CheckApp: A Web-based Multipurpose Telemedicine System for E-checkups and Face-to-Face Consultations

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***Abstract*—The pandemic has impacted how people approach their local clinics, and researchers have developed a telemedicine system to address the resulting challenges. The CheckApp system was developed in five phases: research and analysis, CheckApp development, feature integration, clinic, and patient portal development, and was evaluated using ISO-certified testing tools. The system has a completion rate of 95%, and researchers tested it with five respondents: Quality Assurance, Clinic/Doctor, IT Professional, Juvenile, and Adult Patient. The respondents' feedback was calculated using the SUS testing tool, and the overall weighted average score was 76.5, indicating that the system is acceptable, feasible, and qualified for deployment. The CheckApp system provides a seamless workflow process that can organize the clinic, patient, and doctor's schedules while adhering to government-mandated health and safety protocols due to the pandemic. This system is significant and valuable, especially to the medical sector of society, in the current state of the Philippines.**

Keywords— Telemedicine, Web-based applications, online platforms.

I. Introduction

The pandemic impacted healthcare quality in the Philippines as the Coronavirus Disease 2019 (COVID-19) virus flooded hospitals nationwide, posing numerous obstacles. People hesitate to visit hospitals for health reasons because they fear contracting the illness. Due to the increase in COVID-19-related cases, there has been a shortage of hospital beds. According to [2] as the number of patients rises, so does the number of healthcare workers. As a result of the Philippines' lacking 92,000 physicians and 44,000 nurses due to the COVID-19 pandemic [6], embracing telemedicine technologies will mitigate these issues. Furthermore, using this system will significantly help medical practitioners, clinic owners, and doctors deliver timely care while minimizing exposure to the deadly virus and maximizing the tools and technology around us that will ensure efficiency in healthcare delivery [9].

Aside from the proposed telemedicine or Electronic-checkups, the system can also handle and cater to online appointments or what we know as booking systems. The said system will also have its built-in conferencing platform for cases that do not need face-to-face intervention. This functionality leverages secure and reliable video conferencing technology, allowing patients and doctors to interact remotely without the need for physical presence, the system will integrate or use the API of the google meet conferencing platform due to the reason of ease of use for both patients and clinic users. The proposed system will also be able to store all the necessary medical records of every patient registered to the system for reprinting and the possible transfer of medical records. The system will also integrate a payment system using GCash and a bank transfer system for money transferring on a patient's payment method. The study intends to develop the Web base multi-purpose telemedicine system with the following modules - Log-in and Registration, Appointment, Payment, and Consultation and Diagnosis. It also incorporates an appointment feature through calendar scheduling and integrates video conferencing for a virtual check-up. The usability of the systems was evaluated using the System Usability Scale (SUS). Although CheckApp doesn't introduce revolutionary methods for telemedicine services, it stands out with its subscription-based system, which is not commonly found in some telemedicine platforms. The core functionalities are similar to other systems, but the innovative pricing model allows clinics to pay a recurring fee for accessing bundled services over a specific period. This approach provides users with more convenience and cost-effectiveness for regular check-ups and consultations.

II. Review of Related Literature

A. Telehealth and Telemedicine

Recent studies [1] have focused on the use of telemedicine, especially amid the significant impact of the coronavirus since the beginning of 2020. Despite efforts with vaccinations, the virus continues to spread globally, affecting regions like North America, South Asia, and African nations. Healthcare systems in South Asian and African countries have faced challenges due to poor administration and infrastructure, making telemedicine a crucial solution. Implementing a Virtual Hospital web system can simplify healthcare processes, allowing remote treatment of various infections and freeing up hospital resources. Study [4] suggests incorporating patient choice for in-person or virtual care when scheduling subsequent visits through synchronous video visits online. A discrete-event simulation provides decision-makers with critical data, including provider utilization, patient lead time, and appointment mode preferences. Embracing technology and patient preferences can enhance healthcare accessibility

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and effectiveness worldwide. appointments that meet patients' preferences for appointment mode.

