# INTEGRATED ROAD TRAFFIC ACCIDENT SYSTEMS (IRTAS) FOR EMERGENCY SERVICE PROVIDERS

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**ABSTRACT**

*This study presents the integrated road traffic accident system (IRTAS) in Johor Bahru, Malaysia. This study utilizes the available traffic accident data from emergency service providers to obtain the efficiency of their cooperations. The current emergency response system (ERS) in Malaysia is provided by the following entities: (1) police; (2) hospital; (3) fire and rescue; and (4) civil defense. This research uses the collaboration data from the all providers. ERS operations are conducted in accordance with the provider-specific standard operational procedure (SOP). The differences in SOP can result in poor coordination between providers when providing the emergency services to the victim. Considering that every provider has its merits and weaknesses, therefore, their merits are combined to design the most effective and most efficient IRTAS. The next step is the development of a computerized traffic accident database as a comprehensive database for the providers. Ambulance records and a one-year police data were extracted and transferred into the developed computerized database. Meanwhile available data were classified hierarchically based on their shared characteristics. Integration IRTAS was established by identifying the mapping data to the target data. The available data are used by providers for input and retrieval purposes. The data combination is used to enhance the cooperation between emergency service providers. The result modules can assist the providers to improve their emergency services and to optimize their response time to reduce the fatalities of road accidents.*

**Field of Research:** *Road traffic accident (IRTAS),emergency response,emergency providers.*

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## 1. Introduction

In an emergency, quick and efficient command is important to minimize losses. Achieving efficiency generally depends on relevant policies such as emergency plans, regulations, and laws. When emergencies occur, employing a certain management method is necessary. Based on the stages of crisis development, the emergency response process can be divided into three phases: prophase, metaphase, and post-phase. The prophase includes the emergency reaction mechanism and the improvement of the systems for organizing plans. The metaphase is the process of reacting to emergencies, such as making quick responses, sensible commands, and effective assignment. The post-phase includes the process of improving and perfecting the mechanism of emergency responses (Steven, 1987; Xu et al., 2004).

When an emergency breaks out, relevant emergency plans and regulations that are established beforehand are the most important bases for quick and effective commands and assignments. Speed and efficiency are the two main indexes during this process. Current research on quick emergency

responses mainly includes two classes. One is the quick response information system, which enhances information transfer and feedback on a domainal situation. Examples of a quick response information system are the GIS-based ERS (Xu et al., 2004) and urban linkage systems.

Establishing relevant laws and regulations and applying them quickly in cases of emergency is an urgent requirement of decision makers. Therefore, policy documents on emergency response are the knowledge resource for decision makers to command and assign tasks after an accident. Among such policy documents, response plans are of key importance as it is the direct basis for decision making. Moreover, the first step in an emergency response is to put relevant emergency plans into action (Rong and Jia, 2008). The emergency response process includes a sequence of activities, such as alert and warning, damage assessment, emergency operation, evacuation, and rescue (Haghani and Yang, 2007).

## 2. Emergency Response

The increasing number of natural and man-made disasters, such as earthquakes, tsunamis, floods, aircraft crashes, etc., have been posing new challenges to public service and demonstrating the importance of emergency management. Good collaboration among providers, municipalities, and other authorities, or even among different countries, is needed during the four phases of emergency management, namely, mitigation, prevention, preparedness, and response and recovery.

The survival of victims in emergency situations requires some action to be taken within a period of less than normal time. Emergency is defined as “a sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property or essential public services. Emergency includes such occurrences as fire, road accident, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.” (California Environmental Quality Act 21060.3)

Emergency response is the implementation of processes resulting from planning and preparations for action, and the application of resources that must be utilized to mitigate consequences and recover from an emergency. As illustrated in Figure 1, an emergency procedure involves many essential components and providers involved in rescue operations. The coordination between components and providers directly influence the services provided in an emergency response (Yang, 2006). This paper is focused on developing an ERS that can help integrate the information from different providers with specific significance given to the achievement of optimum response time.

