

Development Of Municipal Disaster Risk Reduction And Management Office Emergency Response Application

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ABSTRACT

The MDRRMO Emergency Medical Services (EMS) has a vital role in the healthcare system, as they are the backbone of first responders during an emergency. Increased workload in emergency settings means an inefficient system in the work area. This study aims to address the problems faced in the EMS Department before, during, and after an incident—digitizing the manual Pre-patient Care Report (PPCR) and creating a centralized system for monitoring, data analyzation and reporting provides the solution for gathering, keeping, and retrieval of crucial information during an incident. The development involved phases of requirements gathering, system design, development, testing, and deployment. The conducted usability tests demonstrated the system's usability and positive participant feedback from the different demographics. The system is fully functional, meets user needs, and enhances information exchange and emergency procedures. The findings stated that providing training will significantly increase the user's proficiency in the adoption of new technological solutions such as the developed system. The study concludes that the emergency response application effectively reduces workloads and enhances disaster response through efficient data management and reporting.

INTRODUCTION

Pre-hospital care service is a fundamental part of the Emergency Medical Services (EMS) system, this would help determine the medical capabilities/inabilities of a society through varying factors such as resource management, or pre-hospital Emergency Response Time (ERT)—total duration from the initiation of an emergency call to the departure of the ambulance, comprising both the Active Response Time (ART) and the time taken from ambulance departure to arrival at the scene, referred to as Passive Response Time (PRT) (Huang, et al., 2020). Lack of proper coordination and communication with the respective medical and emergency institutions during a patient handover is one of the leading causes of preventable deaths, this issue contributes significantly to the loss of lives that could otherwise be saved, healthcare institutions have been the forerunner in voicing the implementation of an e-PCR system to reduce the response time during rescue (Jasbi, Muthaiyah, & Kyaw Zaw, 2021).

The proponents emphasizes the current issues faced by MDRRMO, specifically the EMS Department that handles emergency response situations, which still utilizes a highly manual pre-

hospital patient care report form, operating a insufficient system, which leads to a patient's health deterioration—delays in treatment, and errors in patient handling has been the leading cause of preventable death from traumatic experience (Pfeifer, Halvachizadeh, Schick, Sprengel, Jensen, Teuben, Mica, Neuhaus, & Pape, 2019). The importance of Emergency Medical Services personnel during an emergency is crucial in ensuring maximum patient-care—ambulances or any rescue vehicle is vital in rapid transit and rescue of a patient.

Thus, in proportion to upgrading ambulance technologies, it would also increase the effectiveness and efficiency of emergency personnel during an on-going rescue thereafter saving more lives. (Pulsiri, Vatananan-Thesenvitz, Sirisamutr, & Wachiradilok, 2019).

The Municipal Disaster Risk Reduction and Management Office Emergency Response Application addresses the problem of system inefficiency during an emergency situation of the EMS Department. The system has two aspects; digitization of the Pre-Patient Care Report (PPCR) a highly manual form which is filled out during the rescue, through the use of dropdown menus, checkboxes, pre-defined list and categories and filter options. Also, by creating a centralized system for admin monitoring, record keeping and retrieval, and for monthly/annual reports for disaster prevention and mitigation, these systems may aid in efficient exchange of information between respective offices/institutions for a better and effective procedure before, during, and after an incident.

LITERATURE REVIEW

Based on the study by Goh, et. al., (2023) iAlerto: A Web and Mobile Alert System for Pasig City Disaster Risk Reduction Management Office (PCDRRMO) with mobile GPS service integration underscores how the study utilizes the scrum methodology for the development of the system, Android Studio was used to develop the mobile application and Code Igniter for the web application. Meanwhile, PHP was used for backend scripting with MySQL for database and XAMPP web server for testing. The system was evaluated using ISO-9126 functionality sub-characteristics criteria. The web application has the functionalities to manage users' profiles, barangays evacuation centers, incident reports, send alerts and generate reports for post-assessment disaster mitigation planning. While the mobile application uses GPS mobile service to detect the exact location of the incident, the developed system has two mobile applications intended separately for resident and rescue teams.