B. Medical Records

According to the research [5] on an Electronic Medical Record System Based on the Internet, the patient's disease's onset, progression, examination, diagnosis, and treatment are all documented in the medical records. Medical treatment, education, prevention, research, and development all rely heavily on medical records. They are the fundamental framework requirements for hospital administration. The maintenance of conventional paper medical records is challenging. It is also difficult to search through paper medical records. The ability to handle medical records using information systems has become available with the advancement of information technology. The electronic medical record system is crucial for the digital administration of medical records. The hospital's management effectiveness has been significantly increased. In addition, extensive medical data analysis may use the data from electronic medical records.

C. E-prescription

Managing medical prescriptions digitally and reducing inconsistencies in communication between physicians, patients, and pharmacies are known as electronic prescribing or e-Prescription, supported by a study [2]. In addition, according to a study [3], The ability to electronically submit prescriptions to pharmacies by medical professionals (doctors, physicians, pharmacists, or nurses) is known as electronic prescription (E-prescription). Doctors can skip the typical medical procedures where prescriptions are manually sent in writing form by using e-prescription systems. Additionally, the prescriptions can be delivered straight to the patient's house when a patient may not be able to pick up the medication in person due to physical limitations. Additionally, online payment options are available. However, because of strict legal requirements and privacy rules, these unique qualities necessitate a set of guidelines for successfully deploying the E-prescription system.

D. Virtual Consultation

Clinical and patient remote video consultations are increasingly feasible and popular, sometimes replacing in-person or telephone consultations. Technology-supported consultations offer a solution to the challenges of providing healthcare to an aging and diverse population with higher rates of chronic illnesses and self-managed conditions. The UK's National Information Board recognizes the need for a new healthcare approach to address these trends. Virtual clinics via platforms like Skype have been successfully used for counseling and mental health consultations, particularly for young people between 12 and 18, promoting independence and self-confidence [16]. These advancements show the potential of technology in transforming healthcare delivery.

E. Appointment Scheduler

High patient loads in clinics require more resources and effective appointment scheduling to reduce wait times and manage costs. Uncertain factors, such as appointment length and patient volume, contribute to the need for efficient clinic operations. [10]

The researchers identified the importance of a scheduler in clinics to enhance workflow efficiency. Study [14] emphasized that the clinic's effectiveness and patient satisfaction heavily rely on the appointment scheduling system. A sequential appointment scheduling strategy considers patient preferences while optimizing clinic advantages and patient happiness. It aims to determine the ideal number of patients to book and their scheduling times to maximize outpatient clinic profit. The profit calculation includes revenues from all patients, considering the cost of waiting time, idle time, and overtime. This approach formulates service charges based on the schedule, accounting for general patient behavior.

F. Health Portal

Patient portals, electronic personal health records linked to institutional electronic health records, are acknowledged as promising tools to support greater patient engagement. However, there are still questions about how healthcare leaders, policymakers, and designers can promote the implementation of patient portals and what factors might contribute to prolonged usage. [11]

G. System Usability Scale

Due to the presented facts and data, which are also based on a study [17], the researchers will use System Usability Scale to test their system's characteristics, including but not limited to effectiveness, efficiency, and satisfaction based on the System Usability Scale qualification. In addition, the researchers are to prepare a 10-question survey questionnaire that is based on the standards of the System Usability Scale, which is also based on the International Organization for Standardization (ISO), ISO 9241-11:2018

Ergonomics of human-system interaction. The researchers will select their respondents using purposive sampling methods, which allow them to select their respondents based on the needed characteristics to test the system; those will involve one quality assurance checker, one IT Professional, one clinic/doctor, and two patients who are categorized into two, one adult and one juvenile. Each response is assigned a value for the SUS score calculation. The points breakdown for the responses is: Strongly Disagree = one point, Disagree = two points, Neutral = three points, Agree = four points, Strongly Agree = five points. This point system will then be calculated based on the SUS calculation. After the scores have been calculated and will fall into the acceptability score. The system should acquire at least 68 points and above to consider the system acceptable and pass the acceptability test using SUS.

