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Metacare: A Cross-Platform Healthcare Management System Using Progressive UI Framework and MySQL

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A B S T R A C T

The study aimed to design an automated system for a healthcare centre to manage their records. It aimed to describe the process of designing and developing the system using the modified waterfall model. The International Organization for Standardization (ISO) 25010 software standards were utilized to assess the technical feature of the system and the quality of using the system. The developmental research design was used, and IT experts and healthcare workers/residents served as the respondents. The results were analysed using weighted mean and frequency distribution, revealing that the system was successfully designed and developed using the software development model. IT experts and end-users evaluated the system with highly acceptable ratings. This study concluded that the system met the software quality standards assessment and recommended its implementation to benefit more people in the locality with further improvements

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INTRODUCTION

The coronavirus 2019 (COVID-19) revealed key vulnerabilities in healthcare organizations worldwide, including safety, equipment, data availability, and infrastructure (Martin, 2020). Martin (2020) further explains that relying solely on an organization's supply lines and capacities, or "going it alone," was not possible. As a result, unplanned collaborations arose with providers, suppliers, and non-healthcare groups stepping in to provide resources and capacity to address the situation. He elaborated his stance by stating that in February 2020, telehealth accounted for less than 1% of medicare primary care visits; by April, the figure had increased to 43%, due to the pandemic. This increase appeared to be sustainable if patients and physicians embraced a new virtualized concept. Organizations would need to connect their virtual approach with the changing demands of their market, growth plans, and payment models. This was not a solution, but rather a logical development towards better supporting physicians and patients: virtual needed to become the way organizations functioned rather than a separate component of the strategy (Martin, 2020).

Due to this fact, the likelihood of healthcare access being constantly jeopardized was quite substantial. Not only then, but also in the next decades. Hence, it was critical to establish a system that would help reduce the number of people queuing in health centers while simultaneously adhering to the Inter-Agency Task Force's social distancing protocols. This approach would have allowed people to receive healthcare services without having to wait for the pandemic to end, ensuring ongoing service and access to RHUs throughout the years. Online consultations, which this project aimed to develop, became increasingly popular, especially when the pandemic began to limit social interactions in March 2020. A study by Quilon (2019) proposed and developed an Android application to address current challenges in responsiveness to immediate primary healthcare needs in barangays. It was a program that checked for symptoms relating to the patient's health issues. Although it sought to support Rural Health Units and be available digitally, it did not intend to allow individuals to schedule and reserve a slot for municipal healthcare programs such as dental missions, *libreng tuli*, free vaccines, free check-ups, and many others. It did allow the community to schedule a consultation, but only by giving a doctor's schedule and contact information. However, this was not how most localities in the Philippines provided free healthcare because the goal was to serve more people rather than take one-on-one appointments.

In order to fill the gaps in past studies and contribute to the growing body of literature, the researchers aimed to design and create a healthcare management system to aid in the delivery of healthcare services at City Health Centre of Caalibangbangan, Cabanatuan City. The healthcare management system was a web-based system that allowed individuals to schedule a slot for accessible and free healthcare programs and services, such as medical missions, at their local City Health Centre. For City Health Centre, it helped them in the management of patient information and delivery of services. This could have been used to promote a safer method of implementing and providing healthcare services

without threatening employees' and residents' health, which could have also been part of the government's digitization effort.

Statement of the Problem

Generally, the goal of this project was to develop a web-based healthcare management system for City Health Centre 6 Caalibangbangan, Cabanatuan City, Nueva Ecija, Philippines.

Specifically, it sought to answer the following questions:

1. How may the system be designed and developed based on the stages of the modified waterfall model which include
    1.1. Planning;
    1.2. Analysis;
    1.3. Design;
    1.4. Testing;
    1.5. Implementation; and
    1.6. Maintenance?
2. How may the system be assessed by the IT experts based on the following ISO 25010 criteria which include
    2.1. Functional suitability;
    2.2. Reliability;
    2.3. Usability;
    2.4. Performance efficiency;
    2.5. Compatibility;
    2.6. Security;
    2.7. Maintainability; and
    2.8. Portability?
3. How may the system be assessed by the end-users based on the quality of use in consideration of the selected ISO 25010 criteria which include
    3.1. Functional suitability;
    3.2. Reliability; and
    3.3. Usability?

