

AMBULANCE DISPATCHES SYSTEM

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Abstract

The ambulance dispatches management system is an important platform for managing ambulances and providing timely and effective assistance to patients. The Malaysian Red Crescent has reported an 80% surge in demand for private ambulance services since June 2021. Efficient ambulance resource management and dispatch is becoming increasingly important. However, the current ambulance dispatching system cannot meet the "patient-centered" requirements at present, and patients can only be sent to the nearest hospital and cannot choose a suitable hospital. Moreover, the system is highly dependent on the dispatcher and cannot obtain the exact location of the patient in time, which affects the speed of rescue and reduces the efficiency of first aid. In order to solve these problems, this study designed an ambulance dispatch management system, which can realize automatic positioning, online selection of hospitals, and intelligent dispatch of ambulances according to the patient's condition and location and the situation of the hospital. The system adopts JAVA as the main development language, and uses MySQL database as the database framework. Also use JavaScript to develop web pages. Developed using the waterfall development model. The system improves transportation efficiency, dispatches ambulances according to patients' wishes and conditions, improves patient autonomy before admission, and ensures first aid

effectiveness through case sharing.

Key word: Transportation ambulance intelligent dispatch management, positioning, online selection, pre-hospital first aid.

Introduction

Emergency Medical Services (EMS) provide timely and appropriate interventions to patients in need and transport them to the nearest suitable medical facilities, thus improving survival rates, controlling morbidity, and preventing disabilities. An efficient EMS management system can ensure that proper services are provided to all those in need. The availability of Emergency Ambulance Services (EAS) [1] is a critical element of EMS implementation, especially with the increasing number of patients due to the Covid-19 pandemic, making EAS even more vital.

In Malaysia, ambulance services are mainly provided by the Ministry of Health (MOH) through its public medical organizations and non-governmental organizations (such as St. John's Ambulance and the Red Crescent Society [2]). According to data from the Ministry of Health, as of May 2017, there were 2,039 ambulances in the country. From this number, the ratio of only 0.62 ambulances per 10,000 people falls far short of the standard of one ambulance per 10,000 people, with 1,125 ambulances located in hospitals and the rest in clinics. Ambulances at hospitals are primarily used for emergency treatment and patient transfer, while those at clinics are generally multi-purpose. This service reliance on facilities results in differences in ambulance usage, which are often overlooked. In terms of utilization rates, clinics have significantly higher median numbers of visits and duration (31.88 visits and 58.58 hours) compared to hospitals (16.25 visits and 39.25 hours) [3]. Facing the high demand for ambulance services and the shortage of ambulance numbers and usage efficiency, effective management and dispatching of existing ambulance resources become critical requirements.

However, at present, Malaysia's ambulance dispatch management system has not yet formed a complete, reasonable, and practical system due to several major reasons. Firstly, it heavily relies on dispatchers, and when a patient cannot accurately report their location due to various reasons, the EMS system cannot provide timely assistance. For example, patients who do not know the detailed address of their location, patients unable to speak due to their illness, foreigners who do not use the local language, or those whose language proficiency is not enough to describe the exact address find it difficult to receive timely help from EAS. Secondly, the principle of ambulance dispatching is simplistic. Currently, ambulance dispatch is primarily based on the proximity principle, where patients are sent to the nearest hospital. However, this approach lacks consideration for hospital resources and specialized departments, and it does not allow patients to choose the most appropriate hospital, leading to delays in early patient treatment. Due to differences in facilities, operational priorities, and insurance coverage between hospitals and clinics, there are also discrepancies and waste in ambulance resource allocation [3]. This situation reduces the efficiency of emergency treatment. As a result, Malaysia's average response and arrival time of ambulances at the scene and at the hospital are lagging behind in comparison to countries with well-established EMS systems [4].

Therefore, to improve the availability of EAS, it is necessary to redesign and improve the ambulance dispatch management system. In this study, an ambulance dispatch management system was designed to grant permissions to various terminals for patients, dispatch centers, ambulance personnel, and hospitals. This system enables the transmission of vital disease information, medical records, and emergency information to the dispatch center, as well as real-time positioning, thus allowing for intelligent dispatching of ambulances based on patient conditions and locations. This greatly enhances the efficiency of ambulance resource utilization and ensures the smooth operation of the EMS system, providing timely assistance to more patients in need.

The system developed in this study is intended for patients, dispatch centers,

ambulances, and hospitals that require appointments or emergency medical services. It includes patients' needs for ambulance appointments and EMS, as well as their choices for hospitals. The dispatch center receives patient information and manages ambulances, while ambulances, managed by the dispatch center, receive patient information and convey it to hospitals. Hospitals can receive patient information and medical records and upload hospital information.

