Journal of Innovative Technology Convergence
Vol. 6, No. 4 December 2024, pp. 53-68
https://doi.org/10.69478/JITC2024v6n3a05

Implementation of a Web App for Children's Management and Engagement for Pagsanjan Laguna

Reynalen C. Justo[1], Maria Laureen B. Miranda[2]*

Abstract: The study "Implementation of a Web App for Children's Management and Engagement for Pagsanjan Laguna" was conducted with the primary aim of developing and implementing the Arriola-Robles Children's Clinic Web App to enhance clinic management and patient engagement in Cabanbanan, Pagsanjan, Laguna. Using technology in medical care helps reduce malpractice, costs, and paperwork. This also improves the quality and efficiency of medical care. Various technological applications facilitate patient data's electronic storage, transmission, and display, enabling access to health information and in-person consultations. These advancements help mitigate malpractice, reduce costs, and minimize paperwork while improving the quality and efficiency of care. This study aimed to design and develop a face-to-face medical consultation system for the Arriola-Robles Children`s clinic in Cabanbanan, Pagsanjan, Laguna. Employing a descriptive development research design, the study utilized Rapid Application Development (RAD) methodology during the system's development phase and conducted black-box testing to evaluate functionality. The Technology Acceptance Model served as the primary framework for the evaluation phase, alongside ISO/IEC 25010:2011 for assessing software quality metrics. The findings revealed an overall weighted mean of 4.73, indicating a "Strongly Agree" consensus among target users regarding the face-to-face consultation system's potential to enhance the existing consultation processes at Arriola-Robles Children's clinic.

Keywords: Medical Services, Patient Data Management, Face-to-Face Medical Consultation, and Consultation Process Improvement

1. Introduction

The healthcare business is crucial to individuals' regular daily existences all over the globe. Healthcare is probably the most well-known of all the industries that are making money from different technologies. Individuals' well-being is one of the most significant parts of their lives. The development

[1] College of Computer Studies, Laguna State Polytechnic University, Santa Cruz, Laguna, Philippines
Email: reynalen.justo@lspu.edu.ph
[2]* College of Computer Studies, Laguna State Polytechnic University, Santa Cruz, Laguna, Philippines
Email: laureen.miranda@lspu.edu.ph (Corresponding Author)

Received [October16, 2024]; Revised [November 25, 2024]; Accepted [December 20, 2024]

Published by InnoCon Publishing
ISSN 2704-4440

of new clinical applications and frameworks set off healthcare change. People's lives have improved as a result of this strategic approach. Several mobile health applications were used without any thought given to their quality [1]. Technologies employed include developing infrastructure for information and communication technologies, gathering and analyzing large amounts of data, and facilitating the provision of virtual and/or artificial intelligence-powered healthcare services.

The Arriola-Robles Children's Clinic Web App serves as an innovative platform designed specifically to address the unique needs of pediatric healthcare services in Cabanbanan, Pagsanjan Laguna. The app also provides access to health education resources, empowering parents and caregivers to promote their children's well-being effectively. The development of this cutting-edge web app is rooted in our study, which identified significant challenges in pediatric healthcare management. The Rapid Application Development (RAD) methodology was implemented and created a system that not only meets the technical requirements of healthcare providers but also addresses the needs of families seeking efficient healthcare solutions [2].

The Arriola-Robles Children's Clinic Web App is centered on the pressing need for innovative solutions in pediatric healthcare management in Cabanbanan, Pagsanjan Laguna. In recent years, there has been a growing recognition of the importance of accessible and efficient healthcare services for children and their families. One of the primary challenges facing the clinic is the reliance on traditional, manual appointment systems, which frustrate parents and lead to delays in receiving timely medical care for their children. The absence of a centralized system to manage health records complicates communication among healthcare providers, resulting in fragmented care and a lack of coordination during treatment.

The proposed web app serves as a bridge between healthcare providers and patients, empowering families to take control of their children's health. With features such as online registration, appointment scheduling, and electronic health record management, the app provides a seamless experience for all stakeholders involved in pediatric healthcare. To effectively develop the web app, the project employs the RAD methodology, which emphasizes iterative development and user feedback, ensuring that the system is tailored to the clinic's and its patients' specific needs. By involving stakeholders in the design and testing phases, the project aims to create a user-friendly platform that meets the expectations of both healthcare providers and families, drawing on the Technology Acceptance Model (TAM) to assess user acceptance of the developed system.

The development of the Arriola-Robles Children's Clinic Web App recognizes several key challenges facing pediatric healthcare management and engagement in Cabanbanan, Pagsanjan, Laguna. Through careful observation and consultation with stakeholders for children's clinic manual appointments, the reliance on traditional appointment methods leads to inefficiencies and long waiting times for patients, resulting in frustration and delays.