METHODOLOGY

The researchers utilized the developmental research design, which is a systematic approach to creating, producing, and assessing instructional programs, procedures, and products (Richey, Klein, & Nelson, 2004). This approach differs from basic instructional development in that it places a greater emphasis on internal consistency and effectiveness. Developmental research is a complex process that involves multiple stages, including the identification of learning objectives, the design of instructional materials, and the evaluation of their effectiveness. The goal of this approach is to create instructional programs that are tailored to the needs of learners and that are based on sound theoretical principles.

In recent years, developmental research has also gained popularity in the field of information technology, as software developers seek to create user-friendly, efficient, and effective programs that meet the needs of today's users. By utilizing this approach, researchers can identify the strengths and weaknesses

of different software programs and procedures, and can make informed decisions about how to improve them. Additionally, developmental research provides a framework for ongoing evaluation and improvement, ensuring that software programs are constantly evolving to meet the changing needs of users.

The use of the developmental research design in information technology has revolutionized the way the researchers approach software development. Instead of simply creating programs that meet basic functionality requirements, software developers now place a greater emphasis on usability, efficiency, and effectiveness. This approach ensures that software programs are user-friendly, efficient, and effective, and that they meet the needs of a diverse range of users. The use of the developmental research design has become increasingly popular in the field of research, as it offers a systematic and rigorous approach to producing valuable outputs. Researchers who use this approach are able to create, produce, and assess instructional programs, procedures, and products that are not only effective, but also meet the needs of their intended audience. This is evident in the studies conducted by Dewitt (2010), and Cruz and Dizon (2021) which all utilized the developmental research design in the conduct of their studies, and were able to produce valuable outputs.

The respondents in this study were healthcare workers from the City Health Center 6 Caalibangbangan. A total of twenty respondents were selected using non-random sampling technique to evaluate the quality of the system. Additionally, ten IT experts were recruited to evaluate the technical aspect of the system using the ISO 25010 software standards.

After the system was developed, the twenty healthcare worker respondents were given access to the system and asked to evaluate its quality. The evaluation was based on various factors, including functional suitability, reliability, and usability. The respondents were also asked to provide feedback on any issues or challenges they encountered while using the system. Meanwhile, the ten IT experts were tasked with evaluating the technical aspect of the system using the ISO 25010 software standards.

They examined the system's functional suitability, reliability, usability, performance efficiency, compatibility, security, maintainability, and portability to determine its overall quality. During the data gathering procedures, the researchers ensured that all data collected was treated with utmost confidentiality and anonymity, and was only used for the purpose of the study. The respondents were assured that their personal information would not be disclosed and that their participation was voluntary

RESULTS AND DISCUSSION

The Design and Development of MetaCare Following the Stages of the Modified Waterfall Model.

A. Planning Stage

The project development stage began with the researchers coming up with a strong and relevant issue that needed a solution. They then created a capstone project proposal matrix based on their idea, which served as the initial overview of the project. This stage also involved understanding the system requirements by conducting continuous communications between the customers and the system analysts, as outlined by Alshamrani and Bahattab (2015). The matrix provided observations on the research area and the purpose of the project, and served as the starting point for the project development process. Also Gantt chart was utilized which served as a guide for the researchers in terms of the schedule of the activities to be undertaken.

