

Pandemic Response Based Healthcare Services System Architecture Among Urbanized Communities In The Philippines

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Abstract

Technology innovation has become an emerging concern in addressing the global pandemic response. This study addresses that one (1) health center is available in eight (8) urbanized communities in the Philippines and aims to innovate the current telemedicine application to help the residents for easy access of proper medication and consultation with doctors regarding their physical health amidst COVID-19 pandemic through the system architecture, house of quality (HOQ), and multiple regression analysis. Based from the results, the statistically significant variables include data security (p-value = 0.000), response (p-value = 0.000), time to operate (p-value = 0.001), time to respond (p-value = 0.001), style (p-value = 0.001), and font (p-value = 0.000). The HOQ percentage of importance results concerning user attributes support the identified variables of safety (30.98%), time to operate (22.02%), and time to respond (20.91%). The recommended system which is 8.67 points ahead of the existing system is designed for better accessibility and usability while keeping the data records secured as the target accomplishment of this study is seventy-five percent (75%), focusing on the ratio of health centers per urbanized community and the implementation of telemedicine.

Keywords

Telemedicine, Systems Architecture, House of Quality, Urbanized Communities, Multiple Regression Analysis

1. Introduction

Technology innovation has become an emerging concern in addressing the global pandemic response, particularly among third world countries whose technology has not been widely practice, such as the Philippines. With its emerging need in the healthcare sector, maximizing these advancements through telemedicine will aid workers to provide the needs of the people who needs it the most. Telemedicine capitalizes on using Information and Communication Technology (ICT) to grant the physician in a distant location to gain access to the patient's data. In the year 2010, it has been reported that sixty percent (60%) of Filipinos die without getting medical attention. Also, telemedicine has more effects on developing countries than in developed countries, particularly as developing countries face certain challenges such as lack of resources and financial needs. However, some developing countries have presented telemedicine into remote areas at an affordable cost. (Patdu and Tenorio, 2016)

Low specialist to patient proportion is observed across the country. *The Doctor to the Barrios Program* was propelled by then the Philippines' Department of Health in the year 1998 after founding out that about 271 communities in the entire country have had no community doctor for a long time or more. The issue of "brain drain" is yet predominant in the health division, with medical experts leaving the nation to look for greener fields abroad (PMA, 2014). In the Philippines, the usage of telemedicine is already launched as the Department of Health (DOH) wanted to intensify the healthcare delivery to overcome the hindrances for the public to have adequate access to proper health care. It is with these realities that the National Telehealth Center, National Institutes of Health, envisioned it to be a means of improving health outcomes in the Philippines. Recently, a telecommunications provider in the Philippines has formed

a joint venture with a foreign technology company to launch a 24/7 health hotline service providing medical assessments and advice, including basic healthcare and permissible medication over the phone manned by skilled and licensed Filipino doctors (Mercurio, 2020).

The region of Asia Pacific had the largest number of internet users worldwide last 2019, with 2.3 billion users (Moore, 2020). As of June 2019, the Philippines is ranked 12th among countries with the most internet users (Clement, 2020). In the Philippines, the number of social media users grew to 76 million (Sanchez, 2019). The digital population, on the other hand, is mostly composed of the age group 16 years old and above, and another statistic stated that Filipinos spend the most time online and on social media compared to the rest of the world (Sanchez, 2020). The department of health (DOH) conducted a national survey regarding non-communicable diseases (NCD's) using mobile phone technology. According to the DOH health secretary, the data will provide a national baseline for prevention strategies.

With the problem's occurrence in the Philippines, this study aims to innovate the current telemedicine application to help the residents of an urbanized community located in the Philippines for easy access of proper medication and consultation with doctors regarding their physical health amidst COVID-19 pandemic through the system architecture, house of quality (HOQ), and multiple regression analysis. The target accomplishment of this study is at seventy-five percent (75%), focusing on the ratio of health centers per urbanized community and the implementation of telemedicine.