To address these challenges, the proposed system will utilize the RAD methodology to develop a comprehensive web application, the Arriola-Robles Children's Clinic Care Companion. It emphasizes iterative development through PHP and robust testing procedures; the system will be tailored to meet the specific needs of children's clinics, ultimately improving efficiency, responsiveness, and patient engagement.

The primary aim of this study is to develop and implement the Arriola-Robles Children's Clinic Web App to enhance clinic management and patient engagement in Cabanbanan, Pagsanjan, Laguna. The specific objectives are as follows:

1. To improve the manual procedures of the Arriola-Robles clinic in the following areas: (a) health record management; (b) appointment scheduling; and (c) SMS notification facilities.
2. To design and develop a system that enhances the speed and accuracy of the Arriola-Robles Children's Clinic Web App, thereby providing a superior user experience, specifically in: (a) appointment scheduling; (b) data management for patient records; (c) report generation for clinic operations; (d) SMS notifications; and (e) online prescription services.
3. To conduct a comprehensive evaluation of the web app's functionalities, user acceptance, and overall system performance, focusing on: (a) quality factors; (b) perceived ease of use; (c) perceived usefulness; (d) attitudes toward using the system; (e) behavioral intentions to use the system; and (f) actual system use.

2. Materials and Methods

2.1 System Development

The RAD process was used in conducting the study, particularly in their requirements planning to identify the current consultation process. According to Nalendra [3], RAD is a model that permits non-specialists to profit from superior execution figures while at the same time permitting master developers to make the most of the fundamental equipment.

The System Testing and Evaluation Procedure outlined the procedure for testing the produced system's operation and determining whether it was already error-free software or if there were any potential defects or concerns [4]. Testing Tool was conducted in software testing in order to determine the generated web application's usefulness based on the testers' responses. Ten (10) IT specialists were asked to evaluate the functionality of the created web application.

The system was tested using the Black Box Test during the design and development of the testing instrument. A software technique called "black box testing" is used to evaluate a produced system's functioning. The black box evaluation method functions as a form of software assessment, operating from within the unknown [5]. The procedure of validation of the questionnaire seeks to provide evidence to support the validity of each question asked; thus, validating it before it is given is important. The purpose of the questionnaire was to find out if the respondent benefited from the system's functioning.

2.2 System Evaluation

In developing the system, the expressive examination strategy was utilized to portray the characteristics of a population that is being studied. Quantitative and qualitative research investigates different social phenomena using distinct methods [6]. The study employed a developmental descriptive research where an interview is conducted primarily on the client to collect information regarding the current situation and the client's problems. It was identified that the client faced significant difficulties in providing efficient appointment scheduling and managing children's healthcare records.

In addition, the use of developmental research in the case of the developed system, as cited in the article entitled "Development Research: The Definition and Scope, differentiates development research from simple instructional improvement [7]. The study utilized the developmental research design method to acquire and assemble essential data and distinguish existing circumstances through interviews, research, and observation. The formative examination was utilized for the configuration to distinguish the issues and lacks during the descriptive process.

The locale of the study is the Arriola-Robles children`s clinic in Cabanbanan, Pagsanjan, Laguna. Meetings were conducted with the children`s clinic proprietor, Rona Arriola Robles, RPh, M.D., DPPS, and gathered data about the ongoing counsel process and the discussion issues that they are looking at in the Arriola-Robles children`s clinic. The population of the study comprised 43 patients per day of visit. The total population of 43 and a sample size of 40 respondents were used in the system for testing, including one (1) children`s clinic doctor, two (2) nurse secretaries, and forty (40) patients who've consulted in Arriola-Robles children`s clinic every day.

2.3 Statistical Analysis

Statistical analysis technique that uses a large number of population observations to estimate the criteria and characteristics of respondents. During the initial investigation and collection of data, probability sampling was applied as a technique to get results for the entire population. Purposive sampling technique was also utilized [8]. The purposive sampling is a non-probability sampling method where the selected participants meet the study's objectives based on their judgment [9]. This technique relies on the chosen participants from the study population, making the sampling process dependent on the expertise and understanding of the context. The study made use of the following to gather pieces of information: interviews, observation, library -Internet research, consultation, and questionnaires. Statistics is one approach to getting the data coordinated. The range and interpretation of the five-point scale are shown in the table.

The Frequency and Percentage Distribution formula is depicted in equation 1.

$$\bar{x} = \frac{\sum_{i=1}^{n} Xi}{N} \tag{1}$$

Where:

$\sum x$ = the sum of x

$\bar{x}$ = mean

N = number of data

The Standard Deviation formula is depicted in equation 2.

$$s = \sqrt{\frac{\sum_{i=1}^{n} (Xi - \bar{x})^2}{n-1}} \tag{2}$$

Where:

$\bar{x}$ = elements in population

n = population size

The Likert Scale formula is depicted in equation 3.

$$Weighted\ Mean = \frac{(SA*5) + (A*4) + (N*3) + (D*2) + (SD*1)}{\text{Total Number of Respondent}} \tag{3}$$

Where:

SA (Strongly Agree or 5), A (Agree or 4), N (Neutral or 3), D (Disagree or 2),

SD (Strongly Disagree or 1) = Degree of Agreement

The weighted mean and standard deviation technique was utilized to process the data distribution coming from the user acceptance questionnaires.

