Geospatial Pharmacy Navigator: A Web and Mobile Application Integrating Geographical Information System (GIS) for Medicine Accessibility

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***Abstract*—This project introduces a web and mobile application that integrates Geographic Information Systems (GIS) to identify pharmacies with available prescription drugs, addressing the expanding role of Information and Communication Technology (ICT) in healthcare. The primary objective is to offer the general public an easy-to-use platform that locates the closest pharmacy having the searched drugs or medicines. Adopting the Rapid Application Development methodology ensures continuous engagement with stakeholders, allowing developers to closely align the application with user requirements. Essential elements of the web platform include chat functionality, inventory management, pharmacy oversight, and the display of medication listings. General users may check medication lists, search pharmacies, find pharmacy locations and the best routes, search for specific medications, access comprehensive medication information, and more with the mobile application. Fifty respondents, comprising five pharmacists and forty-five general users, expressed overall satisfaction with the system's functionality, emphasizing its ease of use and straightforward navigation across most features. This project not only amplifies the importance of ICT in the healthcare industry, but it also shows how technology can be successfully integrated to improve accessibility and expedite healthcare procedures for both the general public and professionals.**

***Keywords*—ICT in health; mobile application; web application; GIS; pharmacy mapping**

I. Introduction

Access to necessary medical care, especially prescription medication, is an essential aspect of public health, yet it is still a major problem in the Philippines. People seeking necessary medications face a complicated web of difficulties due to the convergence of factors like escalating medicine costs, insufficient delivery methods, and limited accessibility. As stipulated in international human rights agreements, the World Health Organization (WHO) states that guaranteeing access to necessary medications is a crucial part of the right to health [1].

But in the case of the Philippines, the difficulty in obtaining prescription drugs is made worse by the lack of reliable ICT (information and communication technology) tools that can help people find prescribed medication. Prescription medicine accessibility in the Philippines is impeded by a number of variables, such as geographic differences, financial limitations, and a disjointed healthcare system. The lack of a centralized, dependable system that makes it simple for people to find out whether their prescription medications are available at different pharmacies and medical facilities increases these difficulties. Clinical services offered by pharmacists positively impact disease management, contributing to the broader spectrum of healthcare [2] [3]. The role of pharmacies, often the initial point of contact for patients, is pivotal in diminishing health disparities and strategically influencing patient health [4] [5] The lack of efficient ICT tools complicates the problem of pharmaceutical accessibility in a nation where the healthcare sector faces logistical and infrastructural limitations. Even if the Philippines has achieved progress in the field of healthcare, the lack of digital tools to find pharmacies offering the necessary medications makes it difficult to make the most use of the resources that are available.

Global Positioning System (GPS) and Geographic Information System (GIS) technologies play essential roles to the transformation of healthcare systems, particularly when it comes to medication location. By combining GIS and GPS, a potent toolkit can be developed for improving medication accessibility, resolving distribution issues, and improving public health outcomes [6] [7].

II. Related Literatures

A. Global Perspectives on Healthcare Accessibility

Access to Prescription medication in particular is a global issue with multiple factors to consider. In order to ensure every individual worldwide has access to necessary medical care without facing financial hardship; the World Health Organization (WHO) emphasizes the significance of Universal Health Coverage (UHC) [1]. Studies like the in [8], which examined the costs, accessibility, and availability of medications in 36 developing and middle-income nations and revealed structural and economic factors affecting pharmaceutical access, nevertheless, continue to show the persistence of worldwide inequities. Information technology is becoming a transformational force in the field of global health. The World Bank's "World Development Report 2021" notes how information technology, such as telemedicine and electronic health records, is enhancing access to and the quality of healthcare provided worldwide [9].

Tools for information and communication technology (ICT) have become vital for improving medicine delivery networks throughout the world. e-Prescribing platforms, digital health apps, and mobile health apps all help to provide better patient access and effective prescription medication management [10]. Due to ongoing difficulties in pharmaceutical supply chains, organizations such as in [11] and [12] have launched the Access to Medicine Index, an assessment of pharmaceutical firms' global efforts to improve ethics and accessibility. The significance of inclusivity and innovation in tackling global healthcare accessible concerns is emphasized by collaborative worldwide efforts, patient-centric methods, and strategic collaborations [13].

B. Factors Affecting Medication Accessibility in the Philippines

Medication accessibility in the Philippines has various problems influenced by the country's socioeconomic structure, healthcare system, and geographic dispersion. Affordability is a major concern, especially considering the wide economic gaps among the people. The Philippines has a mix of public and private healthcare services, and medicine out-of-pocket costs can be a burden for a lot of people, particularly those without appropriate insurance coverage [14]. High drug costs add to financial hurdles, influencing treatment adherence and may compromise health results.

The decentralization of the Philippines healthcare system and the geographic dispersal of healthcare institutions offer challenges to pharmaceutical accessibility, particularly in rural or isolated locations. In these areas, limited access to pharmacies and healthcare practitioners might result in increased travel costs and drug outages, adding to health inequities [15]. The government's initiatives to address these concerns, such as the passage of the Universal Healthcare Law, seek to enhance access to vital medications by reducing financial risk and extending healthcare coverage [16]. However, obstacles remain in ensuring that such policies are implemented effectively.

