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Medicine Consumption Reminder and Monitoring Application for Patients with Leprosy Disease

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Abstract. Leprosy or also known as Hansen's disease (HD) or Morbius Hansen's disease (MHD) caused by the bacterium *Mycobacterium leprae.* The symptoms of leprosy are hardly identified. In fact, some symptoms only can be identified after 20-30 years. Recently, the advent of multidrug therapy (MDT) and the use of anti-inflammatory therapies have given substantial improvements in long-term health outcomes for patients diagnosed with leprosy. However, the medication was a time consuming. Healthy behavior in the management of leprosy treatment requires discipline in taking leprosy medication. On the contrary, poor treatment management will lead to permantent consequnces of disability and deformity. Various Android-based applications have been developed by programmers. Smartphone technology is expected to help patients taking medication in supervising and reminding. In addition, through the cloud based technology the mobile application is expected to be solution as medium of information and communication for every stake holder in dealing with leprosy patients. This research involves a series of software development processes which are divided into several phases. Starting with the identification of the problem, moving on to the design of the application and the API service, to the development and testing of the application using a variety of test scenarios, and concluding with the documentation process. Both the functionality and the design were tested using the User Experience Questionnaire (UEQ) and black-box testing. Based on the outcomes of black box testing, the app's functionality work without any issues. The UEQ results show that novelty (Good), stimulation (Good), efficiency (Good), reliability (Above Average), perspicuity (Above Average), and beauty (Good) are all positive (Above Average). According to the UEQ results, the application received the highest efficiency level rating of 1.75, which indicates that it is regarded as having good consumption efficiency and being usable.

Keywords: Medication Consumption, Reminder Application, Monitoring Application, Leprosy

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INTRODUCTION

Leprosy or also known as Hansen's disease (HD) or Morbius Hansen's disease (MHD) caused by the bacterium *Mycobacterium leprae*. The bacterium will induce a persistent infection in people that mostly affects the skin and peripheral nerves, but may also impact places like the eyes, mucous membranes, bones, and testicles. It also causes a range of clinical phenotypes (White, C., & Franco-Paredes, C., 2015). Recently, it has been shown that *Mycobacterium leprae* has the ability to spread infection or attracting macrophages to develop granulomas that affect systemic dissemination of *Mycobacterium leprae*. The presence of bacilli in the skin produces the dermatological manifestations of the disease, and nerve infection produces axonal dysfunction and demyelination, leading to sensory loss and its consequences of disability and deformity.

According to East Java's public health sector, there are about 2,668 or about 24% new leprosy patients and 3,351 leprosy patients who are still receiving treatment in East JAVA region only (Liputan6, 2020). Of the 2,668 new leprosy patients, as many as 255 suffer from visible disabilities due to late detection and about 7.3% are children. The symptoms of leprosy are hardly identified (Bahia El Idrissi, N., Iyer, A.M., et al, 2017). In fact, some symptoms only can be identified after 20-30 years. Skin numbness, a thickening of the skin that is light pale in color, a lack of perspiration, sores that appear but do not hurt, an enlargement of nerves that typically occurs at the elbow and knee hinges, weakened muscles, the loss of eyebrows and eyelashes, dry eyes, a runny nose, and congestion of the nasal passages are some symptoms that can appear (Grzybowski, A., Nita, M. et al., 2015). If the leprosy is severe enough, the doctor will need to perform some additional tests to check the spread of the *Mycobacterium leprae* bacteria in patient's organs.

Recently, the advent of multidrug therapy (MDT) and the use of anti-inflammatory therapies have given substantial improvements in long-term health outcomes for patients diagnosed with leprosy (Kar, H.K. & Gupta, R., 2015). However, the medication was a time consuming. This brought high risk for discipline issues in patients medication (Ministry of Health RI, 2014). In research concluded in 2013, involving 48 patients with leprosy, 62.3% patients were not obedient in their medicine consumption. Patient dicipline affects morbidity and mortality (Siregar, T. & Ratnawati, D., 2019). Patient compliance in the treatment process determines the success of treatment. Healthy behavior in the management of leprosy treatment requires discipline in taking leprosy medication. On the

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contrary, poor treatment management will lead to permantent consequnces of disability and deformity (Andriani, E., Khotimah, et al., 2019). In addition to the treatment for leprosy patients, the medication will involves a number of antibiotic drugs that also require direct supervision from a doctor or health practitioner. Unfortunately, social stigma still become a major problem among other issues (Arisal, A., Agustang, A. et al., 2020). It often prevents doctor and health practitioner from being able to reach the patient. These two factor will be the main focus in this research.

