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An Android Application to Manage House Rental and Maintenance in Sri Lanka

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ABSTRACT The impact of COVID-19 outbreak was felt across all real estate management. A slowdown in the house rental and maintenance management system can be anticipated, as a result of the lock-down and limitations in financing. There is a severe impact on handling the relationship between the house owners, tenants, and the handymen. Property management is a crucial component of being a landlord, but it is far from straightforward. An appropriate methodology was carried out by the researchers to identify all the problems regarding real state property management through quantitative and qualitative data gathering procedures such as semi-structured interviews, face-to-face interviews, questionnaires, and direct observation of the selected sample. After analyzing, the house owner must screen tenants, collect rental fees, handle complaints, and keep tenants satisfied, among other things. In this pandemic situation, tenants faced more difficulties such as difficulty in finding a better house, paying monthly payments, paying utility bills, loss of connection with house owners, and finding the nearest handymen. Handymen suffered a lot mainly because of the inability to find works. Researchers' main aim is to give an appropriate solution for Sri Lankans. By examining the responses this investigation shows that a mobile application would be a better solution than implementing a web application. Iterative waterfall methodology was used for implementing this application. The researchers decided to develop this application using android studio and to enhance the effectiveness of the system by using 360 VR photography, Machine learning (ML)-based technologies, OTP/Fingerprint for User Verification and Geo location, and Geo-tagging.

INDEX TERMS: House Rental Maintenance Management, 360 VR Photography, Machine Learning

I INTRODUCTION

Serious implications have happened with the Sri Lankan economy with the global crisis. The real state sector is the main sector affected due to this pandemic situation. Owing to the changes in the rental market, landlords complained of low rental income and increased risk of losing renters. There are some issues for renters in finding the most suitable house. Compared to other handymen are the people who suffer more from not having a job during these days, even they cannot afford to find money to complete their daily work.//

Therefore, the main aim of the research was to identify the challenges faced by the tenants, handymen, and house owners in the current real estate management systems and give them a solution by implementing an android application for house rental and maintenance management in Sri Lanka.//

Their main objectives of the research were,

1. Analysing the challenges faced by users in current house rental and maintenance management.

2. Examine the current and existing developments which have been done regarding house rental and maintenance management in both Sri Lankan and worldwide contexts.

3. Analyzing the opinion on implementing mobile applications and designing an architecture for implementing a mobile application.

It is especially important to keep an efficient communication between the landlord, tenant, and the handyman, hence the use of mobile phone applications for contact tracing during the COVID-19 pandemic is vital. Accordingly, the researchers have identified that implementing a mobile application is more efficient than developing a web application.

To appropriately determine the processes and house rental and maintenance system user's requirements, quantitative and qualitative methodologies are applied. House owners, tenants, and handymen are the primary sources of collecting data. Data are collected by conducting semi-structured interviews, face- to-face interviews, questionnaires, and direct observations of the selected sample. Secondary data were collected through a survey conducted by house owners and tenants. Factors found to be influencing the real estate of Sri Lanka have been explored using websites and literature of current and past decades. Technologies that were used were 360-degree VR photo-

graphy in which users interact with and manipulate a simulated real or imaginary environment. Geo-Location & Geo Tagging which are helpful to find a nearby handyman using a variety of location-specific information and to identify the geographic location of the handyman, especifically near the specific house that needs repairing and maintenance service at trying times such as the recent pandemic. OTP/Fingerprint for User Verification, is advantageous when it comes to paying rental payments, utility bills, handyman payments requests because fingerprint identification is unique, highly accurate, and simple to use. Accordingly, identifying all the problems and difficulties faced by Sri Lankans, the researchers proposed an appropriate housing rental and maintenance management application.

II LITERATURE REVIEW

The secondary objective of this research is to examine examining the existing developments which have been done regarding house rental and maintenance management in both Sri Lankan and worldwide context. Researchers used research papers and websites to review the existing developments which have been done regarding house rental and maintenance management in both Sri Lankan and worldwide contexts. Here in this literature review, researchers have analyzed the existing developments which have been done regarding house rental and maintenance management in both Sri Lankan and worldwide contexts.