The existing ambulance dispatch system, built in the last century, mainly used fixed telephone communication, becoming the main reason why a series of problems could not be improved. With the continuous development of network technology, the number of people using the Internet is also increasing. Therefore, utilizing the rapid information dissemination characteristic of the Internet through appropriate technologies has solved many problems that were previously difficult to address. The ambulance dispatch management system developed in this study takes full advantage of this characteristic. The system obtains sufficient information for each user of the system. Through the system, patients can send as much detailed information as possible to the dispatch center as soon as possible through pre-storage, text, real-time positioning, and other methods. Ambulances and hospitals will have access to this information when appropriate to better help patients. Through the system, patients can make an appointment or choose the hospital suitable for their injuries as soon as possible or choose the hospital depending on the professional judgment of the ambulance staff to achieve accurate judgment of the on-site situation. The hospital can also prepare treatment plans and resources according to the patient's medical records and information in advance without delaying the early treatment of the patient and improve the efficiency of the use of ambulance resources.

This study's system is expected to address three main issues:

1. Obtaining accurate positioning: The system will no longer rely on dispatchers and patients' verbal description; instead, it will use mobile phone positioning to obtain precise and rapid patient location information.
2. Increasing patient choice: The system will no longer simply send patients to the

nearest hospital but will allow patients to choose the most suitable hospital, taking into full consideration their medical condition and needs to avoid delays in treatment.

3. Allowing ambulance personnel to modify patient medical records based on their condition, preparing adequately for emergency care at the hospital.

This study used the waterfall model as the development model, completing the software development steps in a progressive manner, including analysis, design, implementation, and testing, ensuring that the development meets expectations and requirements.

This report is divided into three parts after the introduction: the research methodology, results and discussions, and conclusion, to introduce the technology and achievements of this project. The research methodology section explains the methods and approaches used in the research. It also describes the specific development process model used and explains the reasons for choosing this model. In the results and discussions section, the development results of this project, including the completed project's functionalities and interfaces, will be presented and introduced. The conclusion section will summarize the results and information obtained from the research.

Methodology

The system will be developed using the waterfall model, a development model introduced by Winston Royce in 1970. The waterfall model divides the software life cycle into six basic activities, such as making plan, requirement analysis, software design, program writing, software testing and operation and maintenance, and specifies their fixed sequence from top to bottom. Each phase must be completed before the next phase can begin with no overlap between the phases [5].

Using this model has many advantages such as:

1. A checkpoint of security phase division is provided for the project.
2. After the current phase is completed, only the subsequent phases need to be

concerned.

3. The waterfall model can be applied in an iterative model.

This model also has a number of drawbacks:

1. There is very little feedback between project stages.
2. The results are only seen later in the project life cycle.
3. Track project phases with multiple mandatory completion dates and milestones.

But at present, although the waterfall model has many shortcomings, it is very suitable for the development of this research project. Because the cost of the project is small, long cycle and has a clear unchanged function is very suitable for the use of waterfall model development, the advantages it brings are very suitable for the system development process of the project.

This study plan is to realize the design of the whole system step by step through three phases, each phase to complete the objectives of the phase. Focus on completing the project proposal in the first phase. Determine the role and feasibility of the project. The second phase will gradually implement the project and implement the various functions. The goal of the third phase is to test the project and integrate the results to complete the study.

Phase 1:

In this phase, I will focus on completing all the projects of TTTM4172 project proposal, including chapter 1 to chapter 4 and the proposal report. Determine the background, significance and function of this study. The design and planning of this study was improved by referring to other similar systems.

Phase 2:

The focus of this phase is to complete the project, including writing the code for the

designed system, implementing the functionality step by step using the aforementioned waterfall model, and completing the project. And improve and learn in the process. The purpose of this phase is to test the acquired skills and knowledge through practice and to complete the project.

Phase 3:

The final phase will focus on testing the built system. Integrate the results of phase 1 and Phase 2, and complete the final report of this study.

The project's development mainly includes four components: the Android application, the frontend for the web platform, the backend, and the database. In the design phase, this project was planned to be developed using the Java programming language, along with a SQL database. However, during the actual development process, Vue, a popular open-source JavaScript frontend framework[6], was introduced based on practical considerations. Vue allowed the construction of interactive user interfaces with features such as responsive data binding, DOM manipulation, component-based architecture, and a rich set of directives and filters, contributing significantly to the successful completion of this project.

Regarding the database, the project adopted both MySQL and Redis to support its execution. Redis, as an open-source high-performance NoSQL database, complemented MySQL by acting as a caching layer, storing certain data in memory, and thereby enhancing read and write speeds while alleviating the pressure on SQL queries[7].

