

LabSeek: An Outpatient Medical Laboratory Testing Information System Using Location Mapping

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Abstract

Locating available healthcare facilities and other medical services has been in demand since the Covid-19 pandemic and post-pandemic. With technological advancement when it comes to location mapping, GIS or Geographic Information Systems are useful tools for locating hospitals and laboratory testing facilities other than hospitals. The remaining challenges in finding healthcare facilities were the absence of a referral system that prevents the opportunities from locating appropriate healthcare facilities and getting medical advice from hospitals regarding medical tests, and procedures. Patients often skip the first level of facilities to seek care from level 2 and 3 facilities, which can lead to the increased cost to receive health care, as there is no effective referral system. The study aimed to benefit healthcare access in the Philippines by providing accurate information gathered from outpatient care services. This study provides assistance to those who struggle with the accessibility to services for health-related issues. The system has the opportunity to aid citizens to gain region-wide information about available laboratory facilities. This study also aims to aid and benefit future research on the integration of at-location mapping technology in healthcare.

Keywords

Applied computing, Life and medical sciences, Location Mapping, e-Health, Internet of Things

1. Introduction

Primary health care plays a critical role in keeping countries safe from health security threats like outbreaks of diseases (Causevic et al. 2018). Primary health care ensures that people have a partner in their health needs from birth and all throughout life – through health promotion, disease prevention, treatment, rehabilitation, and palliative care (WHO 2018).

Healthcare has never been more important today, with the sudden appearance of COVID 19 pandemic, the Philippine government conducted contact tracing and issued travel bans with neighboring countries. While the prohibitions prevented potentially infected people from spreading the disease in the Philippines, travelers from other countries where the disease was already spreading but not subject to the travel bans were not tested. The Philippine government responded to both developments by declaring a ‘community quarantine’ for Metro Manila and was made even more stringent by extending the quarantine to the whole island of Luzon (Amit et al. 2020).

Location mapping is a fundamental service in mobility. In outdoor applications such as wildlife tracking, participatory environmental sensing, and personal health and wellness applications. The Global Positioning System (GPS) is the most common location sensor (Allahbakshi et al. 2020). The development of mobile devices, especially smartphones and tablets, is proliferating. Starting from the average number of users who progressively increase mobile devices drastically. Mobile technology has also been growing with the availability of a variety of platforms (Swastikasari et al. 2018).

According to the Philippines Health System review, one of the remaining Challenges was the absence of a facilitated referral system that prevents the opportunities from locating appropriate healthcare facilities and getting medical advice from hospitals regarding medical tests, procedures (Dayrit et al. 2018). A referral system can shorten waiting times, prevent duplication of tests and improve the treatment for the patient. It is said that Patients often skip the first level of facilities to seek care from level 2 and 3 facilities, which can lead to inefficiencies and increasing costs to receive health care, as there is no effective referral system (WHO 2018).

In terms of healthcare access in Asia-Pacific, up to half of the people lack access to health services. This might be because health services are too far from their homes or lack qualified health workers, equipment, or medications (Ling et al. 2021). The lowest members of society are the primary consumers of government health services, yet these facilities have been neglected due to insufficient health expenditures. Because of declining quality, lower levels of treatment were skipped even for basic primary cases, lack of human resources, medical equipment, and medicines (Mousa and Othman 2020).

Based on the findings of other studies (Sarkisian et al. 2020) (Gholamhosseini et al. 2019), developing a web application that will help patients find medical facilities near them using GPS to point the location of the patient will provide a solution from the mentioned current information dissemination issues (Goodspeed et al. 2018). A system that has the ability to inquire and book appointments with the facilities' operators, booking appointments through the web application will reduce waiting times in hospitals and clinics (Zenk et al. 2018).

This study is about the development of a web-based system that utilizes the location mapping technology for outpatient care services such as laboratory facilities and finding their needed healthcare service providers. The healthcare assistance has been a great demand during the Covid-19 pandemic and post-pandemic.

1.1 Objective of the Study

The main objective of the study is to develop a map locator using search feature for individuals looking for health facilities that offers laboratory testing with appointment scheduling based on the laboratory test they need and those who wanted to talk to health care providers through customer service and helpdesk. Specifically, the study have done the following to achieve the objective of the study: gather multiple hospital services information in the Philippines' national capital region (NCR); design a database for hospital services information such as doctors and facilities, patient profile, and appointment scheduling through customer service; and, to develop a web-based information system that utilizes GoogleMaps API for location mapping.