The SIREPH developed by Ventura (2022) with an Integrated Approach to the Pre-Hospital Emergency Framework underscores how the pre-hospital system framework encompasses the entire processes starting from the victim, incident report, technicians aid, and handover of the patient to the hospital. There are two mobile applications developed, one is for the local users who may witness an accident and can send an emergency report, while the other is for the emergency technicians to communicate and exchange information between the emergency central hospitals. The employed technology was Django framework for its website development and Django REST framework for SIREPH's API toolkit for the development. Using Medix Studio to achieve a low-code style, simultaneously using Nginx for reverse proxying, PostgreSQL for the database, and Unicorn as a server gateway. Waterfall methodology was used in the study as it applies an ordered and linear approach for the researcher's objective in the aforementioned study. According to Atanacio, (2022) Emergency Number Services Rescue mobile app in Sta. Cruz, Laguna discusses the system as an android-based app devised, developed and evaluated by the

researchers that is able to provide multiple emergency units where the victim/patient/bystanders in an incident can send emergency message information, GPS location, and direct calls to the emergency hotlines. The participants of the study were selected through the use of stratified random sampling method. By utilizing developmental and descriptive methods to the study. Also creating questionnaires, formal interviews, observation, library resources and internet resources for data collection. Using ISO/IEC 25010:2011 as an assessment tool for the emergency application. The app was developed through Java SDK and MySQLi for the database, coupled with an Android Package Kit (APK) to test the communication process with the GPS locator from Google API.

MATERIALS AND METHODS

Research Design

Modified Waterfall approach of System Development Life Cycle (SDLC) was used in this project. This model was divided into phases: Requirements Gathering and Analysis, System Design, Development, Testing and Evaluation, and Deployment. The model was a mix of traditional waterfall structure and iteration model. However, unlike sequential progression in the traditional waterfall model, this model allows iteration of phases while maintaining the elements and structure of the traditional waterfall model offering flexibility in the development of the system.

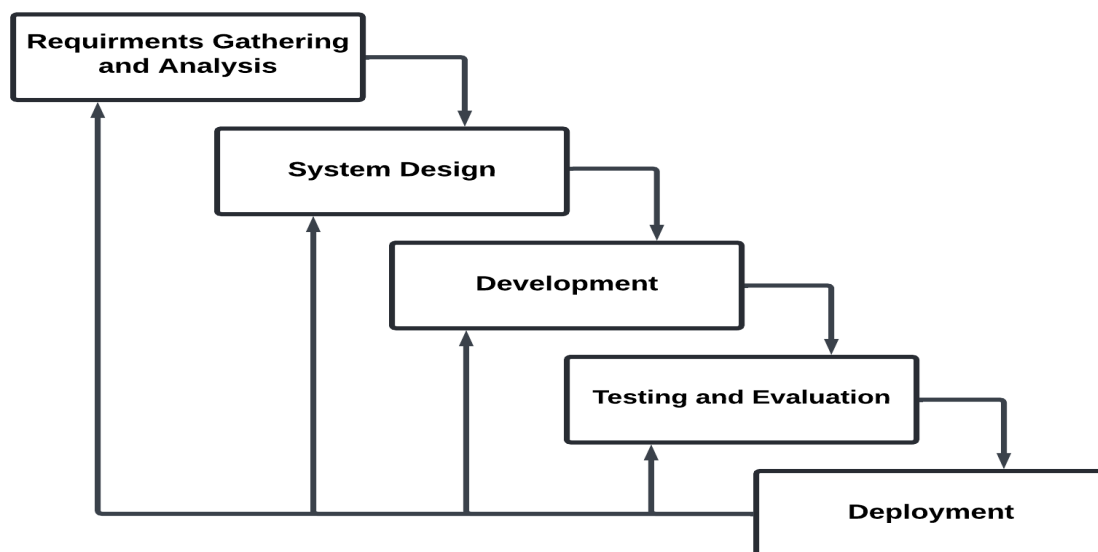


Figure 1. SDLC Modified Waterfall Model

Requirements Gathering & Analysis Phase

In this phase the researcher gathered the data and information for the development of Municipal Disaster Risk Reduction and Management Office Emergency Response Application. The researcher also produced a letter of intent addressed to the Operation and Warning Division of MDRRMO located in Tagoloan, Misamis Oriental. The researcher then produces eight (8) guide questions that help in organizing the data collection process. The data collection was conducted through semi-structured face-to-face interviews with the Deputy Operation Chief and the EMS personnel. The interview identified the workflow and processes in conducting emergency responses, EMS personnel and management challenges, and the functional and non-functional

requirements for the development of the proposed system. The collected data during the interview was then tabulated and analyzed and used as the basis in designing and developing the system.

