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DESIGN OF MOBILE TRAFFIC INCIDENT RESPONSE SYSTEM

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ABSTRACT: The study aims to design an emergency response system for mobile applications to enhance the capability of emergency response units to respond to traffic incidents. The location area, number of accidents and list of top barangays prone to accidents were presented and identified. The accident-prone areas and nearby response units have been mapped on the mobile application to develop the application and integrate spatial data analysis, and can be viewed by the registered users. The result shows that it can be accessed on any mobile device that is enabled and useful to any users or community members for information on optimized routes to nearby response units, in a user-friendly interface. The user could easily report the accident and get the alert, while the response unit would review the report and determine the coordinates for the area of accident. The feature of the study was designed to enhance the reporting process of an incident, enabling the responding units to easily locate the accident area and respond immediately. The evaluation of the mapped accident-prone areas and reporting process on the mobile application of the emergency response system for traffic incidents was also provided. The respondents evaluated the proposed system with a total weighted mean of 4.29 as moderately acceptable.

KEYWORDS: *Spatial Analysis; GIS; Mobile Application; Emergency Response; Traffic Incidents*

1.0 INTRODUCTION

The unpredictable and unforeseeable road accident events have become a development issue for fatalities, injuries and property damages and need to know the factors that affect them [1,2]. Road accidents, especially in developing countries, are increasingly recognized as a growing major issue. They provide significant economic and social losses [3]. The government needs to address the more fundamental issue of inadequate and inaccurate data on traffic accidents. Without an effective system for reporting, processing and dissemination of accidents, it would be extremely difficult to monitor road safety levels, but also to formulate and implement cost-effective programmes. In addition, the need for action and expenditure to increase road safety is a major concern

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with the rapidly increasing rate of motorization [4].

In order to reduce emergency-related incidents, especially road traffic and vehicle accidents, it has long been common practice for the concerned authorities to recognize places and times that are more vulnerable to emergency activities. Consideration is being provided to an emergency response system that would benefit both emergency providers and community members.

With this situation, emergency response needs to be sustained, flexible and clear with proper communication. It is necessary to record decisions and communications. The emergency manager will promote this approach by ensuring that the communication technology is available and effective in the face of potential failure, procedures are developed for sending messages, and stakeholders are aware of the goals of communication [5]. One instrument for enhancing emergency response is rapid access to reliable and updated information. Critical information has a spatial dimension, such as extent and position of damaged areas, location of resource and service, and safe transportation routes. Such geographic or spatial information is useful in all phases of emergency management [6].

The research introduces an emergency response for mobile applications for traffic incidents that would enhance the response unit emergency response process. The researcher gathered relevant data from the Albay Provincial Police Office (Albay PPO) and identified Legazpi City as the study area. The traffic incidents were classified according to Reckless Imprudence Resulting to Homicide (RIR-Homicide), Reckless Imprudence Resulting to Physical Injury (RIR-PI) and Reckless Imprudence Resulting to Damage to Property (RIR-DP).

2.0 LITERATURE REVIEW

When an emergency occurs, various organizations form a joint command center that can oversee the ongoing coordination process, create a global picture of the situation and provide resources to field operators. Effective processes must be in place to collect, integrate and disseminate information. This would help to shape a common understanding of the situation. Both the command center and the work teams need easy-to-learn resources for knowledge handling and proper support for on-site use [7].

Various rescue organizations had great confidence in each other at the site of an accident, and there was no obvious competition between them [8]. The rescue organization that collaborates the most at accident scenes with other skilled rescue organizations was the police [9]. Joint training prior to the crisis can also serve to clarify roles and responsibilities, defining the division and flow of authority and leadership. Actors from different organizations working together to form social relations that would improve decision making in sharp situations [10].

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In this context, Tamboli presented a paper that would be used to report an incident or accident immediately and also to preserve the record of events that, throughout effect, would help the public and authorities deal with problems and emergencies. The system provide notification to any department-related incidents, so that the officials involved can respond quickly and efficiently to the problem; it is also used to access the response team as soon and possible; as it manages the activity log so that it can also be used to keep track of incidents for further investigation. This application helps manage any incident that requires help in a trouble-free manner and analyzes the incident that needs to be reduced [11].