To provide an effective service, emergency vehicles must respond within a minimum amount of time upon the reporting of an incident. Emergency vehicles must also be equipped with sufficient resources to provide fire, rescue, or emergency medical services. Emergency services can be divided into four phases: detection, preparation, travel, and treatment time. Response time is defined as the time it takes for an emergency vehicle to arrive at the scene upon receiving the emergency call at the station. It is the sum of the preparation time and the travel time (Bradley et al., 1998).

Utilizing precise information and reducing the response time can effectively minimize the negative impact of an accident. Preparation time and travel time are noticeably affected by the availability of vehicles, the traffic situation, and the allocation of fleet to facilities. Therefore, the proposed integrated ERS should be able to optimize emergency operations and consequently improve service performance and reduce fatalities and property loss.

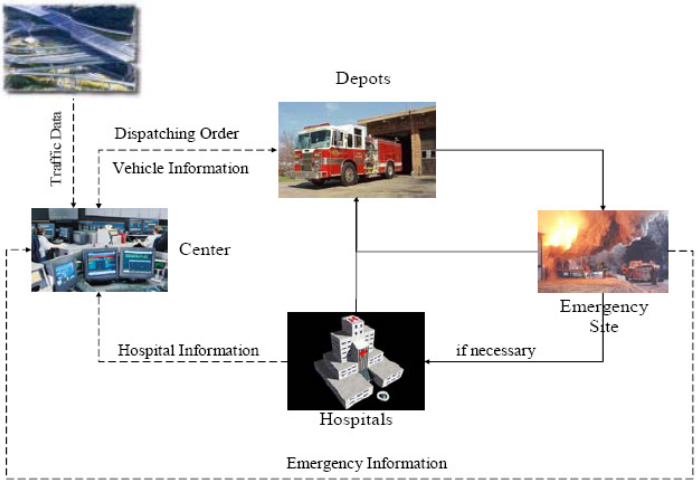


**Figure 1: ERS components**
Source: Yang, 2006

## 3. ERS in Malaysia

### 3.1 Current ERS in Malaysia

Malaysia is a developing country comprising 15 states with a total landmass of 329,847 square kilometers. The area is separated by the South China Sea into two regions- the peninsular and the eastern parts. Borders are shared with Thailand, Indonesia, Brunei, Singapore, Vietnam, and the Philippines. The country's population of over 27.5 million is made up of various ethnic groups, with Malays making up 50.4% of the total. The remaining population includes other ethnicities such as Chinese and Indians. The life expectancy of Malaysians in 2008 was 74 years. The infrastructure in Malaysia is one of the most developed in Asia, and Malaysia's road network covers 98,721 km. Along with the rapid development of the road network and the escalating number of vehicles on Malaysian roads is the increase in the number of road accidents involving fatal and serious injuries (Nik Hishamuddin et al., 2007).

Three core providers are involved in providing emergency services. The fire and rescue services deal with potentially harmful fires, rescue operations, and road traffic collisions. Police services are concerned with the security of persons and properties in all categories of emergencies. Ambulance services aim to reduce loss of life and damage by reducing response time. Other providers, including the civil defense department and volunteer organizations, assist the three main providers (Mustaffa and Hokao, 2011).

All emergency providers have a system in place for conducting emergency response. For example, fire and rescue follow the Hazardous Material (HAZMAT) guidelines and the system of incident command in dealing with hazardous materials. For hospitals, emergency medical systems are in place to improve healthcare in Malaysia. However, such systems are difficult to run and are only implemented in selected hospitals. At present, the civil defense and hospitals have their own emergency call handling service despite the availability of the Malaysian Emergency Rescue Services (MERS 999). Before 2007, different numbers were dialed for emergency services, such as 994 for the fire and rescue services, 991 for civil defense, and 999 for Telekom Malaysia (TM) and the police. All emergency calls at present are made to a single number, i.e., 999 for TM. The call is validated by an operator, and only the genuine ones are transferred to the respective providers for emergency.
The MERS 999 is the central service for emergencies that features single-number dialing. First, calls are made to the MERS 999 call center or directly to the emergency services provider when road traffic accidents occur. The MERS 999 call center is the first to verify and filter the calls. Once the call is