Table 1. Likert Scale

Score	Range	Verbal Interpretation
5	4.20-5.00	Strongly Agree
4	3.40-4.19	Agree
3	2.60-3.39	Neutral
2	1.80-2.59	Disagree
1	1.00-1.79	Strongly Disagree

Table 1 shows the scales of the five Likert items: strongly agree, agree, neutral, disagree, and strongly disagree. The weighted mean will be used to test user acceptance of Arriola-Robles Children`s Clinic Care Companion: Web App for Children`s Management and Engagement, Cabanbanan, Pagsanjan, Laguna. It talks about the instruments that were employed to collect data, address the issues found, and offer a potential fix. The four (4) distinct stages contained the following components of the methodology: cutover, construction, user design, and requirements planning.

3. Results and Discussion

Based on the findings and purpose of the study, the purpose of this part of the paper is to summarize the data collected and how statistical processing or analysis works. It also shows the interpretation of the results of the data obtained from the black box testing and the actual evaluation of the developed web application. In which the project aims to serve a variety of purposes for the Arriola-Robles Children`s Clinic Care Companion at Cabanbanan, Pagsanjan, Laguna. The Children`s Clinic Care Companion is an online tool designed to improve operations by increasing hassle in appointment scheduling, providing a user-friendly online platform for patients to book appointments, and managing patient data more efficiently. The purpose of the study was to demonstrate the managing and engaging in conducting medical consultation with the patient.

3.1 Research Objective 1

To improve the manual procedure of the Arriola-Robles Clinic in terms of the following: (a) health record management; (b) appointment scheduling; and (c) SMS notification facilities.

To identify the current consultation process of the Arriola–Robles Children`s Clinic Care Companion, an interview was conducted with Rona Arriola Robles, RPh, M.D., DPPS owner of the Arriola -Robles Children`s Clinic at Cabanbanan, Pagsanjan, Laguna on March 14, 2024.

The current consultation process at the children`s clinic at Cabanbanan, Pagsanjan, Laguna includes: (1) Patients need to go to the clinic area where they ask about appointing their schedules; (2) Those who are accepted in the appointing schedule will wait their turn for consultation with the doctor. The patient`s

personal information will be needed by the clinic`s secretary to create or find their records in the Arriola-Robles children`s clinic, they will ask about the basic information and the address that they`re currently at for the management of the patient`s records. The patients wait for their turn before continuing their medical consultation. Once they are up for consultation, the staff will call their name and proceed to the consultation with the doctor. Upon completion of the examinations, the patients will receive a doctor`s prescription and a laboratory request.

3.2 Research Objective 2

To design and develop a system that will improve the speed and accuracy of the Arriola-Robles Children's Clinic Web App by providing a better user experience: (a) appointment scheduling; (b) data management for patient record; (c) report generation for clinic; (d) SMS notification; and (e) online prescription.

They conducted interviews with the Arriola-Robles children`s clinic owner, Rona Arriola Robles, RPh, M.D., DPPS, on the current consultation process at Cabanbanan, Pagsanjan. After the interview, it was brainstormed how to develop a web application for online consultation. After gathering the necessary information, it was conceptualized how the system would flow. Then proceed with the development of a medical consultation web application for Arriola-Robles children`s clinic. PHP was utilized as the programming language and MySQL as the database.

3.3 The Development and Enhancement

The system was developed after collecting information from the children's clinic and enhancing the necessary features. A set consultation was followed and decided to include Patient History, Report Generation, Appointment Scheduling, and Payment Receipts. After implementing these recommendations, it presented the system to the doctors and staff at Arriola-Robles Children's Clinic Care Companion in Cabanbanan, Pagsanjan, Laguna. The doctor and staff express satisfaction with the system, praising its user-friendliness.