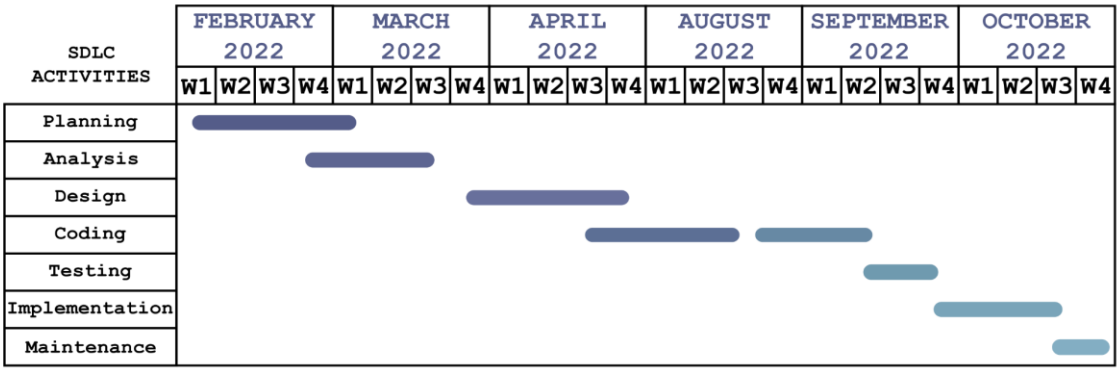

Figure 1. Gantt Chart of Activities

B. Analysis Stage

During this stage, the objective was to understand the specific requirements of the clients and accurately document them, as outlined by Verma (2014). The researchers gathered all the needed information from the chosen research locale, specifically the flows and operations of a city health centre. In-depth research was conducted, and data was collected to be used as a resource in designing the system. This stage was crucial in ensuring that the system would meet the needs of the intended users and operate effectively within the context of a health centre setting. In this stage, the use case diagram was developed.

