus and then hit the bridge parapets (Figure 7). The result of the impact caused the parapets to punch through the lower deck of the bus and immediately killed 10 passengers. Based on MIROS investigation, the bridge parapets was not designed according to standard specification. Based on that crash, MIROS gave a few recommendations to the government to improve bridge parapet which include installation of rigid concrete or guardrail as an end treatment before reaching the bridge in order to minimize the severity of accident and injury.

Figure 6 Absence of road barrier at crash site


Figure 7 Severe damage on the nearside of the bus due to collision with bridge parapet

3.2.3 Safety Health and Environment (SHE)

In general, Malaysia is among the highest fatality rate in South East Asia with over 6000 deaths per year (WHO, 2009). Ironically, most of the accidents are due to human factor such as traffic violation, driving under influence (DUI), fatigue and driver incompetency on the road. For long distance bus journey, the drivers are also exposed to the long hour drive thus may cause fatigue. Studies from other countries have identified that driver fatigue as one of the major causes of road accidents (Connor et al. 2002; Horne & Reyner 1995). This is also proven from the 35 bus accident cases investigated by MIROS, which recorded Safety Health and Environment (SHE) issues with driver fatigue and driving under influence (DUI) recorded 58 and 15 cases respectively.

For example, in early 2008, an accident occurred involving a high-deck express bus. It was believed the driver lost control of the bus and subsequently swerved into the opposite direction, ending up in a rollover. An MPV that was travelling on the opposite lane where the bus overturned collided with the rear roof of the bus. Upon collision with the MPV, two people seated at the back row of the bus died instantly. One person seated on the upper deck was also fatally injured during the crash. Other passengers suffered minor-to-major injury. Based on the evidence and in-depth analysis, fatigue condition is the main factor contributed to this crash. The investigation found that the bus driver drove for more than 8 hours per day.

In order to overcome this issue, Malaysia introduces a SHE Code of Practice (SHE COP) for commercial vehicle industry. This SHE COP focuses on five basic elements which are driver, fleet, risk and travel, and quality assurance system management. With the implementation of SHE COP in commercial vehicle industry, it is hoped to reduce the accident rate involving commercial vehicles especially buses. In short, SHE COP will not only help the bus management (company), but also the drivers.

3.2.4 Periodical Vehicle Inspection

Vehicle road worthiness for heavy vehicles in Malaysia is also an alarming issue. Brakes failure and tire problems are some of the common factors found in post-crash investigation. Based on MIROS crash investigation, there are 52 cases found on the issues related to mechanical failure with regard to brake and tire.

For instance, in December 2007, a road crash occurred at a toll booth plaza involving a tourist bus and a latex tanker. The crash resulted 8 deaths and 33 others injured. Based on MIROS analysis, the bus' brake system probably failed to function. The failure was probably due to overheating of the brake system when it was driving downhill. This situation indicates that maintenance of vehicle and regular inspection are crucial tasks in order to ensure the vehicle is safe to be driven on the road.

In Malaysia, PUSPAKOM is a body that was mandated to conduct periodic technical inspection for commercial vehicles and was gazetted in Road Transport Rule. As of now, the periodical inspection is a compulsory item for commercial vehicles to renew their road taxes. The inspection is required to be conducted every six month. However, a six-month period inspection for every commercial vehicle seems insufficient to evaluate the vehicles' roadworthiness. Since commercial vehicles travel more than private vehicles, the tires, brakes and other parts of the vehicle tend to deteriorate faster. It is proposed that the government evaluate the period of inspection in order to ensure the commercial vehicles are safe to travel on the road.

Figure 8 Condition of the damaged bus with brake failure

4. SUMMARY AND CONCLUSION

Based on the MIROS in-depth crash investigations, most of the accidents involved express buses, collision with object on and off road, occurred at expressways, on straight roads, during fine weather, and in a single-vehicle crash. Few important issues were highlighted from this study and appropriate recommendations were suggested based on the identified issues; implementation of SHE COP, compliance of UNECE regulations and periodic vehicle inspection by the bus manufacturers and operators. It is hoped that the findings from this study could provide insights for future research and necessary countermeasures.

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RELATIONSHIP BETWEEN PEDESTRAIAN FATAL ACCIDENTS AND THEIR CHARACTERISTICS IN TAIWAN

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ABSTRACT:

Pedestrian traffic accidents cause high fatality rates because of the frailty of the human body. This study presents an analysis of a total of 1090 pedestrians' fatalities from 2005 to 2007 in Taiwan. Data were obtained from the traffic accident reports filled by the police. The framework of epidemiology is used to classify the variables into three sectors, namely human, time and locations and to analyze the data by descriptive statistics, chi-square test and a logistic regression. A logistic regression model is then built to determine the odds ratio. A typological analysis is utilized to identify the correlation of all significant variables, which is based on a multiple correspondence analysis. Applying logistic regression and multiple correspondence analyses, the relationship between pedestrian fatal traffic accidents and their characteristics was further investigated. The object is to identify the pattern of pedestrian fatalities, such as time, weather, location, and signal type, the state of pedestrian and motor vehicle, and pedestrian characteristics. Scenario assumption is then used to find out what kind of situations are easy to cause pedestrian fatal accidents and what kind of pedestrian characteristics are easy to be involved in fatal accidents. This study attempts to identify the factors leading to pedestrian fatalities and relative risk. The results show that human factor is the main cause, and the most common pedestrian actions leading to fatal accidents is walking along or crossing the roadway improperly. Additionally, intoxicated pedestrians walking on the road is also found to be at high risk. Unfortunately, similar to other countries, there is no regulations ruling walking while impaired by alcohol in Taiwan.