H. Concept of the Study

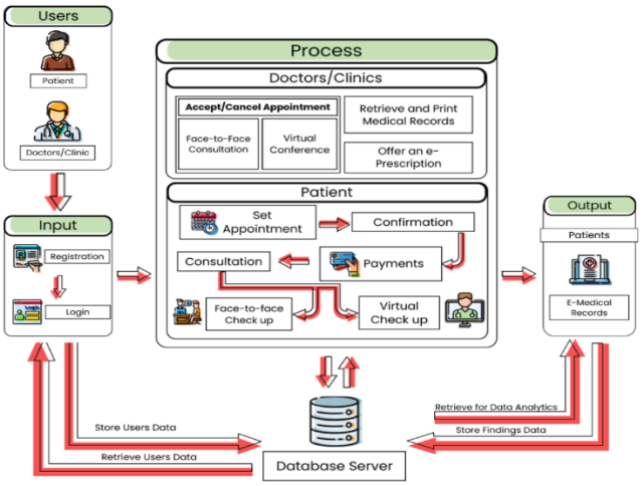

Fig 1. Conceptual Framework.

Fig. 1 shows the flow of the system. To become a registered patient, users need to create an account. On the other hand, doctors/clinics must demonstrate that they are authorized medical professionals working in a legitimate clinic to be registered. Once registered, patients can access all registered clinics and request an appointment at their preferred time and location, whether online or in person. After successfully scheduling an appointment, patients receive an email or message with details, such as the date, time, payment method, and meeting link. Doctors/clinics can accept or cancel the appointment based on availability. Following the consultation or check-up, doctors will provide E-medical records containing the patient's prescription and medical findings, which will be stored on the patient's profile for easy access.

The study provides the researchers and the participants with a way to conveniently set and organize appointments to improve the scheduling of the clinics and the management of patients. In addition, the study will prove significant for the following:

This study focuses on developing a user-friendly web-based telemedicine system, CheckApp, with multiple features for convenient healthcare access. Patients can easily schedule appointments at registered clinics through an online calendar, and virtual consultations are available for remote check-ups. The system enables real-time video conferences between patients and verified doctors, eliminating geographical barriers and saving time and money for both parties. Flexible scheduling empowers patients while attracting a broader range of healthcare providers and enhances the available services. This functionality leverages secure and reliable video conferencing technology, allowing patients and doctors to interact remotely without the need for physical presence. Also, it offers numerous benefits to both patients and healthcare providers. CheckApp ensures patient privacy and data protection through robust security measures. After registration, users can schedule appointments with preferred doctors, and upon confirmation, the system generates unique virtual meeting links and appointment details. Doctors can review requests and accept or cancel based on their availability. During virtual consultations, patients and doctors use a secure video conferencing interface for real-time communication and visual examinations. Post-consultation, doctors create electronic medical records, including prescriptions, securely stored in the patient's profile for future reference. This seamless integration of virtual conferences enhances accessibility, convenience, and patient-doctor interactions within the telemedicine system.

III. METHODOLOGY

A. Materials

1) Hardware

The proposed system is mainly intended to run in a browser and to be used efficiently, meaning having full access to the system's features and a straightforward user interface, the user's desktop device with recommended system requirements of the following - Intel Core i5 7th Gen, 8GB RAM, 512 GB SSD, Intel UHD Graphics 620, and Windows 10 OS.

2) Software

The proposed system will rely on various software tools for design and development. Figma will be used for creating a prototype and user interface design. VSCode will serve as the Integrated Development Environment (IDE) for programming the back-end and front-end using CSS, HTML, JavaScript, and PHP. GitHub will facilitate collaboration and code synchronization among team members. XAMPP will be used as the database to store and manage customer data. The system will be functional on the Google Chrome search engine and will run on a rented domain server to serve its intended users.

B. Procedures

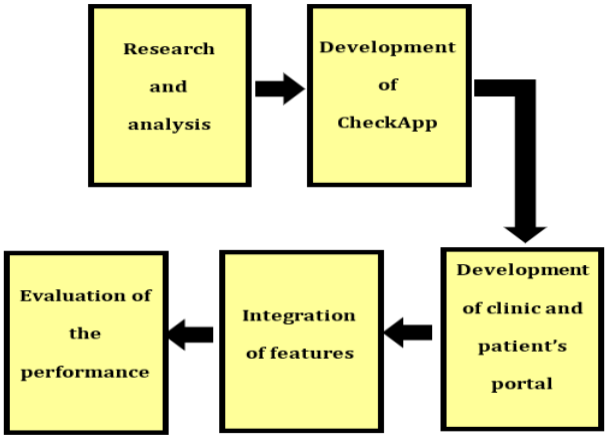

Fig. 2. Research Methodology.