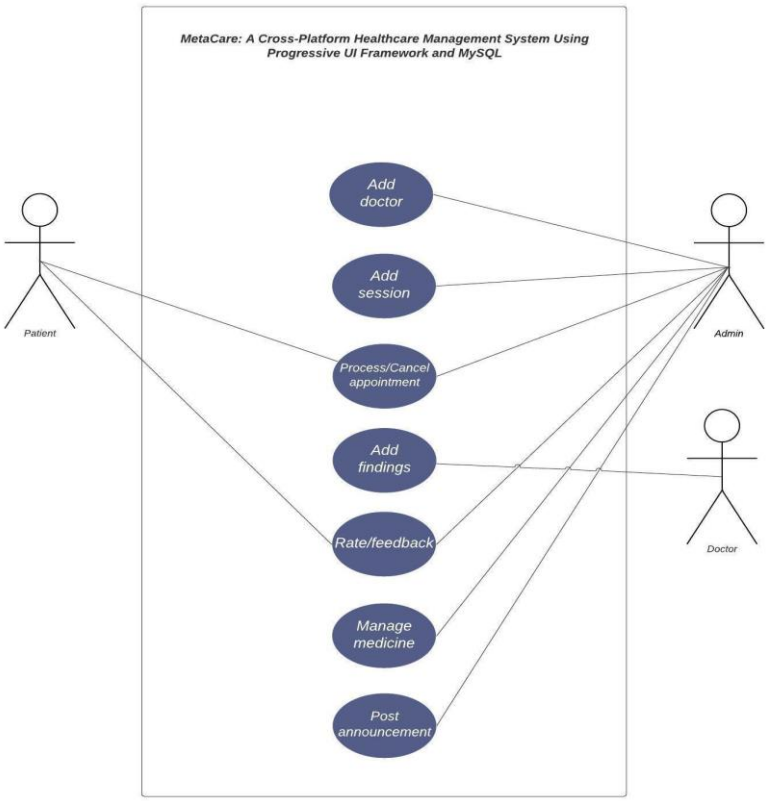

Figure 2. Use-Case Diagram

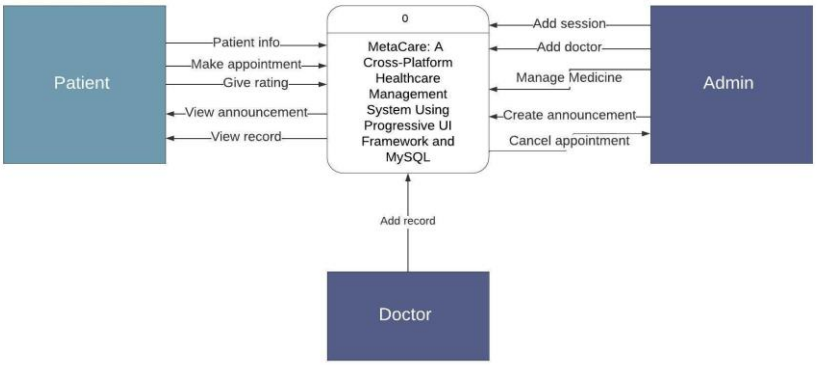

Figure 3. Data Flow Diagram – Context Level

C. Design Stage

According to Alshamrani and Bahattab (2015), the design stage was where the gathered information from the previous stage was evaluated and proper implementation was formulated. It dealt with choosing the appropriate algorithm design, software architecture design, database conceptual schema, logical diagram design, and data structure definition. In this stage, the researchers started the selection of tools to be used in designing the system including the establishment of database structure and identifying the language to be utilized. Then, they implemented them in the development of the system