KEY WORDS: Pedestrian, Fatal Accidents, Epidemiology, Walking Impaired

1. INTRODUCTION

According to the 2007 statistics of the causes of death in Taiwan, accidents and adverse effects are ranked at number five, 7,130 people dead, among which transport accident accounts for 57.9%, where the death rate is 18 per 100,000 populations.

Pedestrians constitute a significant proportion of crash-related deaths and injuries. Pedestrians-related accident is one of the most caused death traffic accident. In 2007, Taiwan recorded 329 pedestrian fatalities and 351 pedestrian-involved fatal accidents, resulting in 12.79% of traffic accident fatalities and 14.25% of fatal accidents (National Police Agency, Ministry of the Interior). Although the events are rare, pedestrians are the most vulnerable road users and can get killed easily. It is therefore important to be concerned with pedestrians' safety.

Pedestrian crash accidents occur mostly when pedestrians cross the road, thus we have to discuss about pedestrian's crossing behavior when it comes to pedestrian characteristics. Some studies discuss about pedestrian's violation and crossing behaviors in order to reveal what factors affect the pedestrians, and putting them in danger (Kim, Brunner and Yamashita 2008, Yang et al. 2006, Räsänen et al. 2007).

Most studies discuss about pedestrian-related accidents by analyzing factors that caused pedestrian deaths, so as to understand more about the accident type and scenario. (Holubowycz 1995, Ryb et al. 2007, Fontaine and Gourlet 1997). Logistic model was used to find out what factors will make pedestrians at risk, people with those factors might get injured, and thus it is possible to predict pedestrian's death and injury odds.

This study used the framework of epidemiology to classify the variables into three sectors, namely human, time and locations. In addition to descriptive statistics, logistic regression models are used to analyze the contribution of human, time and location factors to pedestrian fatal accidents. In order to describe the correlation of all significant variables, a typology of pedestrian fatal accidents is proposed. It is based on a multiple correspondence analysis, followed by a classification which identifies certain groups. And following the discussion of findings, the implications for improving pedestrian safety are described.

Walking is the most sustainable transport mode, whether it is taking public transportation or using private modes, we all have to walk to the stations and our final destinations, so pedestrian safety has become one of the top priorities. The purpose of this study is to examine the accident types and characteristics of pedestrian death accident by using data of pedestrian related accidents from National Police Agency from 2005 to 2007.

2. METHOD

The data analyzed came from fatal-accident reports filled by the police. These reports contain a detailed description of events, and the brief statements made by different parties that are involved were mentioned. They provide an overall view of the accident. A collection of these documents was made by the National Police Agency from 2005 to 2007. During this period, 1090 pedestrians were killed on the road.

First, the variables are classified into sectors of human, time and location, based on epidemiology: (a) gender, age categories, injury area, alcohol use, pedestrian factor, and main cause, (b) time, week, month and weather, and (c) location, and signal type.

Descriptive statistics and logistic regression revealed the main targets of these variables. Most of the data are categorized, so that the dependent variable is expressed as the odds or likelihood of a certain event or type of accident occurred as a function of independent variables, but it would not enable us to describe the relationships between the different criteria.

A multiple correspondence analysis (MCA) was followed to identify the relationship between significant variables that were named. Multiple correspondence analysis is a factorial method for describing data in the form of maps defined by the factors. It created links between variables, and transformed similarities between individuals into geometrical distances that can be easily shown on simple graphs. The primary aim of this paper is to identify the factors that lead to pedestrian fatalities.