3.3.1 System Interface

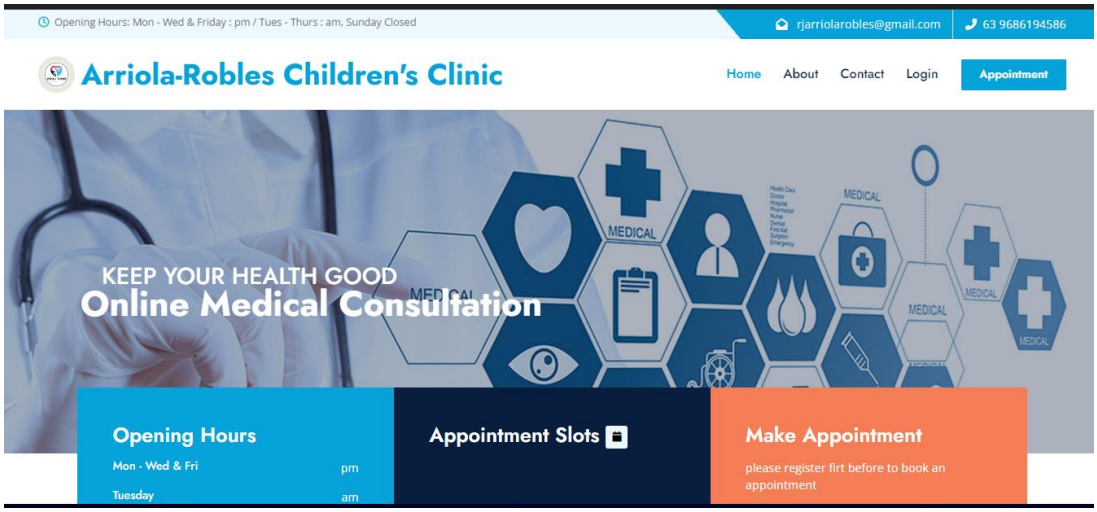

Figure 1. Home Page of the Developed Web Application

Figure 1 shows the screenshot of the homepage for the Arriola-Robles Children`s Clinic Care Companion web application; this was where the user was redirected when they searched for the website address of the system.

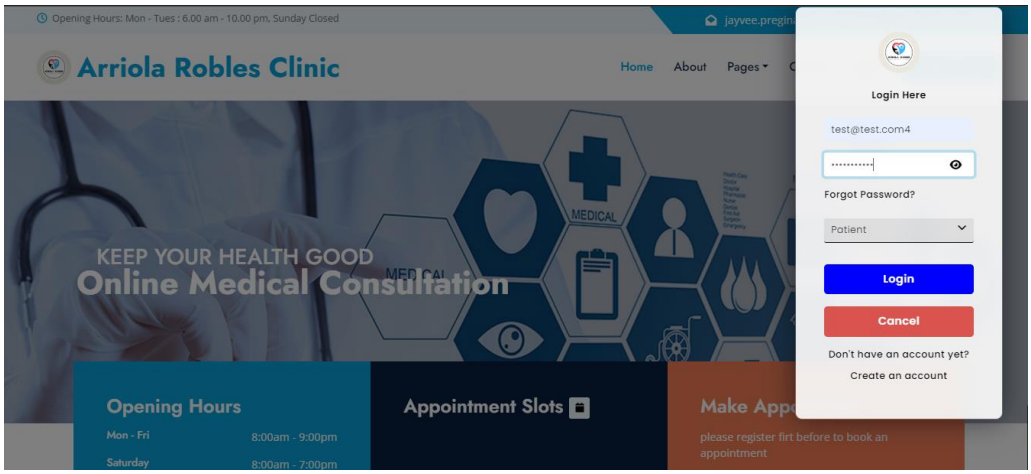

Figure 2. Login Form for the Users with Registered and Verified Accounts

Figure 2 shows the screenshot of the login page of the system with a login form where the verified user can log in to their accounts to use the developed system. Users who are not yet verified cannot proceed to the secretary, doctor, and patient`s dashboard; they need to verify their accounts first via email.

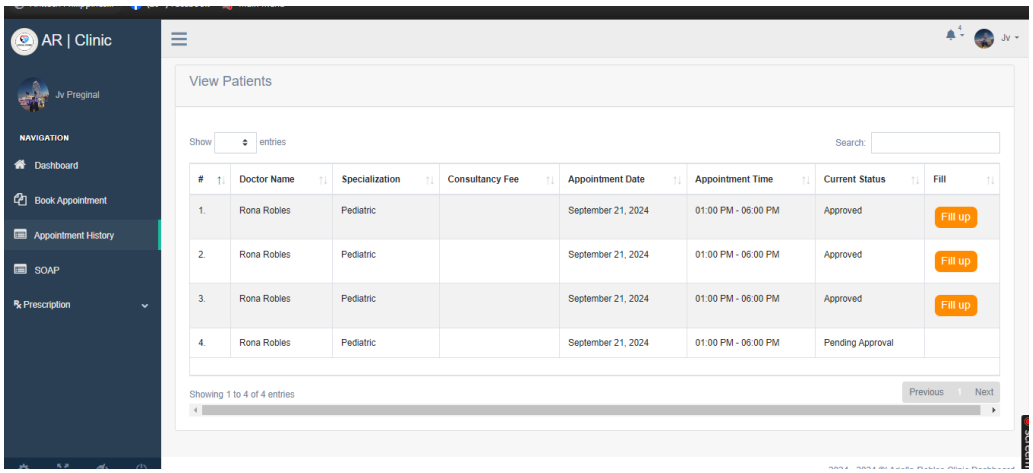

Figure 3. Appointment Records Page for the Patient`s Account

Figure 3 shows the screenshot of the appointment records page for the patient account of Arriola-Robles Children`s Clinic, which consists of the list of consultations if approved or not by the doctor.