confirmed, it is analyzed and forwarded to the provider based on the need of the specific emergency. All providers receive the call and the corresponding call card. The call center at each provider receives the call and gives an order to rescue teams based on the relevant information. The rescue team immediately proceeds to the scene. After the scene is secured, the victim is transported to the nearest hospital aboard the ambulance. All providers use the same SOP (Figure 2).

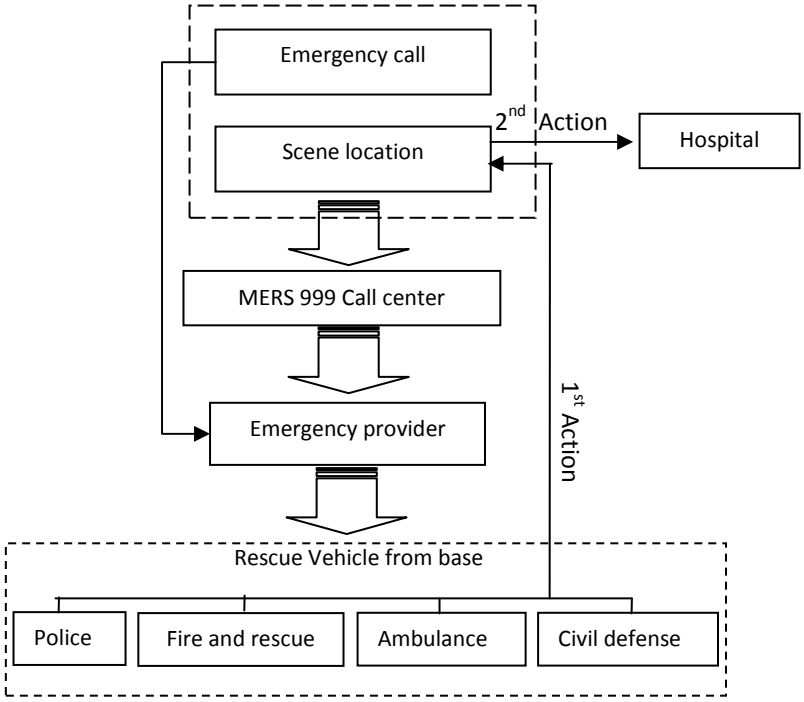


**Figure 2: Flowchart of handling a road accident emergency**

The Malaysian government needs to improve its emergency services, but this improvement should be based on public needs. Previous studies on the evaluation of ERS are not enough to anticipate the attitudes of the public. These kinds of studies were recently conducted in Malaysia only to determine patient satisfaction in hospitals with EMS. One study was conducted concerning ambulance services and patient satisfaction with the emergency departments in hospitals. Except for the study about EMS, no survey report exists concerning emergency services providers in Malaysia. Therefore, the present paper attempts to study ERS from the perspectives of the service providers to provide another viewpoint on emergency response today. Emergency service is extremely significant and studying it is very urgent, most especially because it can serve as an indicator of ERS quality (Mustaffa and Hokao, 2011).

One of the major limitations of ERS in Malaysia is the deficient integration among agencies during an emergency. No uniform communication and dispatching methods are established among the agencies (Anisah et al., 2008; Mohd. et al., 2008; Ismail et al., 2008). Nevertheless, the public demands better emergency response to decrease the total number of victims (casualties/injuries) caused by road accidents. However, the total number of accidents continues to increase annually. Emergency services should be able to respond rapidly to emergencies to ensure that victims receive the required service, the appropriate equipment, and the proper ambulance service, all of which can be guaranteed through a better coordination between agencies. In the present research, a questionnaire survey was administered to determine public satisfaction with emergency agencies.