Disruptions in pharmaceutical delivery, for example, might have an influence on drug supply in the Philippines. The country has faced medicine shortages, impacting the population's access to some prescriptions [17]. Pharmaceutical accessibility in the Philippines is also influenced by regulatory constraints such as demanding licensing processes and limits on specific treatments. Understanding and addressing these characteristics is critical for devising tailored treatments to increase drug availability and adherence, especially given the country's unique healthcare system. Future research and policy initiatives should continue to investigate approaches to improve pharmaceutical accessibility while taking into account the distinct challenges and potential of the Philippine healthcare system.

Finally, healthcare delivery technologies such as telemedicine and digital health solutions have the potential to improve pharmaceutical accessibility by offering alternate channels for prescription distribution and monitoring [18]. Integrating these technologies into healthcare systems can increase convenience and accessibility, particularly for people with mobility issues or who live in rural places.

C. Role of ICT in Pharmaceutical Services

The use of ICT in pharmaceutical supply chain management has substantially increased the distribution process's reliability and transparency. ICT also makes inventory management, order processing, and demand forecasting easier, ensuring that pharmaceutical items are accessible when and where they are required, resulting in a more dependable and responsive supply network. ICT-enabled pharmacy information systems and electronic health records (EHRs) have transformed patient care and drug administration. Telepharmacy services, a subset of ICT in pharmaceutical services, have been recognized, particularly in rural or disadvantaged regions, through offering patients with prescription consultations and professional guidance without the need to visit a physical pharmacy [19].

In the Philippines, Information and Communication Technology (ICT), specifically Geographic Information System (GIS) applications, are establishing themselves as a valuable tool for addressing difficulties linked to pharmaceutical supply and monitoring within the healthcare system. GIS technology proves essential for mapping and visualizing the geographical distribution of healthcare institutions, pharmacies, and pharmaceutical supply chains. This assists in identifying overlooked regions and improving the distribution of healthcare resources across the archipelago to promote more equal access to medications [20]. Furthermore, GIS applications serve to track and monitor drug availability by providing real-time data on the condition of pharmaceutical supplies in various locations, assisting in the management of shortages and improving overall supply chain management.

Integrating GIS into pharmacy information systems has the potential to transform pharmaceutical monitoring and prescription administration. GIS enables pharmacy geospatial mapping, allowing healthcare professionals to analyze the accessibility of pharmaceutical services and identify locations with drug distribution shortages [21]. This data is useful in establishing targeted actions to enhance medicine availability, particularly in rural or isolated areas. The use of GIS in pharmacy information systems can help improve medication adherence monitoring by providing insights into patient demographics and their proximity to healthcare institutions.

While incorporating ICT such as GIS into pharmaceutical services has significant advantages, problems such as data security, interoperability, and providing fair access to digital healthcare solutions must be carefully considered. To realize the potential of ICT in pharmaceutical services, ongoing research and deliberate implementation efforts are required, ensuring that technological innovations contribute favorably to the overall quality, safety, and accessibility of pharmaceutical care.

III. METHODOLOGY

This study adopts the Rapid Application Development (RAD) approach, a methodological framework designed to address the drawbacks inherent in total system development methods [22]. The RAD model emphasizes on flexibility and adaptability facilitating the swift and cost-effective development of high-quality systems that can easily meet changing user needs. The method comprises four main phases: requirement planning, iterative development, system prototyping, and the throwaway prototype as shown in Fig. 1.

Central to this process is the initial development of the alpha version, where subsequent user testing and feedback inform the refinement of subsequent versions. This iterative process establishes a clear and linear understanding of the project's scope, enabling the development team to develop systems with extensive functionality within timelines [22].

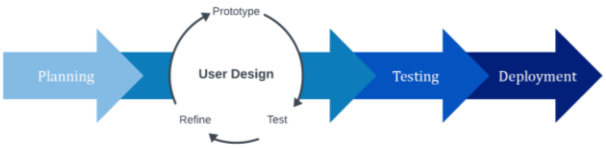

Fig. 1. Rapid application development.

A. Planning

A web application and a mobile application are the two separate application models that are integrated into the system's architecture based on the requirements set by stakeholders. Every model has a different set of features and is designed to meet the needs of particular user groups based on discussions. While the mobile application is meant for general users and offers a user-friendly interface for a wider audience, the web application has been tailored for pharmacists to use, catering to their unique demands such as the management and inventory of medical drugs. The inherent features of mobile applications frequently contribute to their being considered as more adaptive which is more preferred by general users. Research on user-centric design concepts highlights how mobile app development must be customized to users' demands and touch interfaces and smaller screens [23]. Usability and responsiveness are often given first priority in these apps, which makes them ideal for mobile use. Furthermore, mobile applications can be easily integrated with device-specific functionality, such as cameras and GPS, to provide enhanced user experiences.

B. User Design

The system comprises two integral components: the frontend and the backend as shown in Fig. 2. Together, these parts function collectively to provide an effective and logical experience.

The frontend, or user interface, is in the forefront and allows users to interact with the system. When users initiate requests, the frontend actively collects input data, creating a bridge between the user and the system. This input data is then encapsulated into JavaScript Object Notation (JSON), a lightweight data interchange format, preparing it to communicate with the backend.

The backend, which functions as the system's engine, receives the JSON data that has been processed. In this case, the complex task of processing the received request is handled by the backend, which makes use of a number of well-defined system logics to guarantee correct and effective handling. This covers tasks such as running algorithms, querying databases, and managing the system's general operation.

