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RESEARCH ARTICLE

City Wide Emergency/Disaster Coordinating System via Short Messaging Services (SMS)

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ABSTRACT

The City Disaster Risk Reduction and Management Council (CDRRMC) of Dapitan City, ZDN, Philippines used handheld radios for communication to respond emergency/disaster within the locality, wherein, remote places are not covered with this technology. This study aimed to develop software that monitors incident reports from barangay constituents through mobile phone's SMS for quick response. The developmental research method was utilized through stages of software development life cycle for its completion. The software is evaluated by 30 evaluators composing of CDRRMC personnel and I.T. experts to determine its speed, accuracy and functionality. The results showed that the software provided full attributes that accommodates the need among emergency responders and the constituents. Almost all evaluators strongly agreed that the developed software has high level of accuracy in providing prompt delivery and precise content of messages from the clients. It delivers high degree of accuracy in generating statistical reports segregated according to the type of incidents. All system features are highly functional and easy to use program environment desirable to users with an entry level of knowledge in terms of computer literacy. The implementation of the software may aid Rescue Team in providing immediate actions in the course of emergency.

Keywords- Coordinating System, Communication via SMS, Emergency Notification Services, Coordination in Emergency Response, Disaster Management

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INTRODUCTION

The implementation of the new information and communication technologies are unlocking its opportunities for major improvement in incorporating the exchange of communication in emergency services. The most essential for such communication is seriously critical where emergency services are identified to manage the effects of common emergencies and disasters. (Anderson P.S.,1990a). Emergency responses through coordination are an understudied research issue. The impact of the lives and properties in the affected areas are important problems to consider (Chen, et.al, 2008a).

A lot of new faces of technology were being introduced to help our communication easier like computers and mobile phones. These devices help people communicate with other people because they are accessible and easy to use anywhere and anytime. Services of mobile technology are bearers of news and information to create a remarkable range of business opportunities. Although, SMS should be considered a type of private communication messages are directly forwarded from phone to phone. Thus, the system is designed to contact individuals at the same time without other people knowing anything about the information. There are limitations in utilizing SMS messaging for emergencies. It may doesn't meet the requirements of emergency communication that must be highly dependable, protected, have outstanding access control and high-speed delivery (Bambenek, et.al, 2008).

The Safety Notification Broadcast System by (Ranganath, 2012), which intended to build-up a network designed enablingthe safety on means of communication and emergency warning system to a wireless portable devices like cellular phones. The extensive usage of wireless networks, covering a widespread of frequency even reaching into subways, gives emphasis to the significance of the system. An emergency operations center validates alerts and passes them to a joined wireless provider and distributed the alerts to their clients via broadcast messages. The alerts are centered into a geographic area under threat using real time processing system. The vital goal of the system is ensuring that real-time safety notification messages are transmitted to the recipient in specific geographic area under threat through cellular phones. This study is focused on the design and development of a network protocol that supports Android application. Mobile communication messages have a number of parameters that aids devices to identify its purpose and origins. Messages are recognized as a broadcast message. The safety notification / alert message is inserted inside the broadcast message intended to any standard alert protocol. This Android application installed in a mobile device accepts high priority messages decoded according to the protocol and directly notify the user whatever emergency messages being received with special audio-sensatory pattern.

Another study that gives emphasis for the realization of this study is the Integrated Public Alert and Warning System Modernization Act of 2015 as agreed during the 114th Congress of the United States of American Government as stipulated in the Public Law 114-143. This law states a well-time and operative warnings regarding natural disasters, terrorism and hazards, wherein administrators will modernize the warning system in America to safeguard the President, Federal agencies, ethnic groups and local government units are able to notify civilians in areas threatened and apply the warning system in disseminating the information sensibly. Administrators will also launch collective warning and