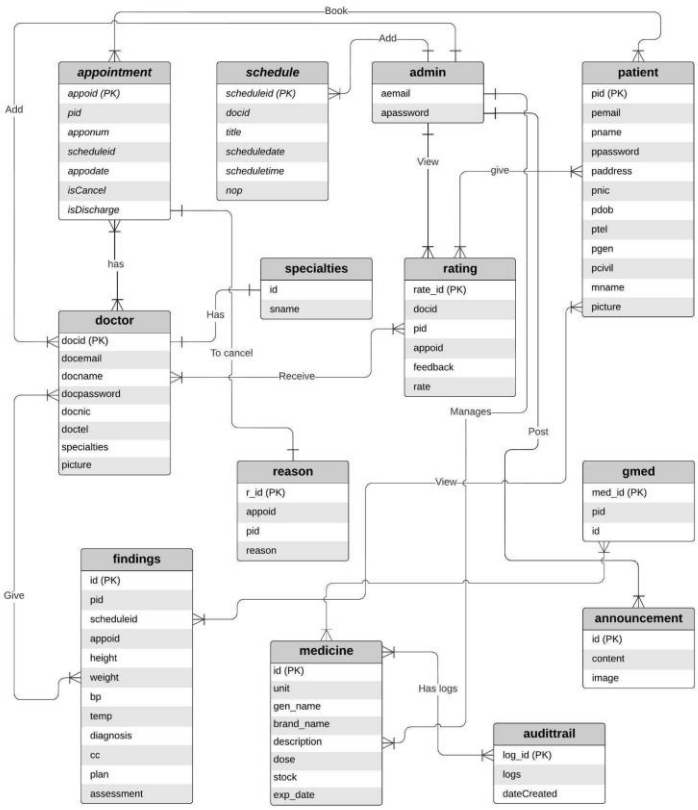

Figure 4. Entity-Relationship Diagram

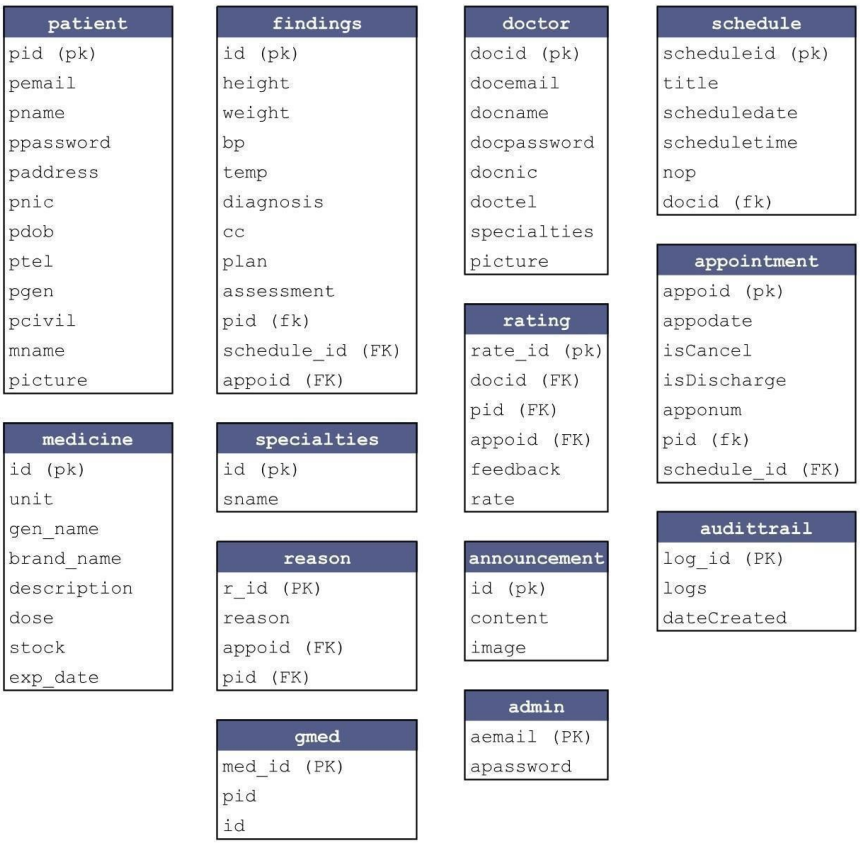

Figure 5. Third Normal Form

The following figures below show the different sample user interfaces of the developed system.