During development, the project leveraged Spring Boot, another open-source framework, which simplifies the development process and configuration with its "out-of-the-box" functionality. Maven was used to manage and build the project efficiently. On the other hand, the Android app was developed entirely using Java for native development.

The frontend and backend are primarily connected through API interfaces[8]. In this project, functionalities such as obtaining location information and nearby hospital details are facilitated by map software, utilizing API interfaces to achieve these tasks.

Results and discussion

1. Web login page

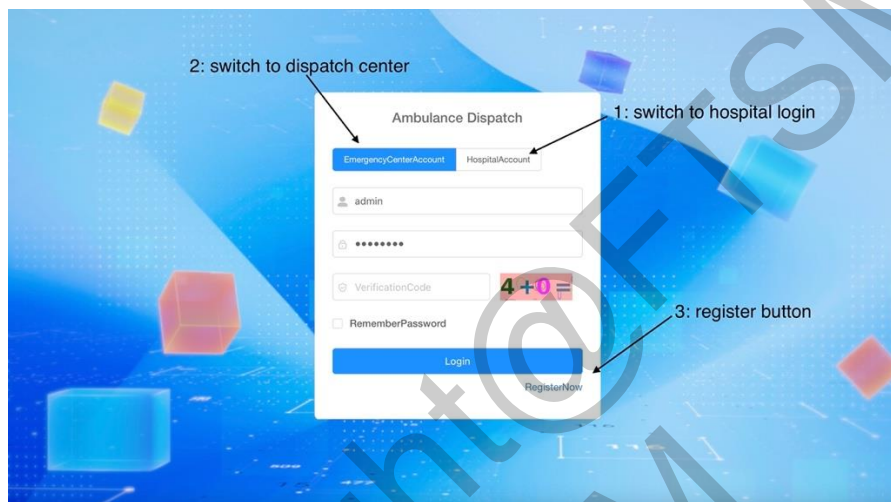


Figure 1: Web login page

The login page for the web application allows users to switch between logging in as a dispatch center account or a hospital account by clicking the button above the account input field. Below, there is a "Register Now" button for creating a new account.

2. Dispatches center page

username	name	ambulanceCode	status
A0001	A0001	A0001	Free
A0002	A0002	A0002	Free
A0003	A0003	A0003	Working
A0004	A0004	A0004	Free
A0005	A0005	A0005	Free

Figure 2: Dispatched center page

This page is the dispatch center interface for managing ambulance status. On the left side of the page are other management options for the dispatch center, including receiving emergency requests, ongoing task details, and a history of all past tasks.

3. Patient home page

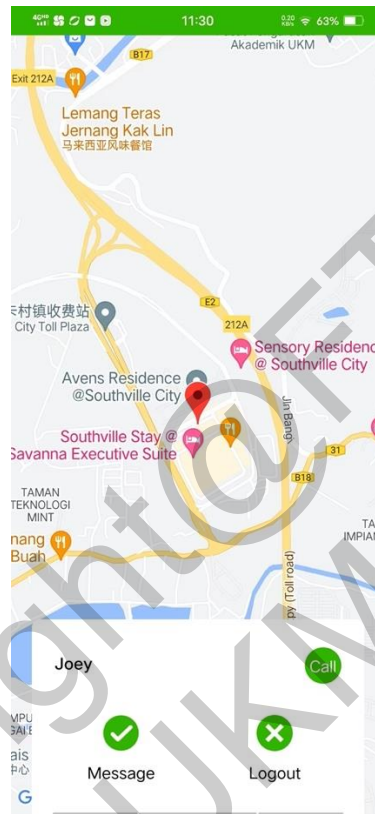


Figure 3: Patient home page

This page is the Home page of the patient application. Patients can click on their name to modify their profile. For patients who prefer to seek assistance from the emergency center via phone, they can click the "Call" button to dial the emergency center's number. By clicking on "Message," they can view nearby hospitals and select the hospital they wish to seek help from.

4. Choose hospital



Figure 4: Choose hospital page

The interface will display nearby hospitals, arranged in order of proximity (the top one being the nearest hospital). Users can select the hospital they wish to go to and click the "Confirm" button to proceed.

Usability testing is conducted to evaluate the user experience of the project from the perspective of users' perceptions and opinions during usage. The purpose of this testing is to collect user evaluations and feedback on the usability of the ambulance dispatching system, as shown in Table 1. This valuable feedback helps developers understand the real needs and experiences of users, enabling them to make improvements and optimizations to the program, thereby enhancing user satisfaction and overall experience.