According to the literature review and field research, the lack of medical professionals makes it challenging to treat leprosy patients who live in distant areas. This makes it even more challenging to keep track of the patient during therapy. This is still made worse by the patient's continued disobedience and by the absence of family and community support in efforts to recover leprosy patients. As a result, it frequently affects how successfully the therapy is being administered.

Along with the rapid development of Information Technology especially in mobile computing technology, smartphones are present in everyday life. Smartphone now can be used to access and process data with robust computing power and able to run applications that help daily life. Android is one of the most smartphone operating system that widely used today (Holla, S. & Katti, M.M., 2012). Various Android-based applications have been developed by programmers. Smartphone technology is expected to help patients taking medication in supervising and reminding. In addition, through the cloud based technology the mobile application is expected to be solution as medium of information and communication for every stake holder in dealing with leprosy patients.

PROBLEMS

There may be many people out there who require ongoing assistance, including our elderly elders, family members, and persons with special needs. In this case, most patients with leprosy are difficult to be traced. They are mostly isolated in remote places that are hard to reach. The difficulty of access to health facilities, as well as the lack of support from families and communities make the medication more difficult to carry out. The patient's lack of medication compliance makes this condition worse, contributing to the low success rate of the current treatment plan. An application prototype that can be used as an alternate solution to enhance the healing of leprosy patients will be developed in this

research. A medication reminder feature will be included in the created application to make sure that patients are always compliant with their treatment. On the other hand, the application's design aims to make it simpler for medical professionals to monitor the treatment of leprosy patients. Decisions on efforts to treat leprosy patients can be based on the data gathered through this application.

METHOD OF IMPLEMENTATION

This research involves a series of software development processes which are divided into several phases. Starting with the identification of the problem, moving on to the design of the application and the API service, to the development and testing of the application using a variety of test scenarios, and concluding with the documentation process. The following are the results of each phase which are presented in detail.

1. The problems identified in this study were the difficulty of leprosy patients to be disciplined during their treatment period and the difficulty of health actors to be able to supervise the treatment being carried out, making the treatment that was carried out less effective and often failed.
2. A number of visual diagrams employing UML diagrams, including Use Case Diagrams, Class Diagaram, Entity Relationship (ER) Diagrams, Application Mockups loaded with Application Workflows, as well as a number of Application Test Scenarios, are used throughout the system design stage.
    - The key elements that need to be included in the created application will be determined using Use Case Diagrams. Diagram visualization will involve a number of actors who will utilize the application.
    - The physical model of the database design application that will be created is based on ER and Class diagrams. Data and information that will be used to initiate application functions are shown using entities and attributes.
    - An application workflow is a plan that outlines how each element of the program can be accessed by the end user to address the current issue. There are at least three aspects of the program that serve as reminders to take medications and a tool for health actors to monitor the behavior of leprosy patients while they are undergoing treatment.

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3. The process of creating a mobile application will be carried out based on the designs created in the prior phase throughout the application development and testing phase. Numerous computer codes will be used during the development phase to create an effective user interface and functional application.
4. The application, which focuses on two different aspects, will be tested when it is developed. To determine whether all functionalities developed are operating at their best, program functionality is tested using a number of black box tests. UI/UX testing will be carried out using the UEQ research tool involving a number of respondents (Schrepp, M., Thomaschewski, J. and Hinderks, A., 2017).
5. Research objectives are evaluated by a series of UI/UX and application functionality tests, and the results are then presented as the project documentation, which is the last step in the development process.

RESULT AND DISCUSSION

This part serves as the reports of the results and discussion. According to the Use Case Diagram in Figure 1, there are three different types of users: administrators, medical professionals, and patients. Access privileges to features vary depending on the user. Patients only have access to the medication reminder tool, while health professionals can choose the medications to be taken on what timetable, as well as keep track of the patient's disciplinary information.