Table 1 General Summary

Parameters	2005 (N=399)		2006 (N=362)		2007 (N=329)		Total (N=1090)	
	N	%	N	%	N	%	N	%
Gender								
Male	215	53.88	191	52.76	163	49.54	569	52.20
Female	184	46.12	171	47.24	166	50.46	521	47.80
Age								
0-14	18	4.51	21	5.80	17	5.17	56	5.14
15-24	15	3.76	11	3.04	6	1.82	32	2.94
25-44	55	13.78	48	13.26	42	12.77	145	13.30
45-64	104	26.07	86	23.76	77	23.40	267	24.50
65 and up	207	51.88	196	54.14	187	56.84	590	54.13
Major Injury								
Head	222	55.64	197	54.42	187	56.84	606	55.60
Neck	4	1.00	5	1.38	4	1.22	13	1.19
Chest	19	4.76	12	3.31	14	4.26	45	4.13
Abdomen	7	1.75	8	2.21	10	3.04	25	2.29
Waist	4	1.00	2	0.55	0	0.00	6	0.55
Back	1	0.25	1	0.28	0	0.00	2	0.18
Arm	2	0.50	0	0.00	0	0.00	2	0.18
Leg	5	1.25	3	0.83	5	1.52	13	1.19
Multi injury	135	33.83	134	37.02	109	33.13	378	34.68
Pedestrian Action								
Walking opposite	11	2.76	8	2.21	13	3.95	32	2.94
Walking parallel	36	9.02	23	6.35	28	8.51	87	7.98
Crossing the road	226	56.64	220	60.77	179	54.41	625	57.34
Playing on road	1	0.25	1	0.28	1	0.30	3	0.28
Working on road	3	0.75	3	0.83	3	0.91	9	0.83
Running to road	6	1.50	4	1.10	2	0.61	12	1.10
Walking from behind a car	2	0.50	1	0.28	0	0.00	3	0.28
Standing by road	6	1.50	13	3.59	6	1.82	25	2.29
Others	85	21.30	65	17.96	79	24.01	229	21.01
Time of Day								
12-6 am	87	21.80	76	20.99	73	22.19	236	21.65
6-12 am	85	21.30	77	21.27	63	19.15	225	20.64
12-6 pm	72	18.05	57	15.75	57	17.33	186	17.06
6-12 pm	155	38.85	152	41.99	136	41.34	443	40.64
Signals								
Signal	47	11.78	43	11.88	47	14.29	137	12.57
Signal w/ Pedestrian indicator	17	4.26	18	4.97	19	5.78	54	4.95
Flash	53	13.28	49	13.54	41	12.46	143	13.12
No signal	282	70.68	252	69.61	222	67.48	756	69.36

3. RESULTS

A total of 1090 pedestrian deaths were registered at the National police Agency in Taiwan from 2005 to 2007. Table 1 shows the general statistics. Among the 1090 deaths, 569 (52.2%) were male and 521 (47.8%) were female. There are no significant differences between male and female. Age was transformed into five age groups (0-14, 15-24, 25-44, 45-64 and 65+). Most (54.13%, n =590) of the pedestrian deaths occurred in the 65+ years age group, followed by the 45-64 years age group (24.5%, n =267), and 13.3% young adults that is in the 25-44 age group. The head area is most commonly injured that would cause death (55.6%, n =267) in pedestrian fatal accidents, followed by multiple parts (34.68%, n =378) and breast part (4.13%, n =45).

The traffic law in Taiwan only regulates drivers under the condition of drink and driving, so only drivers were required by law to take alcohol tests when accidents occurred. Blood alcohol tests were only conducted in 81 pedestrian deaths, among which only 47 cases were tested positive for alcohol. 786 pedestrian deaths were not taken alcohol tests.

There are 1025 pedestrian-vehicle crash type cases, where 57.34% resulted from crossing the road As for the cause factor, 20.09% resulted from crossing the road inappropriately, and 17.43% resulted from crossing the road without using the pedestrian crossing, underground passages, and pedestrian bridges. We can divide the main factors into vehicle driver's factor and non-vehicle driver's factor. The vehicle driver's factor represents 75.96%, which is three to one.

Although deaths were equally distributed across the year, the peak months for pedestrian deaths were in January (10.83%, n = 118) followed by December (10.55%, n = 115). Between 6.7% and 9.17% of the pedestrian deaths were recorded for all of the remaining months of the year. Day of death has no significant differences, and the percentages are between 12.11% and 16.97%. Time of death was classified into four groups: 12-6 am, 6 -12 am, 12-6 pm, and 6-12 pm. Over 40% (n = 443) of the pedestrian fatalities occurred during the evening between 6 pm and midnight. Most of the pedestrian fatal accidents occurred on sunny days (71.01%) and then rainy days (16.7%) followed by cloudy days (11.83%).

If we separate the locations into intersection, roadway section, interchange, and others, pedestrian fatal accidents occurred mostly on the roadway section (57.26%). The signal type in accident locations is no signal (69.36%), flashing signal (13.12%), and complete traffic signal (12.57%). These explain why most accidents occurred on roadways, as there is no signal on roadways.

The accident type model results is shown in Table 2, which indicates that not pay attention to upcoming traffic (OR= 9.148), 12-6 am (OR= 5.964), intersection (OR= 21.222) and complete traffic signal (OR= 7.324) are conditions more likely to have pedestrian-vehicle type accidents occur. It stands to reason that pedestrians walk at intersection with traffic signal during 12-6 am and not pay attention to upcoming traffic are particularly in high risk.

We examined whether categorical variables such as main factor, alcohol use, accident type, pedestrian factor, location and signal type. The results of the logistic regression models are shown in Table 3 (main factor model). It appears that no alcohol use (OR= 1.03), crossing the road not following signs, lines, signals, or directions (OR= 9.931) and at interchange (OR= 10.628) are strongly and positively associated with pedestrians accidents. Pedestrian-vehicle accident type (OR= 0.241) and traffic signal (including pedestrian signal) (OR= 0.142) show that when accidents occurred within these two factors, the main accident factor is mainly the driver.