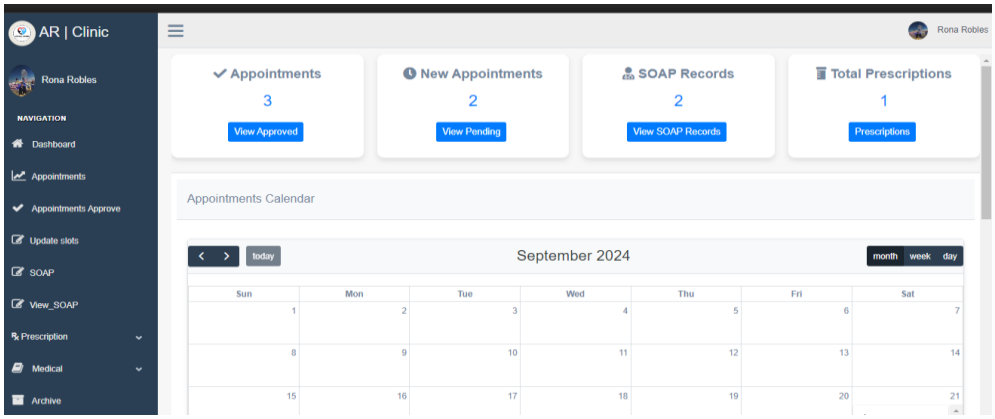

Figure 4. Dashboard for the Patient`s Account

Figure 4 shows the screenshot of the dashboard of the clinic`s doctor which consists of the patient's total number of appointments, pending appointments, total appointments, and appointment calendar.

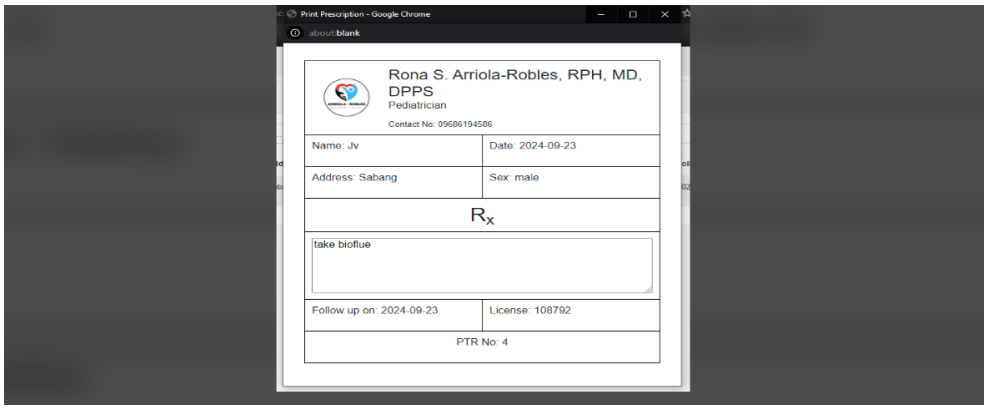

Figure 5. The Online Medical Prescription Given by the Doctor

Figure 5 shows the screenshot of the online medical prescription provided by the doctor of Arriola-Robles children`s clinic to the patient who conducted the medical consultation.

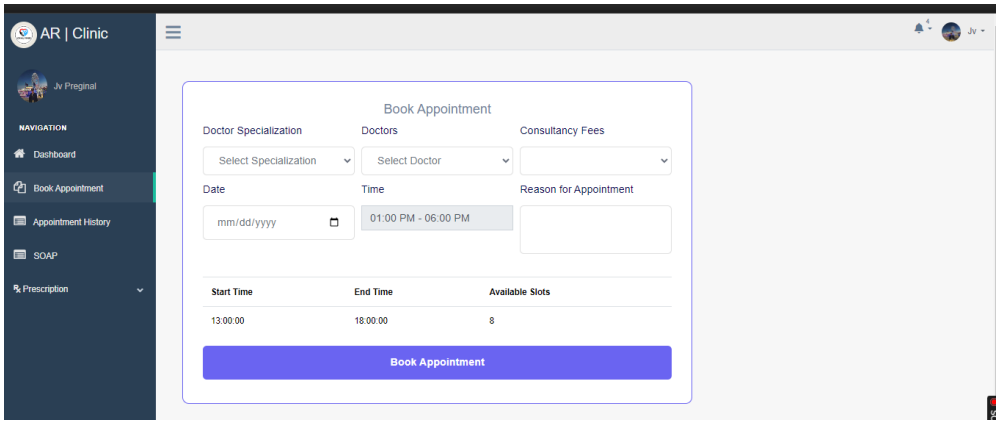

Figure 6. The Filling Out of the Appointment Schedule for Medical Consultation

Figure 6 shows the screenshot of the appointment schedule form that the patient can fill out to schedule a consultation appointment with the children`s clinic doctor. The developed online consultation web application enhanced the current consultation process of the Arriola-Robles children`s clinic using easy appointment scheduling, easy retrieval of data and records whenever the doctor needs them, and security from physical threats, for there will be an online database to secure the patient's data and information.