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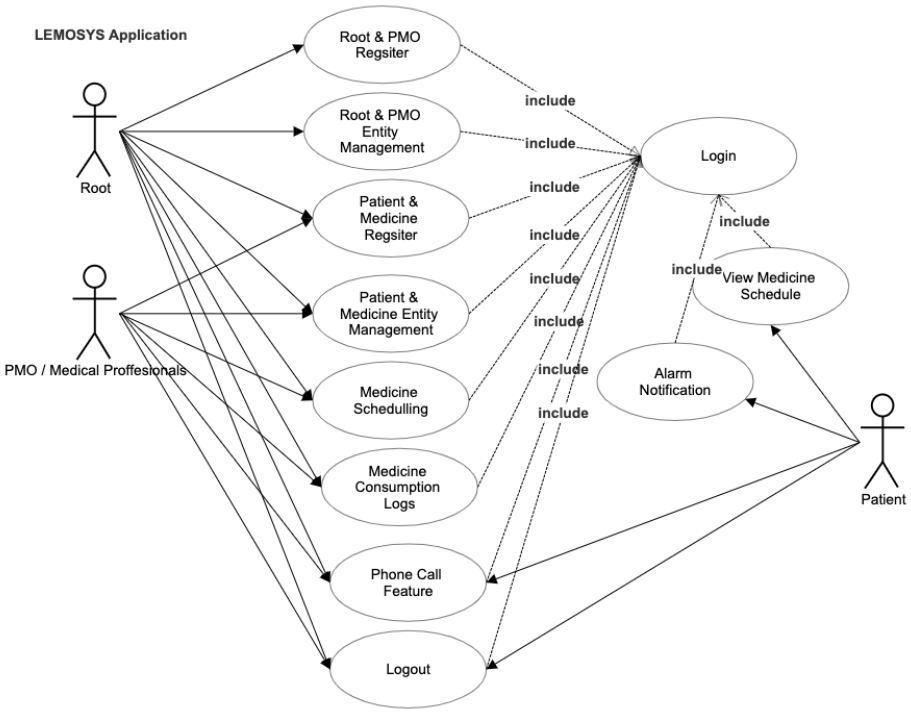

Figure 1. Use Case Diagram of LEMOSYS Aplication.

Figure 2 shows ER Diagram, which is the actual representation of the Class Diagram. The entities and attributes that will be used as part of the application work are described in the ER Diagram. The name, date of birth, gender, and address are used to identify patients and medical professionals. Particularly for patients, there are characteristics such as a leprosy-related medical history, prescription information and dosage regimens, as well as the patient's disciplinary status. Only health actors will have access to these data as part of the monitoring process. The name of the drug, the dosage, and the timing of taking the drug will be noted in a log that will be utilized by medical professionals to assess the extent of the treatment's efficacy.

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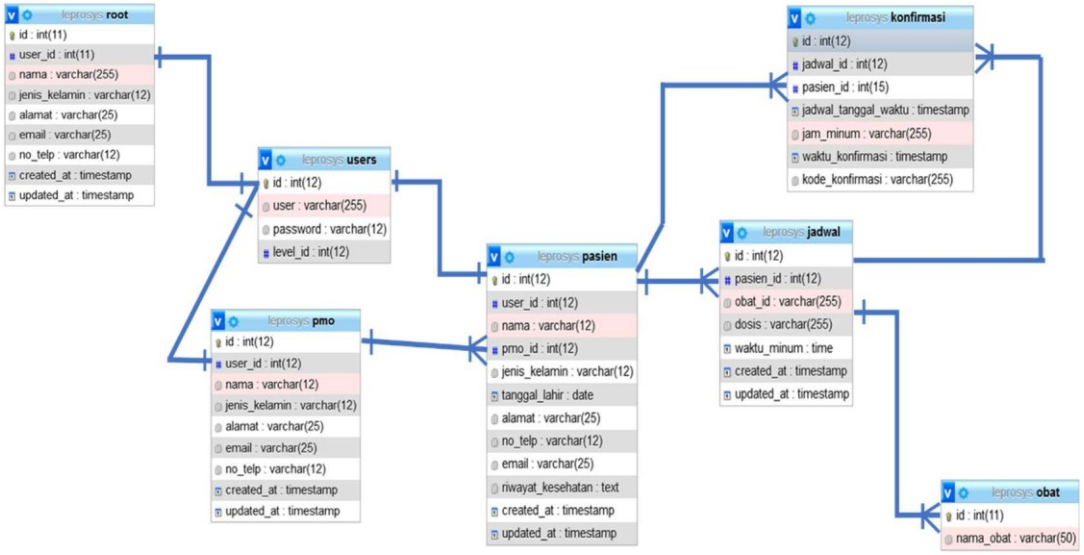

Figure 2. ER Diagram of LEMOSYS Application.