With the advancement of technology in Sri Lanka, most of the fields involved in the use of automated systems to enhance the performance and the efficiency of the tasks of organizations. However, the usage of automated systems for the real estate sector is low when compared with other developed countries. Nonetheless, it is possible to argue that recognizing possibilities from challenges and transforming obstacles into opportunities is the most strategic course of action in the country's real estate sector at this critical juncture.

And with the COVID-19 pandemic [19] the need for automated systems has arisen than the previous era. A considerable amount of literature has been published on property management systems all around the world and in Sri Lanka in past few years. This study [1] examined the current use of computer softwares in the New Zealand residential property management industry, as well as property managers' perspectives and experiences with the program. Property management software solutions handled a wide range of tasks, including tenant database management, rent roll and payment processing, vacancy management, maintenance of record keeping, financial accounting and reporting, and tenant communication. To find out what factors were most significant to survey respondents when choosing their company's property management software, they were given a list of major software characteristics and asked to rate how important each one was when choosing their current program. Reporting capabilities, ease of use, technical support, security processes, flexibility, communication capabilities, scalability, data storage and retrieval, maintenance activities, and software cost were all high-ranking qualities. However, it was recognized as one of the areas in which property managers were the least satisfied and had issues. The issue was discovered to be not with the technical support service itself, but with the difficulties of contacting the technical support service. In the past two decades, number of researchers [2] have sought to determine rent house management systems with basic technologies. Existing systems have basic features such as using the command buttons to manipulate the database, having the ability to add deleting viewing, and inserting data. The role of object-oriented programming and the role of relational database management system managing mostly important task. The systems have very simple interfaces only with the details of the tenant and the property owner.

The evidence of the research [3] resulted in the creation of a web-based housing management system. The system's purpose is to manage senior staff housing and to make it easier to apply for and update housing. It also enables the housing unit to gain simple access to data, boost productivity, and reduce manufacturing costs. The approaches utilized in this study were Adobe Creative Suite 5, which was used to construct the front end, while CorelDraw Version 15 was used to design the visuals on the pages, and XAMMP Server version 5.3.5, which had PHP and MySQL applications, that were used to make the site pages dynamic. Housing management systems are intended to handle data, keep track of it, and enable quick access to accommodation applications. This is necessary to establish decision-making procedures and institutional arrangements. However, suggestions for further enhancement were given, such as including a mobile alert and payment system notification. Problems of the existing system were typically characterized by paper-based information management practices. The advantages which have been identified by maintaining a web-based application were easy deployment, security, highly economical, cross-platform compatibility, and easy access to the database.

These studies discussed the study of the implementation of android applications for housing society management. Throughout the android platform, this project mainly used "Push notification Technology". This study [4] shows that the disadvantages of the existing system such as unreachable information, lack of authenticity and reliability and high time consumption. This paper proposes a smarter way of communication, fruitful solutions for day-to-day

problems. This application-based on the mobile platform it uses MVC architecture.

The most obvious finding that emerged from this study is [5] researchers establish a web application that helps the user to register an individual home or apartment to assist you to find the perfect rental home or property for search view in your target area. Understanding how exhausting it is to contact individual property agents, schedule appointments, and supply better service this application was designed. This website is designed to fulfill all the needs from buying property, selling property, leasing the property.

This study of the application [6] focuses on building a better relationship between buyers and sellers by simplifying many tasks such as mainly focusing on the nearest location prediction, identifying the vacant places, sending automatic rent reminders, package notifications, utility bills, emergency info, location information. In the extended system added the GPS in build and gave a live chat online option. Java script technology was used for implementation. The suggested approach supposes security mechanisms using a distance-vector algorithm including the message exchange and updates message security authentication mechanism without introducing significant network overheads and complexity.