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operating procedures for the community that consists of the know-how on familiarizing the delivery of communications to any geographic location or in any endangered area with several communication systems and equipment as promising as possible. This technology also embraces the skill to warn the same facts to persons with incapacities with partial proficiency in English language, which guarantee that the training and exercises are conducted for the community alerting system by integrating into the National Incident Management System with ample regular training program to instruct the community from the State to utilize the system.(FEMA, 2014) also designed a communication system that improves the alerting delivery to the American community using the Integrated Public Alert and Warning System Strategic Outreach Plan - IPAWS in order to achieve the Presidential Executive Order 13407 that combines different technologies to offer protection to the community and government officials with a comprehensive emergency communication selections to the general public in the United States of America. In some course of emergency, safety responders must provide the public with quick information as possible. IPAWS facilitates timely and consistent transfer of warning information throughout several broadcasting channels. This technology also delivers ratified alerting specialists in the government with competence to integrate their alerting systems with the national warning infrastructure. Consequently, IPAWS expands its potentials and selections accessible to local and national officials in which speedy information are spread in some course of crisis. The Program Management Office of IPAWS' is affiliated to several government offices and business leaders, experts in different technologies and consultants to guarantee that IPAWS combines the modern technology and is available to the emergency responders in the government. The associates of this task are the emergency responders from the government, Federal executive governance, private business establishments, legislators; and non-profit organizations. Whereas, the Emergency Notification by the (Campus Announcement Alert Solutions, 2013) also designed a warning solutions enterprise that advances emergency notification system using advanced features that utilized purely SMS text, e-mail communication messages, voice and desktop notification as the basis of communication for emergency mass notifications, campus alert and incident warning system. This emergency notification system was constructed to function competently anyhow in worst case scenarios. It also guarantees a dependable scheme of transmitting information in a course of situation as soon as it is needed. It permits the emergency personnel to concentrate on sustaining an up to date community. In the peak of a campus urgent situation, it is essential to make sure a quickest and dependable campus warning system aimed at sending mass notification within the vicinity. Life-threatening conditions may happen at any twinkling of an eye. The capacity to interconnect directly and consistently throughout any disaster is essential for protection and security.

In Dapitan City, emergency services are generally appeared to be more dependent on land-line based networks and handheld radio specifically urban areas. Remote barangays not covered in a range of frequency using handheld radio and those who have no landline connection used mobile phones to inform the local emergency response team for any incidents happened in their areas. In most cases, some informants got a problem in calling the emergency service landline hotline, specifically prepaid subscribers, since calling an emergency landline service needs a prepaid load in order to call.

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Emergency responses are not assured in this context. The unavailability of land-line connections in the majority of Dapitanons is the most common issue. The best alternative to land-line coordination during disasters or emergencies is through SMS.
In view of these issues, there is noticeable need for enhancing electronic exchange of communication and information tools among people and across emergency/disaster services. This study aimed to provide a software solution to address the community needs when it comes to information dissemination to proper authorities of incidents that threaten public safety, health and welfare. Such incidents range widely in size, location, cause, and effect, but nearly all have an environmental component namely: Geologic incidents (landslides, mudslides, land subsidence /sinkholes); Hydrologic incidents(floods, storm surges, coastal / rapid erosion, droughts); seismic incidents(earthquakes and tsunamis); Transportation incidents (vehicular, accidents, ships, boats, ferries, bridge collapse, tunnel accident / fire); Civic Disruption incidents (hostage, bomb / explosion, disturbance, sabotage, mass hysteria / riot, terrorism) and Violence at home, workplace, school, hospital and any public violence.

The application of this technology provides new opportunities for putting together and enhancing the exchange of information across offices in the local government unit in Dapitan City, geopolitical boundaries, not only for improving disaster emergency preparedness, response and recovery operations but also to facilitate better prevention and efforts mitigation.

MATERIALS AND METHODS

The researchers used the developmental research method, which is a methodological study of developing and assessing software, procedures and inventions or artifact that must meet the standards of internal consistency and usefulness. Developmental research is particularly important in the field of information technology. This study entails situations wherein software product development process is analyzed, illustrated and the final software product is assessed.
The software development underwent stages of Software Development Life Cycle (SDLC) in developing the proposed system, which includes planning / preparation, analysis of requirements, design, pseudo coding, testing and evaluation.

Planning phase defines the requirements for mobile application, the developers were conducting a key informant interview with the officials of the important offices involved in the system. Internet research shall also be done to acquire more knowledge on the development of such software. Once the requirements are established, the design of the software is created from scratch and continuously documented. The system architecture is drawn and the graphical user interface (GUI) was designed. Application developers used a graphics and multimedia software in preparing audio and images in the design phase. While coding phase is the process of making the GUI into action by putting pseudo code or command / instruction to a specific object from the design in order to execute needed processes using the Microsoft Visual Basic 6.0 programming language. To test the effectiveness of the system, the researcher installed the prototype in an appropriate offices involved during testing and evaluation. Test cases are conducted to document the result. The developers of the system conducted software revision whenever bugs or errors occurred. The process is repeated until the result of the test cases become perfect.
The software output is evaluated by IT experts, community concern citizens and

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the sole users namely: peace /police officers; coast guards; fire department officers; emergency medical services and volunteers (Re-act/Orasis).