Fig. 2 presents the totality of the project, starting from research and analysis, where the formulation of ideas starts until the evaluation of the project's performance. The steps mentioned above are used in the web development life cycles that will also be used to develop the proposed system.

C. Development Model

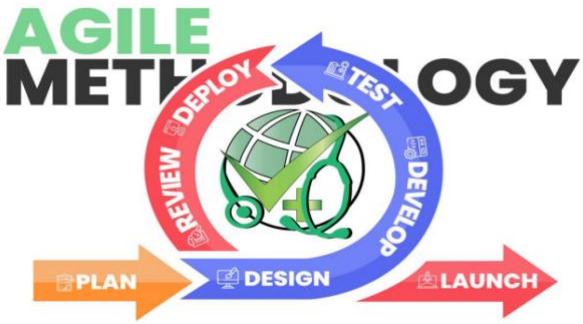

Fig. 3. Development Model.

The researchers will be using agile as their development method (Fig. 3). Agile lets teams offer value to their clients more quickly and with fewer difficulties through an iterative approach to project management and software development.

The first step involves proper planning and scheduling by the project leader to ensure timely completion. Tasks will be assigned to team members based on their expertise to optimize output. In the design phase, the researchers will finalize the system's foundation, services, and features. They will also create a prototype to visualize the expected output. During the development phase, both the front-end and back-end of the system will be hard-coded. Front-end programming using HTML, CSS, and JavaScript will be done, while the back-end will involve database creation. In the testing phase, the prototype will undergo rigorous testing for bugs, errors, and potential enhancements. Detected issues will be fixed, and

suggested features will be considered. The deployment phase will involve using an improved prototype for a mock launch, simulating the final launch. Minor updates may be made based on the findings. Following the deployment, a final review will be conducted to further enhance the user experience before the actual launch. The launch phase will proceed only after the system has undergone thorough testing and has been deemed satisfactory. The researchers will release the system to intended users, confident in its reliability and performance.

D. Use Case Diagram

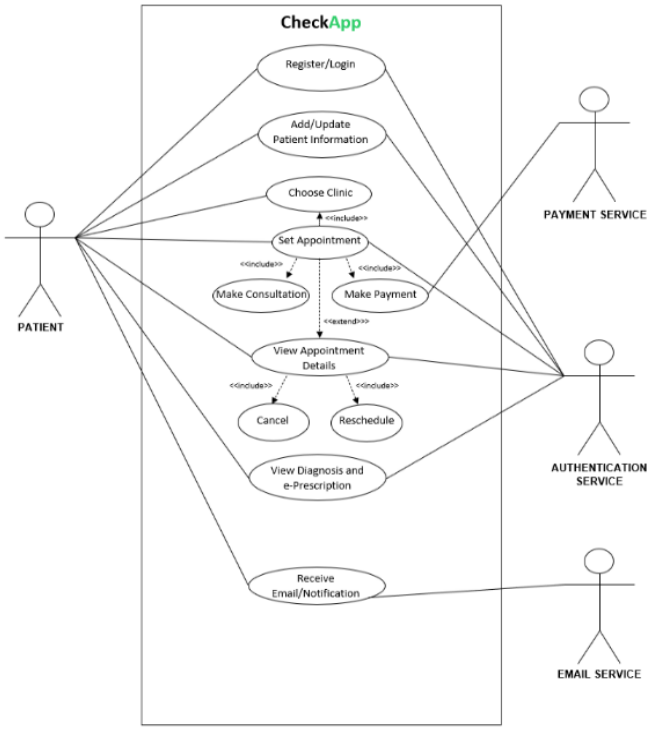

Fig 4. System Use Case Diagram.

Fig. 4 presents the use case diagram of the proposed system. It is divided into two, the patient's side and the doctor's side. Both show and demonstrate the possible workflow process of the system from the register/login stage to the appointment module, payment module, and notification module.