Table 2 The accident type model

Parameter	Estimate	S.E.	Odds Ratio Estimate	Sig.
Intercept	1.139	0.468	3.124	0.015
Not Pay Attention to Upcoming Traffic	2.241	0.758	9.148	0.004
12-6 am	1.786	0.620	5.964	0.004
Intersection	3.055	0.587	21.222	0.000
Traffic signal	1.991	0.818	7.324	0.015

Furthermore, we want to look more closely at pedestrian-vehicle accidents, and figure out what factors will be related to pedestrians, which are the main factor caused the accident. We chose 1025 pedestrian-vehicle accidents and run logistic regression to examine the factor associated with pedestrian factor. The results are shown in Table 4. The significant variables include no alcohol use (OR= 2.706), crossing the road not following signs, lines, signals, or directions (OR= 7.078), and at interchange (OR=64.790). The fact that pedestrians cross the road not following signs, lines, signals, or directions and not impaired by alcohol are more likely to involve the pedestrian-vehicle accidents.

After the descriptions of pedestrian fatal accidents, a typological analysis is proposed in order to examine the relationships between variables. The classification identified groups in each model, simply revealed the most discriminating characteristics. Figure 1 showed that when pedestrians walk on the roadway (location2) with no signals (signal4) and did not pay attention to upcoming traffic (factor3) at 6-12 pm (time4) were most likely to end up in pedestrian-vehicle accidents.

When accident took place on roadways (location2) and when the pedestrian factors are crossing the road not using pedestrian crossings, underground passages, or pedestrian bridges (factor1), the main factor is more likely to be pedestrian factor (Figure 2). When pedestrians were tested positively in alcohol use (alcohol2), the accident would most likely to occur on roadways (location2) or at interchange (location3), and the pedestrian factor is crossing the road not paying attention to upcoming traffics (factor3).

The pedestrian-vehicle accident type occurred because pedestrian crossed the road and did not pay attention to upcoming traffics (factor3), and

Table 3 The main factor model

Parameter	Estimate	S.E.	Odds Ratio Estimate	Sig.
Intercept	-0.940	0.403	0.391	0.020
No Alcohol Use	0.936	0.220	2.550	0.000
Pedestrian-Vehicle Accident Type	-1.423	0.343	0.241	0.000
Crossing The Road Not Following Sign, Line, Signal, or Directions	2.296	0.246	9.931	0.000
At Interchange	2.363	1.066	10.621	0.027
Traffic Signal (Included Pedestrian Signal)	-1.951	0.767	0.142	0.011

Table 4 The pedestrian-vehicle Crash accident factor model

Parameter	Estimate	S.E.	Odds Ratio Estimate	Sig.
Intercept	-4.171	0.605	0.015	0.000
No Alcohol Use	0.995	0.224	2.706	0.000
Crossing The Road Not Following Sign, Line, Signal, or Directions	1.957	0.259	7.078	0.000
At Interchange	4.171	1.169	64.790	0.000

the main factor is pedestrian factor (main1) mostly (Figure 3). Most of these accidents took place on roadways and pedestrian was tested positively in alcohol use (alcohol2), while crossing the road not following signs, lines signals, or directions.

4. DISCUSSION

When pedestrians consumed alcohol, it could also be a potential danger to traffic. There are no particular laws in Taiwan that restricts pedestrians from drinking alcohol. Unlike pedestrians, drivers of a moving vehicle are exposed to alcohol tests by law, which could lead them to a large fine or even imprisonment. Education in alcohol consumption should also be clearer to prevent drunken pedestrians from causing accidents.

Pedestrians walking across roadways and at interchange areas are also potentially dangerous. Vehicles usually are at a significant speed when entering or exiting at an interchange ramp. Laws and educations on crossing the road should be implemented and be taken seriously.

Laws should be enforced on pedestrians as well as vehicle drivers to prevent accidents. Education for the road users should be taken more seriously, teaching pedestrians to protect themselves as well as others. Such education programs should be adapted to all the road users, and make road users pay more attention to pedestrians’ safeties.