Research Instrument and Validation

This study used one set of evaluation sheet which was prepared by the researchers, based and modified from (Abel, et al., 1993), (Scalet et al., 2000) and ISO/IEC 9126-1 Software product Quality Requirements and Evaluation. It consisted three parts. The first part dealt with the profile of the evaluators along the type of users, profession and field of expertise. The second part dealt with the software quality factors as to speed and accuracy. There were 5 items to determine the level of speed and accuracy of the developed software and the third part contains five (5) items in determining the software quality assurance in terms of functionality.
It was revised by the researchers and was carefully examined by the IT experts. The instrument/evaluation sheet was subjected to a reliability test. The instrument was first pretested in a group of 10 users with (5) IT experts and (5) users from the rescue team who are not part of the actual sample. The final software output was used as pilot samples to test the reliability of the instrument. Cronbach's Alpha was used to measure the internal consistency and reliability of the instrument employing the Statistical Package for the Social Sciences (SPSS Statistics version 17.0) and Microsoft Excel. The results were 0.71 and 0.70 for the speed and accuracy and functionality respectively. The Cronbach's alpha reliability for the overall scale was 0.85 for the present sample. The pilot study indicated that the tool was adequate. Thus, it enabled the researchers to assess the suitability of the tool for use.

RESULTS AND DISCUSSION

The emergency/disaster coordinating system is a software solution bridging the gap between the concerned citizen and the emergency response team in Dapitan City. It enables commuters or the growing public to communicate with the local government units / department who are involved in emergency responses and inexpensive way. This system accepts messages from clients who are currently availing unlimited calls and text services and to those subscribers with prepaid and postpaid SIMs. The following lists below are the procedures on how users use the system interfaces specifically client registration, client interface and operator's interface.

Client Registration

This procedure is optional for the first time message sender, client users are encouraged to register using their mobile phones so that their profile may be included in the system's database.

Step 1.Using mobile phone, go to "write message" or "create message".
Step2.Write<REG><SPACE><Name/ Address/Gender/Age><Designation in the Barangay> and send to the Server Modem Sim Card Number.
Step 3. Wait for the confirmation (there's an auto reply message confirming the registration)

Client User Interface

When ever incidents may occur, client users are task to do the following processes using their mobile phones.

Step 1. Using mobile phone, go to "write message" or "create message".
Step 2. Write <TYPE OF INCEDENT> <SPACE> <MESSAGE> and send to the Server Modem Sim Card Number.
Step 3. Then wait for the system auto-generated reply.

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Step 4. If the message is successfully delivered to the server, the auto-generated reply is received by the client user stating that "The transaction is being processed".

Step 5.Waitfor a phone call from the City Disaster Risk Reduction Management Council (CDRRMC) for verification.

Operator's Interface (CDRRMC Office)

The procedure below is the list of steps to monitor text messages from the concern citizens or the client users.

Step 1. Start the developed software and log-in using the username and password

Step 2. Monitor the incoming text messages from clients.

Step 3. If there is an incoming text message from the client

True: Read the message and call the sender for verification of incident then go to Step4

False: Go to step 2

Step 4. Forward the text message to specific department/office concern for rescue.

Figure 1 presents the processes on how the proposed system works. As shown in the diagram, the client/text sender sends a message to the broadcast server. The operator may verify whatever content of the message by calling the sender's mobile number and collects more information regarding the incident. Right after the confirmation, the operator may broadcast the message to the offices concerned namely: Police station, Mayor's office React Rescue Team and other offices concerned. Messages are automatically displayed or logs on the receiving offices with a beeping sound or voice alarm upon receiving messages. The message contains the following namely: date, time, report, location and sender's name and mobile number.