3.3.2 System Testing

For the testing of the system functionalities, the Black Box Test process was used. Black Box Testing is a software method to test the functionality of the developed system. Black box testing does not require an evaluator to have good programming skills, as they only examine the basics of the system without going into detail. There was a developed questionnaire to be used to evaluate the system and collaborated with a statistician to ensure its validity. Five (5) IT experts were invited to test and demonstrate the functionalities of the system.

Table 2. Results of the Blackbox Testing Questionnaire

CRITERIA	PASSED	FAILED	PERCENTAGE
1. Patient account registration	10	0	100 %
2. User account login for patient and Arriola-Robles secretary	10	0	100 %
3. Viewing of appointment records and adding new appointment (patient)	10	0	100 %
4. Secretary`s sending consultation reminder	10	0	100 %
5. Secretary`s updating of consultation status	10	0	100 %
6. Secretary`s updating of diagnosis, recommendations, status and prescription	10	0	100 %
7. Viewing of consultation records and downloading of medical prescription (patient)	10	0	100 %

8. Updating of profile and account settings both for patient, doctor and secretary.	10	0	100 %
9. Secretary and doctor`s consultation records and report generation	10	0	100 %
10. Doctor and secretary`s account registration	10	0	100 %

Table 2 shows the results of the conducted system testing with the ten IT experts invited to test the developed web app functionality. The table consists of the criteria, passed, failed, and the overall percentage of the testing. The developed system passed all sorts of testing by the IT experts. The first system testing was done personally via a home visit and performed a system demonstration with Mr. Bien Carl Andres Bonifacio, a data analyst on October 2, 2024. During the demonstration, Ms. Gemarie Ambrosio, an N1 Infrastructure Monitoring Analyst, suggested removing the bounce animation of the time and date of the clinic schedule. On the same day, the following testing was done by Mr. Balbas, Mr. Tamang, Mr. Cueto, Ms. Tumbokan, and Mr. Narido, a computer programmer; the developed system passed all the system testing. Ms. Frias and Ms. Reano, an executive assistant, system testing was done through a video call with Mr. Preginal, a CAD/CAM. During the system testing, the developed system was working error-free, and all IT experts confirmed that the system performed well.

3.4 Research Objective 3

To comprehensively evaluate the Children`s Clinic Web App functionalities, user acceptance, and system development: (a) Quality Factors; (b) Perceive Ease of Use; (c) Perceived Usefulness; (d) Attitude Towards Using; (e) Behavioral Intention to Use; and (f) Actual System Use.

To achieve the last objective of the study, the Technology Acceptance Model (TAM) was used to obtain insight into the users' input and actions towards the developed system, as well as to determine the level of satisfaction. It helped to gain a deeper grasp of the users' perspective, resulting in more reliable and accurate results.

The statistician projected 43 respondents, one (1) doctor, and two (2) children`s clinic staff members, with the remainder being patients of the Arriola-Robles children`s clinic. The survey questionnaire will be used to evaluate the system by the 43 respondents.

The questionnaires are validated to determine the accuracy of each question and if there is a valid measurement of the concept being evaluated. The statistician assists in determining the appropriate sample size. The statistician suggested using non-probability sampling to obtain the required sample size because non-probability sampling allows the choice of the number of respondents who will participate in the study. A face-to-face and virtual system demonstration were conducted to allow the respondents to evaluate the electiveness and efficiency of the web application, specifically quality

factors, perceived ease of use, perceived usefulness, attitude toward using it, behavioral intention to use it, experience, and actual use.

The functionality and the level of user acceptance for the developed system were evaluated by letting the respondents use it as well as answer the questionnaire.

3.4.1 Socio Demographic and Personal Details of the Respondents

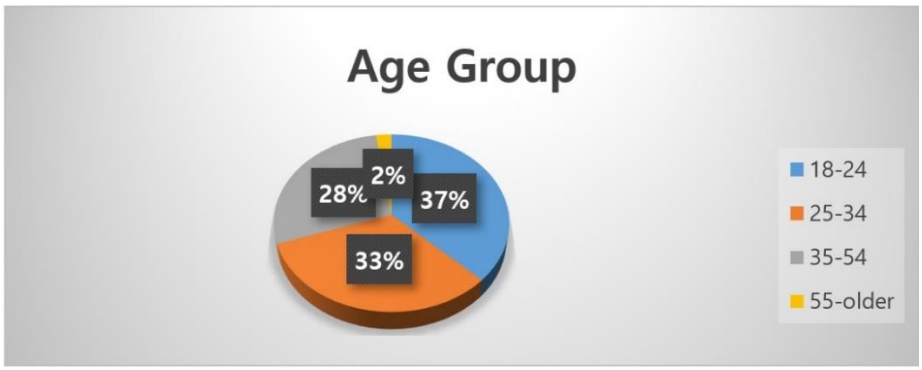

Figure 7. The Socio-Demographics and Personal Details of the User Respondents

Figure 7 presents the socio-demographic and personal details of the respondents, categorized by age group, occupation, educational attainment, and computer proficiency level.