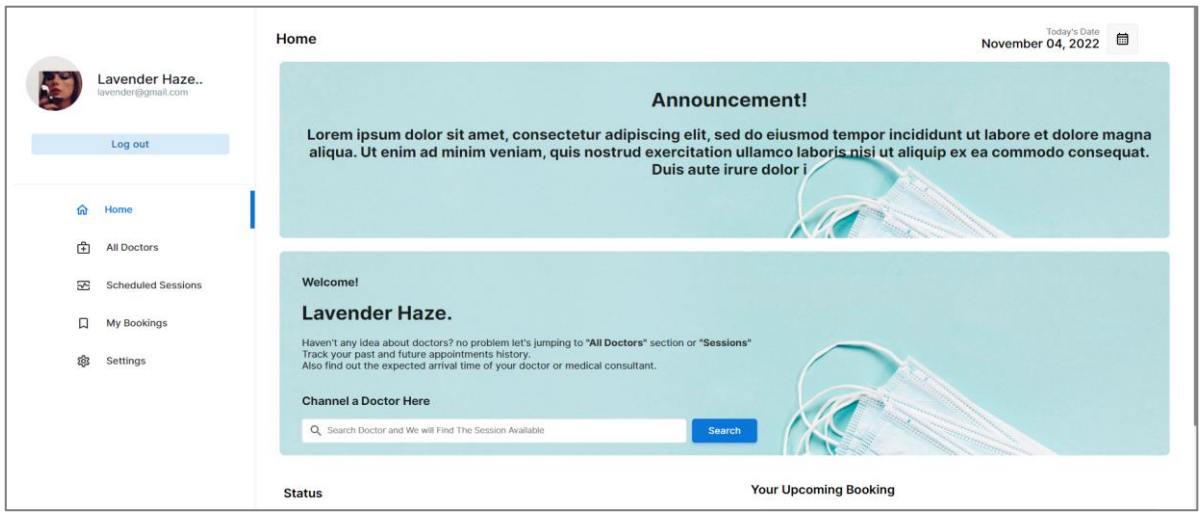

Figure 6. Landing Page of the Developed System

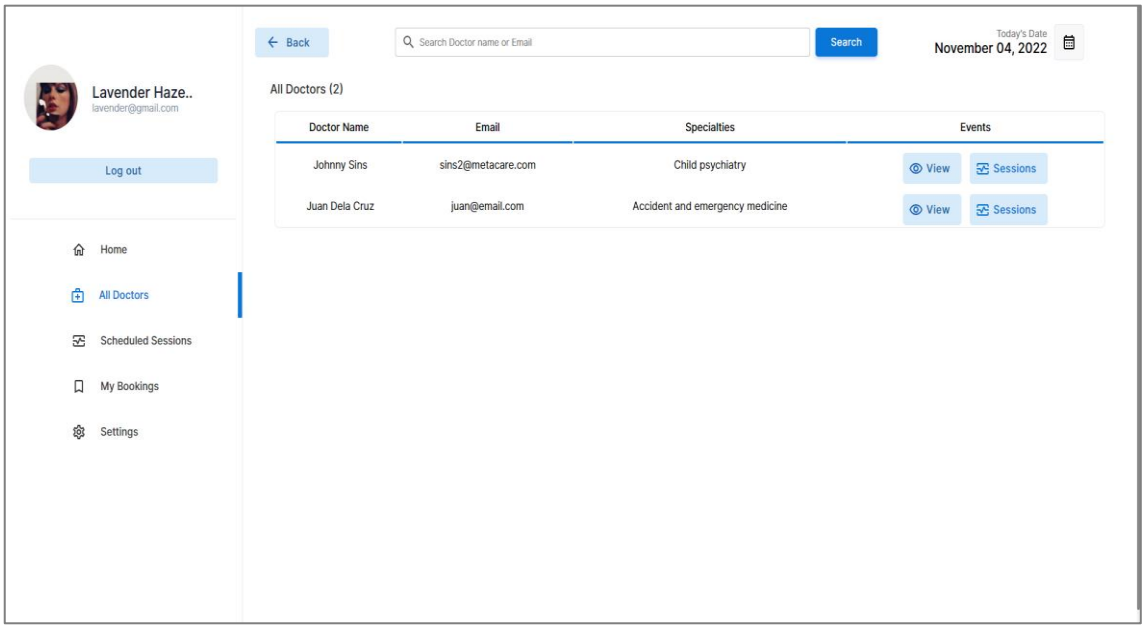

Figure 7. Doctor's Menu Form

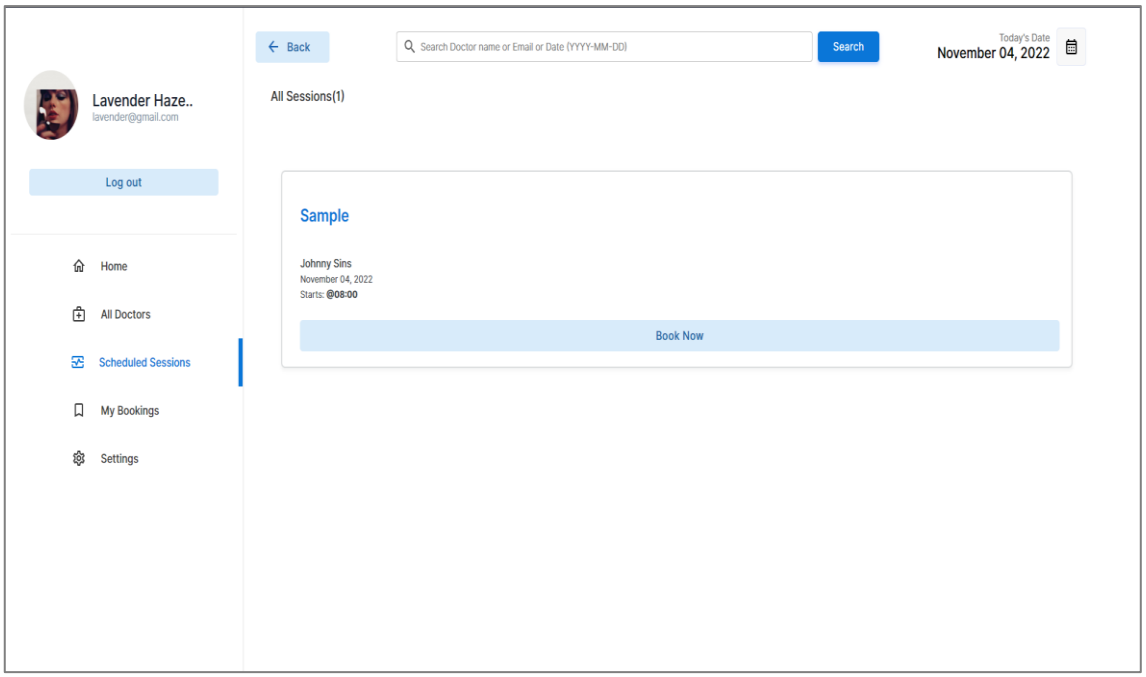

Figure 8. Scheduling Form

D. Testing Stage

In this stage, the software solutions that had been developed to meet the original requirements were actually tested and checked. This was also the stage where the bugs and system glitches were found, fixed, and refined (Alshamrani & Bahattab, 2015). After the development of the system, the researchers performed testing which aimed to collect errors and bugs that were not identified or found in the system during the coding process. Here, all the collected bugs were eliminated and corrected. The specific testing techniques included agile testing, which adhered to the ideals of the agile manifesto by prioritizing testing from the standpoint of users who would use the system. Ad-hoc testing without preparation or documentation was also conducted to 'break' the system by randomly attempting its functionality. Additionally, branch testing was performed, which involved testing all branches of the software source code at least once.

E. Implementation Stage

The implementation stage encompassed the processes that happened after the customer had bought the product to get it operating properly. Errors that were made in the design stage could also be identified during implementation (Matkovic & Tumbas, 2010). During the implementation stage, the researchers deployed the system to the intended City Health Centre. At the centre, the intended users utilized the developed system in their day-to-day operations. This was also the stage where the users evaluated the usefulness and effectiveness of the system that had been developed by the researchers.