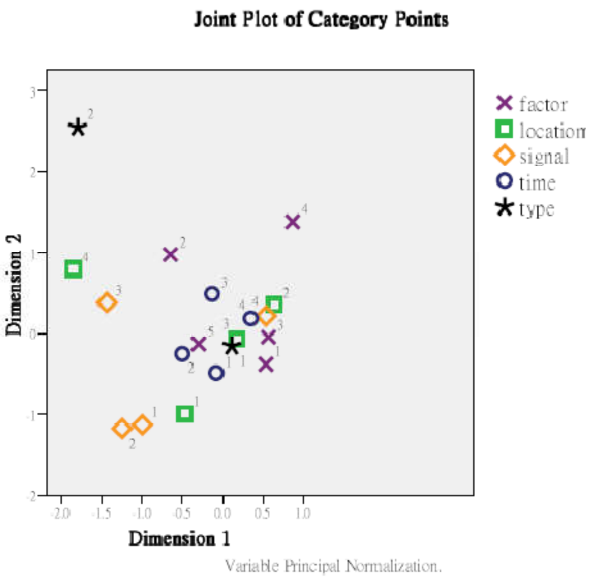

Figure 1 The accident type model

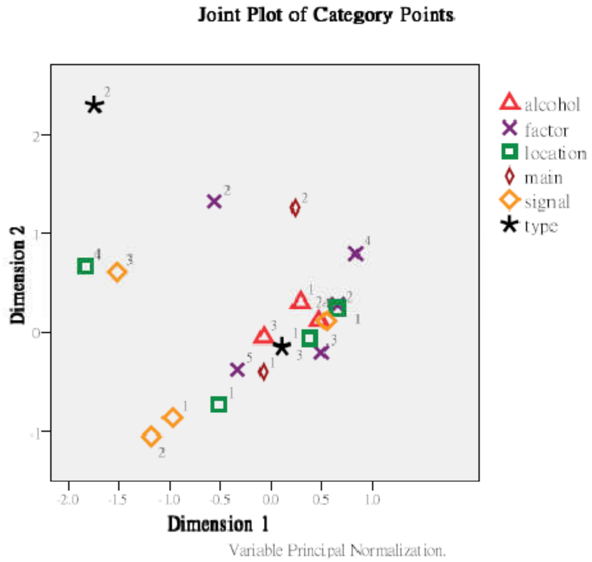

Figure 2 The main factor model

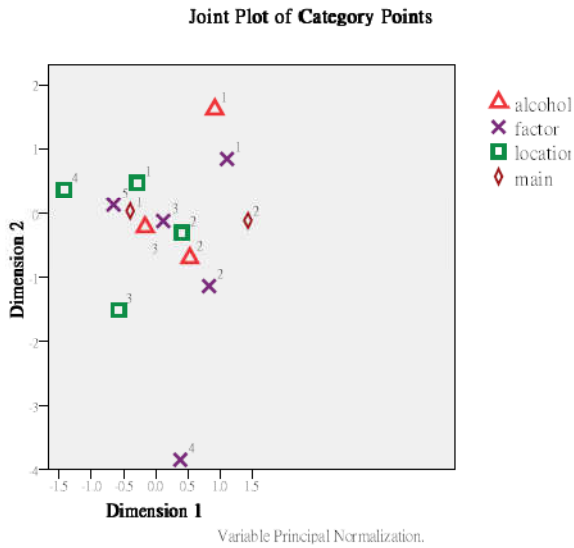

Figure 3 The pedestrian-vehicle crash accident factor model

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COMPARISON OF INTERNATIONAL ROAD ACCIDENT DATABASE AND THAILAND'S

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ABSTRACT:

There are about ten thousand fatalities per year from road accidents in Thailand. The correct solutions for road accidents come from correct road accident data. So, road accident database is very important for analyzing causes of accidents and producing effective counter measures. Thailand has various road accident databases making difficulty to analyze cause of accident. Some databases have low data quality and incomplete data. After comparing Thailand's road accident database with international database such as IRTAD and ITARDA, the result represents that Thailand should improve road accident database urgently by implementing central road accident database and support data collecting organization with legal authority and budget.

KEY WORDS: road accident, accident database, international, Thailand

1. INTRODUCTION

Road traffic accident is an important cause to make Thai citizen death over 10,000 people every year (RTP, 2010). Although the last year statistics 2010 shows decreasing of fatality number from 10,439 to 7,284, Thai death rate is still high at 11.40 per100,000 population and 2.56 per 10,000 registered vehicles. These death numbers are like that there is a war in Thailand.

"Road safety research is needed to clarify the current situation in terms of priorities and problem areas, as research provides the framework of knowledge against which policy decisions can be taken and countermeasures devised. Accurate and comprehensive accident data is required to provide a base comparison for identifying problems, evaluating any changes, and assessing the effectiveness of any countermeasures adopted. Consequently, improving the accident database is frequently one of the first priorities when seeking to establish a road safety research program." (ADB, 1995)

Thailand has various road accident databases both official organization such as Royal Thai Police (RTP), Department of Highways (DoH), Ministry of Public Health, and Department of Disaster Prevention and Mitigation and non-government organization such as insurant companies, rescue team volunteer, traffic radio stations, traffic hotline center and accident research center of various university. The problems from various road accident database causes difficulty of data analysis, differential data quality, and lack of effective road safety measures. The one solution for this problem is upgrading existing accident database to meet the international standard.

This research has objectives to find what data were contained in an international accident database, to review international process for gathering accident data, to compare accident database in Thailand with international standard, and to recommend obligational ways to develop road accident databases in Thailand.

Because of some limitations while doing this research, number of international accident database is limited by two databases from Europe and Asia. The study accident databases are IRTAD of European Union and ITARDA of Japan.