The study will only be focusing on one (1) urbanized community in the Philippines and will assume that all urbanized communities in the Philippines are experiencing the same problem. This study will also not be concerned with the health providers since the professionals are not the focus of this study.

2. Literature Review

Telemedicine has diversified the implementation of the health care system as it continuously provides services and information that help doctors to easily diagnose patients who need help across large distances. Moreover, it surmounts changes that happen in the health care environment since telemedicine is equipped with technological advancement. In times of pandemic, patients prioritize convenient and inexpensive care where visiting hospitals in times of crisis will be the last option, telemedicine can be the innovation that supports the response in a health crisis because it will help to avoid exposure to the number of people (Katiyar, 2020). The World Health Organization (2020) categorized the coronavirus disease as a pandemic and stated that it is expanding quickly. (Smith et al., 2020).

As specified by Kapur and Boulton (2020), the crisis-related surge in the number of patients utilizing telemedicine platforms and applications in the Asia-Pacific region is speeding the reception of advanced medical instruments. Effectively before the COVID-19 pandemic, telemedicine was approaching a defining moment. Research shows that Asia-Pacific consumers are increasingly intrigued by health protection, accommodation, and responsibility for care. In Bain's 2019 Asia-Pacific Front Line of Healthcare survey, about half of patients said that they hope to utilize advanced health services in the following five years. Moreover, 91% of customers said that people would utilize digital health services if the expenses were secured by an employer or insurance provider. Based on the Digital 2020 report, an average internet user spends 6 hours and 43 minutes online per day, which accumulates to more than a hundred (100) days of connected time, per person, per year.

As stated by Klaassen et al. (2016), the quick improvement of sensors and communication advancements empower the development of new innovative services in healthcare, such as Telemedicine. A fundamental fixing in the advancement of a telemedicine framework and its last acknowledgment by end clients are usability examines. The standards of usability engineering, assessments, and telemedicine are settled, and it might add to the appropriation and in the long run arrangement of such systems and services. An inside and out usability evaluation, including execution and demeanor measures, requires information about accessible usability procedures and is relying upon the measure of assets. Hence, it merits researching how usability techniques are applied in creating telemedicine systems. Furthermore, according to Glass (2020), telehealth will speed up the response and help people to stay healthy from a distance. Simulated intelligence can help medicinal services experts see designs and foresee the following issues that may emerge. The mix of these innovations — though in early stages of development — could innovate critical public health tools.

Advances in health care system help to hugely improve the delivery of health services to people and its accessibility significantly enhanced the quality of life for people who cannot afford health services in large distances like rural areas and people with disabilities; technology advanced to the extent that people can do things quickly and safely. Barriers to accessing health services remains a prominent issue (Sandre et al., 2016). Despite various advancements, some people still cannot afford health services, and telemedicine is an effective health care measure that will bring the health care value through its ability to immediate access to health care professionals, real-time access to health data, and health monitoring capabilities, applying telemedicine has the potential to increase the health care performance and gain a sustainable competitive advantage in global health care (Kasemsap, 2017).

Some of the major concerns when designing a telemedicine system are confidentiality and security (Putrino, 2014). According to Nabi et al. (2010), the users of telemedicine can increase when health providers give importance to using strong security tools. According to Watzlaf et al., (2010), the patients must sign an informed consent that includes privacy and security issues of the telehealth system. In line with the article of Hall and McGraw (2014), the accomplishment of telehealth could be subverted if genuine privacy and security dangers would not tend. For instance, sensors that are situated in a patient's home or that interface with the patient's body to distinguish safety issues or medical crises may accidentally transmit touchy data about family exercises. Correspondingly, routine data transmissions from an application or medical gadget, for example, an insulin siphon, might be imparted to third-party advertisers. Without satisfactory security and privacy assurances for basic telehealth data and systems, providers and patients will need trust in the utilization of telehealth arrangements. As specified by the American Telemedicine Association (2014), with regards to the privacy of the patients, the sensitive information given by the patients should not be accessed by unauthorized persons.