To ensure consistency in data transmission, the backend encodes the response into JSON format after processing is complete. The frontend receives this response, which presents the results of the user's request. The JSON respond to is then decoded by the frontend and formatted such that it can be readily read and understood by the user.

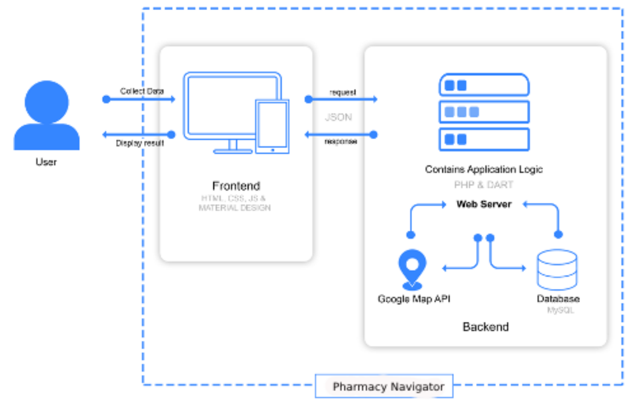

Fig. 2. Pharmacy navigator architectural framework.

On the other hand, after three iteration and frequent consultations from stakeholders, two of whom were pharmacist, five general users, and two developers, features which are distinct and common to both applications are shown in Table I.

TABLE I. LIST OF FEATURES, DISTINCT AND COMMON TO THE MOBILE AND WEB APPLICATION

Application Model	***Features***
Web Application	The software is intended for use by pharmacists and their staff. It includes a thorough list of all the prescription medications that the pharmacy has on hand. A specialized component of the system is designed to manage the stock of pharmaceutical drugs that are available. This section offers a simplified interface to facilitate effective inventory management.
	Geographic information systems are incorporated into both models, which improves their functionality by offering location-based information like the closest pharmacy having the needed prescription medication. Chat system is also incorporated to allow users to communicate with the pharmacy or the client vice versa.
Mobile Application	The application is exclusively designed for patients or general users. It incorporates a search feature that enables users to check the availability of specific pharmaceutical medicines. Upon initiating a search, the system provides information on the nearest pharmacy where the desired pharmaceutical drug is available.

The system has been purposefully developed to meet the user requirements collected during the Rapid Planning Phase, translating these requirements into an effective system design. Table II and Table III provided below present a list of the functional requirements distinct for web and mobile applications respectively.

TABLE II. LIST OF FUNCTIONALITY AVAILABLE FOR THE WEB APPLICATION

Web Application	
Functions	***Actions***
User Registration	The system is expected to prompt an error message for unsuccessful registration and confirmation message if successfully registered.
Login/Logout	The system has a validation process for registered users. If either or both of the username or password are/is invalid, the system is expected to prompt an error message. The system will allow the entry of the user in the system of username and password are verified. The system is expected to allow the user to logout from the system
Display List of Medicines	The system is expected to display all medicines stored in the pharmacy. The system is expected to display the medicine searched by the user
Manage Inventory	The system will prompt a response message when updating, adding, and deleting inventory
Manage Pharmacy Information	The system allows the management of information and is expected to prompt a response message for every action performed.
Chat System	The system is capable of sending and receiving messages

TABLE III. LIST OF FUNCTIONALITY AVAILABLE FOR THE MOBILE APPLICATION

Mobile Application	
Functions	***Actions***
View List of Pharmacies	The system is expected to show the list of pharmacies available in the database.
Search Pharmacy	The system is expected to display the information of the pharmacy, based on the information provided to the system.
Get Pharmacy's Location	This allows the user to get information of the pharmacy selected by tapping or navigating within the map.
Get Pharmacy's Shortest Route	The system is expected to show the shortest route leading to the selected pharmacy having the prescribed medicine.
Search Medicine	The system is expected to display the drug(s) information based on the search item.
Display Medicine	The system is expected to display all stored medicine in the database.
Chat System	The system is capable of sending and receiving messages

C. Testing

For the usability test of the mobile application, the study targeted random participants aged eighteen (18) and above who met at least one of the following criteria: (a) residing in Iligan City, (b) having studied in Iligan City, or (c) currently enrolled in a school in Iligan City.

This research study includes the voluntary participation of respondents with basic understanding of pharmaceuticals and be able to perform activities such as naming, classification, and categorization of pharmaceutical goods. Participants are not required to live or study in Iligan City.

Demographic information was collected as part of the questionnaire. To uphold ethical standards, letters of consent were provided to participating respondents. A total of forty-five respondents have tested the mobile application while there were only five pharmacists for the web application.

The tests were conducted online, utilizing the "Play Store" for the mobile application (for general users) and a URL for the web application (pharmacist/staff role). The main goals of the alpha test, which is the initial assessment stage, were to get relevant user feedback and validate that the developers had successfully complied with the user system requirements.

To begin the testing procedure, participants were given a Google Form with instructions and tasks. This method allowed for "freestyle" testing, allowing participants to explore the application in their own way. The given activities were designed to determine if the application efficiently meets the research questions and preserves the integrity of its functionality, especially in the context of the mobile application and web application. A survey was given after the task. This survey was essential in determining how well the application met the users' expectations and requirements. It examined a number of issues, such as overall application satisfaction, interface design, and user experience. A five-level Likert scale was employed for rating each question.