A considerable amount of literature has been published on mobile applications for real estate management in various countries. These studies [7] presented a model mobile application to the automated monitoring system to determine the quality of housing to check the performance of low and medium costing and its assessment. The study briefed about the transformation of empirical housing data into the integrated software to determine housing quality. This study identifies the design quality indicators and parameters for affordable housing in Karachi Pakistan. The context of quality indicators for housing design are classified under various segments of housing design components. Using mobile applications in housing sector has been advantage for proposing a conceptual model for the building designing, proposing a model for selection of interior furnishing and floor covering materials and developing an automated building element selection system.

This research [8] extends knowledge on recent developments for locating the available handyman services within a locality identifies the advantage of having a mobile application that helps in streamlining the process of acquiring a handyman. This study applied agile methodology as software technology. handyman location details were obtained by GPS. The study [9] has confirmed a recommendation system that allows the users to hold out a preference-based cooperative filtering search on rental properties which preferences based on shallow learning, which could be applied to ease the task of locating the desired things online. AR and Vuforia are also used to visualize the space. The system was designed as an internet application victimization handlebar for the front-end and Nodes-ExpressJs for Back-end. The system performs better than existing algorithms and predicts better in a memory-based approach.

Recent evidence [12] suggests the solutions for proving adequate public rental housing (PRH) with decent quality and desirable location. This study utilized a machine learning technique called long short-term memory (LTSM) to construct a set of housing price prediction models which indicate the proximity to impact on nearby housing prices at the city. The approach taken by the study can facilitate improving the PRH policies and programs.

The first serious discussions and analyses of the study [13], technologies that were used to improve the efficiency of real estate management applications emerged during 2019. Disruptive digital technologies are a necessary part of today's reality. These technologies are converting traditional industries into more innovative and adaptable ones around the world. The situation of global real estate, on the other hand, has failed to improve and it is currently falling behind the technological curve. As a result of this latency, the relevant information is either not made available to end-users or is shared too late, resulting in an increased risk. Users of internet real estate platforms have expressed their concerns. As a result, there are more vacancies and post-occupancy regrets among the service providers.

The Big9 technologies, which include drones, the internet of things (IoT), clouds, software as a service (SaaS), big data, 3D scanning, wearable technologies, virtual and augmented realities (VR & AR), and artificial intelligence and robotics, are assessed and identified as the new technologies that are used for real estate management.

The RESTAM framework, which focuses on online platform-based real estate users, is expected to lay the groundwork for introducing the missing technology acceptance model for real estate stakeholders, so the real estate business is transforming traditional to smart real estate because of Big9 disruptive technologies. This will lessen real estate service users' post-occupancy regrets and improve relationships amongst diverse real estate stakeholders.

The empirical study [11] found new methods for creating information-rich interactive 3D environments that are increasing in demand as virtual reality (VR) and the corresponding 3D documentation and modeling technologies evolve into increasingly powerful and proven

tools for numerous applications in architecture, monument preservation, conservation/restoration, and the presentation of cultural heritage. The researcher discusses the creation of an immersive virtual reality application for the Imperial Cathedral in Königslutter, in which 360° panoramic pictures were merged as a novel and complementary method of visualization within the virtual world. So those empirical studies which were published open a path for a researcher to establish this implementation.

Referred [20] shows that the details on the real state app development companies in Sri Lanka. The architecture and the design that there used are much valuable for this research.

III METHODOLOGY

For an explicit research methodology, adapting the research onion model for this study is much efficient for the researchers. Research philosophy of this research is based on finding the best-suited android application for house rental maintenance management of Sri Lanka. As an ongoing research, it adheres to the view that only factual knowledge is gained through the observations and measurements, the researcher conducts a positivism research philosophy. A deductive approach was conducted by the researchers through this research, by through examining the existing application on real estate management of Sri Lanka which was invented and used by the expertise.

As the researcher mentioned previously, the first objective of this research is to identify and analyze the challenges faced by users in current house rental and maintenance management. And the third objective of the research was to analyze the opinion on implementing mobile applications and designing an architecture for implementing the mobile application.