1.2 Scope and Delimitation

The study used GoogleMaps platform, which is an open-sourced software while HTML, CSS and PHP are used for the web application development. The MySQL allows data storage and data access which collects its data into an offline mode. A chat service was integrated in the system allowing an e-helpdesk feature for communication purposes between end-users and hospital customer care operators

The LabSeek web application only cover the national capital region (NCR). When the user starts searching for a laboratory testing facility, all of the results available in NCR will display on the map. The help desk function will only be available depending on the office hours of the selected facility, clinic. The appointment scheduling will be handled by the help desk operator of the clinic since every clinic has a different appointment scheduling process from each other. Payment methods will not be available in the web application, and the help desk will be the one who will provide for the transaction process. After the appointment exchange between the user and help desk, a notification will be sent to the user's account, finalizing the transaction between them.

2. Literature Review

Geographic information is the result of the data processed for location mapping, and with its technological advancement it is called Geographic Information Systems (GIS). It contains information such as traffic measures, statistics, and so on (Causevic et al. 2018).

Popular instant messaging or chat messengers are Facebook Messenger, WhatsApp, Telegram, and many others. This technology tallows two or more people to communicate via a network (Köksal and Tekinerdogan, 2019). The

popularity of the messaging technology enables communication faster and has been integrated to many information systems (Altaran et al. 2019).

The Department of Health (DOH) is responsible for acting as the Philippines' final technical authority on health. The major function of the Department of Health in the realm of health is to formulate national policy and produce national programs, technical standards, and recommendations.

A study developed on Android Studio which include an interactive GoogleMap that provides the locations of nearby health care facilities. The current capabilities of the application allow users to access the locations and details of health clinics while using a minimal amount of data, as the efficiency of data usage stands as a priority for the homeless when installing mobile applications. This study suggested for future researchers to add more features so that it will serve as a central means of locating services for the homeless in a data efficient manner (Surapur et al. 2021).

Another study focused on creating a location-mapping mobile application that uses maps for breastfeeding mothers to search and view for places that other breastfeeding mothers use for breastfeeding publicly (Meedya et al. 2021). The system displays recommendations of other mothers who have previously breastfed in a certain area along five categories such as Comfy(ness). Clean(liness), Privacy, Baby Facilities, and Average Spend.

Another web-based application created a virtual “helpdesk” for users to veteran affairs especially during the Covid-19 pandemic focused on three priorities: to continue providing access to medical and mental health care, to avoid Covid-19 infection to others, and to maintain or expand access in Covid-19 hotspots and during the lockdown period (Heyworth et al. 2020).

3. Methodology

3.1 Data Gathering

Gathering of reference studies and analyzing the gap on existing systems where the first steps took to collect information for the development of this study. Various applications were also searched and used to find the recommendations of users for the improvement of the web application.

3.2 Requirements Analysis

The minim hardware and software requirements were identified before the design phase of the study. This study used HTML, CSS and PHP in the development of the web-based application. While XAMPP is used to test them. On a local computer, the XAMPP server software provides an adequate environment for testing MySQL, PHP, Apache, and Perl projects. MySQL is used for the design of database and JavaScript for the implementation of the GoogleMaps API and the TalkJS API. Javascript was also used in various parts of the web application, such as the autocomplete function of the search bar. For the interest of time, TalkJS , a chat API, and Javascript SDK with a pre-built user interface were used to add user chat to the website. GoogleMaps API were used for the maps and JavaScript and PHP are for the implementation and map processes.

3.3 Design

The developed system has the following modules: e-Helpdesk, Location Mapping and Messaging service.

In the development of e-Helpdesk module, the stuyd used TalkJS API as a chat function. The UI design was taken from an API. Each conversation is unique via the conversation ID that is generated by the API. The API has its own database for their conversations, messages, and users. The users are from the web application’s database and connected to the API’s database.

For the location mapping module, the study used the GoogleMaps API. The contents inside the map retrieved from the database using the latitude and longitude which will come from the database. The map consists of custom markers and info windows for additional information which will come from the database. The API also has a GPS function that points out the location of the user.

For the messaging facility, the users can communicate with the chat service about the inquiries of a certain facility, and medical lab procedures. Appointments are done in the exchange between users and operators while the transaction

occurs. An automated email will be sent out to the users validating the transaction. The user accesses the help desk by communicating with the selected clinic, hospital and receives information given by the help desk. The operator will discuss with the users some reminders before going to the facility like drink a glass of water, fasting, etc. The target platforms for this system are Laptop/Desktop computer browsers, and mobile phone browsers. Gathering the modules for the system, the researchers developed the process flow of LabSeek on how the system is functioning.