System Design

In this phase, the accumulated data from the data gathering phase was used as a basis for designing a new system that addresses and solves the gathered requirements. The researcher uses a structured design technique in visualization and designing the system. These techniques involve breaking down a system into smaller components, defining the relationships, and organizing the processes. The researcher uses Unified Modeling Language (UML) use-case diagrams to visualize how users would interact with the system to achieve specific goals or tasks. Entity-Relationship Diagram (ERD) was applied to design the structure of the database ensuring normalization and helping the database designer. The researcher also uses flowchart to determine the workflow of the organization. Data Flow Diagram (DFD) was also used to visualize how the data moves within the processes. These diagrams are chosen to offer visualization in different fields.

Development Phase

In this phase, the researcher adapted the three-tier architecture design in visualization of development of the system. This architecture design consisted of three layers: presentation layer, application layer, and database layer. The presentation layer was responsible for handling user interfaces and interactions. Application layer was where the logic and scripting software technologies used are presented. The database layer was where the database software technologies used were presented.

The proponents used Hyper Text Markup Language (HTML), Cascading style sheet (CSS), Bootstrap, and JavaScript for web development and React Native was utilized for mobile application. In the application layer, the proponents used PHP as it is an established server-side scripting language for web development. The proponents also used Laravel framework for application layer as it offers elegant coding and features like routing, authentications, and security. REST architecture was also implemented enabling integration between different platforms. In the database layer, the proponents used SQLite for the mobile database management system and MySQLi for web app database management system. These programming languages, databases, framework and front-end technologies are chosen as these technologies are not only acquainted to the researcher but also perform well in their respective proficiency.

Testing and Evaluation Phase

In this phase, the researcher tested and evaluated the proposed system. The researcher also tested the system input fields, drop down menus, and buttons to identify if the system works as intended. Additionally, the researcher also tested if the mobile application was able to upload, and also if the web dashboard for admin was able to download files from the web database. Furthermore, the researcher uses the System Usability Scale (SUS) tool to measure the Usability of the proposed system. It consists of ten (10) questions and five (5) responses options. The participants were the deputy warning monitoring chief and the warning and monitoring personnel of the MDRRMO's Operation and Warning Division. Participants rate the questions from 1 to 5 on how much they agree in the statement where 5 means they strongly agree and 1 means strongly disagree. Overall scores were then calculated and are used in interpreting the data. These results would then be used to evaluate the proposed system overall performance. Moreover, post-assessment was also taken where the end users were asked for their comments and suggestions to improve the system.

Deployment Phase

In this phase, the completed system was released to the clients. The system was composed of a mobile application and web application dashboard. The proponents utilized the tablet provided by the client for the mobile app deployment. The mobile app was accessible both online and offline since the organization's area of responsibility has dead zones making the app flexible thus enhancing the app usability. While the web app was deployed through the client's desktop and can only be accessed through online as it is designed to capture real-time data visualization and analysis which typically relies on accessing and updating from online sources such as server and databases.

The researcher provided a user manual consisting of written instructions on how to use the system. Aside from the user manual, the researcher also scheduled a date for physical demonstration to the client. The demo aimed to demonstrate the use-cases and the feature functions the system provided to the users.

RESULTS AND DISCUSSION

Findings

As far as the functional testing is concerned, the system is fully functional and was able to address the user needs. The function and features were successfully accomplished by the users. The system has undergone usability measures together with its effectiveness, efficiency and user acceptance. The results of the usability study were 68.4. The result shows that the application is usable with certain revisions. The users were also able to perform the task in a short period of time, when compared to its allotted threshold, and as far as the answers to the open-ended questions are concerned, the participants like most of the aspects of the system.

A cross analysis between SUS Scores and Technical proficiency suggests that, beginners, participants with basic skills (A, D, G) rated the system usability relatively low, with SUS scores ranging from 55 to 60. This suggests that beginners may have found the system more challenging to navigate and use effectively. However, intermediate participants with intermediate skills (C, E, F, H) showed higher SUS scores, ranging from 60 to 85, indicating a more positive usability experience. While, the only advanced participant (B) rated the system usability high, with an SUS score of 82.5, reflecting ease of use and familiarity with similar systems.

Participants who interacted with similar systems "weekly" (B) had higher SUS scores compared to those who interacted "rarely" or had "zero experience" (A, C, D, E, F, G, H). This suggests that frequent use of similar systems can contribute to better usability ratings.