To realise both above mentioned objectives researcher identified a specific set of people for the data collection. The specified audience were Sri Lankan tenants, handymen, and house owners. Researchers decided that the best way of collecting data from a specified audience was through a mobile survey. Then the researcher conducted a mobile survey among a specific group of people. Moreover, the researcher used to have some observations made on the current situation and took some ideas from users by meeting them directly through video conferencing. The firsthand attitudes of the community were collected by using primary sources mainly from semi-structured interviews, face-to-face interviews, questionnaires, and direct observation of the selected sample. Personal records, client histories, and service records gave additional information on existing systems.

The second objective of the research was to examine the current and existing developments which have been done regarding house rental and maintenance management in both Sri Lankan and worldwide contexts. Then researchers review research papers and websites. The analysis of those papers was mentioned in the above literature review.

The researchers used several kinds of research strategies such as conducting surveys on the identified audience, understanding the grounded theories and algorithms which were used, clearly understanding the current scenario, and focusing on the best solution for recovering the problems in the current situation. Researchers use an interactive inquiry technique that combines collaborative problem-solving with data-driven collaborative analysis or research to uncover underlying causes and make predictions about personal and organizational transformation in the future. Background investigation, habits, lifestyle, behavior, mutual differences, and the different perceptiveness of the clients are some parameters used in the investigation of the ethnography. Time horizon takes a major part in research for a while, here a cross-sectional time frame was used to conduct this research at one point in time using different samples of a selected group of people and the snapshots of a given point in time change at a societal level. Requirements for the mobile-based feedback system are collected during the literature review by observing similar types of systems and fact-finding techniques. This system is technically feasible as most of the house owners, tenants, and handymen have a smartphone.

The system is developed using android studio, Android SDK, and NetBeans. The server-side language is Java and database is based on cloud technology. The Google Play store sells Android apps, and researchers are use the Google Pay API to integrate them. The developer even set it up to accept credit cards. The researcher will define the google pay API version to request a payment token for the payment provider. Then developer should define the supported payment card networks and describe all allowed payment methods. Moreover, should create the PaymentClient instance by determining the readiness to pay with the Google Pay API. Then the developer should create a PaymentDataRequest object for registering event handler for user gesture to handle the response object. Iterative waterfall methodology is used during the development of the system as it reduces the developers' effort and time required to detect and correct the errors.

A Sample Population

The population of this research to gather data through questionnaire was selected normally from the people older than 20 years. People have been classified into three categories as house owners, tenants, and handymen. Thus, a non-

random sampling method was used to select the covering several provinces in Sri Lanka. Among the identified population, about 134 sample participants was selected to elaborate and collect the data while some data was collected through the research papers. In order to maintain high data accuracy, a formal way has been used in collecting data.

B Data Gathering

The survey data for this study was gathered through a questionnaire and literature reviews. The survey was conducted by delivering a questionnaire to publications and websites. This was done to collect 70 customers or tenants, 26 house owners, and 38 handymen and the literature review was completed by consulting 15 research data extremely precisely to improve the effectiveness of the research outcomes.

IV RESULTS AND DISCUSSION

Although the first objective of the research is to identify the challenges faced by the tenants, house owners, and handymen who are involving house rental and maintenance. As a result, the data was gathered by the quantitative approach using a survey. Those results were analyzed by the researcher as mentioned below.

Roles

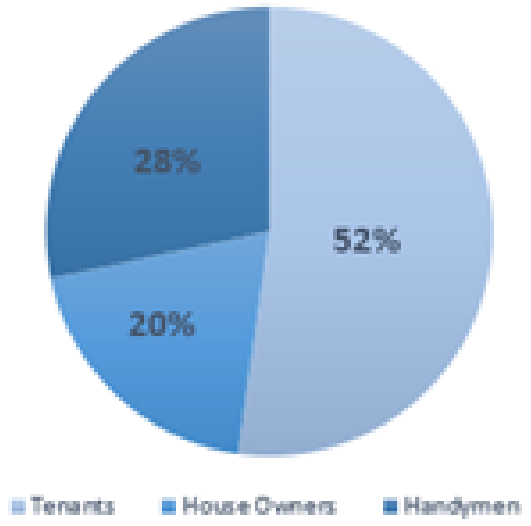

Figure 1. Designation Population Distribution

Analysis and Interpretation: As shown in Figure 1 of the 130 specimens that responded to the survey plurality of 52% were Tenants, 20% were house owners and 28% were handymen.