F. Maintenance Stage

According to Alshamrani and Bahattab (2015), this stage took care of some modifications, improvements, error correction, and refinement after the software had been released. The researchers intended to conduct four types of software maintenance at this stage: corrective, adaptive, preventive, and perfective. In corrective software maintenance, the researchers observed faults or problems while the system was in use and then remedied them. In adaptive software maintenance, the researchers were able to adjust software in response to changes in the system's environment. The researchers focused on features that improved the user experience through functional enhancements based on customer feedback for perfective maintenance. Finally, the researchers conducted preventive software maintenance by improving maintainability and stability through code optimization, restructuring, and documentation updates to reduce the risk of deterioration as software was operated for a long time.

Assessment on the Technical Quality of MetaCare made by IT Experts

The assessment results on the technical quality of MetaCare, as evaluated by IT experts, are presented in Table 1. These results were crucial in gaining insight into the experts' perspectives on the technical aspects of the project developed by the researchers.

Table 1. Assessment on Technical Qualities of MetaCare by IT Experts

Criteria	Mean Rating	Verbal Interpretation
Functional Suitability	3.64	Strongly Agree
Reliability	3.50	Strongly Agree
Usability	3.67	Strongly Agree
Performance Efficiency	3.64	Strongly Agree
Compatibility	3.63	Strongly Agree
Security	3.62	Strongly Agree
Maintainability	3.62	Strongly Agree
Portability	3.53	Strongly Agree
Overall Mean	3.61	Strongly Agree