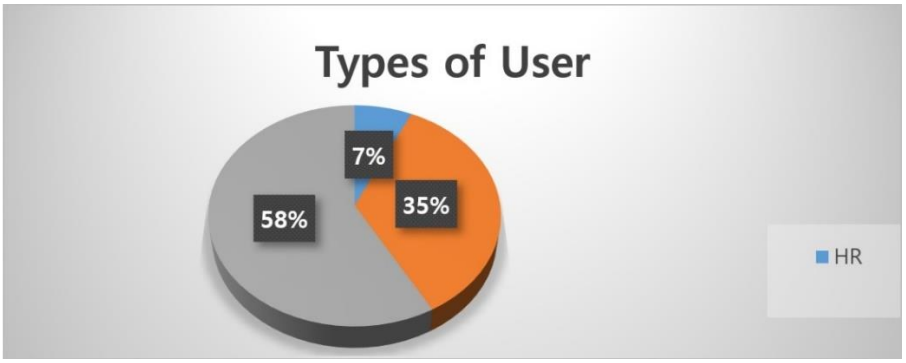

Figure 8. The Types of Users that Answered the User Acceptance Questionnaire

Figure 8 shows the age group of 43 respondents who answered the user acceptance questionnaire. The majority (37% of the respondents) are in the age group of 18-24 years old, 33% of the respondents are in the age group of 25-34 years old, 28% of the respondents are in the age group of 35-54 years old, and 2% of the respondents are in the age group of 55 years and older.

3.4.2 User Acceptance Evaluation Results

Table 3 shows the results of user ratings from Arriola-Robles children`s clinic respondents. A total of forty-three (43) responses of the respondents from forty-three (43) total population of the patients that appoints a schedule a day.

Table 3. Results of the User Acceptance Questionnaire from the Quality Factors Category

Category	Mean	Standard Deviation	Interpretation
1. Reliability	4.91	0.29	Strongly Agree
2. Efficiency out relevant and full features.	4.72	0.45	Strongly Agree
3. Usability	4.70	0.46	Strongly Agree
Weighted Mean	4.78	0.42	Strongly Agree

Table 3 shows the respondents' perceptions of the quality factors of the developed web applications. The reliability of the web application has an average of 4.91, with the interpretation of "Strongly Agree". Efficiency received an average of 4.72 and an interpretation of "Strongly Agree" " and Usability received an average of 4.70 and an interpretation of "Strongly Agree". The overall weighted average of the quality factor is 4.78, and the verbal interpretation is "Strongly Agree". The results showed that the Arriola-Robles children's clinic web application meets the respondents' perception of quality factors.

Table 4. Results of the User Acceptance Questionnaire from the Perceived Ease of Use Category

Category	Mean	Standard Deviation	Interpretation
1. Learnability	4.67	0.47	Strongly Agree
2. Operability:	4.88	0.32	Strongly Agree
3. Attractiveness	4.74	0.44	Strongly Agree
Weighted Mean	4.77	0.42	Strongly Agree

Table 4 shows the respondents' perceptions of the perceived ease of use of the developed web applications. The learnability of the Arriola-Robles children's clinic web application for perceived ease of use has an average of 4.67, with the interpretation of "Strongly Agree". Operability received an average of 4.88 and an interpretation of "Strongly Agree", and attractiveness received an average of 4.74 and an interpretation of "Strongly Agree". The overall weighted average of the perceived ease of use is 4.77, and the verbal interpretation is "Strongly Agree". The results showed that the Arriola-Robles children's clinic web application meets the respondent's perception in terms of perceived ease of use.

Table 5. Results of the User Acceptance Questionnaire from the Perceived Usefulness Category

Category	Mean	Standard Deviation	Interpretation
1. Efficiency	4.63	0.49	Strongly Agree
2. Functional Completeness	4.70	0.46	Strongly Agree
3. Learnability	4.77	0.43	Strongly Agree
Weighted Mean	4.70	0.46	Strongly Agree

Table 5 shows the respondents' perceptions of the Perceived Usefulness of the developed web application. The efficiency of the Arriola-Robles children's clinic web application for perceived usefulness has an average of 4.71, with the interpretation of "Strongly Agree". The functional completeness received an average of 4.58 and an interpretation of "Strongly Agree", and the learnability received an average of 4.65 and an interpretation of "Strongly Agree". The overall weighted average of the attitude towards using is 4.65, and the verbal interpretation is "Strongly Agree". The results showed that the Arriola-Robles children's clinic web application meets the respondent's perception in terms of perceived usefulness.