- Confirmation Statements

Table 1. Confirmation Statement 1

Confirmation 1	Yes	No	Maybe	Total
Facing a lot of challenges for daily life and economy due to covid -19 pandemic	119	2	13	134

Analysis and Interpretation: Table 1 shows the responses of the sample population for confirmation statement 1 and most of the respondents have agreed with the statement by giving all together 132 responses for yes and maybe.

Table 2. Confirmation Statement 2

Confirmation 2	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Total
Opinion on implementing mobile application to overcome the problems in house rental and management system.	91	27	9	4	1	134

Analysis and Interpretation: Table 2 shows the responses of the sample population for the confirmation statement 2. Most of the respondents have agreed with the statement by giving all together 118 responses for agreeing and strongly agree with implementing a mobile application to overcome the problems in the house rental management system.

- Challenges for house owners for their economy due to the covid-19 pandemic.

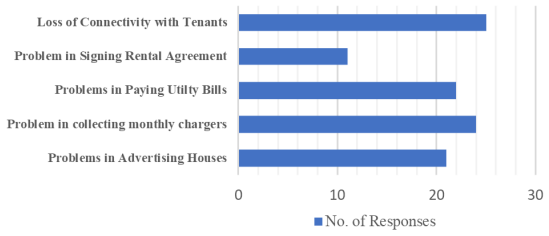

Figure 2. Challenges faced by House Owners

Analysis and Interpretation: Figure 2 shows the Challenges for house owners for their economy due to the covid-19 pandemic. Other than these challenges owners mentioned that it was very difficult to identify the nearest handymen for services.

- Challenges faced by tenants due to the covid-19 pandemic

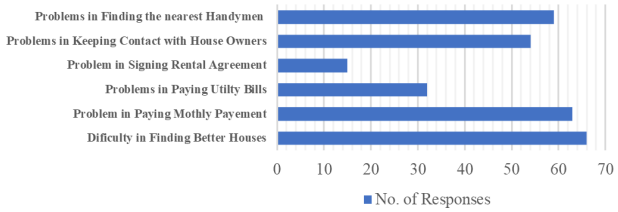

Figure 3. Challenges faced by Tenants

Analysis and Interpretation: Figure 3 shows the samples listed the attitudes on problems faced by tenants.

V REQUIREMENT ANALYSIS

There are four main user types in this system. This proposed system may be accessed by the administrator, house owner, handyman, and tenant using those four unique logins. Furthermore, each house owner and handyman have a unique username and password provided by the system when they register. The tenant can log in with their username and password, which they created when they first registered to the system. There are major functional requirements are listed below. Admin should be able to,

- Perform CRUD operations in the system.
- View house owners, houses, tenants, and handyman's details.
- Remove property advertisements.
- Update and remove owner-related house details and handyman details.

House owner should be able to,

- Add advertisements including house details.
- View appointments of tenants
- Search rented houses and tenants' details.
- View tenants' requests for maintenance.
- Sign house rental agreement with the tenant.
- Do handymen payments if need.
- Change own profile details and password

Tenants should be able to,

- View the properties available.
- Choose suitable houses and create an appointment to meet the owner.
- Choose the nearby handyman who suits their task.
- View the details & contact the handyman.
- Pay handyman payment.
- Sign house rental agreement with the owner.
- Pay house rental fees and utility bills through the app.
- Change their profile details and password.

The handyman should be able to,

- Notifications about the requests.
- Change their profile details and password.
- Add/Update their qualifications.
- Take work from the tenants and house owners.