As part of user authentication, the flow of the registration process for patients and medical professionals must be followed as shown in Figure 3 and Figure 4. At the start of the treatment procedure, health actors acting as the authorities will complete the patient registration process. The administrator will especially handle the registration process for medical professionals. To ensure that only authorized users can schedule medicine intake, choose the dosage and kind of medication for leprosy patients, user authentication must be carried out. The patient's level of discipline is evaluated by how well they stick to their prescription routine. It is envisaged that the reminder function and monitoring of drug intake will boost the success rate of the pharmaceutical process.

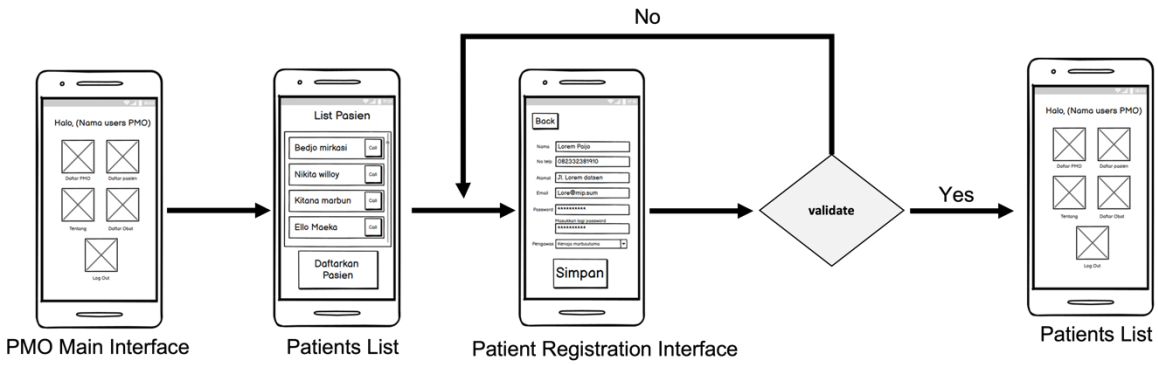

Figure 3. Patient Registration Userflow on The LEMOSYS Application.

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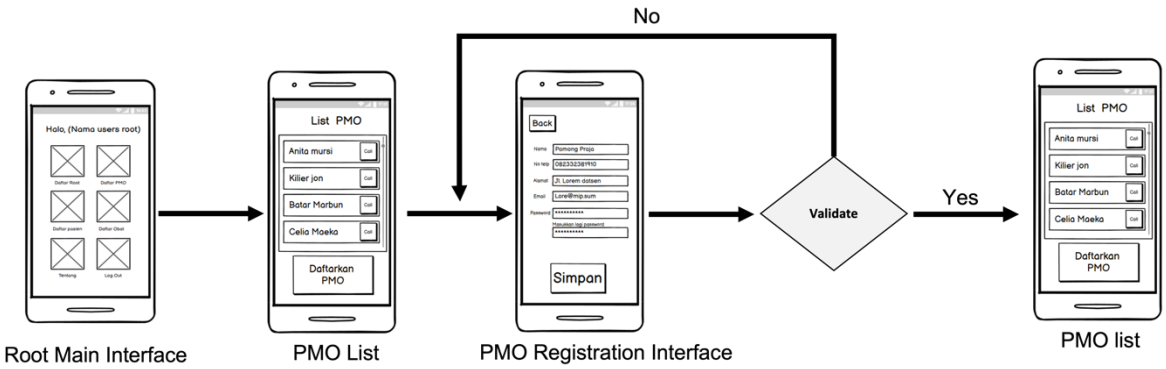

Figure 4. Medical Proffesionals Registration Userflow on The LEMOSYS Application.