The process flow of the developed system is shown on Figure 1. When the user launches the web application, they can search for available application services. The user will have the option to communicate with a help desk of the selected service and ask for information and other inquiries. After the inquiries, the user will have the option to appoint a schedule for the selected test if the operator says so. After the appointment, the user will receive a notification in the user's account as a transaction notification. The user will then proceed to get the location for that service for them to go to and will be given reminders before the tests e.g. drink water before the tests, fasting for 12 hours, etc. When the operator logs in as a help desk, they have the ability to communicate to the users who seeks services that they provide e.g., health service and give them directions and information. The operator will also have the ability to add, edit, or delete tests in their respective facilities.

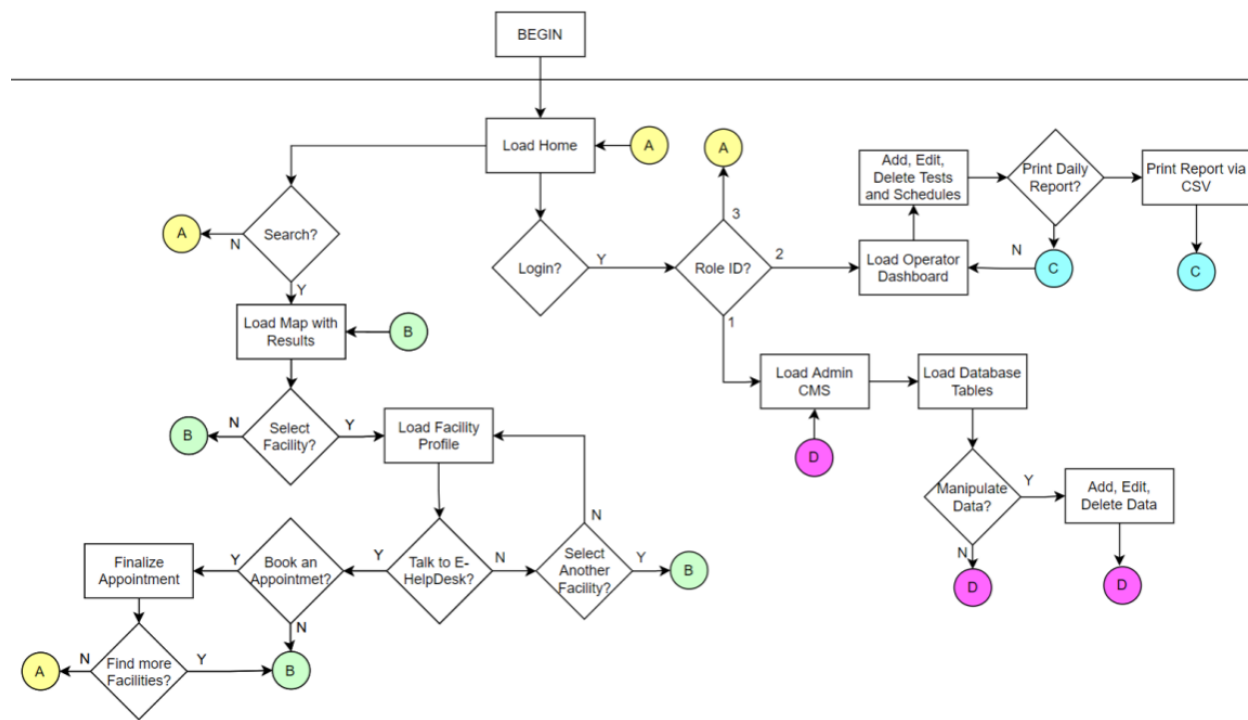


Figure 1. Process Flow of LabSeek

After analyzing the required specifications, the study started doing the software design where solutions will meet the required essentials of the software. The system architecture of the developed system is in Figure 2. The user of the web application requests data from the database, the web server, which is "DreamHost," a web-hosting service connected to the database; the webserver sends the command to the database, and the database finds the requested results for the given commands. The processed information is delivered to the web application, which sends it to the webserver. The web server will provide the requested data to the user. The Google Maps API Services will provide accurate location mapping information to the user via the Internet. The data inside the map comes from the database where it was requested by the user when they search for a test. The user will be able to communicate with an operator from a selected facility via Chat Service using TalkJS API. The TalkJS API has its own database for messages, conversations, and users. The users from the database are connected to the users of TalkJS's database. Each conversation is unique and is generated by the chat API as a conversation ID. The design for the application is minimal and easy to navigate. The web application mainly has two parts, the location mapping for basic hospital information

and the chat service for the users to ask FAQ's and inquiries. The map shows users nearby services and events and gives the users the options to search for specific services such as search, inquire, and communicate to the help desk.