2. LITERRATURE REVIEW

ESCAP (1999) presented the systematic planning of action and intervention required to tackle the problem of road safety, 14 major sectors are presented below and as in Figure 1.

1. Coordination and management of road safety,
2. Road accident data systems,
3. Road safety publicity and campaigns,
4. Traffic legislation,
5. Traffic police and law enforcement,
6. Driver training and testing,
7. Vehicle safety standards,
8. Safety planning and design,
9. Improvement of hazardous locations,
10. Road safety education of children,
11. Emergency assistance to road accident victims,
12. Road safety research,
13. Funding of road safety activities, and
14. Road accident costing

Na Ranong, A. (2007) made a research in "On Traffic Accident Database in Thailand: the Unknown Territory" and presented the lack of road accident data quality because of non-accident report standard in some database both in government organization and non-government organization. This research lists important database problems as:

1. Thailand lacks of in-depth accident investigation.
2. Every Thailand accident database does not have complete accident data.
3. Some accident database just copied the other data involving their duties and ignored the rest data.
4. Each accident database contains different data type or characteristic.
5. In some database, reporters try to cover road accident number because of wrong policy to punish them in case of accident increasing.

This research recommends Thai government should set up a road accident database center for developing standard of accident data collecting and factor definition in order to get better accident data quality.

Simaskul, C. (2008) revealed Thailand accident database in his Doctor of Engineering thesis "Development of Provincial Road Safety Management System in Thailand" that there are various existing road accident database but they have never shared information among concerned agencies. So he introduced a Development of Provincial Road Safety Management System (PRSS) in order to promote the sharing of traffic

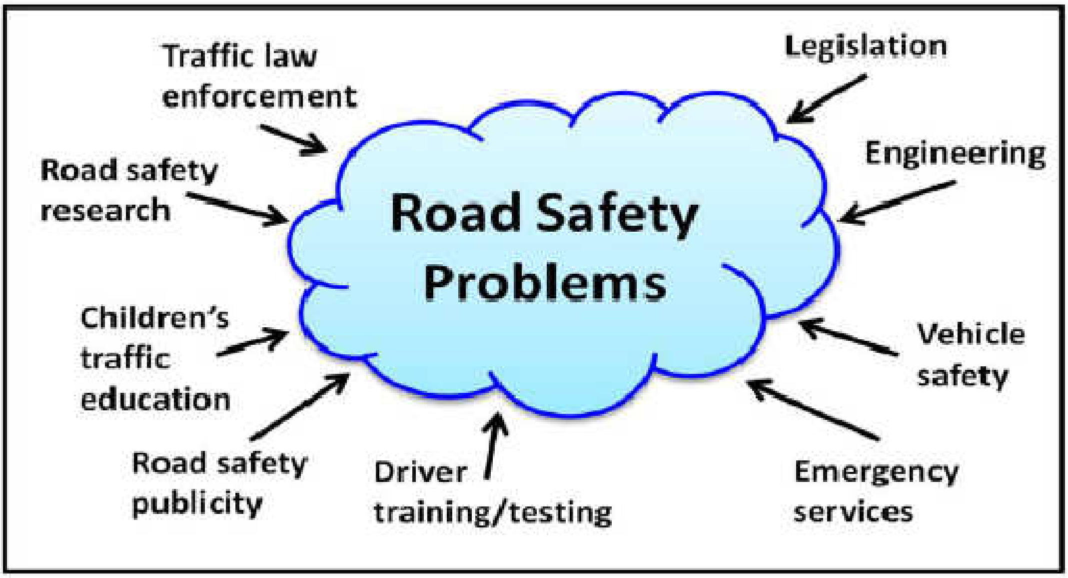

Figure 1 Road Safety is a Multidisciplinary Problem
- All relevant agencies need to be involved ESCAP (1999)

accident information among concerned agencies, and to disseminate the knowledge gained from the system to government officers, researchers, and practitioners.

Road accident database improvement needs linking hospital and police data in order to offer a tool to get a more comprehensive picture of the consequences of accidents, particularly with respect to non-fatal casualties. More accurate data on injury crashes is critical to responding adequately (IRTAD, 2010).

IRTAD recommend an accident database should focuses on:
1. The definition of serious injuries
2. The use of police data and its limitations
3. The use of hospital data and other sources of information
4. The quality of data
5. Linking procedures for hospital and police data
6. Best practices for assessing the real number of casualties (IRTAD, 2010).

3. ACCIDENT DATABASE REVIEW
3.1 European's Accident Database

The International Traffic Safety Data and Analysis Group (IRTAD) is a permanent working group of the Joint Transport Research Centre of the Organization for Economic Co-operation and Development (OECD) and the International Transport Forum. It is composed of road safety experts and statisticians from renowned safety research institutes, national road and transport administrations, international organizations, universities, automobilist associations, car automobile industry, and others from OECD and non OECD countries. Its main objectives are to contribute to international co-operation on road accident data and its analysis. The objectives of the IRTAD Group are to (IRTAD, 2010):
1. Be a forum of exchange on road safety data collection and reporting systems and trends on road safety policies.
2. Collect accident data and conduct data analysis to contribute to the work of the International Transport Forum (ITF) from OECD, as well as to provide advice on specific road safety issues.
3. Contribute to international co-operation on road accident data and its analysis.