In addition, Pacot state that both social media and the internet have emerged as an important information source. It uses two mobile communication devices, such as the internet or plain SMS, in terms of data processing for emergency response. It stipulated that the use of mobile technology could be a key source in seeking the shortest path to emergency response. Its study ensures that reliable information is sent to the web server as the key source of emergency response team and this technology can forecast an accident for analysis and potential preventive measures. Mobile users can report incidents of any kind within the region, thus providing information to local authorities [12].

Similarly, a method of delivering emergency-related information over a wireless network to and from a centralized location was introduced. The method uses cell phones in emergency communications and includes two implementations of security applications that use location-conscious technology, in portable form. Cell phones with digital cameras allow instant capture and remote submission of suspicious circumstances to law enforcement via photographs or videos [13].

The above-mentioned literature and studies are related to this study since they share similar ideas and thoughts. Previous studies help to expand the awareness of researcher on traffic incidents, emergency response, coordination and communication process, GIS spatial analysis and mobile technology, which is the study's main concern. The raw information on local traffic incidents is still manually recorded. Police stations use social media to update the community what is happening in an event or operation, but they do not have the ability to manage restrictions based on the needs of emergency incidents, specifically in addressing the immediate response and determining map locations. With this situation the researcher design and proposed a mobile application that has a GIS spatial analysis and emergency reporting system for traffic incidents within Legazpi City area.

3.0 METHODOLOGY

Rapid Application Development (RAD) was used in this analysis. The key advantage

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of a RAD approach is the quick turnaround of the design, making it an attractive choice for developers working in a fast-paced environment such as software development. RAD helps project managers and stakeholders to accurately measure progress and consult on emerging problems or improvements in real time by increasing planning time and promoting model iterations. This results in more performance, quicker growth and better interaction [14,15].

The researcher followed the following methodology phases of RAD: (1) Requirements Planning, to obtain accurate location data, the Legazpi City map, number of accidents and list of top accident-prone barangays were identified. (2) User Design, the accident-prone areas and nearby response units within Legazpi City were mapped to the proposed mobile application using GIS spatial analysis. (3) Rapid Construction, with the used of GIS spatial analysis, reporting process is also integrated into the emergency response system for mobile application to ensure that the system is design-based and fulfills all the requirements set out in the specification documents. Then, (4) Cutover shows the study's output. In describing the entire project process to Albay PPO as the concerned police station response unit and administrator of the proposed mobile application, a system presentation was carried out. Researcher did not cover the implementation and delivery of the program, but on the development process, the researcher developed the emergency response system for mobile applications and still converted the design into executable code with supporting documentation and performed a simple test level. For the usability and efficiency of the proposed system, the characteristic and sub-characteristics of ISO 9126 were used to test and evaluate the study [16,17].

4.0 RESULTS AND DISCUSSION

The study presents the location map, number of traffic incidents and list of top accident-prone barangays in Legazpi City. GIS spatial analysis was applied to the proposed mobile application emergency response system to determine the location's accident areas. This would provide information to local response units on the accident-prone areas with highest frequency of incidents and routing information. The emergency response system was designed to increase the speed of traffic incident reporting easily, reach the location and immediately respond to the traffic incidents.

4.1 Location Map, Number of Incidents and List of Top accident-prone Barangays

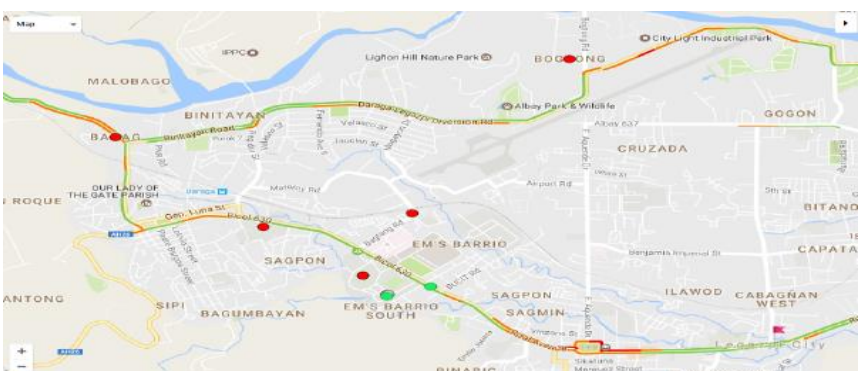

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Figure 2: Map of Legazpi City