As stated by Jeffery Kendall of mHealth Intelligence (2017), one of the challenges for healthcare providers is to design and develop an application that works well, looks good, and can be sustained. The author also said that designing for simplicity and scalability are two of many factors that can make an application better. Kendall also stated that it is important to know what are the target audience will like or dislike. For example, an older person would prefer his fonts to be bigger while the younger individual would prefer a colorful app. From a dissertation titled, Understanding the Effect of Font Type on Reading Comprehension/Memory under Time Constraints, comprehension scores are significantly affected by the use of font and the amount of time. In this study, the test using Times New Roman had more correct answers than the test using Haettenschweiler. It was also concluded that a better font yields a better reading comprehension score and memory (Dressler, 2019). According to the principal consultant at UsabilityWorks, san serif fonts are best for older adults and people with low vision because it is easier to recognize the characters.

The figure shown below shows the framework that was formed which are based on literature review and expert insights of experts.



Figure 1. Conceptual Framework

A. Engineering Characteristics

Engineering Characteristics are factors relating to the surrounding effects on the telemedicine application in the Philippines in quantifiable terms. The considerations include Usability, Accessibility, Data Security, Style, Font, and Response.

B. User Attributes

User Attributes are factors relating to the characteristics that a user needs in an application of Telemedicine in the Philippines. These factors include Comprehensible, Time to Operate, Safety, Aesthetic, and Time to Respond in an emergency case scenario.

Telemedicine provides a significant improvement in the health care systems such as strengthening the needs of local health workers in integrating the structure, reducing healthcare costs, enhancing traditional face-to-face medical consultation, less exposure to illness and infections, and less travel time to hospitals and health centers (Harper, 2012). Many countries have shown their interest in embracing telemedicine. However, the success rate of third world countries like the Philippines fails to sustain the implementation of telemedicine due to improper documentation and inconsistencies during execution. The study establishes the idea and addresses the lack of telemedicine application and accessibility to health care services to provide convenience to the people.

3. Research Design and Methodology

The approach utilized in this paper is descriptive and qualitative research, as both methods were needed to gather necessary information. These include data of the current population in an urbanized community located in the Philippines and the factors affecting the telemedicine implementation as it is important for the interpretation and analysis of the feasible outcomes that can determine the best solution for the rapidly increasing number of individuals that are not capable in going to the hospitals and health centers.