Currently, more than 60 institutes from 31 countries are members of IRTAD – representing a wide range of public and private bodies with a direct interest in road safety (IRTAD, 2010). The IRTAD software is a web base application accessing via internet on http://cemt.org/IRTAD/Login_Users.aspx as in Figure 2.

Figure 2 IRTAD database web application
Source: http://cemt.org/IRTAD/Login_Users.aspx (2011)

The most visible product of the IRTAD Group is the International Road Traffic and Accident Database. The database includes aggregated data on injury accidents, road fatalities, injured and hospitalized road users, as well as relevant exposure data such as population, vehicle fleet, road network length, vehicle kilometer rage and seat belt wearing rates from 30 countries, covering every year since 1970 (IRTAD, 2010). Moreover, key road safety indicators are compiled on a monthly basis.

3.2 Japan's Accident Database

Japan used to have a critical road accident problem in 1970. The number of fatalities which had increased with the advance of motorization peaked at 16,765 fatalities (ESCAP, 2008). In 1971, the Central Committee on Traffic Safety Measures produced the first Fundamental Traffic Safety Programs, which has been reviewed every five years thereafter. Each program covered the five-year period. The actual countermeasures of the program comprise: (1) Road environment enhancements, (2) Implementation of the traffic safety initiative, (3) Promotion of safe driving, (4) Implement of vehicle safety, (5) Preservation of order on the road, (6) Enhancement of rescue systems, (7) Improvement of liability security and victim support, and (8) enhancement of research, development, surveys, etc (ESCAP, 2008).

Institute for Traffic Accident Research and Data Analysis or ITRADA was established on March 05, 1992. On June 11, 1992, Japan gave authority to ITRADA about road accident data by designing as the Traffic Accident Research Center in Section 1 of Article 13 of the Road Traffic Law 108. This organization has a major purpose to do a comprehensive study on road traffic environment and efficiency of reducing the traffic accident damage and prevention of traffic accidents. Finally, traffic accident investigation office was installed in Tsukuba on April 01, 1993. ITRADA collects traffic accident data and traffic data (volume, speed, etc.) and maintains an integrated traffic accident database. ITARDA systematically collects the data and expertise accumulated in the government (National Police Agency, Ministry of Construction, Ministry of Transport), links those data and conducts comprehensive investigations and analyses of road traffic accidents. This analysis leads to more effective traffic safety measures and contributes to the creation of a safer, more orderly motorized society (EAGAR, 2010). ITRADA collects accident locations and distribute accident black spots to the public. Because of main black spot focusing, Japan government released accident countermeasures during year 1993 – 2000 and reduced fatalities by 30% approximately (Okuda, 2007). The examples of ITARDA publications are in Figure 3.

Figure 3 ITARDA information publications
Source: http://www.itarda.or.jp/itardainfomation.php (2011)

3.3 Thailand's Accident Database

Thailand does not have an accident database center but there are some databases of organizations involving road safety only. The main road accident government organizations are Royal Thai Police, Department of Highways, Ministry of Public Health, and Department of Disaster Prevention and Mitigation. Each organization has own collecting officers, accident data collecting forms, and database. They have same purposes to mitigate road accident damage but their data are different standard.

These are major accident database in Thailand:
1. POLIS: POLice Information System
This database is managed by Royal Thai Police (RTP). Most data in this database is criminal records and police management data. POLIS contains traffic accident case records limited serious case only. The accident data quality is useful for law enforcement and quite able to present causes of accident. The causes of traffic accident in POLIS data were written by policeman. The data about involving vehicles was recorded with low detail. The environment data such as road alignment and curve radian was recorded in paper case only but not including POLIS. The details of case accident data are not public because of security policy.

2. TRAMS: Thailand Road Accident Management System
In 2007, TRAMS was set up by Ministry of Transport (MoT) and managed by Department of Highways (DoH). Road accident data in this system is high road environment data quality. The geography information data is collected in each accident location. Data about driving behavior detail is quite lower police. TRAMS has one purpose to share traffic data and produce cooperation between government to government organization in Thailand. This system shares real time accident report of each case to the public also. TRAMS publics both traffic and road accident data by website http://gis.mot.go.th/tramsgnr/.

3. DDPM: Department of Disaster Prevention and Mitigation

Department of Disaster Prevention and Mitigation (DoDPM) has own road accident database. The accident data comes from officers in each province. They report road accident data via web base application monthly. Most of reporters retrieve accident data from police in each area. Some of them ignore slight accident data and make database incomplete. Because of officer duty limitation, this database does not collect causes of accident details.

4. EMS: Emergency Medical Services
There are various organization provide EMS to the public such as Narenthorn hospital EMS units, Pohtecktung and Ruamkatanyu rescue units. These EMS units have interesting records of time accuracy from people informing record. They usually record casualty severity also. These units do not have policy to public road accident data. Accident data is limited injury and fatal accident only.