A key part of the survey was obtaining qualitative input from users. It was encouraged for participants to share thoughts and recommendations, especially with reference to areas where changes or enhancements could improve their experience. Users were encouraged to provide their opinions on possible improvements by answering questions like "Is there anything else you would like us to improve or change?" in order to gather insights that might not be addressed by initial activities.

IV. RESULTS AND DISCUSSION

The design, functionality, and user interfaces of the desktop and mobile applications are assessed and compared in this section. Aiming to improve stakeholders' engagement and satisfaction, developers designed at incorporating all of their requirements in the digital interfaces and functionalities.

Incorporating participants' feedback from the alpha testing is enhanced in the beta testing phase, which is the final stage of assessing the mobile application in the research study. Coherence with the parameters and constraints of the research is certain through this method. During the alpha testing, the researchers identified human errors, which prompted a series of UI/UX re-engineering for the program.

A. Mobile Application

This mobile application is intended for patients or general users, and it was developed to a user-friendly search option that lets people locate whether certain prescription medications are available. The following are the features of the mobile application.

1) View list of pharmacies, search pharmacy and get pharmacy's location: This functionality enables users to navigate, tap, and untap specific pharmacy using the participant's geo-coordinates, facilitating interaction with the application map. A persistent bottom sheet emerges on the bottom left, displaying the pharmacy's name and a "view" button that directs the user to the pharmacy's dedicated page.

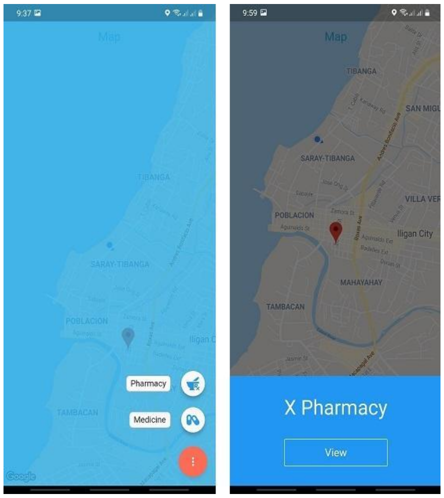

Fig. 3. Screenshot of the get pharmacy's location feature in the alpha test.

The challenge with this interface as shown in Fig. 3 during the alpha test was the number of underlying pages, which could be minimized for a clearly defined functionality. As a result, it becomes diverted by the multitude of page elements and deviates from its primary goal of locating a pharmacy.

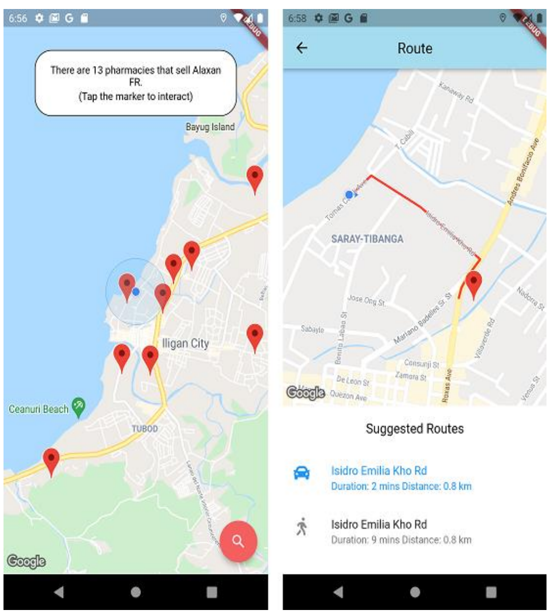

Fig. 4. Screenshot of the get pharmacy's location feature in the beta test.

Fig. 4 displays an improved iteration of the Get Pharmacy's Location Feature, incorporating feedback obtained during the alpha test. In this version, the search function is exclusively in the persistent bottom sheet, minimizes pages and buttons. Upon conducting a search for a specific medicine, the system displays all pharmacies offering the desired drug, allowing users to tap on a location/pharmacy to access detailed information. Each pharmacy's location is displayed, allowing users to make informed decisions based on proximity and convenience. The objective is to provide a user-friendly interface that promotes ease of use and accessibility.

2) Get pharmacy's shortest route: An essential component of the application's testing phase, this functionality uses the Google Map API in order to guide visitors from their starting place to the selected pharmacy. Based on the user's starting location and preferred method of transportation (walking, cycling, or driving), participants assess how well the program performs in providing directions. Walking is chosen as the default method to consider the means of transportation by the majority of users. Furthermore, the feature provides users with several route possibilities, enabling them to select the most appropriate direction. In order to enhance the entire process of decision-making, this user-centric approach also includes crucial information like arrival time, distance, and route means.

Similar with the Get Pharmacy location, the alpha test result pointed out that this feature loses efficiency because it takes up numerous pages rather than being contained to one, making it difficult to use as shown in Fig. 5.

