EMERGENCY ROUTE PLANNER SYSTEM WITH GIS/GPS

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ABSTRACT

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Emergency caused by road accidents can be stressful and involved with wide range of activities. The situation can get worse when handling multiple accidents. Therefore to provide immediate medical attention to the accident victims, an efficient and reliable emergency response by emergency rescue service is required. Furthermore, dispatching a victim to a medical centre in an appropriate time frame will be crucial. A delay for further treatments of victim, and victim with severe injuries, is proof to be fatal. Therefore, an emergency management system will be required. Therefore, a solution is proposed in this paper as an alternative to problem associated with handling emergency situation in Kota Kinabalu city, Sabah, Malaysia. The system (ERPS) is developed by incorporating Geographical Information System (GIS) and Global Positioning System technologies. These technologies enable exact location of incident scene, emergency vehicle and medical center to be discovered. All these data will be used in GIS as it can be displayed, analyzed and organized for the purpose of emergency handling. The final outcome of this research is to develop an Emergency Route Planner System which is capable of performing routes analysis, thus providing necessary assistance for rescue service in Sabah.

ABSTRAK

Kecemasan disebabkan oleh kemalangan jalanraya boleh menjadi rumit terutamanya apabila kecemasan yang dihadapi adalah disebabkan oleh beberapa kejadian kemalangan. Ini akan mengakibatkan banyak kerja-kerja atau aktiviti khususnya aktiviti menyelamat yang harus dilakukan. Bagi memberikan rawatan kecemasan secepat mungkin kepada mangsa kemalangan, respon terhadap kecemasan tersebut haruslah efisyen dan mampu dipercayai.Tambahan pula penghantaran mangsa ke pusat kesihatan dalam masa yang sewajarnya amat penting. Masa yang panjang bagi seorang mangsa untuk menerima rawatan susulan terutamanya kepada mangsa dengan kecederaan yang teruk mungkin akan membawa maut. Oleh kerana itu suatu Sistem Pengurusan Laluan Kecemasan (ERPS) amatlah perlu. Didalam projek tesis ini, satu sistem akan dibangunkan bagi pengurusan kecemasan di bandar Kota Kinabalu, Sabah. Sistem ini akan mengintegrasikan Sistem Informasi Geografi (GIS) dan Sistem Kedudukan Global (GPS) didalam pembangunannya. Lokasi kawasan kemalangan, lokasi kenderaan kecemasan, dan lokasi pusat perubatan boleh diperolehi menggunakan GPS dan seterusnya GIS akan bertanggungjawab membentuk data tersebut untuk tujuan paparan, analisis dan pengurusan untuk sebarang kegunaan kecemasan. Hasil akhir penyelidikan ini adalah untuk membina ERPS (Sistem Pengurusan Laluan Kecemasan) yang memiliki kebolehan untuk melaksanakan analisis lintasan atau laluan, yang dijangkakan dapat membantu memperkembangkan kualiti menyelamat dan seterusnya memberi alternatif baru dalam perlaksanaan aktiviti menyelamat, khususnya mangsa kemalangan jalanraya di Sabah.

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LIST OF ABBREVIATIONS

GIS	-	Geographical Information System
GPS	-	Global Positioning System
EMSS	-	Emergency Management Smart System
RCTM	-	Radio Technical Commission for Maritime Services
NMEA	-	National Marine Electronics Association
AVL	-	Automatic Vehicle Location
GNSS	-	Global Navigation Satellite System
GPRS	-	General Packet Radio Service
GLONASS	-	Global Navigation Satellite System
LBS	-	Location Based System
VECON	-	Vehicles Control Navigation
EMS	-	Emergency Management System
AP	-	Access Point
WLAN	-	Wireless Local Area Network
CMU	-	Central Monitoring Unit
PD	-	Patient's Device
HTTP	-	Hypertext Transfer Protocol
PDRM	-	Malaysian Police Department
SMC	-	Sabah Medical Centre
JUPEM	-	Malaysian Survey and Mapping Department
R2V	-	Raster to Vector Software
GSM	-	Global System for Mobile Communication

CHAPTER 1

INTRODUCTION

1.1 Introduction

As vehicles become cheap and affordable, the increasing number of road accidents will continue to rise due to the fact that more vehicles are used on the road. It was reported in December 2004 that eleven major accidents occurred in Kota Kinabalu and along Tamparuli - Ranau highway (Sabah) in a span of 24 hours (Daily Express Newspaper, 2004). In these eleven accidents nearly everyone involved suffered serious injuries and two perished. During those times, rescue services (the ambulance, fire department and police force) were working around the clock to help save lives.