E. System Architecture

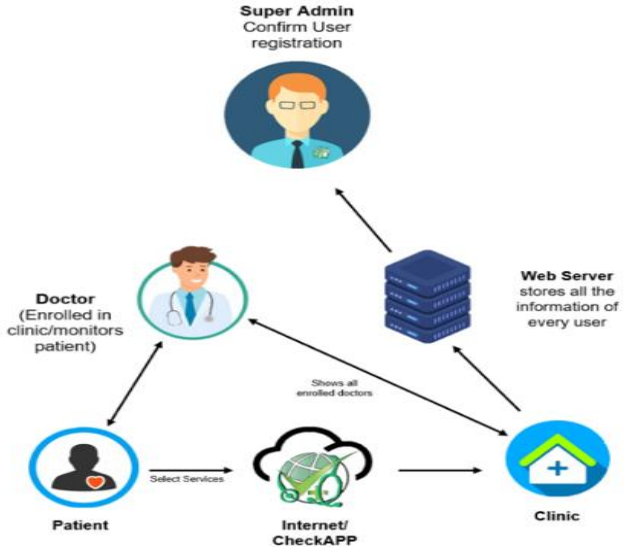

Fig. 5. System Architecture

The process of how the system would work is shown in Fig. 5. It is a conceptual model which explains the system's behavior from the patient to the admin side of the system. This model will show us how each actor will connect to others. First, patients will enroll in the clinic and select services via the Internet. Then the clinic will hold doctors and show them to the web system so that patients can choose that doctor and the service they want. Every data is stored in the web server, including the name and unique id of all the system users. The admin manages the web server and oversees all the processes. For example, they are responsible for accepting or declining an incoming enrollment request.

IV. Results and Discussions

A. Development and Testing

The study aims to develop a telemedicine system that will revolutionize the traditional scheduling of appointments. This system provides an online appointment service and enables users to store their medical records on the system's database, which they can access anytime they need a copy. The researchers identified five project phases to complete the development process: Research and Analysis, Development of CheckApp, Integration of Features, Development of the Clinic and Patient Portal, and Evaluation. In the Evaluation phase, the researchers will use a testing tool supported by a study and an ISO-certified testing evaluation tool for system usability. The data gathered will be presented and calculated using the System Usability Scale based on Brooke's (2020) study. In addition, the researchers will use a 5-point Likert scale evaluation tool, proven reliable in assessing the system's acceptability, as mentioned in the literature review.

The researchers recognized five respondents to evaluate the system during the testing phase. Each with corresponding roles, namely, Quality Assurance, IT Professional, Health Personnel, and Patients, which are also categorized into two, adult and juvenile. The Quality Assurance scored the system 77.5 points, Juvenile Patient scored the system 77.5 points, the IT Professional scored 85 points, the Adult Patient scored 70 points, and the Clinic/Doctor respondent scored 72.5 points. A weighted average of 76.5 points makes the system acceptable, feasible, and qualified for deployment and monetization.

The results indicate that most respondents found the system easy to use (Question 3 average score of 4.4) and did not encounter significant inconsistencies (Question 6 average score of 2.0). Respondent 3, an IT professional, had the highest overall SUS score of 85, benefiting from their technical expertise. Respondent 4, an adult patient, provided the lowest overall SUS score of 70, likely due to limited digital system familiarity. However, the system's acceptability score shows that even individuals with limited IT knowledge found it easy to use. Overall, the system received positive feedback, with minor challenges for some users. The test was conducted to ensure that the system meets all its objectives presented in the proposal phase of this study. Through the testing, the researchers confirmed that the system was working and feasible and that its goals were satisfied.

B. Evaluation Results

The CheckApp's performance is based on its four primary web application modules: log-in and registration, appointment, payment, and consultation and result modules. The log-in and registration module is divided into user/patient

registration and clinic registration, each with its page and text fields that must be filled out and submitted for approval by the clinic admins or super admin, depending on the type of registration.

The appointment module is the system's core module, allowing users/patients to select a date on a calendar and choose a time, doctor, and type of consultation (face-to-face or virtual) through a calendar scheduling method. The payment module enables the system to import a GCash QR code, which the patient can scan to complete the payment transaction efficiently. Finally, the consultation and result module is where the clinic or doctor can enter the diagnosis, prescription, and dosage into a text field, which will be sent to the patient and can be accessed through the notification feature.

The system was evaluated by five respondents with different roles, including Quality Assurance, IT Professionals, Health Personnel, and Patients. The patients were further categorized into adults and juveniles. The answers from the respondents were divided into odd and even numbers, which were then used to calculate the final score using the System Usability Scale (SUS) guidelines. The SUS uses a 5-point Likert scale, and the system needed to achieve 68 points to be considered acceptable.