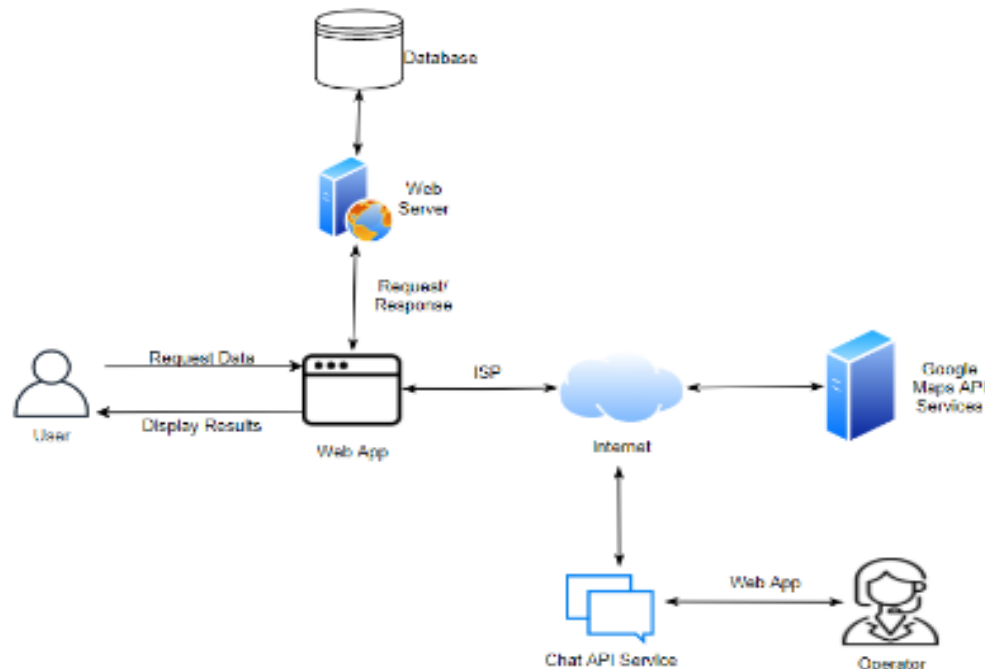


Figure 2. Illustration of System Architecture for LabSeek

3.4 Development and Testing

Once the data has been analyzed and the requirements for the system has been found, the study was able to start developing the system. The web application was developed using PHP as the main scripting language and MySQL for the database. In this phase, the study conducted a functionality testing to check if there are any bugs or errors detected, and fix them. Once the errors have been fixed and have met the requirements. The feedback gathered after the initial testing was used to improve the application. After the application has been modified, another testing was conducted for another functionality testing until the target users are satisfied with the results.

a. **Unit Testing** – Throughout unit testing the developers documented everything (test case list, sample output, data printouts, and defect information) as proof that the testing has been fulfilled and also to make sure that every module has passed the testing.

b. **User Acceptance Testing** – this part of the testing was conducted by the target users which are the urban gardeners. The UAT was the final verdict of the whole mobile application, how the app looks and feels like for the target users.

4. Results and Discussion

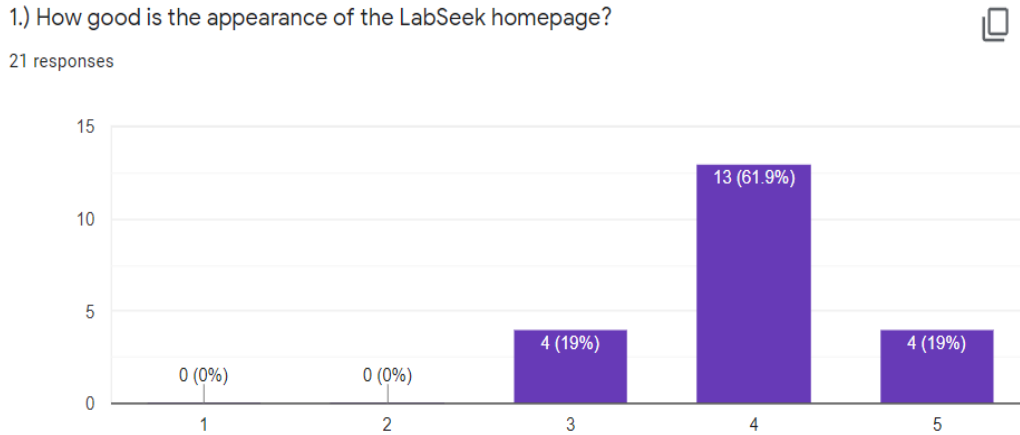
The user acceptance testing survey was by twenty-one (21) respondents. The results of the survey were based on the respondents' use of the application.