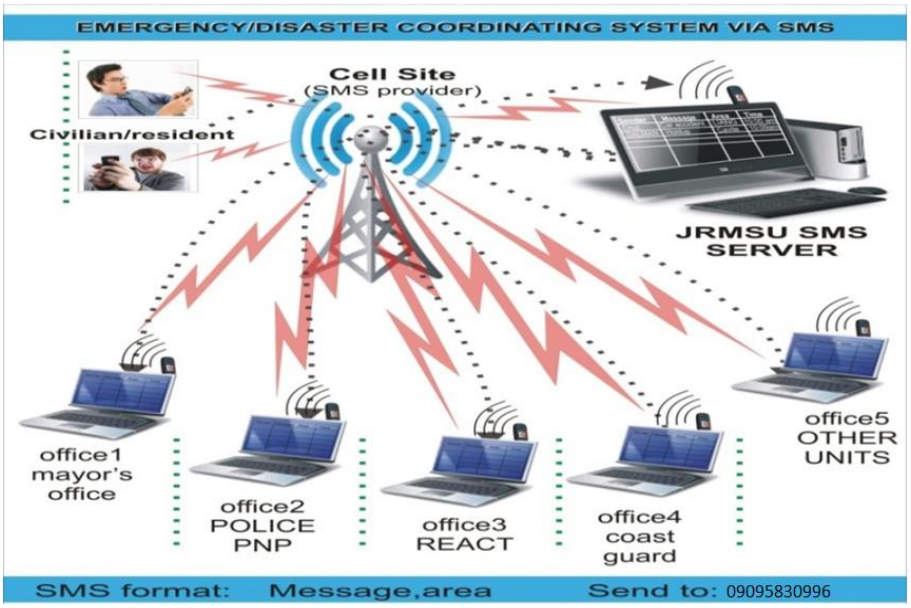

Fig-1: System Architecture

Figure 2 illustrates the graphical user interface of the City-wide Emergency/Disaster Coordinating System through mobile phone's short message service. The first column is the sender's area where the name of the sender is displayed. In case that the sender's number is not yet registered in the phonebook, only the mobile phone number is displayed. To view full details of the sender's message, the user may select or highlight on the specific row where the message is located. After highlighting, the full details are displayed at the lower portion of the figure. The third column is the verification status of the sender, which

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signifies the validity and legitimacy of the message being sent. The user (CDRRMC) may still verify it by calling the sender's phone number just to clarify the specific details of an incident. Right after the process of verification, the message is forwarded to the appropriate office concern for immediate actions.

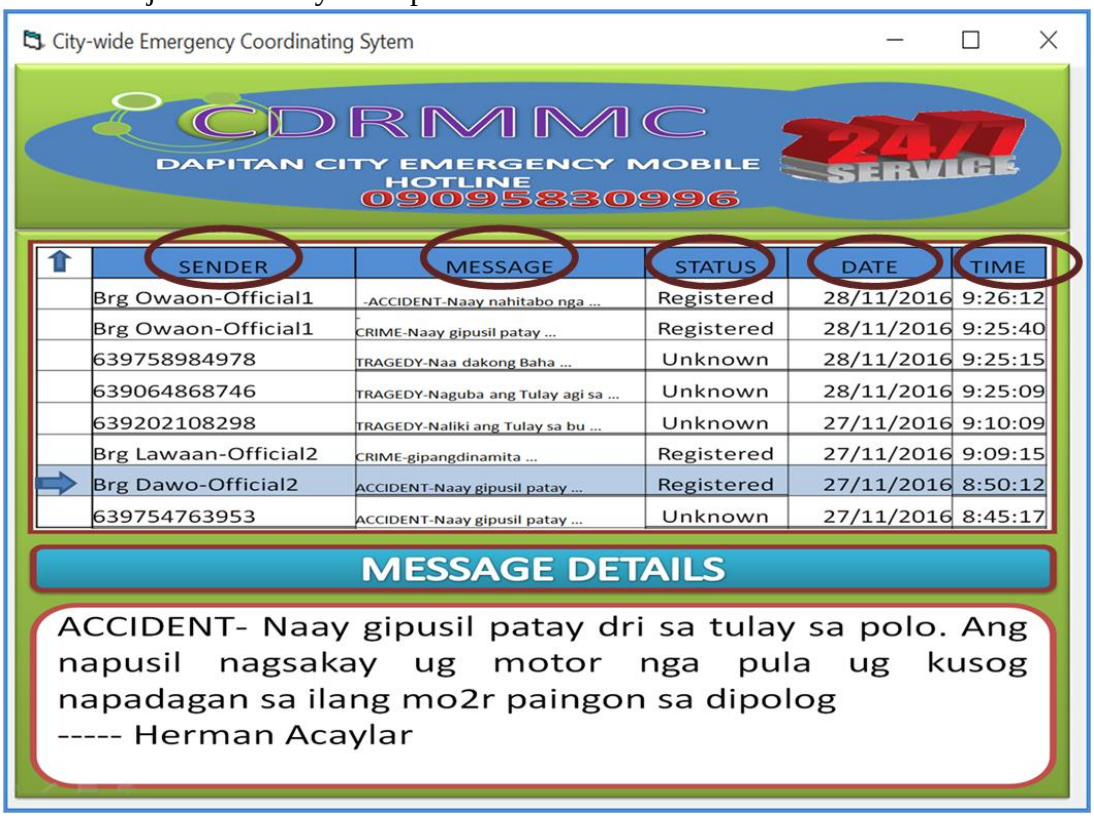

Fig-2: Sample Screenshot of Monitoring Screen for incoming Incident Reports

Software Quality Factor as to Speed and Accuracy

*Accuracy is the degree of closeness of measurements on the correctness of an actual value or content of the message (*BS ISO 5725-1, 1994*).*The software product is capable to provide the right or agreed results or effects of the needed degree of precision.