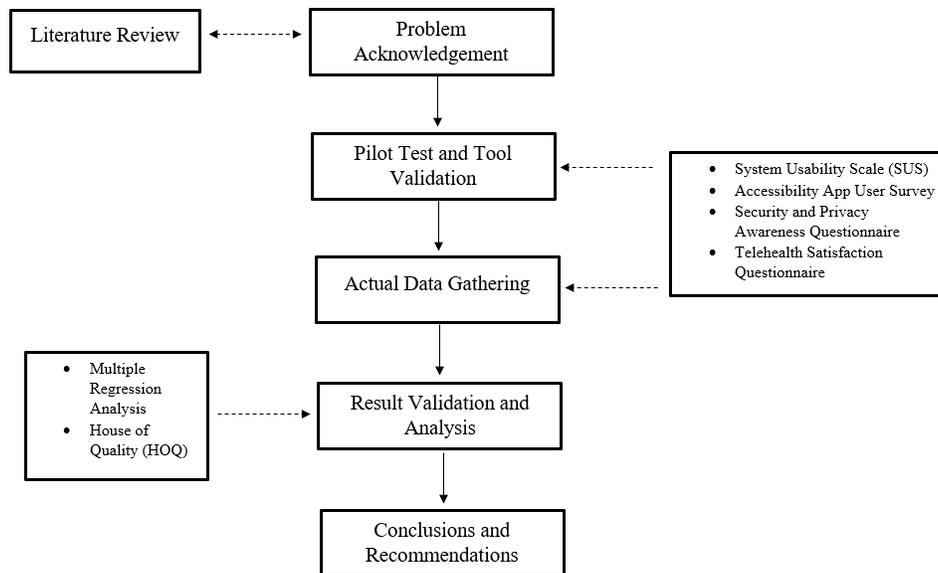


Figure 2. Methodologies

The figure shows the steps that had been done in the paper. The literature review of the study focuses on technology applications in urbanized communities in the Philippines, and it determines the effectiveness of delivering the health care system using technology advancement. However, there are barriers to access to health services, factors were reviewed and evaluated to develop systems architecture that will aid individuals in their daily health checkups and simultaneously minimizing their travel time. House of quality (HOQ) was utilized to facilitate group decision making as it includes customer's needs and requirements ensuring that the customer's satisfaction is being established. The engineering requirement for the system architecture shows a need in the prioritization are data security, time to respond, and time to operate. To validate the result of the study, regression analysis will be utilized to examine the relationship between two (2) variables. The design of the survey applied pairwise comparison, which determines the influence of factors to develop a system architecture of a health care system.

4. Results and Discussion

The results below show the summary of results from the gathered data. Multiple regression analysis was used to predict two (2) or more variables from a set of normalized data. The information was accomplished through the use of multiple regression tool on Minitab 19 statistical software.

GENDER		
Female	26	43%
Male	34	57%
AGE		
0-20	11	18.33%
21-40	40	66.67%
41-60	8	13.33
61-80	1	1.67%
NO. OF PHONES OF THE RESPONDENTS		
1 Phone	46	76.67%
2-4 Phones	14	23.33%

Table 1. Demographic Data

The table shows the gathered demographic information of the respondents residing in an urbanized community in the Philippines. The gender of potential users of the system shows that most of the respondents are male; the ages range from twenty-one (21), up to forty (40) years old where the majority of employment rate is measured in this age group, and most of the people are using only one (1) smartphone.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	10	501.156	50.116	8.13	0.000
DATA SECURITY	1	100.004	100.004	16.22	0.000
RESPONSE	1	72.902	72.902	11.82	0.001
TIME TO OPERATE	1	23.172	23.172	3.76	0.060
SAFETY	1	19.422	19.422	3.15	0.084
TIME TO RESPOND	1	86.017	86.017	13.95	0.001
STYLE	2	65.469	32.735	5.31	0.010
FONT	3	156.957	52.319	8.49	0.000
Error	36	221.950	6.165		
Lack-of-Fit	34	219.950	6.469	6.47	0.143
Pure Error	2	2.000	1.000		
Total	46	723.106			

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
2.48300	69.31%	60.78%	44.76%

The results shown above demonstrate the most elevated possible R-sq(adj) value for the given information, which stands at 60.78%, and took four (4) runs and iterations before all observation values were removed and were considered fit for use. The data shown is the result of the final iteration, where the distinguished factors were Data Security, Response, Time to Operate, Time to Respond, Style, and Font.