The case which was stated above was one of among many cases which are occurred and recorded in Sabah. It is believed that there are a sharp increasing number of accidents recorded in Sabah in the last few years. A total of 7564 accidents was recorded in the first seven month of the year 2006 compared to 7279 accidents in 2005. This is an increase of 285 accidents from the previous year. Despite the advancement of rescue services, accidents are still happening everywhere. Furthermore, it is obvious that multiple accident cases are more difficult to be managed and stressful. Therefore, emergency services will need to cooperate and communicate with each other at all time to ensure that victims can receive medical attention as soon as possible (Esri, 2000).

This is why an efficient emergency route planner system is required to coordinate paramedics and rescuers to ensure that they can deliver a victim to the hospital in the shortest time possible (Ishidas *et al.,* 2004). The emergency route planner system will need to be managed and monitored frequently by using tools that can pinpoint accident locations and shows routes information during the rescue service (Halls, 2002). At this particular time, those who involved including the paramedics, police officers, ambulances driver, fire and rescue team and medical doctors will need to be alert. These people will need to cooperate with each other in order to handle the emergency successfully (Lang, 2002).

Furthermore, the success is also depending on the amount of data available in an emergency route planner system. Some examples of these data are the coordinate location of the accident, the number of victim, the routes information, and the number of ambulances available. Unfortunately, there is an insufficient amount of data available by the rescue departments in Sabah.

To have sufficient data in an emergency route planner system, it is important to collect updated raw data (latest maps version, coordinate, routes and etc). Usually, an updated raw data will be converted into a digital format (hardcopy format to digital format; raster/vector) by a user in order for them to generate useful data (Crosiers *et al.,* 2004). However, the rescue departments in Sabah were currently using conventional application to manipulate raw data (not in digital format). Conventional application in this context means that the rescue services was still using paper maps and hardcopy data, tables, historical records, charts and reports (Derekenaris *et al.,* 2001).

These data is often found in a variety of different locations (from one department to another which may be located in different building or floor) and formats, furthermore require a great deal of time to acquire, prepare, and formulate into useful format (Derekenaris *et al.,* 2001).