### 3.2 Malaysian ERS Providers

The following four providers in Malaysia are involved in road accident rescues: the police, fire and rescue, hospitals, and civil defense. Each provider has a distinct duty in handling emergencies. The role of each provider is explained below.

#### 3.2.1 Police

The police have various roles when handling road accidents, but their duties vary depending on the type of accident. They receive emergency calls regarding the accident from MERS 999, the public, or the hospital. Contacted police immediately proceeds at the scene if the accident calls for an investigation. At the scene, they control traffic and investigate the accident. They then record the details of the accident and the statements of witnesses. If the accident is fatal, senior officers take over the investigation, which is a process that becomes more complex because no piece of evidence can be moved. All details are recorded on the POL 27 form and are integrated into the CARS system. The events at the scene are important data that must be documented because the information gathered can serve as an important element in the event of a prosecution.

#### 3.2.2 Fire and Rescue

The fire and rescue department receives calls from MERS 999 on road accidents involving fires from motor vehicles. They also get calls from other providers or from the public who are in need of direct fire and rescue service. Cases of accidental vehicle fires are stated as special service. Fire and rescue service providers immediately proceed to the scene of the accident to carry out rescue operation. The roles of fire service providers during a road accident vary. In general, their task is to deal with fires, but they also often deal with other tasks. When the fire service is called to a scene of an accident, their job is to attempt to rescue the victims and prevent vehicle fires. Therefore, they secure the site from any fire threats. One major task of the fire and rescue service providers is to rescue victims who are trapped in vehicles. This task requires skills and tools possessed by the fire brigade. Thus, they are trained to handle these types of situations. Fire and rescue service providers also play a role in any rescue efforts and in situations involving hazardous materials. They record relevant data on site, including basic information, types of equipment used, clarification of the accident, and services provided. In addition, details of the victims are also recorded before the data is presented to the superiors. The recorded data are stored for monthly statistical purposes using the format provided. Fire and rescue service providers have yet to use a comprehensive computerized database system.

#### 3.2.3 Hospital (Trauma and Emergency unit)

The tasks conducted by ambulance workers, particularly the paramedic, at the site of accidents are the most important. The number 999 is the universal emergency number in Malaysia. Calls to the ambulance can be made directly to the hospital or through MERS 999. Most of the ambulance workers are paramedics who are trained to face emergencies and to promptly help accident victims.

Ambulances are sufficiently equipped and are manned by experienced and skilled paramedics. Thus, rescue operations become easier when an ambulance arrives at the scene of an accident. Paramedics usually identify the injuries of the victims and prepare to give early treatment. One of the roles of an ambulance worker is to stabilize and treat patients before they are safely transported to the hospital immediately. Ambulance workers are expected to be able to handle the situation immediately while remaining in control and calm. They often carry out diagnostic tests at the scene and, if possible, carry out basic first aid. From there, they decide whether to take the casualty to the hospital or simply deal with them at the scene. All paramedics and ambulance technicians are highly skilled in advanced

driving so that they can move people away from the accident site as safely as ossible. All victim and accident data are recorded.

**iv. Civil Defense**

Malaysia has a team called the civil defense department, which was formed by the British Passive Defence under Chapter 41 of the Emergency Regulations Enactment to provide support measures during World War II. It was officially enacted as law under the Malaya defense system. This law was extended to the country when Malaysia gained independence. The civil defense was initially assigned to assist rescue teams during emergencies such as floods, which frequently occur in Malaysia. In 1993, after the tragic collapse of the Highland Towers, which claimed many lives, the civil defense department was reorganized. They started doing disaster relief work and provided protection to ensure the safety of life and property in the event or possibility of a disaster. They also began facilitating the rehabilitation of the victims after the disaster. Civil defense has become an additional body that augmented the services provided by fire and rescue, the police, and hospitals during an emergency. Today, they are recognized as an agency that provides assistance in small-scale emergencies and in the event of road accidents. Civil defense personnel are equipped with rescue equipment and ambulance, similar to hospitals. They are also trained to perform the basic work of paramedics and fire fighting to assist other providers. In the course of rescue, they also record the details of the incident.