Figure 4. UML Use Case Diagram for Proposed System

VI SYSTEM DESIGN

A *Technologies*

This mobile application supports the following technologies. The interactive viewing of panoramic images, usually comprising a 360-degree circle or a spherical perspective, is known as VR photography (virtual-reality photography). The art of recording or generating a full scene as a single image, as seen when rotating around a single central spot, is known as virtual reality photography. The entire virtual reality image might be a computer-generated effect, or a mixture of photography and computer-generated objects, and is usually formed by stitching together a series of photographs taken in a multi-row 360-degree rotation or utilizing an omnidirectional camera. To give the best

experience for tenants can optimize 360 player experiences for mobile applications, The application supports all panoramic images. Images can be captured with a 360 camera such as Ricoh Theta, Gopro MAX, Insta 360, or DSLR. Images can be rendered using 3D software. House owners could upload and share on the application. The efficiency of the application is increased as VR photography keeps human interaction intact which users interact with and manipulate a simulated real or imaginary environment.

The sole purpose of the smartphone app is to make our lives easier. As a result, when developing an Android application to provide the best handyman service, it's critical to consider the consumers' ease in locating the handymen who are the closest to them. As a result, the most significant feature in this application is the 'Find Nearby Handyman' option. Along with the location selection, it assists users in the following ways.

Machine learning (ML)-based technologies are rapidly being employed in real estate property management to improve service quality and efficiency. In-house rental and maintenance management presents a novel strategy for precisely predicting where the handymen are located. The researcher uses global positioning system (GPS) information from tenants' and house owners' mobile devices as well as Wi-Fi data that covers the whole area. Researchers learn some of the user's behavioural preferences based on the prediction findings. Researchers use these projected handyman locations to give more accurate services to our tenants and house owners.

All these novel technologies that the researchers are supposed to use will enhance the system's performance. Panoramic images which were added using 360 VR photography, will help users to take an accurate imagination of the houses. Further, machine learning, GPS, Geo location and Geo tagging technology, increase the easiness of finding nearby handymen. The authentication level of the application increased by OTP/Fingerprint.

VII DESIGN APPROACH

The house rental and maintenance management system mainly consist of seven main modules. Interactive mobile prototypes were created for each module for efficient the tasks of implementation.

A Registration and Login Module

House owners, handymen, and tenants should register for this system by themselves by entering their username and password as they preferred. Those usernames and passwords are used to log in to the system. If required users can change their passwords after login into their account. Login function should be used to access system users to log into the system. Users should already be with their usernames and passwords.

B Administration Module

The administrator has the authority to access all the house ownersâ€™ details, property details, handyman details, and tenant details. Admin can access the system by adding, editing, and deleting, and removing the users.

C House Rental Procedure Module

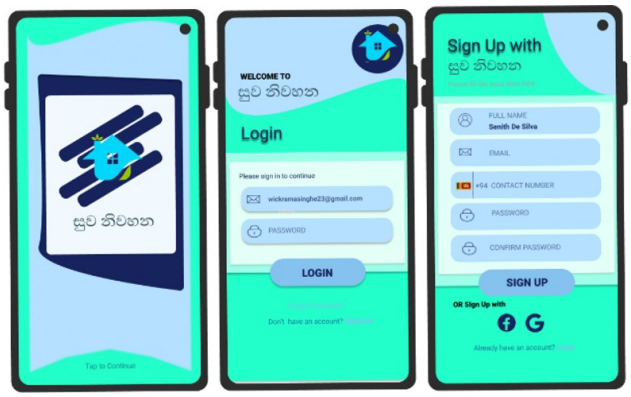

Figure 5. Mobile Prototypes for Login and Registration Module

The system provides the main function as rent a house. Property owners can advertise an advertisement to rent their houses. The owner should enter the house details which are mainly useful for tenants. owner details should be supplied for the contact purpose. House ID is auto generated when posting a house. Tenants can go through those advertisements to choose the best house by contacting using house owner details. Mainly the house owners can capture images of houses using a 360 camera and 3D software can be used for rendering the images. Those photographs can be posted with house details to give a live experience of the house.