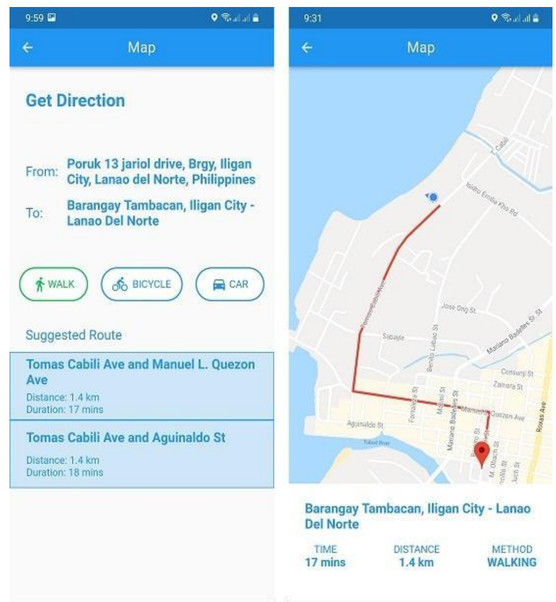

Fig. 5. Screenshot of the get pharmacy's shortest route in the alpha test.

With the influence from Google Maps for navigation, showed that a single page approach was more practical and user-friendly which is shown in Fig. 6. In addition to being in line with this preference, combining the two pages into one, improves interaction and simplifies the functionality for users.

3) Search medicine and display medicine: This tool makes it simple for consumers to search for a specific medication. It executes a case-insensitive search algorithm by interpreting the user's input and taking into account both the brand and generic names of medications. A list of medications that match the keyword entered appears as the result, making the search process simpler and user-friendly.

Fig. 6. Screenshot of the get pharmacy's shortest route in the beta test.

The researchers discovered that one issue with the previous version of the feature was that it displayed extraneous information and was not engaging enough as shown in Fig. 7. Instead of needing to present the results on another page, smart predictions will appear below the search box and, when clicked, will divert to another website.

Fig. 7. Screenshot of the search medicine in the alpha test.

In order to enhance user convenience, when a user chooses their preferred medicine, pertinent medical information will instantly display within the same window. This design improvement attempts to provide consumers fast access to important facts, reducing the need for further clicks and producing a more streamlined and user-friendly interface as shown in Fig. 8.

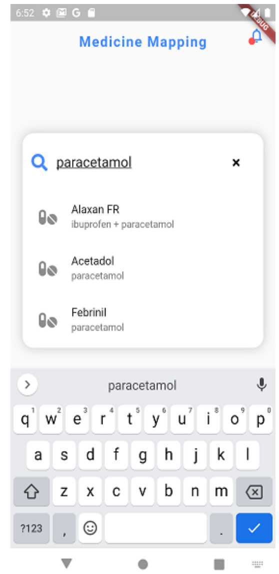

Fig. 8. Screenshot of the search medicine in the beta test.

B. Web Application

The web application's core functionalities; Registration, Login, Medicine Display, Inventory Update, and Pharmacy Management, performed as expected during usability testing, aligning with the positive ratings provided by respondents. While the overall functionality met expectations, constructive feedback from one participant emphasized the need for enhancement in the UI/UX design. This feedback emphasizes the need of refining the user interface's perceived plainness and lack of vitality.

Despite the feedback, the Pharmacy Management tool was a significant feature. This module is excellent for developing trust in both the general public and pharmacy management. The pharmacy must register the pertinent data in the Register Pharmacy feature, as depicted in Fig. 9 to keep track of important pharmacy information. It works by including a pharmacy log, which carefully documents every activity taken by a certain pharmacy. This thorough documentation process maintains transparency and prevents pharmaceutical brands from being swapped. As a result, this feature adds greatly to the pharmacy's operational integrity.

The Display Medicine functionality, shown in Fig. 10, which allows the system to display every medication stocked in the pharmacy, is strength of the program. Notably, one respondent suggested that the presentation be improved by including the medication expiration dates for tracking. In addition, another respondent recommended changing the "Availability" label to "Stock" for consistency. This recommendation would include existing pharmaceutical information such as Generic Name, Brand Name, Dosage, Form, and Price, as well as real-time stock levels. The refinement intends to provide management a picture of the pharmacy's inventory, supporting informed decision-making and effective pharmaceutical resource management.

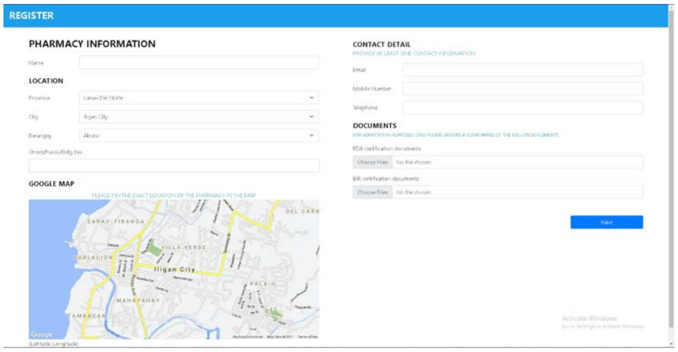

Fig. 9. Screenshot of the register pharmacy in the beta test.

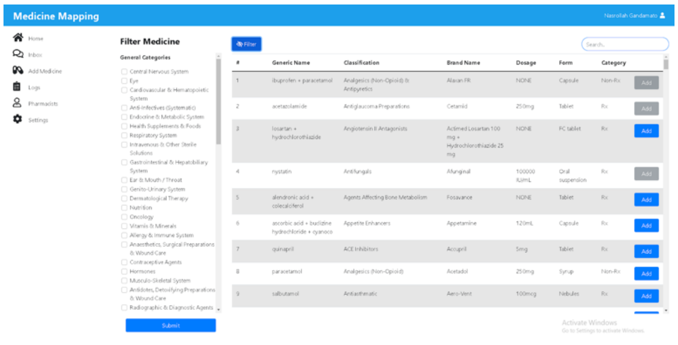

Fig. 10. Screenshot of the display / manage medicine in the alpha test.