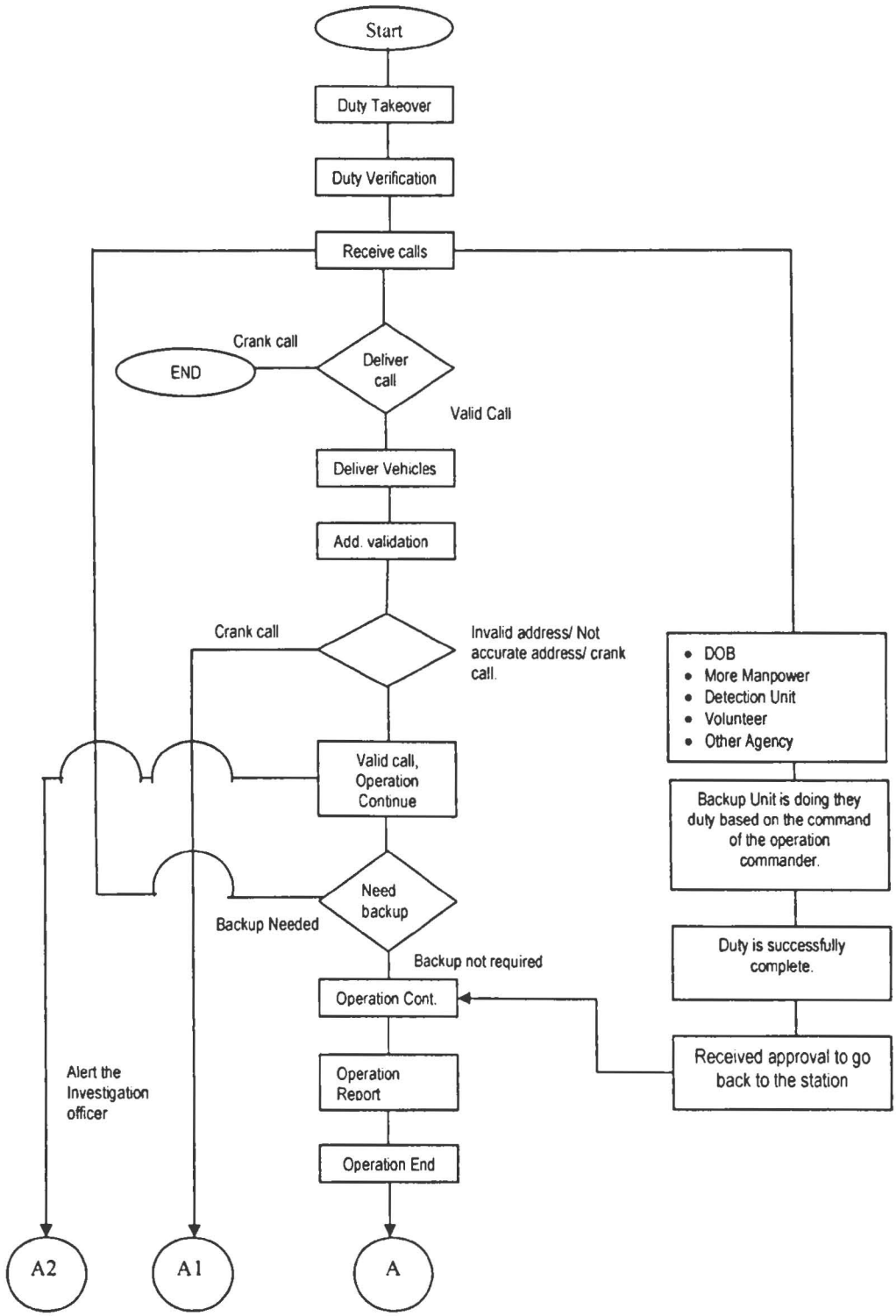
For example, finding a location for a certain accidents will require user to find the correct paper map (stored in a cupboard drawer) which is in F4 size and stretching it one by one to find which map are required. This will not be suitable to solve any emergency situation because this may cause a log delay in determining the rescue routes. Deployment planning in the conventional sense is more of an event than an ongoing process.

This means that conventional planning will only take place when accidents occur without any possible mitigation planning or criteria of emergency involved (Chewputtanaguls *et al.,* 2004). The workflow in Figure 1.1 provided by the fire and rescue department of Sabah shows the workflow for rescue operation which relies on an experienced personal to deal with an emergency situation.

Experienced personal or individual will be required during emergency rescue operation. This is not only to direct an emergency vehicle driver to follow appropriate route but at the same time the latest location of the driver will need to be identified (Wayne, C. 2002). Confusion can occur during an emergency operation for inexperience staff. Problem can lead to miscommunication, thus causing time delay, and therefore affecting the rescuing effort by an emergency responder (Gonzalez, D. *et al.,* 2001).

As shown in Figure 1.1, the emergency service will begin as soon as an emergency call is received. The emergency call will need verification that's confirmed the caller validity. A quick action will be determined to response to a valid emergency call by the operator in charge. Therefore, sufficient manpower will be required.

With sufficient manpower, deployment of an experience rescue team is then will be dispatch immediately to the emergency location. The rescue team will be allowed to return to the station when the rescuing activities have been successful. A post-mortem will be held and a report will be prepared assessment regarding the rescue mission. Finally the report is finalized and submitted to the IBPM (fire and rescue headquarters).