The question about the web application's homepage appearance is shown in Figure 3.. The respondents were to choose from "very unsatisfactory (1)", to "very satisfactory (5)". The survey shows that 60% of the respondents responded to "satisfactory (4)," and 19% of respondents responded to "very satisfactory (5)" to the design of the homepage of the

website. This shows there is still some room for improvement in the web application's homepage appearance to further satisfy users of LabSeek.

Figure 3. Question regarding the appearance of LabSeek Homepage

The questions regarding the registration page appearance and the respondents' experiences in registering an account



is shown in Figure 4. The result of user acceptance survey states that the appearance of the registration page balances between “satisfactory (4)” and “very satisfactory (5)”. Since the responses are balanced, we can assume that the registration page appearance is satisfactory enough for the respondents.

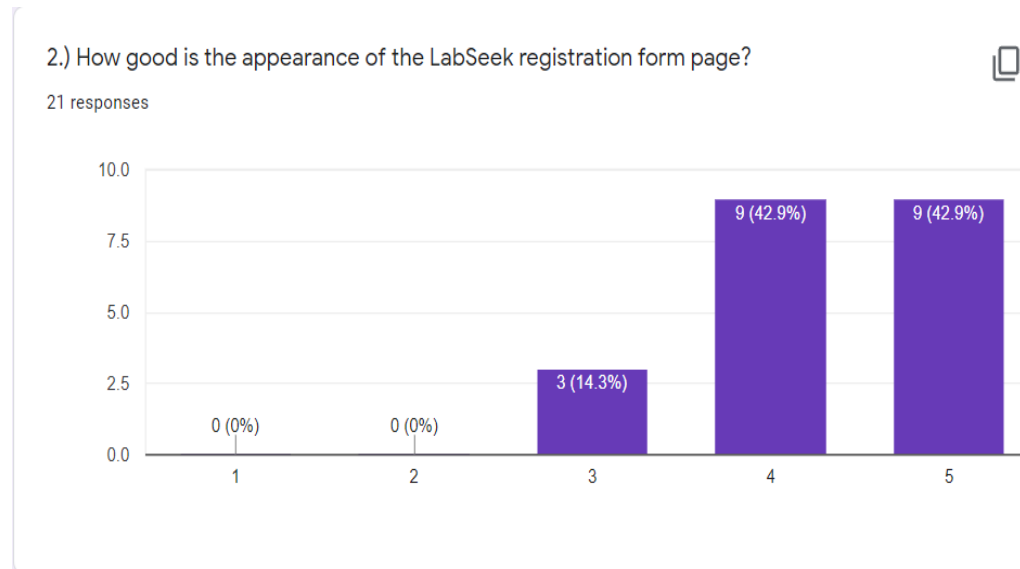


Figure 4. Question Regarding the appearance of the LabSeek Registration Page

The survey question asked the respondents for their experience in registering their accounts for the web app and the results show that 60% of the responses were “very satisfactory (5)”. With these results we can assume that our current process when registering for their accounts to be functional and has shown no signs of issues as shown in Figure 5.