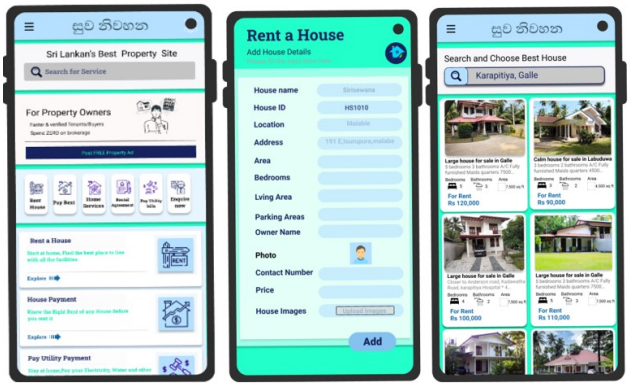

Figure 6. Mobile Prototypes for Rental House Procedure Module

D *Handymen Service Module*

The main function given by the application is handyman can add their service details to the system on their own. Tenants can go through the relevant service category, and they can find the handyman who can fulfill their request and contact them through using the given handyman details. The availability of the option of nearest handyman, prediction is very helpful during the current situation. The handyman who is available for the chosen service category will be shown on the map with their location.

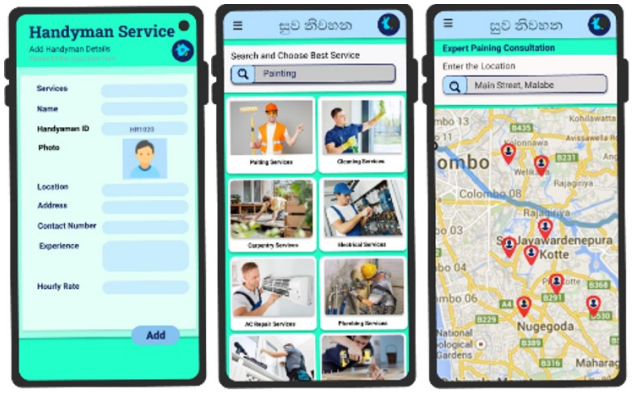

Figure 7. Mobile Prototypes for Handymen Service Module

E *Rental Agreement Module*

Renting a house according to the rules, regulations, and policies is vital to avoid conflicts. After tenants choose the best suitable house for them, an agreement should be signed between the house owner and the tenant. By using this application that purpose can be fulfilled. The owner and tenant can upload and download those relevant documents and those will be fully secured.

F *Payment Module*

There should be a connection between the tenant and the house owner mainly for the payment purpose. This application allows the tenants to pay the monthly house rentals for owners with other utility bill payments through the application itself and also handymen service payment can also pay through the app directly. Owner and tenants can pay an advance payment or full payment when requesting a service from the handyman. Tenants can transfer money to the handymen's bank account and the house owner's bank account through this application.

G *Notification Module*

Reminders, notifications, emails, and messages are compulsory in connecting the users to the application. The system should generate notifications on requests for maintenance service, tenants should be notified with newly posted advertisements, rental house payments, utility bills, and handymen payments. House owners should be notified of rental payment, tenants, and handyman's requests. The handyman should get reminders on their scheduled works, tenants' requests to be accepted or ignored.

After designing the flow of the application, researchers will implement this application. The application should be tested on a sample population and encouraging those users to provide their feedback and suggestions for this application.

Finally, researchers conclude that establishing this application by targeting the real estate users of Sri Lanka will effectively increase the direct communication and engagement between real estate owners and clients, improve customer engagement, create loyalty among users, create competitive advantage, offer an opportunity to provide offer unique services, and create efficient marketing in real estate industry in Sri Lanka.

VIII CONCLUSION & FURTHER WORK

This paper presents a solution to the problems faced by Sri Lankan house owners, tenants, and handymen during this COVID-19 pandemic situation. As the mobile phone is an essential device for people in these days, mobile application takes a prominent place in every industry. For further work researchers would recommend improving this android application with many more options for its users and to address the above-mentioned limitations and it would be more helpful to face the challenges in real estate industry in Sri Lanka during this COVID-19 pandemic situation. For future works, researchers plan to develop the paramedic application activating a mobile application into the IOS platform. Further, this system can be improved by using this application in both Sinhala and Tamil languages and USSD activation mode can be developed in this system as an additional functionality.

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