Table 6. Results of the User Acceptance Questionnaire from the Attitude Towards Using Category

Category	Mean	Standard Deviation	Interpretation
1. The time and effort will be saved when examining, printing, and downloading consultation results thanks to the designed method.	4.74	0.44	Strongly Agree
2. The newly designed system will make it easier for consumers to manage their appointment schedules than it was previously.	4.84	0.37	Strongly Agree
3. The developed system comes to obtaining the data that the user provides, the	4.60	0.49	Strongly Agree

built system is dependable.			
Weighted Mean	4.73	0.45	Strongly Agree

Table 6 shows the respondents' perceptions of the attitude towards using the developed web application. The first identifier of the Arriola-Robles children's clinic web application for attitude towards using has an average of 4.74, with the interpretation of "Strongly Agree". The second identifier received an average of 4.84 and an interpretation of "Strongly Agree", and the third identifier received an average of 4.60 and an interpretation of "Strongly Agree". The overall weighted average of the attitude towards using is 4.73, and the verbal interpretation is "Strongly Agree". The results showed that the Arriola-Robles children's clinic web application meets the respondent's perception in terms of attitude towards use.

4. Conclusion and Recommendations

The feedback from the testing evaluation indicated that respondents were satisfied and committed to using the developed system. In conclusion, the study successfully achieved its main objective of providing a solution to enhance the consultation process at the Arriola-Robles Children's Clinic in Cabanbanan, Pagsanjan, Laguna. The following conclusions were drawn:

1. The developed system found that it significantly enhanced the consultation process at the Arriola-Robles Children's Clinic in Cabanbanan, Pagsanjan, Laguna, enabling the provision of high-quality medical care through web-based consultations. This system serves as a vital solution for meeting the healthcare needs of its patients.
2. It was concluded that the developed system is efficient, effective, and convenient for users regarding prescription management, laboratory requests, and appointment scheduling. This conclusion is supported by feedback collected from user acceptance questionnaires utilizing the TAM and ISO/IEC 25010:2011 software quality metrics [10].
3. It found out that the target users of the developed web application "Strongly Agree" that the application is beneficial to both the Arriola-Robles Children's Clinic and its patients, particularly in facilitating online appointment scheduling.

References

[1] A. Gonzales, R. Custodio, M. C. Lapitan, "*Mobile Applications in the Philippines During the COVID-19 Pandemic: Systematic Search, Use Case Mapping, and Quality Assessment Using the Mobile App Rating Scale (MARS),*". BMC Digital Health, vol. 1, no. 8, March 2023, https://doi.org/10.1186/s44247-023-00007-2.

[2] T. Kissflow, "*RAD Methodology | Rapid Application Development Phases*," Kissflow Inc., https://kissflow.com/application-development/rad/rapid-application-development-methodology-essentials/.

[3] A. K. Nalendra, "*Rapid Application Development (RAD) Model Method for Creating an Agricultural Irrigation System Based on the Internet of Things*," IOP Conference Series: Materials Science and Engineering, vol. 1098, 2021, https://doi.org/ 10.1088/1757-899X/1098/2/022103.

[4] A. Karimoddini, M. A. Khan, S. Gebreyohannes, M. Heiges, E. Trewhitt, A. Homaifar, "*Automatic Test and Evaluation of Autonomous Systems*," IEEE Access, vol. 10, January 2022, pp. 72227-72238, https://doi.org/10.1109/ACCESS.2022.3183145.

[5] I. R. Munthe, B. H. Rambe, R. Pane, D. Irmayani, M. Nasution, "*UML Modeling and Black Box Testing Methods in the School Payment Information System*," Jurnal Mantik, vol. 4, no. 3, November 2020, pp. 1634-1640, https://doi.org/10.35335/mantik.Vol4.2020.969.pp1634-1640.

[6] J. Pyo, W. Lee, E. Y. Choi, S. G. Jang, M. Ock, "*Qualitative Research in Healthcare: Necessity and Characteristics*," Journal of Preventive Medicine and Public Health, vol. 56, no. 1, 2023, pp. 12-20, https://doi.org/10.3961/jpmph.22.451.

[7] R. C. Richey, "*Developmental Research: The Definition and Scope*," ERIC, 2021, https://eric.ed.gov/?id=ED373753.

[8] M. Khalil, A. S. McGough, Z. Pourmirza, M. Pazhoohesh, S. Walker, "*Machine Learning, Deep Learning and Statistical Analysis for Forecasting Building Energy Consumption — A Systematic Review*," Engineering Applications of Artificial Intelligence, vol. 115, October 2022, https://doi.org/10.1016/j.engappai.2022.105287.

[9] E. I. Obilor, "*Convenience and Purposive Sampling Techniques: Are They The Same?*," International Journal of Innovative Social & Science Education Research", vol. 11, no. 1, 2023, pp. 1-7.

[10] ISO, "*ISO/IEC 25010:2011*," https://www.iso.org/standard/35733.html#:~:text=ISO%2FIEC%2025010%3A2011%20defines,a%20particular%20context%20of%20use.