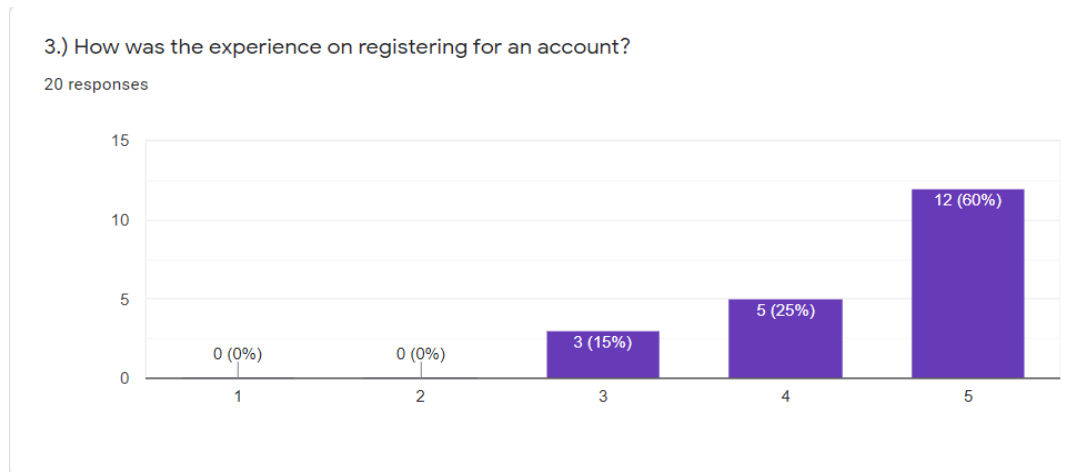


Figure 5. Question regarding the experience of the user account register process

The survey question asked the respondents regarding the responsiveness of the page when it loads. The results show that 38% were satisfied and 52% were very satisfied with the responsiveness, meaning that the majority of the respondents had no problem with the page loading on their devices. This shows that the current responsiveness of the pages is satisfactory and does not require any sudden changes unless necessary as given in Figure 6.

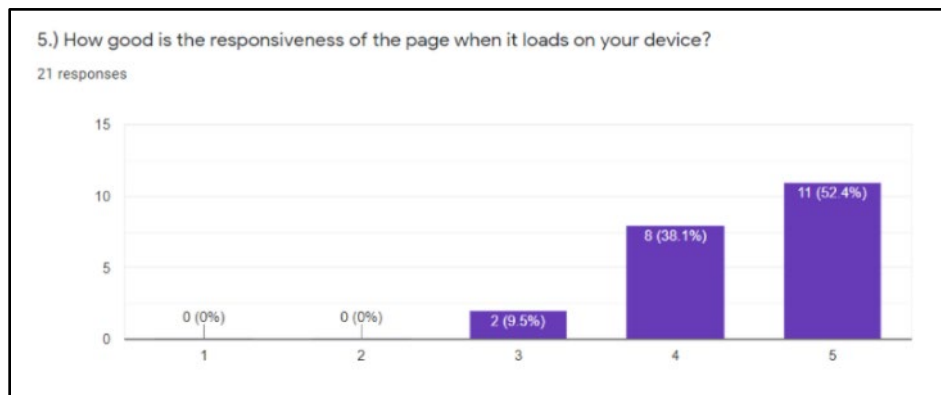


Figure 6. Question regarding the responsiveness of the page on the device

The survey asked the respondents for their experience in navigating the map when looking for facilities as shown in Figure 7. The survey states that 47% were satisfied and 42.9% were very satisfied with their experience. The higher percentage for the respondents who voted for “satisfactory” shows that the map is easy to navigate, there are still room for improvement or changes to further enhance user experience.

The survey also included a question if the respondents encountered any issues when choosing a facility, and 81% said no and 19% said they encountered issues. While the majority had no issues when choosing a facility, there were a small number of users who had difficulty. This shows that there are instances where problems arise in the process of choosing a facility which may need to be addressed immediately, please see Figure 8.