To determine the system's acceptability, the researchers calculated the respondents' raw odd and even scores and subtracted them from 25 and five, respectively. These scores were then used in the final SUS equation. The results are presented in Table 3, which shows the total points achieved by the system from each respondent group. The table also indicates whether the system passed the SUS acceptability test and identifies the highest and lowest scoring groups based on experience and respondent role.

Although the adult patient group had the lowest score, all respondents agreed that the system was easy to access. In conclusion, the SUS tool was used to evaluate the system's acceptability, and the results indicated that the system was feasible and acceptable to all groups of respondents.

Table I shows the simplified results interpreted from the answers of the recognized respondents using the SUS evaluation tool guideline.

TABLE I. RAW RESULT OF RESPONDENTS' RESPONSE TO THE 5-POINT LIKERT SCALE

	IT Professional QA	**Patient (Teen)**	**IT Professional**	**Patient (Adult)**	**Clinic / Doctor**
Question	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5
1	4	5	5	3	5
2	3	3	4	3	2
3	5	4	4	4	4
4	4	2	1	3	3
5	4	4	5	5	4
6	2	1	2	2	3
7	5	3	4	4	5
8	2	1	1	3	2
9	5	4	5	5	3
10	1	2	1	2	2

TABLE II. CALCULATED RESULTS OF THE ODD AND EVEN NUMBERS

	IT Professional QA	**Patient (Teen)**	**IT Professional**	**Patient (Adult)**	**Clinic/Doctor**
Score	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5
Odd Score	18	15	18	16	16
Even Score	13	16	16	12	13

Table II shows the calculated odd and even scores based on the raw scores using the SUS equation - Calculated Odd Score = (#1+#3+#5+#7+#8) – 5) (25 - (#2 +#4+#6+#8+#10) = Calculated Even Score.

TABLE III. SYSTEM USABILITY SCALE CALCULATED SCORE

IT Professional QA	**Patient (Teen)**	**IT Professional**	**Patient (Adult)**	**Clinic/Doctor**
Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5
SUS Score	SUS Score	SUS Score	SUS Score	SUS Score
77.5	**77.5**	**85**	**70**	**72.5**

Table III shows the calculated score of each respondent using the SUS equation for the total SUS Score (SUS Score: (Calculated Odd Score + Calculated Even Score) x 2.5 = SUS Score).

Fig. 6. Acceptability Score Table.

Fig. 6 shows the scores where the researchers could base whether the system is acceptable or not depending on the scores that the respondents scored the system. It also shows the adjective rating of the system based on the score from the SUS result. Since the system scored a total mean average of 76.5, then we can say that the system is good.

V. CONCLUSION

The researcher's main objective was to develop a web-based multipurpose telemedicine system with four modules: Log-in and Registration, Appointment, Payment, Consultation, and Result modules. After months of development, System Usability Testing (SUS) was conducted to evaluate the system's effectiveness, efficiency, and user satisfaction. The data showed that users found the overall system acceptable, with a weighted average SUS score of 76.5 points. Individual scores ranged from 70 to 85, with an IT Professional giving the highest score, and an Adult Patient providing the lowest. The results demonstrated that the system is feasible and qualified for deployment and monetization. The study's approach aligns with the SUS scale by Brooke (2020) and ISO 9241-11:2018, supporting the validity of the testing method.

In conclusion, making a telemedicine system that replaces the long-used conventional way of setting an appointment in clinics is the best way to take advantage of today's ubiquitous computing technology, which allows all sectors of society, especially the medical sector, to deliver healthcare services to all its constituents with ease. Despite the limitations, such as the internet connection available for registered users and given that the system was proven acceptable and feasible, this system is likely to still be relevant soon, especially with society's new normal stage, which was a result of the coronavirus pandemic. This system will help society adapt to the constant changes caused by the pandemic and can work with remarkable comfort, productivity, and efficiency.

VI. Recommendations

By the results of the study and the testing conducted, the researchers, together with the evaluators, recommend the following to future researchers for further development of the project:

1) Mode of payment should be expanded, including but not limited to credit/debit cards, remittance centers, and other wireless money transfer applications.

2) Analytics on the user and clinic dashboard to show all the necessary data.

3) Integrate Short Message Service (SMS) notifications for patient convenience.

4) Increase the sample population size.

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