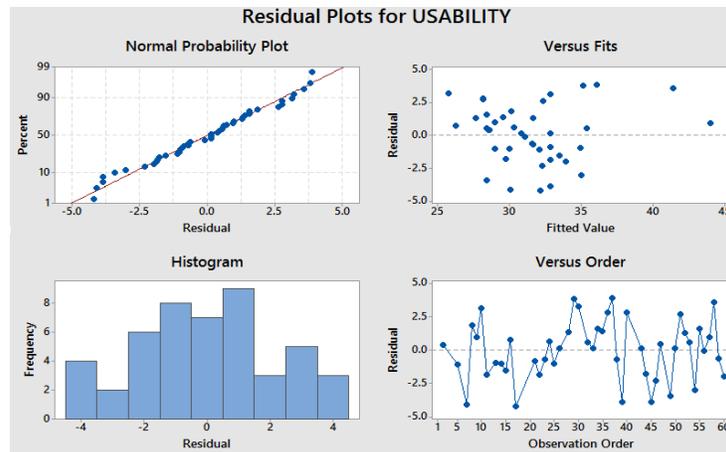


Figure 3. Residual Plots for Usability

The normal probability plot shows that it is normally distributed therefore, multiple linear regression is appropriate for the data. In addition, versus fits plot displayed a scattered set of data hence, supporting the first conclusion that the data should undergo multiple regression analysis. The histogram graph supports the normal probability plot wherein the data is suitable for the multiple regression analysis method, while the versus order plot displayed the independence of the residuals.

House of Quality (HOQ) refers to a well-known process for product development that is inspired by customer desires for a product or process development and anchored by the capabilities and resources of the organization seeking to meet those desires (“What is House of Quality”, n.d.). Moreover, this paper has provided a detailed explanation of the results of HOQ, which shall be discussed in this chapter as well.

The figure beneath shows the house of quality (HOQ) on which the rankings of the factors are pertinent so as to build up an application. It is positioned as follows.

	IMPORTANCE OUT OF 5	PERCENTAGE	COMPREHENSIBLE	TIME TO OPERATE	SAFETY	AESTHETIC	TIME TO RESPOND		
	MAX/MIN		↑	↓	↑	↑	↑	Competitor A	Competitive Advantage
USABILITY	4.53	17.54	○	●	●		○	3.08	1.45
ACCESSIBILITY	4.61	17.85		○	○			2.95	1.66
DATA SECURITY	4.38	16.96			●		○	2.9	1.48
STYLE	4.07	15.76	△			●		2.68	1.39
FONT	4.15	16.07	○			○		2.77	1.38
RESPONSE	4.08	15.80		○			●	2.77	1.31
TOTAL	25.82	100%						17.15	8.67
TOTAL IMPORTANCE = 1175.2			116.59	258.81	364.05	190.05	245.70		
PERCENTAGE			9.92%	22.02%	30.98	16.17	20.91		

Figure 4. House of Quality

The result of the House of Quality analysis shows that usability, data security, and the response came up as the most essential among the user attributes. For the engineering characteristics, the percentages show that the time to operate, time to respond, and safety are the most important factors for the application of telemedicine in the urbanized communities in the Philippines.

5. Recommendations

This study intends to advance the current telemedicine application to help the occupants of an urbanized community situated in Metro Manila for simple access of proper medication and consultation with doctors in regards to their physical wellbeing amid COVID-19 pandemic through the system architecture, house of quality (HOQ), and multiple regression analysis.

The study recommends an application intended for telemedicine for every individual that needs diagnosis or checkup. It is created to help any individual that is having a difficult time going to health centers or hospitals for their medical concerns. The application was also produced to fill in the lack of attention that is given to the citizens in an urbanized community due to having only just one (1) health center amongst eight (8) urbanized communities in the vicinity. It also covers the concern to provide easy access to healthcare up to seventy-five percent (75%) of the community. Therefore, the study has met the objectives by gathering data from interviews, survey questionnaires, and using tools such as House of Quality (HOQ), Systems Architecture, and Multiple Regression Analysis.

Thus, creating and proposing an application that will help the residents of an urbanized community in the Philippines to have a travel-free checkup that they can access whenever or wherever they are. They will also have enough time to talk privately to their physicians and ask or consult the doctors what they are feeling. Four (4) features are available for this application, which are the following: the users can register their email for free, list their symptoms, medical history or background, and book a doctor for emergency use. Moreover, the application can detect location automatically, and chat a doctor if users have any questions/queries regarding their medical concerns. Users can also view the background of the company and contact number. For privacy reasons, this application also features a login/logout button.