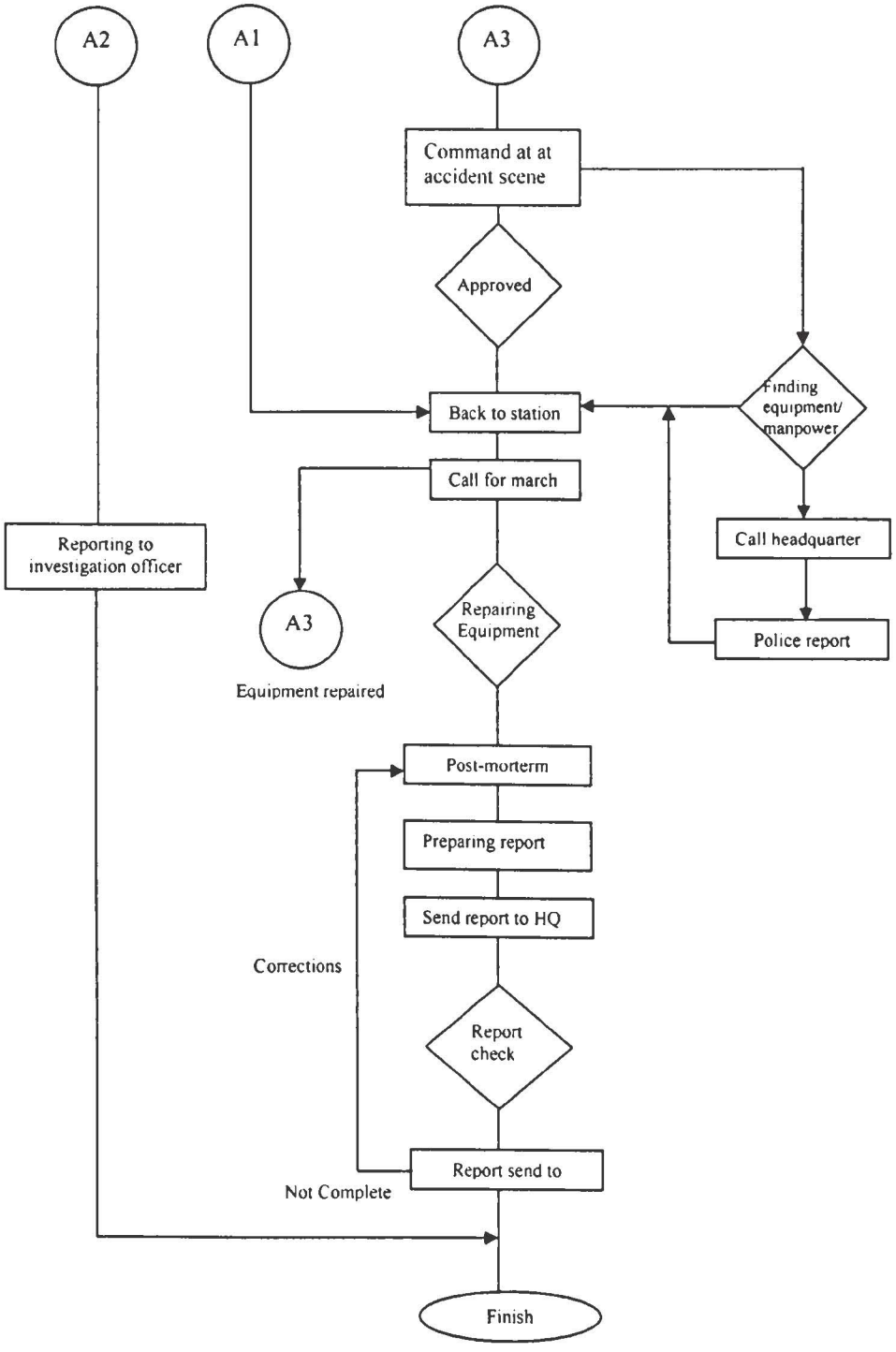


Figure 1.1: Workflow diagram used by Sabah Fire and Rescue Department.

Source: Sabah Fire and Rescue Department.

The workflow methods depicted in Figure 1.1 was greatly affecting the way response is handled emergency situation, as more time is needed and there is no routing guidance available. Insufficient emergency handling presented in the fire and rescue workflow chart shows that procedures have to be followed. Following this conventional workflow chart was believed to be time consuming as there are no adequate references can be used to pinpoint the location of an incident. Furthermore, other additional problems can take place whenever a multiple emergencies occurred (Belardos *et al.,* 2002). One example was when a location of other rescue services will not be available. Hence, there will be no precise time that can be estimated by the rescue services, therefore creating delay in dispatching any rescue team to the next incident scene (Shaheins *et al,.* 2004). This is elaborated in section 1.2.