Participants with previous experience (B, C, D, G, H) generally rated the system higher than those without experience (A, E, F). This indicates that familiarity with similar systems can enhance the perceived usability of a new system. The level of expertise with previous systems also played a role in SUS scores. For instance, Participant B, who had an intermediate level of expertise with a previous system, rated the new system highly (82.5), whereas beginners with previous experience rated it lower.

Lastly, the task completion and user feedback show that beginners may have faced difficulties in completing tasks efficiently due to limited technical skills and lack of familiarity with the system.

This could have led to frustration and lower SUS scores. While, intermediates and advanced who are more comfortable with technology, likely completed tasks more efficiently and encountered fewer usability issues, resulting in higher SUS scores.

Results of EMS Personnel and Staffs

The result of the usability study participated by eight (8) EMS personnel participants whom were able to complete all the tasks successfully with an average completion time of 11 minutes and 29 seconds for task 1, 1 minute and 44 seconds for task 2, 2 minutes and 30 seconds for task 3, and 12 seconds for task 4. All of the tasks were able to easily achieve a 100% completion rate after the much complex and longer initial tasks (task 1) were completed.

Open-ended questions were used in order to understand more on the reactions and opinions of the participants. And majority of the participants like how the system can potentially reduce their workload—from conventional methods to an electronic one. Moreover, most of the participants do not have something they like least from the system, as well as experienced difficulty in navigating the system and the participants felt mostly positive and confident in using the system. All participants successfully finished the task set by the researchers.

The usability study involved a diverse group of 8 participants, including both the operation manager and EMS personnel. Among these participants, there were 3 beginners with basic technological skills, 4 intermediates who were comfortable with technology, and 1 advanced user who was an expert in using technology related to the system. The participants interacted with similar systems mostly rarely or had zero experience, with only one participant using similar systems on a weekly basis. Five participants had previous experience with similar systems, while three did not. The SUS scores ranged from 55 to 85, with lower scores generally associated with beginner proficiency and higher scores with intermediate or advanced proficiency.

CONCLUSION

The development and usability evaluation of the Municipal Disaster Risk Reduction and Management Office Emergency Response Application have highlighted its effectiveness in addressing the needs of the EMS Department. The system's complete functionality and features have been shown to significantly reduce workloads by replacing conventional methods with electronic/digital processes, ultimately supporting the overarching goal of risk reduction and mitigation through efficient data management and reporting. By creating an innovative solution to the old process of managing data, through the digitization of the Pre-patient Care Report (PPCR) and by creating a centralized system for admin monitoring and data management, the developed system satisfied the user requirements, garnering positive feedback and satisfaction among all the demographics.

In conclusion, the Emergency Response Application for the MDRRMO represents a significant advancement in managing emergency incidents more efficiently. By addressing the usability challenges and leveraging the strengths identified in the study, the system can become an indispensable tool for EMS personnel, ultimately contributing to better emergency response and risk management outcomes, aiding the LGU by providing a statistical report with enhanced data accuracy. The system also helps the intrahospital settings during a patient handover, thus maximizing patient care. The findings underscore the importance of considering user proficiency, providing adequate training, and adopting a user-centered design approach to ensure successful implementation and adoption of new technological solutions in emergency management.

Recommendation

Based on the System Usability Scale (SUS) evaluation results, which yielded a score of 68.4, it is recommended that enhancements be made to the emergency application's UI simplifications and functionality to further improve its usability with additional training and support, especially for beginners—zero experience of using a similar system and/or not proficient in technology. Specific recommendations include:

- Provide comprehensive training sessions and user support to help beginners become more familiar with the system.
- Consider refining the other aspects of visual elements to make them more intuitive and accessible. This could involve increasing font sizes, enhancing contrast, and simplifying navigation to cater beginners who may benefit from clearer, more readable elements.
- System flow enhancement can be achieved by reducing unnecessary steps, providing clear guidance for each phase, and ensuring that each action naturally progresses to the next. Simplifying the workflow will help users, especially beginners, to complete tasks more efficiently and with fewer errors.
- Adding a crucial file status should indicate whether the file is currently 'on-going' or 'case-closed' (completed).

The resulting usability indicated positive feedback from the participants. Many participants provided satisfying feedback to the researcher. The system can better cater to users of all technical proficiency levels. Therefore, the system is recommended for deployment once the recommendations for improvements have been implemented.

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