Figure 2 shows the Legazpi City map and Table 1 presents the number of traffic incidents from year 2014 to 2018. The total number of traffic incidents was 1,060 in 2014, 1,234 in 2015, 1,392 in 2016, 1,476 in 2017 and 1,520 in 2018. Then, the Reckless Imprudence Resulting to Damage to Property (RIR-DP) was the highest number of traffic incidents in Legazpi City. In comparison, from year 2014 to 2018, Reckless Imprudence Resulting to Homicide (RIR-Homicide) has a total traffic incident of 56, Reckless Imprudence Resulting to Physical Injury (RIR-PI) has a total of 2,111 and Reckless Imprudence Resulting to Damage to Property (RIR-DP) has a total of 4,518.

Table 1: Number of Traffic Incidents in Legazpi City from year 2014-2018

Type of Traffic Incidents	Year					
	2014	2015	2016	2017	2018	Total
Reckless Imprudence Resulting to Homicide (RIR-Homicide)	15	9	14	10	8	56
Reckless Imprudence Resulting to Physical Injury (RIR-PI)	369	418	505	472	347	2,111
Reckless Imprudence Resulting to Damage to Property (RIR-DP)	676	810	873	994	1165	4,518
Total	1060	1237	1392	1476	1520	6,685

Table 2 shows the list of accident-prone barangays in year 2016 to 2018. For RIR-

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Homicide, Brgy. 56-Taysan in 2016, Brgy. 47-Arimbay in 2017, and Brgy. 41-Bogtong in 2018. For RIR-PI, the top barangays are 37-Bitano in 2016, Brgy. 42-Rawis in 2017 and Brgy. Bitano again in 2018. For RIR-DP, the top barangay from year 2016 to 2018 is Brgy. 37-Bitano.

Table 2: List of accident-prone Barangay of Legazpi City from year 2016-2018

Type of Traffic Incidents	Year		
	2016	2017	2018
Reckless Imprudence Resulting to Homicide (RIR-Homicide)	Brgy. 56 – Taysan	Brgy. 47 – Arimbay	Brgy. 41 – Bogtong
Reckless Imprudence Resulting to Physical Injury (RIR-PI)	Brgy. 37 – Bitano	Brgy. 42 – Rawis	Brgy. 37 – Bitano
Reckless Imprudence Resulting to Damage to Property (RIR-DP)	Brgy. 37 – Bitano	Brgy. 37 – Bitano	Brgy. 37 – Bitano

In summary, it merely indicates that the same names of barangay were regularly and consistently involved in traffic incidents. There is an urgent need to recognize the road situation of barangay and actions should be taken to minimize the number of accidents and improve overall road safety.

4.2 Application of GIS Spatial Analysis

Figures 3, 4, 5 and 6 presents the screenshots of the proposed mobile application emergency response system for traffic incidents. The GIS spatial analysis accurately reference the Legazpi City geo-mapping and accident locations. It obtains useful site information, like the name of the road, highway, police station and hospital locations.

It also consists of location information in the form of latitude and longitude (spatial data). The user or concerned community can interact with graphical user interface (GUI) designed for mobile application and access the application. The GUI form containing the map is loaded on the screen and the user can select the area of incident and mark the appropriate location. Then the required information, as per the service demanded, is fetched from the database and the distance between current position and

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nearby response unit locations such as police station, hospital, or fire station. The user can select any name as per its convenience or as per the order and click on detail button to know the optimized path.

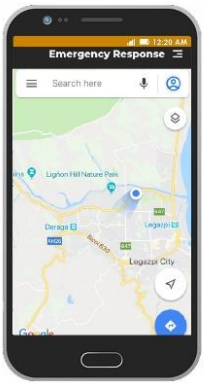

Figure 3: Current Location

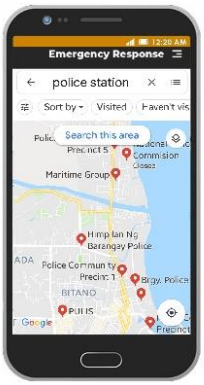

Figure 4: Searching Police Location

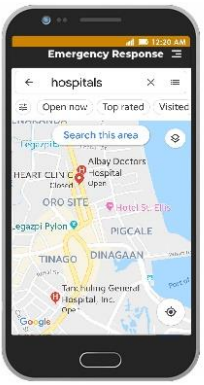

Figure 5: Searching Hospital Location

Figure 6: Optimized Path

4.3 Traffic Incident Mobile Application

Figure 7: Log-in page area

Figure 8: User's page

Figure 9: Accident-Prone Area

Figures 7, 8 and 9 shows the home page features of the emergency response system for mobile applications. This consists of a login page, user's page and accident-prone area location information in the form of spatial data in latitude and longitude. It has

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information on different fields such as a pin, barangay name, and the number of accidents recorded as of 2018.