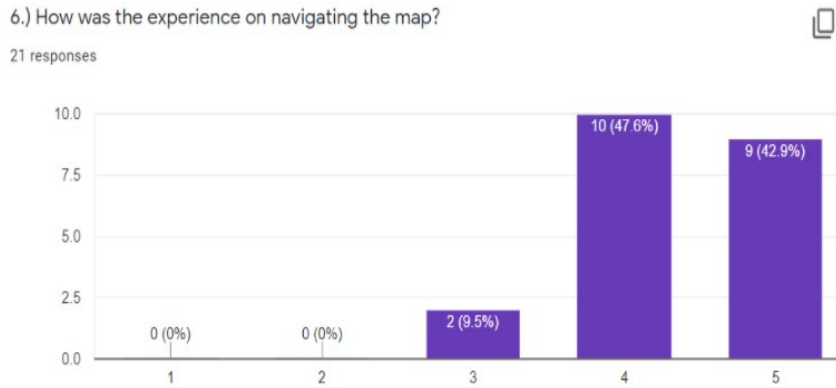


Figure 7. Question regarding navigating the Map in LabSeek

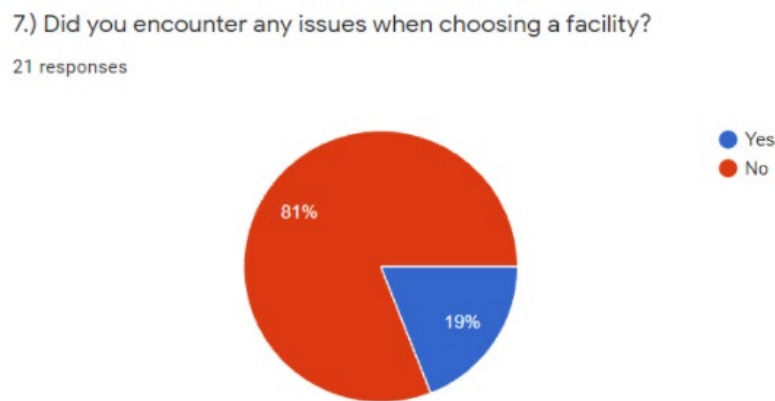


Figure 8. Question regarding encountering any issues when selecting a Facility

The survey included a question for the respondents' experience in talking to an operator and booking an appointment. The results shows that 47% of respondents were satisfied with the communication with the operator, and 47% were satisfied as well for the appointment experience as shown in Figure 9 and Figure 10. We can assume that while inquiring at the facility, the users had no issues and were able to book their appointments easily.

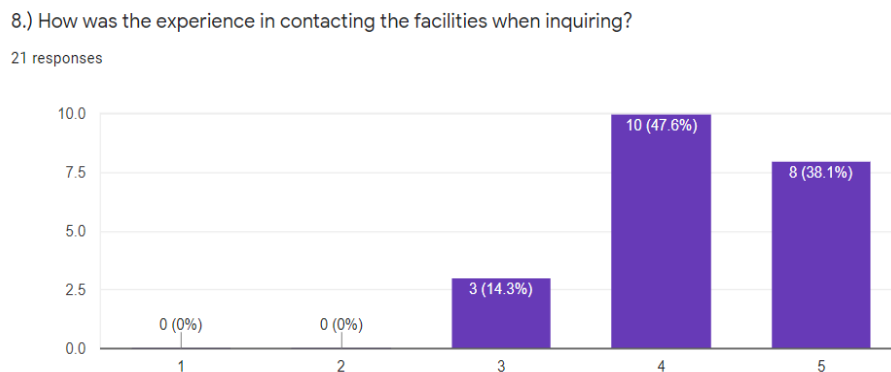


Figure 9. Question regarding the experience communicating with health care facilities

9.) How was the Experience in booking an appointment?

21 responses

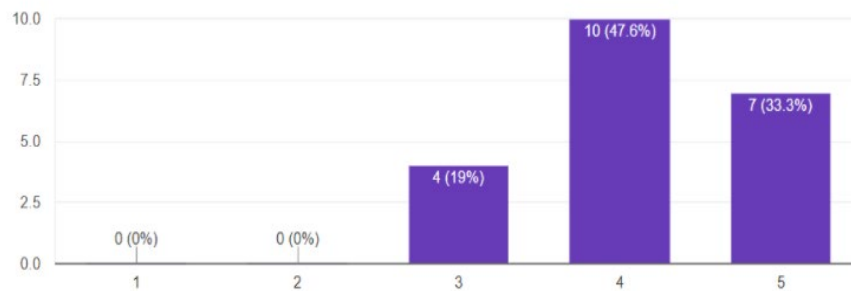


Figure 10. Question regarding the experience in booking appointments

The survey questionnaire specifies if respondents' navigation experiences and the result shows that majority of the respondents (47.6%) were very satisfied as shown in Figure 11. With this, we can assume that the navigation through the pages meets the respondents' expectations, and they were able to navigate easily.

The results present that 100% of the respondents like using the web application and 95.2% of the respondents found the web app necessary, as shown in Figure 12 and Figure 13. respectively. This shows that people like the idea of the application, satisfied with its functions and found it helpful and necessary.

10.) How was the Experience when navigating through the pages?

21 responses

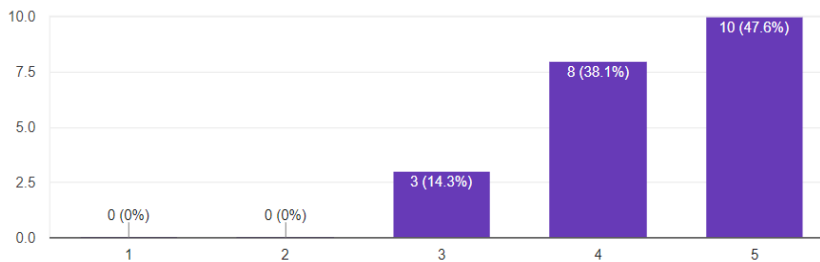


Figure 11. Question regarding the navigation through LabSeek Pages

11.) Did you like using this Web Application?