## 4. ERS Development

The most important consideration for the ERS operator (provider) is to serve to a level deemed satisfactory by the public, especially the victims. The lack of integration among providers and the absence of a uniform communication and dispatching system among them has become a major issue in ERS in Malaysia. Nevertheless, the public demands for better emergency response (Mat et al., 2001). Even though ERS can be enhanced with information technology, the most pressing issue regarding emergency response is the lack of information for providers to arrive at the scene on time. This problem negatively affects the response time of emergency service providers. The information referred to here should also be used for their emergency plans during and after the accident. A minimal response time will lead to good general public perception on the services.

### 4.1 System Design of ERS

To develop the systems, the concept design of IRTAS must be explained. The design follows a sharing concept to overcome the coordination problem among ERS providers. In this concept, all providers involved in ERS must be included in the RTA database. The existing systems are based solely on RTA data on individual providers rather than on a comprehensive database. The main problem of these systems is the limited functionalities and the very different system types (i.e., manual and digital). Thus, combining the existing data for the redevelopment of IRTAS is very important to ensure ERS success in the study area. One method is to employ a structure that allows analysts to breakdown complex systems into smaller parts. The most widely used methods are systems analysis and design method.

The first principle is the top-down functional decomposition wherein the systems are given more importance and the small details are ignored. The scopes of the systems are clearly defined, and the physical aspect of the current system is analyzed by observing how tasks are currently being accomplished and who performs them. The process then moves to what is currently being done from the logical point of view, which completes the analysis phase. The process moves on to the next phase, which is the design. In the design phase, the analyst considers the tasks the new system should do and how the tasks should be done.

### 4.2 ERS Management

#### 4.2.1 Overview of RTA Database

The accident database mainly presents the overall picture of the traffic systems. The major components of traffic data given by the National Highway Traffic Safety Administration (NHTSA, 2000). The factors are categorized into six groups, namely, crash, injury surveillance, roadway, vehicle, driver/person, and enforcement or adjudication. The data from the traffic accident database in Malaysia are collected and maintained by all service providers, namely, the police, ambulance providers, fire and rescue, and civil defense. Based on the MAAP and CARS, the police department maintains their RTA database adopted from the POL 27 form. Other providers involved in RTA have no proper database system, and several of them still use hard copies. The database sources of providers involved with RTA were used for IRTAS development.

The most reliable source of RTA data in Johor Bahru is the Hospital Sultanah Aminah and Balai Polis Traffic Johor. Two main types of data are available, namely, RTA with accident statistic and response time data. The RTA data from police are used for black spot identification, whereas the response time data from hospitals are used for optimum response time analysis. Using standard classification and assigning codes to the collected data is critical in making accident data consistent and reliable. The definitions of traffic accident vary in some countries. The United Nations defines traffic accidents as "accidents which occurred or originated on a way or street open to public traffic; which resulted in one or more persons being killed or injured and in which at least one moving vehicle was involved. These accidents therefore include collisions between vehicles, between vehicles and pedestrians, and between vehicles and animals or fixed obstacles. Single vehicle accidents, in which one vehicle alone (and no other road user) was involved, are included" (IRTAD, 1998).

#### 4.2.2 RTA Database Development

In Malaysia, RTA data from emergency providers are not acquired from a shared source. Data partnering can be advantageous for all participants. Data sharing can help providers save on data collection cost because of the more efficient collection process and the multiple uses of the collected data (Heanue, 2000). In applying the concept of sharing, Brown (1991) proposed the use of a distributed responsibility concept in improving the quality of accident data. This concept requires a direct distribution of data benefits throughout the data of responsible organizations in the sense that the useful information is fed back to the organization that generated it. Figure 3 shows several data of the collecting agencies involved. These agencies include all providers involved with ERS that can provide accident information.