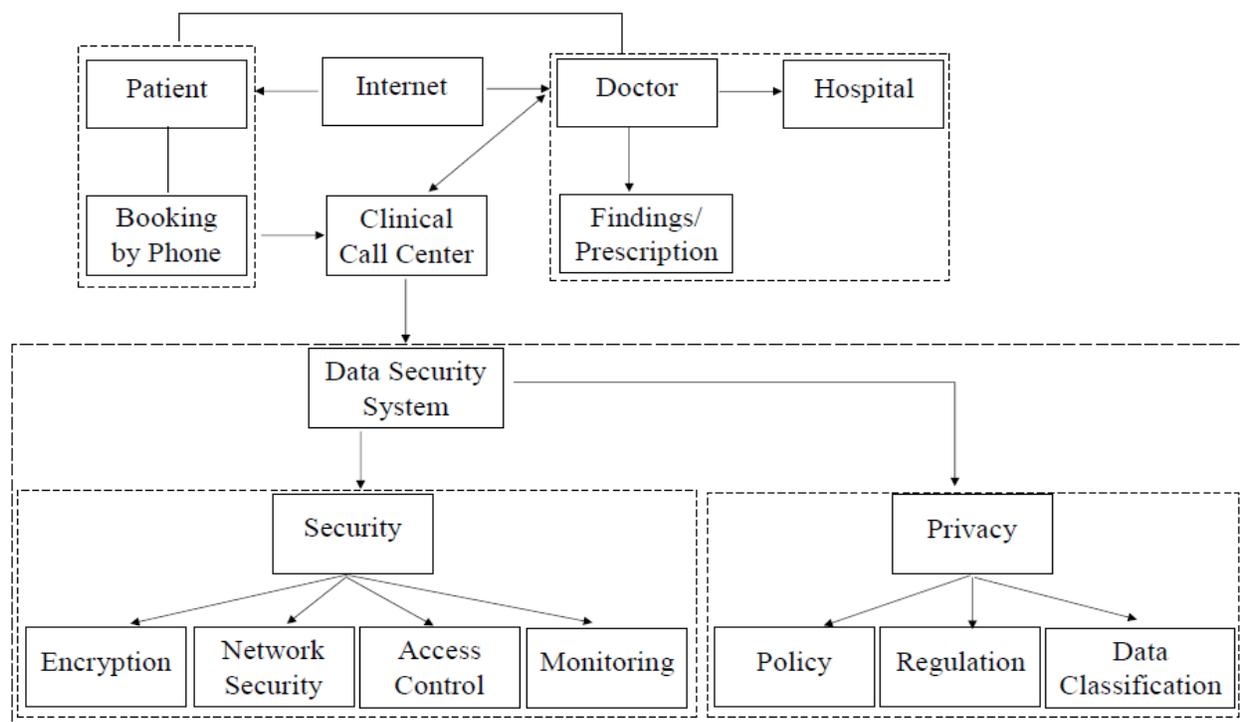


Figure 5. Proposed System Architecture Diagram

The figure shows the proposed system architecture flow process of how the system works. It starts with a user installing an application to book for an appointment. The application system will then transfer the relevant data to an affiliated call center, where an agent will process the appointment with a doctor. The application will contain data security to ensure confidentiality in the health records of the users since there is sensitive information such as images—sent by users if requested by doctors for a more accurate diagnosis. If the case is mild and can still be assisted virtually, an online prescription will be provided, whereas severe cases will be advised to visit a hospital.