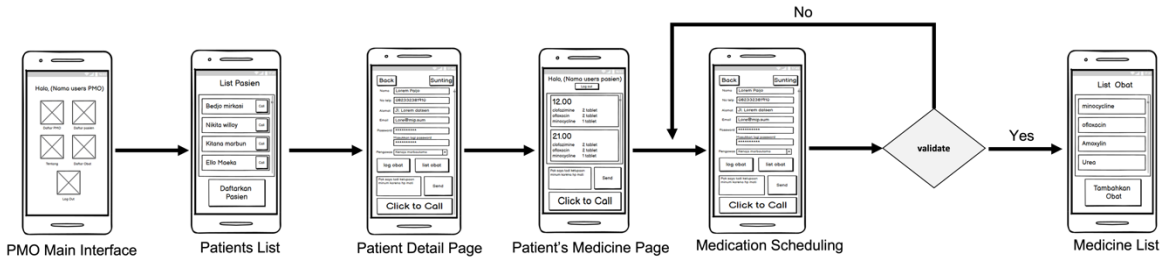

Figure 5. Medication Scheduling Userflow on The LEMOSYS Application.

The authentication process makes sure that each user has the necessary access rights to use the application's functionalities. After completing the authentication process, users can access the application's major features. Four program features, including Root/Administrator, Medical Proffesionals (PMO), Patients (*Pasien*), and Medicines (*Obat*) collectively represent the four key entities. User accounts are created using the PMO and Patient functionalities. The list of medications used for the patient's medication procedure is kept in the Medicines feature. Entity sub features are used for entity (Root, PMO, Patients and Medicine) management, which includes adding, modifying, and deleting entity data. Every step of the data management process, including validation, is documented in the application system log. This seeks to guarantee the data in the system's integrity. A number of crucial details, like who handled the data management and when, will be recorded in the application's system log. Only administrators specifically have access to these logs. Figure 6 shows the main feature of LEMOSYS Application.

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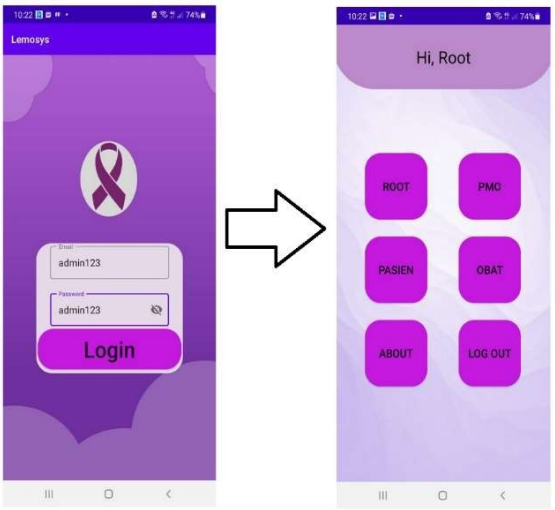

Figure 6. Main Feature of LEMOSYS Application.

Medical professionals are the only ones who can use the medication scheduling feature. By including the drug's take-time in the patient's data, the scheduling process is completed. The internal alarm feature of the smartphone device will be used for this scheduling process. This is done in anticipation of the fact that the internet connection is not required for the medication reminder feature. As part of the monitoring procedure for taking medicine, patient confirmation must be made following the completion of scheduling. The patient's level of discipline will be evaluated by the promptness of the confirmation. Similar findings were made by Yusmaniar (Yusmaniar, Susanto, Y., et al., 2020) in his study on the use of drug taking alarms (AMINO), which showed that they considerably improved patient medication compliance. Figure 7 shows the medication notification feature of LEMOSYS Application.

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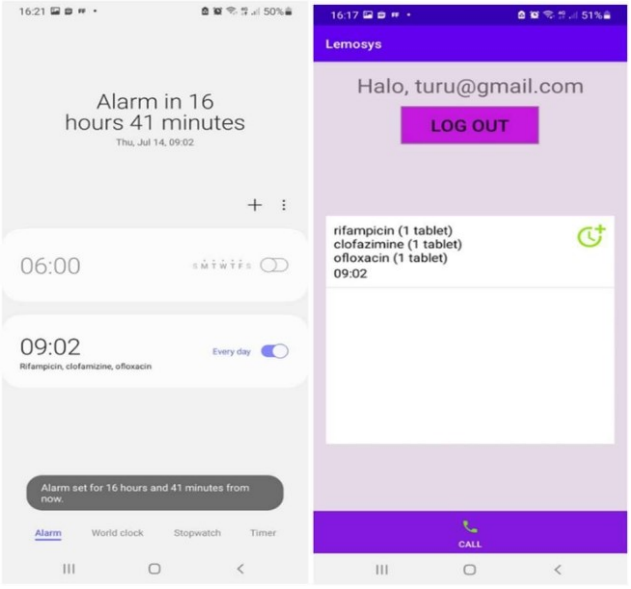

Figure 7. Medication Notification Feature of LEMOSYS Application.