21 responses

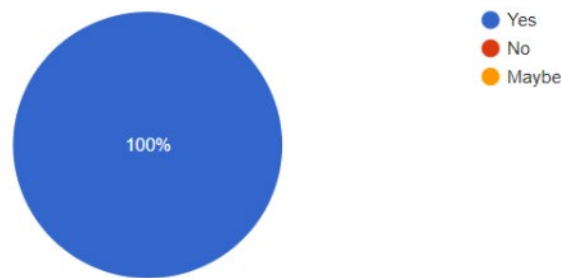


Figure 12. Question regarding whether Users liked the Application

12.) Did you find LabSeek necessary?

21 responses

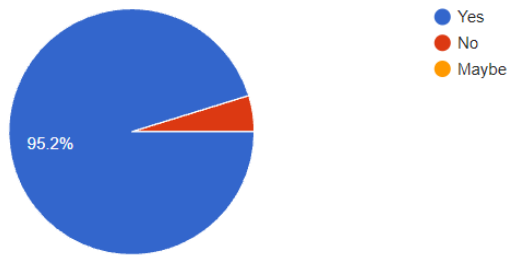


Figure.13. Question regarding whether Users think LabSeek is necessary

The survey questionnaire also identifies if the respondents will use the web application again. From “very unlikely (1)” to “very likely (5)”. 52% of the respondents answered very likely as shown in Figure 14. This can be interpreted as LabSeek has an appeal and was helpful to its users that they are likely to use LabSeek again. While Figure 15 shows that that 100% of the respondents recommend LabSeek to others. With this, we can assume that the respondents were very satisfied and would want others to experience using Labseek and its services.

15.) Will you use this LabSeek again?

21 responses

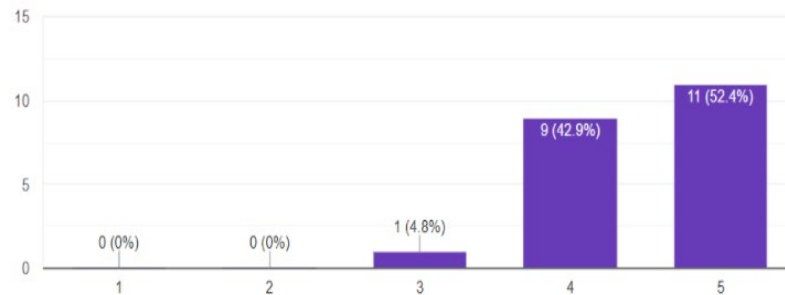


Figure 14. Question regarding the likeliness of users using LabSeek again

16.) Will you Recommend LabSeek to Others?

21 responses

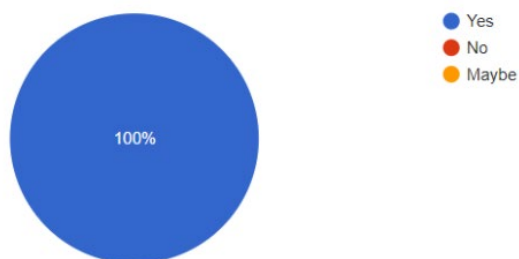


Figure 15. Question regarding whether Users will recommend LabSeek to others

5. Conclusion

The main objective of the study is to develop a map locator using search feature for individuals looking for health facilities that offers laboratory testing with appointment scheduling based on the laboratory test they need and those who wanted to talk to health care providers through customer service and helpdesk. Based on the unit testing, all program bugs have been fixed and met all the requirements set in the study.

Specifically, the study have done the following to achieve the objective of the study: gather multiple hospital services information in the Philippines' national capital region (NCR); design a database for hospital services information such as doctors and facilities, patient profile, and appointment scheduling through customer service; and, to develop a web-based information system that utilizes GoogleMaps API for location mapping. The User Acceptance Test (UAT), resulted in respondents' satisfaction. The result shows that majority of the respondents are satisfied with the appearance of LabSeek while there are some areas that we can improve on. The overall user experience results were mostly satisfactory while a small percentage of users experienced issues, the researchers have successfully fixed present issues. 100% of the respondents liked using the web application and 95.2% of the respondents found the web app necessary. The results show that LabSeek has done its intended purpose which includes easy navigation, user-friendliness, and successful transactions between the user and the facility.

The study has concluded that the developed web application achieved its objective. The specific goal of locating and directing users to an outpatient laboratory testing facilities in national capital region (NCR) are successfully executed. The developed application provides accurate searching for laboratory testing facilities without finding hospitals one by one online.

6. Recommendations

The researchers identified the following recommendations on future research that can help utilize the maximum potential of the system: expanding the scope of the system where the laboratory facilities in the system can be made available extensively and not limited in a region. Expanding the covered hospital and laboratory facilities are also highly recommended. And lastly, to include features like text-to-speech" and "speech-to-text" for the use of people with special needs and with disabilities.

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