Table 1 illustrates the results of software evaluation as to the speed and accuracy of the developed system. It showed that almost all of the evaluators strong agreed that developed software delivers a high level of accuracy in delivering accurate message content based on what is being sent by the recipient, which has a descriptive rating of "Strongly Agree". The system also provides a high level of exactness on the generation of daily/monthly/yearly statistical reports based on the consolidated daily text messages log that is segregated according to the type of incidents reported, which is also strongly agreed by the respondents. The accuracy in keeping text messages history is given high importance by the system. It has also a high degree of preciseness on activating distinct voice alarm assigned to a specific incident.

The overall accuracy of the developed software is very high, which means a high level of exactness of all features initiated by the newly developed system, specifically in providing accurate message content, generating statistical reports, keeping previous text message logs and providing appropriate voice alarm system assigned to a certain incident that include faster and accurate responses in generating statistical reports. The standard

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deviations of all indicators are both small, which indicates that almost all of the evaluators agreed of their perceptions on the quality of the developed software in terms of speed and accuracy.

Table-1: Result of Evaluation of the Software Quality Factor as to Speed and Accuracy

Criteria	stDev	AWV	Description
Gives accurate content of messages delivered from the recipients	0.507	4.53	Strongly Agree
Provides accurate statistical report daily/monthly/yearly	0.430	4.77	Strongly Agree
Accurate in saving/storing recipients' historical data like text logs with corresponding date and time for future use	0.183	4.97	Strongly Agree
Precise voice alarm system depending on the type of incidents reported	0.479	4.67	Strongly Agree
Faster response in disseminating report	0.507	4.47	Strongly Agree
Total	**0.421**	**4.68**	**Strongly Agree**

Table 2 shows the results of evaluation for the software quality assurance in terms of functionality. Based on the tabulation, it indicates that the level of functionality of the developed software is highly functional and really intended for the CDRRMC rescue team to have quick dissemination of information to the appropriate departments involved to rescue whatever incidents happen as requested by the recipients. It also shows that data manipulation is error-free, and the graphical user interface is very easy to navigate with highly functional features. The new software has a high degree of compliance that satisfies the requirements and needs of the end-users, which has a description of "Very Much Functional". Further, the developed system has a high storage capacity, which is capable to store millions of text messages including its high storage capacity in preparation for data warehousing. The validity of text input is also highly regarded including the use of extended characters or non-Latin scripts.

The overall functionality of the designed software has a descriptive rating of "Very Much Functional", which means that the system is fully functional and ready for deployment in the selected LGU offices in the city of Dapitan. The overall impression of all evaluators is so identical with each other since the standard deviation for each item is closer with each other.

Table 2. Result of Evaluation of the Software Quality Assurance as to Functionality

INDICATORS	stDev	AWV	DESCRIPTION
Intended use of the software for CDRRMC	0.504	4.30	Very Much Functional
Data manipulation is easy to use and functional	0.776	4.40	Very Much Functional
Compliance with the end-user needs	0.504	4.31	Very Much Functional
Data Storage	0.479	4.48	Very Much Functional
Validity of Text input	0.509	3.56	Much Functional
TOTAL MEAN	0.554	4.21	Very Much Functional

CONCLUSION

It is globally accepted that communication plays a significant role in a day-to-day undertakings. The Emergency/Disaster Coordinating System via SMS is specialized software to deal with the community needs electronically when it

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comes to message broadcasting and reporting to disseminate information to the appropriate authorities in handling incidents like car/motorcycle accidents, crimes and any illegal activities that endanger public safety, health and welfare. The developed software is found accurate, secured and very fast in terms of disseminating accurate information to the city disaster and risk reduction management council and different departments namely: Bureau of Fire Protection (BFP), React-Dapitan City Chapter, Police Station, Hospital, City Information Office, Coast Guard Office and many others. Further, the system is highly functional and reliable without errors during software testing with easy to use graphical user interface environment. All features are tested with very high level of functionality. On the other hand, the CDRRMC rescue team may be able to quickly respond the needs of the recipient with the use of the system. The team may also be able to inform directly all departments involved in addressing the needs of barangay constituents. Thus, the dissemination of information is very quick with high degree of compliance that satisfies the requirements and needs of the end-users.

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