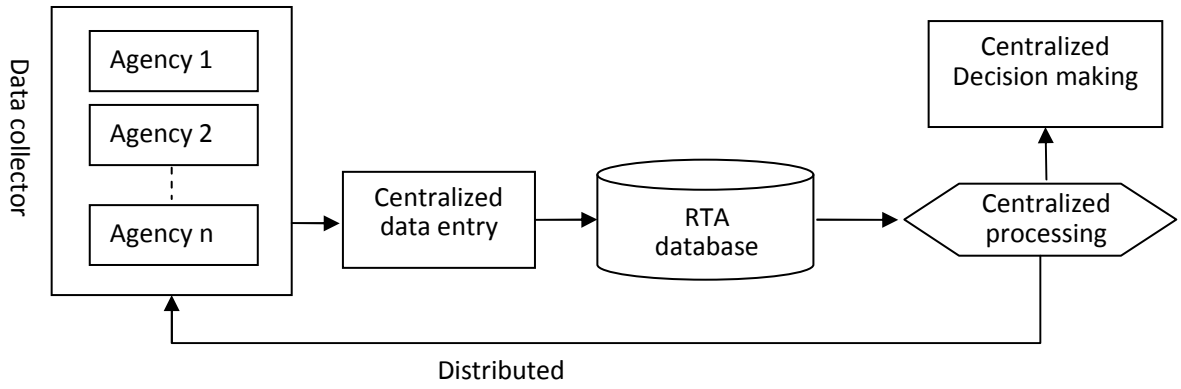


**Figure 3: A distributed responsibility concept**

Following the concept of sharing, IRTAS is developed by combining the data from different providers including the police, fire and rescue, hospital, and civil defense. Data warehouses are used as common storage for combined data, as shown in Figure 4. The IRTAS database in the study area with source types of collected data and the limitations of accident data are shown in Table 1.

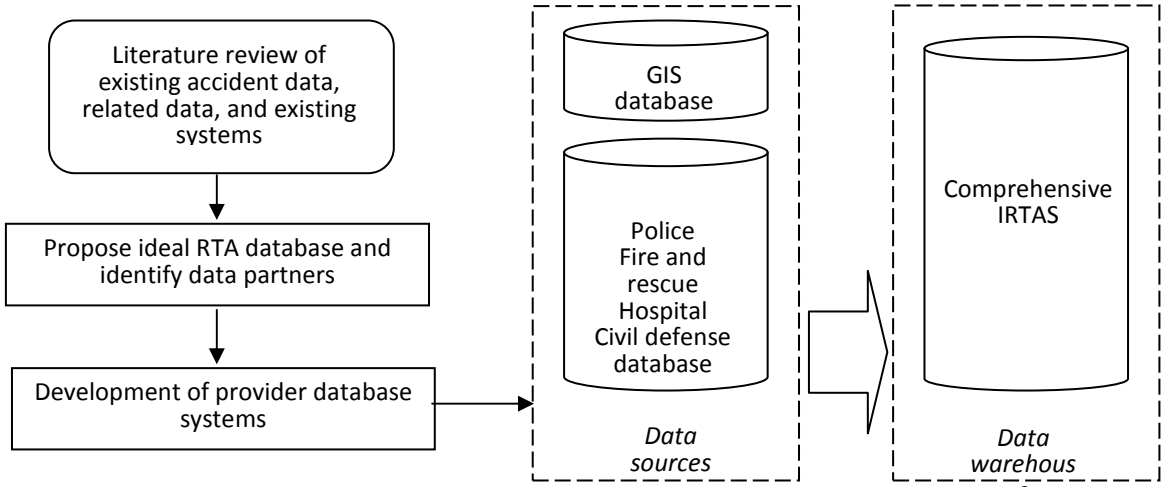


**Figure 4: Development of IRTAS accident database systems**

**Table 1: Summary of collected data sources and limitations in Johor Bahru The IRTAS database from the provider is classified into five main areas: traffic accident general data, vehicle data, accident involved personal data, injury surveillance data, and road inventory data (Figure 5).**