One of the distinguished features of the system is the incorporation of a messaging system that allows users to communicate directly with any pharmacy's representative, enabling responsive and customized engagement environment. The feature was designed to serve as a dynamic link for users for inquiries, seek information, or address any concerns. As the system develop from the alpha test phase to the more polished beta version, the focus of development shifts to the complexities of its user interface. This shift is more than just a standard upgrade; it is a concerted attempt to improve the user experience. The refining process is extremely responsive to user feedback, ensuring that the system not only meets the different demands of its user base, but also delivers an intuitive platform.

C. For Both System

Fig. 11 shows the interface of the chat system incorporated into the system. Users can navigate questions about dose, possible side effects, and other options through interactions, which promotes a more informed and decision-making process. To put it simply, the integration of this chat system simplifies communication while also providing people with a useful tool for getting precise and customized information on their medical needs and health.

D. Testing and Evaluation

A majority found the implementation of the Google Map API, with the utilization of geo coordinates, to be successful in its early stages. A substantial 37 respondents, as shown in Fig. 12 were extremely satisfied with the functionality of the Search and Locate Pharmacy. It is clear that the majority of respondents thought the feature was useful and functional, despite the fact that one and five respondents, respectively, expressed a modest satisfaction and neutrality with the feature. The majority of participants' overall favorable response highlights the usefulness of the Search and Locate Pharmacy capability, demonstrating that it satisfied their needs and expectations.

Forty-four respondents were satisfied with the functionality of the "View Available Medicine/Drug" feature as shown in Fig. 13. One of the comments emphasized how simple it was to locate particular medications, indicating that the search medicine feature answers the needs of most users. This feedback means how well the functionality works to give consumers a practical and easy-to-use experience when looking through the medications that are accessible.

A word cloud of comments received during the alpha testing stage is shown in Fig. 14. Respondents generally expressed satisfaction for the application's overall convenience, ease of use, and user-friendliness. Users responded positively to the application's design and use, highlighting its simple navigation and easy operations. A subset of feedback highlighted concerns related to the redundancy of pages and experience (UI/UX) during testing. In response, the research team proactively addressed these issues, focusing on the refinement of redundant pages through a comprehensive re-engineering process.

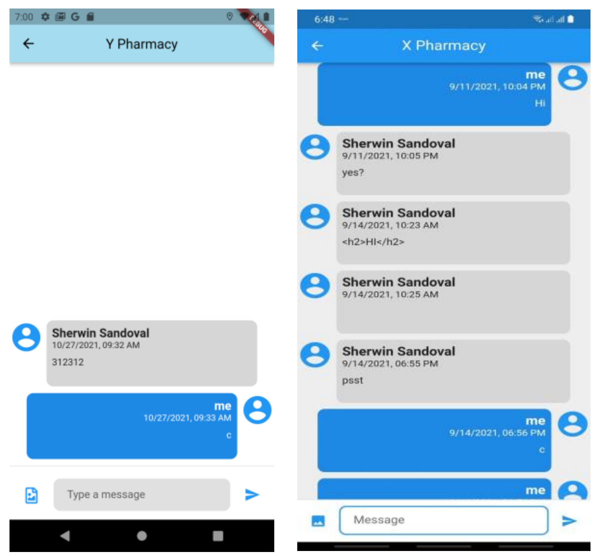

Fig. 11. Screenshot of the chat system.

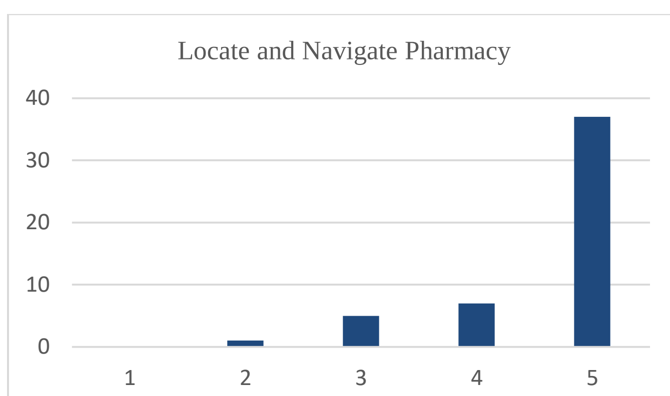

Fig. 12. Result of the locate and navigate pharmacy.

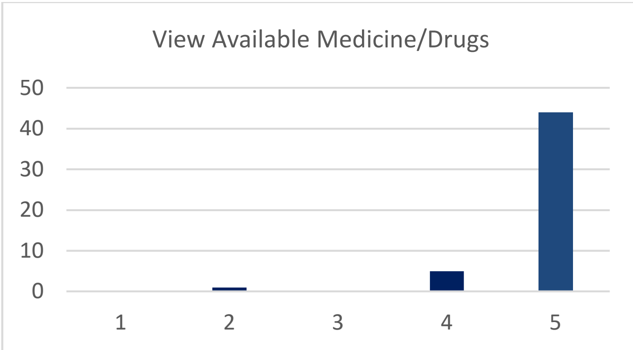

Fig. 13. Result of the view available medicine / drug.