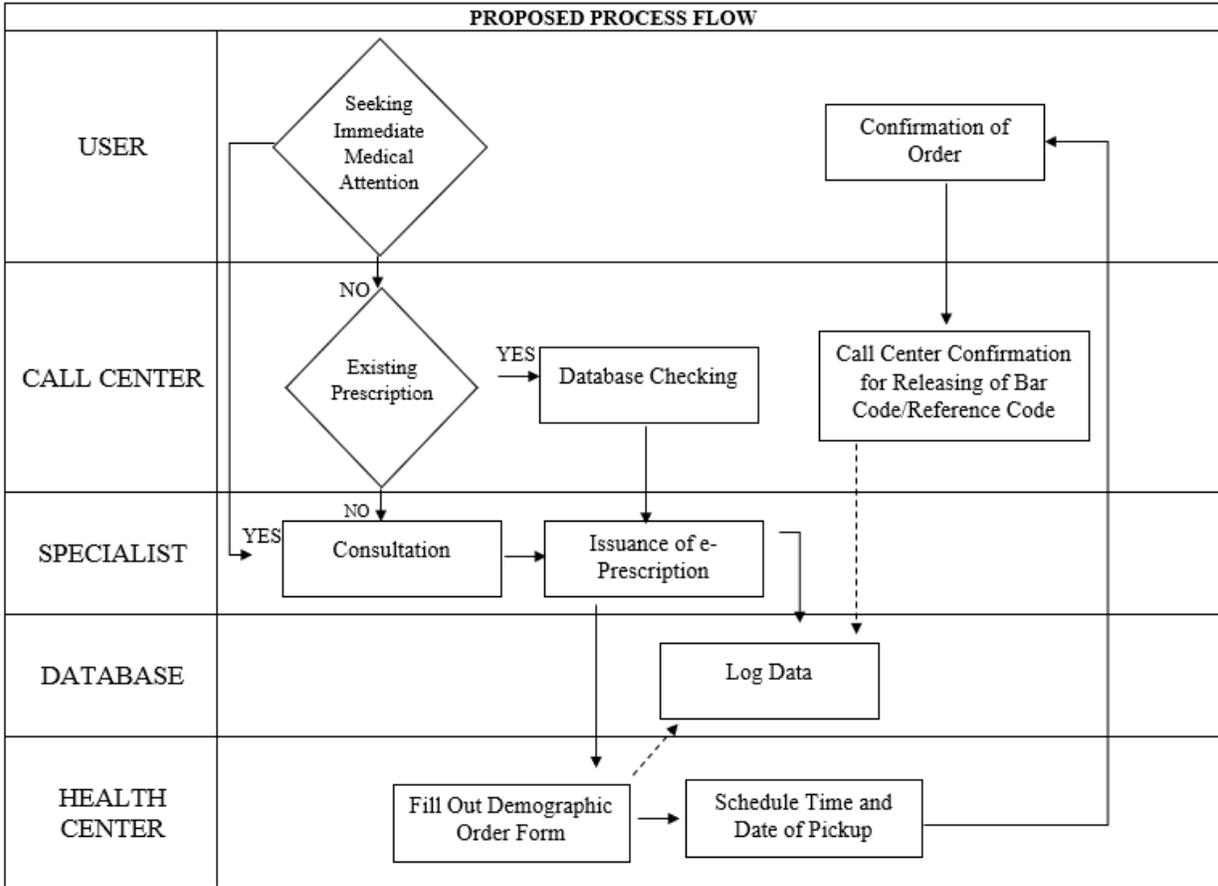


Figure 6. Process Flow for the Recommendation

This figure shows the overall process flow for the application. It begins when the users open the application and then book their appointments by phone. After that, the call center agent will transfer the interaction to the available doctors for the prescription of medicines that will come from the health centers.

The equation (1) is the formula for the percentage difference of the proposed and existing system.

$$\text{Percentage Difference} = \frac{\text{Proposed System} - \text{Existing System}}{\text{Existing System}} \times 100 \quad (1)$$

Based from the results shown on House of Quality (HOQ), the proposed system is 8.67 points ahead of the existing system which has a percentage difference of 50.55% shown in equation (2).

$$\text{Percentage Difference} = \frac{25.82 - 17.15}{17.15} \times 100 = \mathbf{50.55\%} \quad (2)$$

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