| Source | Kind of data | Limitations |
|---|---|---|
| Hospital | Demographic characteristics, time and date, type of injury, response time, etc. | Data from only one out of three hospitals; Data should be transformed from hard copies to digital. |
| Police | Type of injury, road condition, number of casualties, location, etc. | Data from MIROS after clean-up of raw data from the police department |
| Fire and rescue | Type of services, number of persons involved, location, response time, etc. | Response time data are transformed to digital only |
| Civil defense | Type of services, location, response time, type of injury, etc. | Data cannot perform |
| GIS existing data | Road network, infrastructures, etc. | Coverage of study area with spatial and attribute for accident location |

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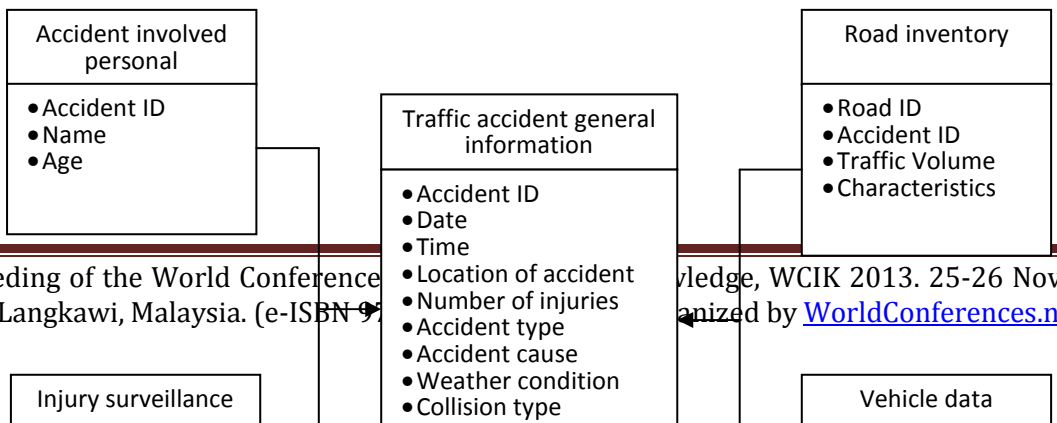

**Figure 5: Main areas of interest in traffic accident data**

### 4.2.3 GIS Technology Development

GIS technology and its applications have been discussed in recent years across a wide variety of settings. Moreover, transportation planning has undergone several GIS-related developments. GIS is a very important and comprehensive management tool for traffic safety. Several agencies have been using GIS for accident analysis. GIS can hold a vast amount of data that can be easily stored, shared, and managed. This technology also provides a platform for data analysis and visualization, allowing users to explore the relationships between data and providing them with graphical or non-graphical outputs.

The amount of data that can be incorporated into a GIS is almost limitless. Consequently, GIS does not only allow input, maintenance, and output of robust data sets, but it also has the capability to model the spatial distributions and trends of these data sets. GIS appears to be a solution for numerous problems when these powerful capabilities are factored in. Considering the extent of spatial data associated with traffic collision locations, GIS seems to be a logical choice in defining spatial trends or patterns (Brose, 2003). Hence, ArcGIS is preferred because of its straightforward graphical user interface, powerful spatial analysis capabilities, and inherent capacity to geocode locational data.

## 5. Conclusions

The point of improvement from current situation describes the framework of analysis and the role of method to integrate the systems development. The emergency processed and typical design of the ERS was discussed together with the current procedures of ERS in Malaysia. Application to enhance the effectiveness and efficiency of ERS response time. Finally, how the ERS was developed with integrated database and GIS technology. To develop ERS, the user requirement is needed to explained how the time response being effected in ERS.

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