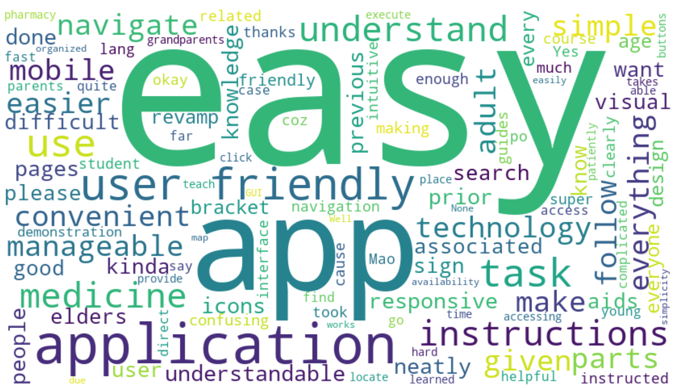

Fig. 14. Word cloud of the application during the alpha test.

The word cloud in Fig. 15 depicts the input gathered throughout the beta testing stage. Remarkably, more users acknowledged the application as an improved version over the alpha test. The redesign prioritized resolving issues brought up in previous testing, making the experience more efficient and user-friendly. In particular, unnecessary pages and intricate content were improved for more basic versions, in line with user expectations for a more refined application.

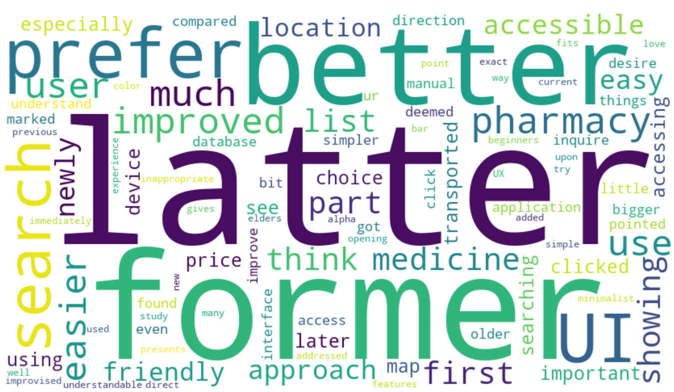

Fig. 15. Word cloud of the application during the beta test.

In addition to verifying the changes made, the beta testing stage reaffirmed at improving the application in response to user feedback. The purpose is to make sure that the application satisfies the needs and preferences of a wide range of users by optimizing the user experience and improving the way information is presented.

V. CONCLUSION

In conclusion, the development and implementation of the web and mobile application integrating Geographical Information System (GIS) for locating prescribed medicine have been driven to enhance medication accessibility, distribution challenges, and improve public health outcomes [24] [25]. The adoption of the Rapid Application Development (RAD) methodology, having continuous engagement with stakeholders aims to meet user needs and requirements in efficiently locating prescribed medicines from nearby pharmacies. The mobile application, equipped with features such as viewing medicine lists, searching pharmacies, obtaining pharmacy locations and shortest routes, searching for specific medicines, displaying medicine details, and incorporating a chat system, serves as a user-friendly platform designed for the general public in managing their healthcare needs in terms of searching prescribed medicine. Simultaneously, the web system offers features like displaying medicine lists, managing inventory, overseeing pharmacy information, and integrating a chat system to cater to a wider range of user needs. The positive feedback received during both the alpha and beta testing phases further validates the success of the application's functionalities. Respondents consistently reported that the features were easy to use, easy to navigate, and aligned with their needs. This user-centric approach, with the set of features, positions the integrated web and mobile application as a valuable resource in locating medicines, and contributing to the overall improvement of public health outcomes.

REFERENCES

[1] World Health Organization (WHO), "Tracking Universal Health Coverage: 2019 Global Monitoring Report.," [Online]. Available: https://www.who.int/healthinfo/universal_health_coverage/report/2019/en/. [Accessed January 2023].

[2] M. d. C. V. B. Sousa, B. D. Fernandes, A. A. Foppa, P. H. R. F. Almeida, S. d. A. M. Mendonça and C. Chemello, "Tools to prioritize outpatients for pharmaceutical service: A scoping review," *Research in Social and Administrative Pharmacy,* vol. 16, no. 12, pp. 1645-1657, 2020.

[3] B. D. Fernandes, P. H. R. F. Almeida, A. A. Foppa, C. T. Sousa, L. R. Ayres and C. Chemello, "harmacist-led medication reconciliation at patient discharge: A scoping review," *Research in Social and Administrative Pharmacy,* vol. 16, no. 5, pp. 605-613, 2020.

[4] K. Hurley-Kim, J. Unonu, C. Wisseh, C. Cadiz, E. Knox, A. Ozaki and A. Chan, "Health Disparities in Pharmacy Practice Within the Community: Let's Brainstorm for Solutions," *Front Public Health,* vol. 8;10:847696, 2022.

[5] M. L. Ilardo and A. Speciale, "The Community Pharmacist: Perceived Barriers and Patient-Centered Care Communication," *Int J Environ Res Public Health,* vol. 17(2): 536, no. 10.3390/ijerph17020536, 2020.