ID	QUESTION	DESCRIPTION	SCORE
Q0001	Are you satisfied with the user interface design of this program?	To understand user satisfaction with user interface design, so as to evaluate the usability and user experience of the program.	7/10

Q0002	Do you think the operation flow of this program is intuitive and easy to understand?	Explore the user's feelings about the program's operation process, and help discover whether there is room for improvement to improve the user's experience.	7/10
Q0003	While using the program, did you encounter any features that were difficult to understand or use?	To detect whether users encounter functional obstacles during use in order to improve the usability and user-friendliness of the program.	8/20
Q0004	Are your feedback and tips for this program clear enough?	To understand the user's understanding of program feedback and prompt information, in order to optimize the expression of prompt and feedback, and help users better understand the operation of the program.	7/10
Q0005	Do you feel satisfied with the system response speed when using this program?	To understand the user's feelings about the response speed of the program, and judge whether it is necessary to improve the performance of the system to improve user experience and satisfaction.	8/10

Conclusion

This technical report introduces the development of an ambulance dispatch system,

which includes the dispatch center and hospital system on the web page, as well as the user and ambulance system on the Android phone. Through this project, we successfully achieved the following key objectives and outcomes:

1. Realize automatic positioning and information transmission: By using mobile phone positioning technology, patients can accurately and quickly send emergency information and location, reducing dependence on dispatchers and improving rescue efficiency.
2. Provide patients with the right to choose: patients can choose a suitable hospital according to their own conditions, avoiding delays in treatment and waste of medical resources, and improving patient experience.
3. Improve patient communication: Through the system, information transmission and exchange can be realized among patients, ambulance personnel and hospitals, which improves rescue efficiency and hospital preparations.

During the development process, we adopted the waterfall model and gradually completed the key steps of system analysis, design, implementation and testing, ensuring the stability and functional integrity of the system. The system uses JAVA as the main development language, uses MySQL database and Redis, and uses HTML, CSS and JavaScript to develop the web interface.

However, there are still some areas that can be improved in the project, such as further optimizing the user interface and enhancing the security of the system. In the future, we plan to continue to improve the system and add more functions and services to meet changing needs.

In general, the development of this ambulance dispatching system contributes to improving rescue efficiency, optimizing hospital selection and accelerating

Reference

1. Olive C. Kobusingye, Adnan A. Hyder, David Bishai, Manjul Joshipura, Eduardo Romero Hicks, and Charles Mock. 2006. *Disease Control Priorities in Developing Countries. 2nd edition.* Chapter 68 Emergency Medical Services. <https://www.ncbi.nlm.nih.gov/books/NBK11744/> (11/10/2022)
2. Trek Medics International. 2015. *Malaysia: Ambulance and Emergency Medical Services.* <https://trekmedics.org/database/malaysia-2/?country=Malaysia> (11/10/2022)
3. Bahari, M.S. *et al.* (no date) *Analysis of costs and utilization of ambulance services in the Ministry of Health Facilities, Malaysia, PLOS ONE.* Public Library of Science. Available at: <https://journals.plos.org/plosone/article?id=10.1371%2Fjournal.pone.0276632> (11/11 2022)
4. Rahman, N.H. *et al.* (2015) *Emergency medical services key performance measurement in Asian cities, International journal of emergency medicine.* U.S. National Library of Medicine. Available at: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4412872/> (11/11/ 2022)
5. Matthew Martin. 2022. *What is Waterfall Model in SDLC? Advantages and Disadvantages.* <https://www.guru99.com/what-is-sdlc-or-waterfall-model.html> (13/1/2023)
6. Li, N. and Zhang, B. (2021) *The research on Single Page Application Front-end development based on Vue, The Research on Single Page Application Front-end development Based on Vue.* Available at: https://www.researchgate.net/publication/351145453_The_Research_on_Single_Page_Application_Front-end_development_Based_on_Vue/fulltext/609d6083299bf1476996106b/The-Research-on-Single-Page-Application-Front-end-development-Based-on-Vue.pdf (Accessed: 21 July 2023)

7. Puangsaijai, W. (2017) *A comparative study of relational database and key-value ... - IEEE xplore*. Available at:
<https://ieeexplore.ieee.org/document/8075813> (Accessed: 20 July 2023)
8. Inc., J.B.G. *et al.* (2006) *How to design a good API and why it matters: Companion to the 21st ACM SIGPLAN symposium on object-oriented programming systems, languages, and applications, ACM Conferences*. Available at: <https://dl.acm.org/doi/abs/10.1145/1176617.1176622> (Accessed: 20 July 2023)

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