Other related example that can be identified was when dealing with emergency situation which is situated at remote areas. A large number of remote locations were found in Sabah (including in Kota Kinabalu). Improper development of basic infrastructure of road and healthcare center in most places in the Sabah's remote area is therefore resulting a poor rescue services (Anris Yaakup *et al.,* 2003). Poor road network can certainly affect the dispatching period for a victim. It would create stress and even a life threatening situation.

As mentioned earlier, a smart emergency route planner system or an *Emergency Route Planner System* will be introduce as an alternative measures to emergency department to work with the management of emergency situation thus reducing severe injuries and death. *Geographical Information System* (GIS) technology integrated with *Global Positioning System* (GPS) will be introduced and implemented in the emergency route planner system.

The Global Positioning System (GPS) and Geographic Information System (GIS) are a complementary technology that helps each other to enhance the data quality and expand the application potential. Nowhere is this more apparent than in the transportation industry, especially for applications related to vehicle tracking and routing. Therefore, a proposal to deploy a centralized command center will also be covered in this chapter.

In this thesis project, alternative method is provided for all emergency services in Kota Kinabalu, aspect covering the managing of routing excess for emergency vehicles which is navigating those vehicle movements or their location by referring to command center or control room. Achievement can be made resulting from this systematic coordination, and therefore improving the rescue services, specifically at handling emergency situation (Martins *et al.*, 2004).

Other advantages that can also be expected from this project including; routing capability, monitoring of available emergency vehicles, locating the incident location, finding the shortest path during rescue services and a platform for remote tracking capability (Steede-Terry, 2001). The command center will make use of the GIS technology to identify the location of the accident and GPS at the same time are used to monitor an emergency vehicle.

1.2 Problem Statement

Managing emergency involved a wide range of activities (Kowtanapanichis *et al.,* 2005). Therefore, to mitigate emergency involving severe injuries or death, inadequate response will need to be identified and solved, thus reducing the number of death among accidents victim with severe injuries. In this section, the problems associated to achieve the best rescue response are reviewed. Most of these problems are related indirectly with the population growth (Kopits *et al.,* 2003).

The population growth has contributed to the increased number of accidents (including Malaysia) and since in the last decade, Malaysia has experienced a remarkable period of economic expansion and growth in population, economy, industrialization and motorization. The total population has increased from 26.13 to 27.17 million at an average growth rate of about 3% per year (Department of Statistic, 2007). The demographic change has created a significant demand for appropriate emergency handling and health care.

As population grows, life expectancy also increases and there is a higher demand for basic needs (including automobile and road network for mobility) (Kopits *et al.,* 2003). The health care demands associated with risk will need additional health resources. In addition, a migration of population from rural to urban city is also

contributing to the increase of the new range of health and risk problems related to the human-caused emergencies and urban lifestyles (Kopits *et al.,* 2003). This is why accidents are occurring more often in the urbanized area with good infrastructure access.

Good infrastructure will include proper roads and highways and this is always associated with high speed vehicles. Therefore, most accidents are occurring on proper roads or highways. More accidents are contributing to more emergency situations. Solutions to address this issue normally involved with wide range of activities. Managing routes for emergency vehicles is one of several examples and considered to be one of the most important aspects in achieving effective response for emergency rescuer such as the police, fire and rescue department, traffic police or ambulances.

Mentions in paragraph before, a wide range of activities are required in addressing an emergency situation. But the resulting of technological advancement nowadays, addresing particular technology, such as GPS and GIS can be essential tools to mitigate emergency situations. By using this technologies, issues such as the need to find the shortest route from one location to another location can be resolved systematically and therefore high efficiencies in providing accurate reliable route path for emergency vehicle from and to accicent location can be achieved. A more detail discussion regarding this issues will be presented in chapter 5.

The emergency handling in Malaysia is going through a lot of improvements. The need for road safety research and scientifically driven initiatives are now recognized. This is a critical success factor of the safety investment in Malaysia. In addition, providing a useful emergency route planner discussed in this thesis will help to coordinate, implement and evaluate the safety measures in the country (Kota Kinabalu, Sabah). By looking at the trend of fatalities and death accidents in Sabah depicted in Figure 1.2, it can be seen that the emergency or accidents has been increasing in number.

From the finding described in Figure 1.2, it is to believe that the increasing number of death in accidents can be reduced if there is a systematic and efficient emergency route planner system being available and applied. A systematic management of emergency is required to achieve effective response during emergency in delivering

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