Table 1 shows the results of an assessment conducted by IT experts on the technical qualities of MetaCare, with criteria such as functional suitability, reliability, usability, performance efficiency, compatibility, security, maintainability, portability, and overall mean being evaluated. The mean ratings for each criterion ranged from 3.50 to 3.67, with an overall mean rating of 3.61. The verbal interpretation for each mean rating was "Strongly Agree," indicating that the experts had a positive view of the technical aspects of the project. The high mean ratings for functional suitability, usability, and performance efficiency suggest that MetaCare was able to meet the functional requirements of its users and perform efficiently. This indicates that the software is reliable and can be used by healthcare professionals to improve the quality of care provided to patients. It also suggests that the software is easy to use, which is crucial in a healthcare setting where time is of the essence and ease of use can directly impact patient outcomes. The high mean ratings for compatibility, security, maintainability, and portability suggest that the software is adaptable, secure, easy to maintain, and can be used across various platforms. This is crucial in a healthcare setting where technology is constantly evolving, and healthcare professionals need software that is easy to maintain and can adapt to changes in technology. Overall, the high mean rating for the overall technical qualities of MetaCare suggests that the software is of high quality and can be used effectively in a healthcare setting. This can have significant implications for the healthcare industry, as software like MetaCare can improve patient outcomes and reduce the workload of healthcare professionals. Additionally, the positive evaluation by IT experts can increase the confidence of potential users in the software, leading to increased adoption and use of the technology in the healthcare industry.

Assessment on the Quality of Using MetaCare Made by End-Users

Table 2 presents the findings of the assessment conducted by end-users on the quality of using Metacare. These results provided valuable insight into how the end-users perceived the quality of the project developed by the researchers.

Table 2. Assessment on Quality of Using the MetaCare by End-Users

Criteria	Mean Rating	Verbal Interpretation
Functional Suitability	3.37	Strongly Agree
Reliability	3.41	Strongly Agree
Usability	3.43	Strongly Agree
Overall Mean	3.40	Strongly Agree

Table 2 presents the results of the assessment on the quality of using MetaCare by end-users, where the mean rating for functional suitability, reliability, and usability was 3.37, 3.41, and 3.43, respectively, indicating a strong agreement on all criteria. The overall mean rating for MetaCare was 3.40, indicating a strong agreement among end-users on the quality of the software. The high ratings for functional suitability, reliability, and usability suggest that MetaCare met the end-users' requirements and expectations in terms of the software's features, performance, and ease of use. This result is important because end-users' satisfaction is critical to the success of any software project, and their feedback can help in further improving the software. The strong agreement among end-users also implies that MetaCare is perceived as a reliable and trustworthy system, which is crucial in the healthcare industry where accuracy and dependability are essential. End-users' trust in the system could lead to increased adoption of MetaCare, which could ultimately result in improved patient care and outcomes. The high rating for overall mean suggests that MetaCare is perceived as a high-quality software by end-users, which could positively impact the reputation of the researchers and the organization they represent. The strong agreement among end-users on the software's quality could also lead to increased recommendations and referrals, which could further enhance the software's adoption and usage. In summary, the results of the assessment on the quality of using MetaCare by end-users indicate a strong agreement among end-users on the software's functional suitability, reliability, usability, and overall quality. This result is important as it suggests that MetaCare met end-users' requirements and expectations and is perceived as a reliable and trustworthy system. The positive perception of end-users on MetaCare could lead to increased adoption and usage of the software, ultimately resulting in improved patient care and outcomes.

CONCLUSIONS AND RECOMMENDATIONS

MetaCare was developed to provide quality healthcare by utilizing six different stages of the modified waterfall model which include planning, analysis, design, testing, implementation and maintenance. The system passed the assessment based on the ISO 25010 software standards made by the IT experts. In terms of the quality of using the system, MetaCare was assessed as highly acceptable for the end-users as can be seen on the computed mean rating.

Based from these conclusions, the following are recommended:

1. Future studies may use other software development models to test how such system can still be made using different techniques;
2. The healthcare may consider recruiting personnel who can be designated to manipulate the system; and
3. Future studies may still be conducted as result of this undertaking.

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