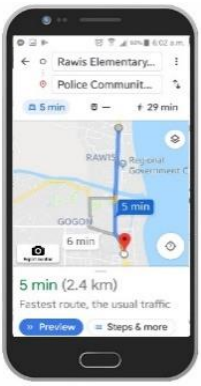

Figure 10: Searching nearby response unit

Figure 11: Reporting incident

Figure 12: Notification

In addition, as shown in Figures 10, 11 and 12, the user can search the nearby response unit location such as police station, hospital or fire station. Users can report the incident easily and send pictures of the actual accident, while the administrator of the emergency response system can easily identify the sender's spatial information as they received the reported incident. It would provide GIS spatial analysis and mobile services for broader access to emergency response on traffic incidents. It can be accessed on any GPRS enabled mobile device and can be of use to any community member for information on nearest routes to nearby response units. The system would help to increase the speed of reporting an incident so that the police and traffic officers would easily reach the traffic incident location and response to it.

4.5 Evaluation of the Emergency Response System

The study evaluation results were shown in Table 3 in terms of (a) usability and (b) efficiency using ISO 9126 characteristic and sub-characteristics. Five (5) PIDMB officers, seven (7) Albay PPO staff and 38 community members are the randomly selected respondents. For usability sub-characteristics, understandability obtains a 4.30 weighted mean or moderately acceptable; learnability obtains a 4.80 weighted mean or highly acceptable; operability obtains a 4.20 weighted mean or moderately acceptable; and attractiveness obtains a 4.30 weighted mean or moderately acceptable. A total of 4.40 weighted mean or moderately acceptable for usability characteristics. For efficiency sub-characteristics, time-behaviour obtains a 4.00 weighted mean or moderately acceptable and resource utilization obtains a 4.20 weighted mean or moderately acceptable. A total of 4.17 weighted mean or moderately acceptable for

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efficiency characteristics. Moreover, respondents evaluated the proposed mobile application as moderately acceptable with a total weighted mean of 4.29.

Table 3: Evaluation Result of Traffic Incidents Emergency Response System

Characteristic	Sub-characteristic	Explanation	Weighted Mean	Interpretation
Usability	Understand-ability	Does the user comprehend how to use the system easily?	4.30	Moderately Acceptable
	Learnability	Can the user learn to use the system easily?	4.80	Highly Acceptable
	Operability	Can the user use the system without much effort?	4.20	Moderately Acceptable
	Attractiveness	Does the interface look good?	4.30	Moderately Acceptable
Weighted Mean			4.40	Moderately Acceptable
Efficiency	Time Behaviour	How quickly does the system respond?	4.00	Moderately Acceptable
	Resource Utilization	Does the system utilize resources efficiently?	4.20	Moderately Acceptable
Weighted Mean			4.17	Moderately Acceptable

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Total Weighted Mean	4.29	Moderately Acceptable

5.0 CONCLUSION

As for the basis on the development of the study, the number of accidents and the list of barangays vulnerable to accidents were identified. The mapping of accident-prone areas was utilized. This uses GIS spatial data analysis to map areas that are prone to accidents in order to accurately classify the locations and enhance incident reporting mechanisms. Developing the mobile application emergency response system for traffic incidents thus provides broader access to emergency response on road traffic and vehicle accidents, available to any activated mobile device and useful for reporting accidents of any community member. The study results would help the response units in supporting emergency responses and responding on traffic incidents immediately. The evaluation of the system was conducted using the ISO 9126 characteristics and sub characteristics that provide the descriptive rating of the usability and efficiency of the study. Result shows that it is moderately acceptable by the respondents with a total weighted mean of 4.29. With the usage of GIS technology, the mobile application emergency response system would help community members and response units to easily monitor and respond to a certain traffic incident immediately.

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