Furthermore, there are some traffic radio stations and traffic hotlines recording accident data twenty four hours per day and seven day per week. They are Traffic Police Hotline 1197, Highways Police Hotline 1193, J.S. 100 Radio 1137, and FM 91 Traffic Pro 1644. These hotlines get accident data and many road safety comments from drivers which are valuable for every road authorities to concern and improve Thailand's road safety. The examples of road accident database in Thailand are in Figure 4.

4. COMPARISION OF ROAD ACCIDENT DATABASE

Each road accident database has own purpose to be established and collect accident data. While most of developed countries select central database system to collect road accident data, Thailand still use distribute database system because of some limitations. The different of advantage of each database can be compared as Table 1.

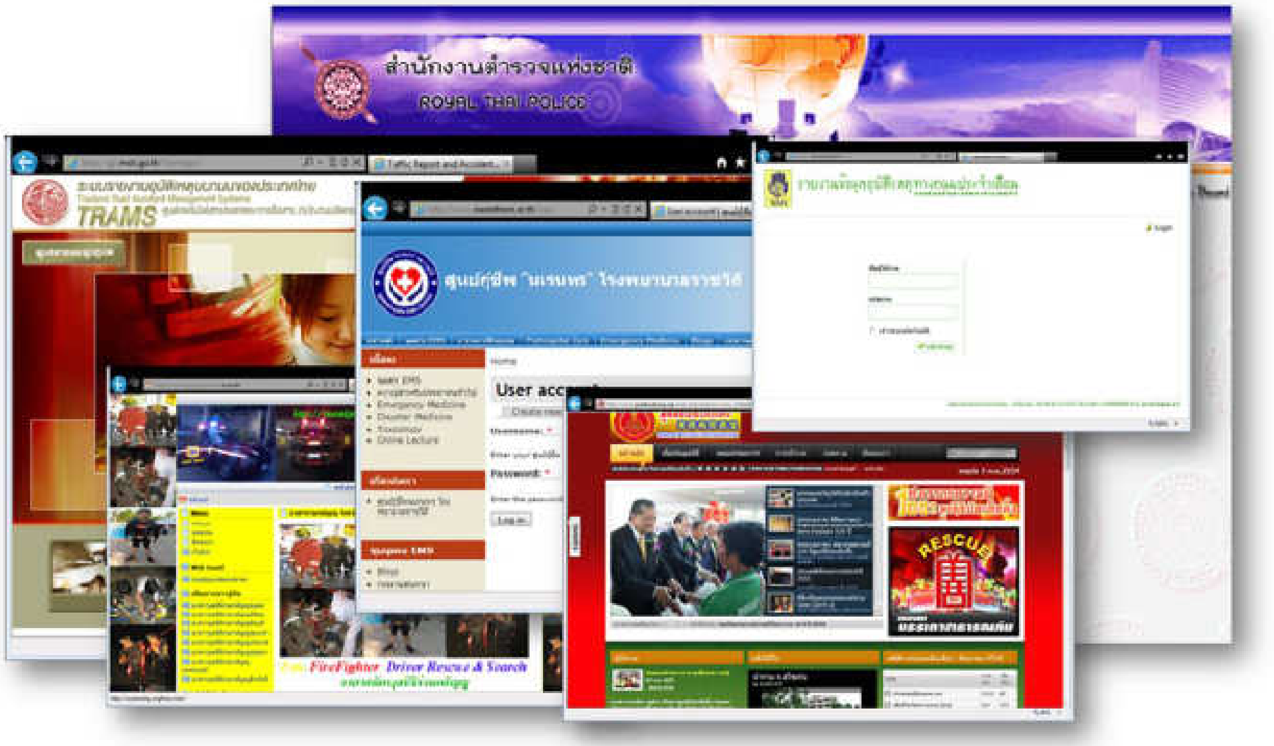

Figure 4 Major Accident Database in Thailand

Table 1 Comparison of Road Accident Databases

Database characteristic	IRTAD	ITRADA	Thailand's
1. Computer database	Yes	Yes	Yes
2. Internet access	Yes	Yes	Some
3. Official data	Yes	Yes	Some
4. Government budget support	n/a	Yes	Some
5. Road environment detail	Yes	Yes	Yes
6. Driving behavior detail	Yes	Yes	Some
7. Vehicle type detail	Yes	Yes	Yes
8. Central database	Yes	Yes	No
9. Data publicizing	Yes	Yes	Some
10. Suitable to analyze as model	Yes	Yes	Some

*Some = some databases are acceptable for database characteristic

5. CONCLUSIONS

Thailand's road accident database lacks of some required characteristics comparing with international road accident database. The important requirements are:

1. Thailand needs to centralize road accident database.
2. Thailand needs to link road accident data between police and hospital.
3. Thailand needs to support road accident database organizations by law and budget.
4. Thailand needs to improve accident data quality standard for analysis.
5. Thailand needs to accept current road accident situations and find better solutions

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