[6] B. K. H. T. J. V. L. J. A. S.-P. A. R. Neda Firouraghi, M. Furs, L. Salvador-Carulla and N. Bagheri, "The role of geographic information system and global positioning system in dementia care and research: a scoping review," *Int J Health Geogr,* vol. 21, no. 8, pp. https://doi.org/10.1186/s12942-022-00308-1, 2022.

[7] G. Musa, P.-H. Chiang, T. Sylk, R. Bavley, W. Keating, B. Lakew, H.-C. Tsou and C. Hoven, "Use of GIS Mapping as a Public Health Tool-–From Cholera to Cancer," *Health and Nursing,* p. https://doi.org/10.4137/HSI.S10, 2013.

[8] A. Cameron, M. Ewen, D. Ross-Degnan and D. Ball, "Medicine Prices, Availability, and Affordability in 36 Developing and Middle-Income Countries: A Secondary Analysis," *Lancet,* Vols. 373(9659):240-9, 2009.

[9] The World Bank, "DATA FOR BETTER LIVES," International Bank for Reconstruction and Development, Washington DC, 2021.

[10] P. De and M. Pradhan, "Effectiveness of mobile technology and utilization of maternal and neonatal healthcare in low and middle-income countries (LMICs): a systematic review.," *BMC Women's Health,* Vols. 23, 664 , pp. https://doi.org/10.1186/s12905-023-02825-y, 2023.

[11] Access to Medicine Foundation, "Access to Medicine Index," The Netherlands, 2021.

[12] P. Yadav, "Health Product Supply Chains in Developing Countries: Diagnosis of the Root Causes of Underperformance and an Agenda for Reform," *Health Systems & Reform,* vol. 1:2, pp. 142-154, 2015.

[13] S. Flessa and C. Huebner, "Innovations in Health Care—A Conceptual Framework," *Int J Environ Res Public Health,* vol. 18(19): 10026., 2021.

[14] X. Javier, P. Crosby, R. Ross, M. E. Ranchez-Vila and M. S. Santos, "Understanding Out-of-Pocket Expenditure for Outpatient and Inpatient Care," 2022. [Online]. Available: http://www.healthpolicyplus.com/ns/pubs/18653-19126_PhilippinesOOP.pdf. [Accessed October 2023].

[15] M. J. N. Naria-Maritana, G. R. Borlongan, M.-A. M. Zarsuelo, A. K. G. Buan, F. K. A. Nuestro, J. A. Dela Rosa, M. E. C. Silva, M. A. F. Mendoza and L. R. Estacio, "Addressing Primary Care Inequities in Underserved Areas of the Philippines: A Review," *Acta Medica Philippina,* vol. 54, no. 6, pp. 722-733, 2020.

[16] A. M. Amit, V. C. Pepito and M. Dayrit, "Advancing Universal Health Coverage in the Philippines through self-care interventions," *The Lancet Regional Health - Western Pacific,* p. https://doi.org/10.1016/j.lanwpc.2022.100579, 2022.

[17] "Presidential Decree No. 651, s. 1975," Official Gazette, [Online]. Available: https://www.officialgazette.gov.ph/1975/01/31/presidential-decree-no-651-s-1975/. [Accessed 10 June 2023].

[18] A. Haleem, M. Javaid, R. P. Singh and R. Sumanc, "Telemedicine for healthcare: Capabilities, features, barriers, and applications," *National Center for Biotechnology Information,* vol. 2:100117, 2021.

[19] S. Baldoni, F. Amenta and G. Ricci, "Telepharmacy Services: Present Status and Future Perspectives: A Review," *Medicina (Kaunas),* vol. 55(7):327, 2019.

[20] C. T. Jagadeesan and V. J. Wirtz, "GIS technology proves essential for mapping and visualizing the geographical distribution of healthcare institutions, pharmacies, and pharmaceutical supply chains. This assists in identifying overlooked regions and improving the distribution of healthcare," *Journal of Pharmaceutical Policy and Practice,* 2021.

[21] B. D. Fernandes, A. A. Foppa, P. H. R. F. Almeida, A. Lakhani and T. d. M. Lima, "Application and utility of geographic information systems in pharmacy specific health research: A scoping review," *Research in Social and Administrative Pharmacy,* vol. 18, no. 8, pp. 3263-3271, 2022.

[22] R. Delima, H. B. Santosa and J. Purwadi, "Development of Dutatani Website Using Rapid Application Development," International Journal of Information Technology and Electrical Engineering, vol. 1, no. 2, p. https://doi.org/10.22146/ijitee.28362 , 2017.

[23] L. Punchoojit and N. Hongwarittorrn, "Usability Studies on Mobile User Interface Design Patterns: A Systematic Literature Review," *Advances in Human-Computer Interaction,* vol. 2017, p. https://doi.org/10.1155 /2017/6787504.

[24] C. Smith and J. Mennis, "Incorporating Geographic Information Science and Technology in Response to the COVID-19 Pandemic," *Preventing Chronic Disease,* vol. 9;17:E58, 2020.

[25] C. Vîlcea and S. Avram, "Using GIS methods to analyse the spatial distribution and public accessibility of pharmacies in Craiova city, Romania," *Bulletin of Geography Socio-economic series,* vol. 45(45), pp. 125-132, 2019.