This entity administration feature has undergone extensive and detailed testing. For all the developed application functionality, there are thirteen test cases. The thirteen test scenarios as in Table 1 examine entity management, setting medicine schedules, setting alarms, verifying taking medication features, and taking medication history features, among other things. All of the examined features have demonstrated proper operation in compliance with the requirements and layout of the application system, according to test results.

Table 1. Application Functionality Testing Result

No	Test Scenario Code	Application Features	Result
1	P001	Login	Success
2	P002	Root and Medical Proffesionals Registration	Success
3	P003	Root and Medical Proffesionals Data Management	Success
4	P004	Medicines and Patients Registration	Success
5	P005	Patients and Medicines Data	Success

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No	Test Scenario Code	Application Features	Result
		Management	
6	P006	Patients Medication Schedule	Success
7	P007	Patients Log	Success
8	P008	Medication Schedule	Success
9	P009	Alarm Notification Feature	Success
10	P010	Alarm Feature	Success
11	P011	Patients Confirmation	Success
12	P012	Logout	Success
13	P013	Calling Patients and Medical Proffesionals	Success

To assess the level of applicability of the application interface design, UI/UX component testing is done. UX evaluation is done to make sure the application's design adheres to excellent interface design and user experience standards so that users will not find it challenging to use (Wawolumaja, J. F., 2021). Six assessment components were evaluated by using a questionnaire to collect data. Attractiveness, clarity, efficiency, correctness, stimulation, and innovation are among the assessment's six criteria. The six assessment components are represented by the 26 questions. Testing was done on a selection of respondents chosen at random. The UEQ Data Analysis Tool is used to calculate the test data. The test results show that the component of the overall assessment receives a favorable score. The qualities of attractiveness, perspicuity, efficiency, and stimulation receive high marks. The dependability and novelty components, meanwhile, received ratings that were above average.The test results are displayed in Figure 8.

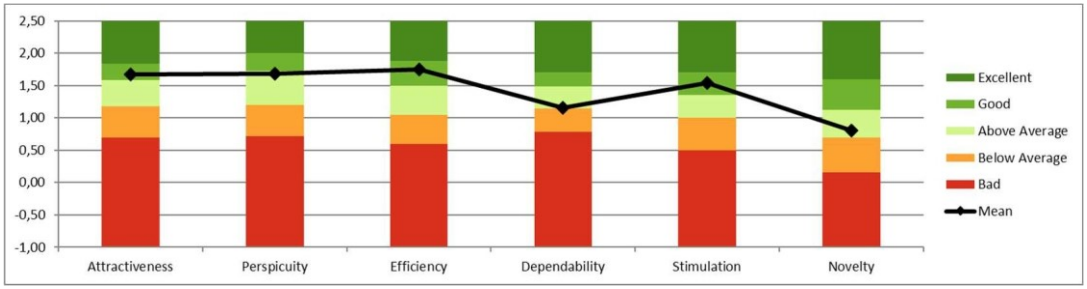

Figure 8. Benchmark Chart of UEQ Test Results.

CONCLUSION

The User Experience Questionnaire (UEQ) and black-box testing were used as the testing techniques for both functionality and design. The outcomes of the black box testing support the smooth operation of the application's functionalities. The UEQ results show that uniqueness, perspicuity, efficiency, dependability, dependability, and attractiveness are all above average (Above Average). The program received the maximum efficiency level rating based on the UEQ results 1.75, which indicates that it is regarded as having good usage efficiency and being usable.

As a result of the investigation that was done, this article was written. The outcomes of this study are anticipated to advance research in related areas and provide as justification for additional advancement. To obtain more concrete outcomes, additional testing and in-depth analysis to assess the effectiveness of this application when implemented are required. Because of the author's limited perspective and domain of competence, the researcher is aware that the work is still far from being directly applied. As a result, recommendations and helpful feedback are highly desired.

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