

# مِهْرَاب | Mehrab

IT 497: Graduation Project Report  
Product Release-2

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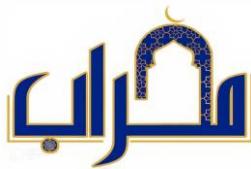


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## Mehrab (مِحْرَاب)

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### Abstract (English):

This project aims to enhance mosque management and community engagement by introducing the Mehrab system. Mehrab adopts a comprehensive approach that leverages IoT technology along with a mobile application to enhance user experience with respect to mosque activities management. The Agile methodology was used throughout the development process to ensure flexibility and continuous improvement. Mehrab system offers a range of functionalities designed to improve communication, task delegation, and decision-making within the mosque community. To ensure a secure and trackable solution, Mehrab incorporates IoT smart locks for controlling and monitoring mosque door access. This feature enables mosque managers to delegate tasks such as opening and closing doors, while tracking the time and the person responsible for each task. Mehrab also emphasizes data confidentiality and inclusivity by providing a single channel for both male and female users. It is expected that Mehrab impact will be extended beyond the local community, serving as a universal model for efficient mosque management practices. Mehrab system aims to make the global mosque community more connected by introducing innovative technologies and encouraging a sense of community. Experimental evaluation shows that the Mehrab system improves the mosque experience, enhances communication, enables effective task delegations, and enhances community engagement.

### Abstract (Arabic):

يهدف هذا المشروع إلى تعزيز إدارة المساجد والتواصل مع المجتمع من خلال تقديم نظام محراب. يعتمد محراب على نهج شامل والذي يتم فيه الاستفادة من تقنية إنترنت الأشياء بالإضافة إلى تطبيق محمول لتحسين تجربة المستخدمين في المسجد. استخدمت منهجية الأ杰يل طوال عملية التطوير لتعزيز المرونة والتحسين المستمر للمشروع. يوفر نظام محراب مجموعة من الميزات المصممة لتحسين التواصل وتوزيع المهام واتخاذ القرارات في مجتمع المحيط في المسجد. يمكن للمستخدمين التواصل بشكل فعال وتلقي الإعلانات من خلال التطبيق. بالإضافة إلى توفير منصة لمشاركة المجتمع في اتخاذ القرارات المتعلقة بالأنشطة الدينية اليومية. لضمان حلاً آمناً وقابلًا للتتبع، يتضمن محراب أقفالًا ذكية للتحكم ومراقبة عمليات فتح وإغلاق الأبواب في المسجد. تتيح هذه الميزة للإمام المسجد والمؤذن تفويض مهام مثل فتح وإغلاق الأبواب، مع تتبع الوقت والشخص المسؤول عن كل مهمة. يولي محراب أيضًا اهتمامًا بالغاً بسرية البيانات والمسؤولية من خلال توفير قناة واحدة للمستخدمين من الجنسين. كما أنه يوفر منصة موحدة حيث يمكن للمستخدمين الوصول إلى المحاضرات والبقاء على اطلاع على أنشطة المسجد. يتعدى تأثير المحراب المجتمع المحلي، حيث يعمل كنموذج لممارسات فعالة لإدارة المساجد على المستوى العالمي. من خلال تقديم تقنيات مبتكرة وتعزيز الروح المجتمعية، يهدف محراب إلى خلق مجتمع عالمي أكثر ارتباطاً وإدارة فعالة. بشكل عام، يهدف نظام محراب إلى تحويل تجربة المسجد، وتحسين التواصل، وتمكين تفويض المهام



بفعالية وتعزيز مشاركة المجتمع. من خلال التركيز على جانب جوهرية لإدارة المساجد، يقدم محراب نموذجاً لممارسات مبتكرة وأكثر شمولية يمكن أن تعود بالفائدة على مجتمعات المساجد في جميع أنحاء العالم.

**Keywords:**

Mosque activities management; smart lock; smart buildings; smart mosques; smart delegation; social enhancement; agile; mobile application.

## 1 Introduction

In Muslims communities the mosques are often serve as religious schools and community centers beside its typical role as place for five obligatory prayers. According to the latest statistics released by the Ministry of Islamic Affairs, Daw'ah and Guidance (MOIA) number of mosques in Saudi Arabia exceeds 80,000 [1]. These mosques play an active religious role that includes, but is not limited to, giving Qur'an educational sessions (Tahfeed), Qur'an recitation sessions and preaching lectures. These activities are organized by mosque's Imam and Muezzin, who referred to it in this document as mosque managers. In many cases, the times for preaching lectures and Qur'an educational sessions are usually announced in the mosque after or before prayers time. In some cases, social network applications such as WhatsApp are used to announce these activities across a limited number of participants. Using both communication channels, there is a possibility that not all expected beneficiaries receive the announcements, and thus miss out the activities.

On a typical day, Muezzin calls for Al-jama'ah pray (congregational prayer) by athan followed by iqama (after almost 15 minutes from the athan). The time for each prayer is known and there is enough time for prayers to prepare. This is not the case for Friday prayer, Taraweeh and Tahajjud (the late-night) prayers in Ramadan as the time is flexible. The Friday prayers are conducted when Friday sermon (khutbah) is finished whereas the time for Taraweeh and Tahajjud are usually selected to suit a group of people called "Jama'ah Almasjid". The time will be selected and announced in the mosque and thus the same problems in managing the religious activities are encountered. In bad weather conditions, there is an excuse from congregational prayers and everyone is supposed to pray in his home or some prayers can be combined. When such conditions occur, there is no communication channel that can be used to reach a wide range of mosque communities. The problem increases in modern neighborhoods that have a random distribution of mosques without considering site accessibility and centralization [2]. The random distribution leads to decreased social interaction between community members, making access to the congregational mosque more difficult. Therefore, many families face difficulties finding the best mosques, from this random distribution that offer Qur'an educational sessions (Tahfeed or recitation).

The tradition of congregating in mosques as a place for worship is deeply rooted in Islamic heritage. The mosques play an active role in the community [3]. They have great potential to serve community and contribute to disaster response and recovery phases through providing shelter, food, and medical supplies [4][5][6]. Therefore, there is a developing social relationship among the mosque community, especially between Jama'ah Almasjid, who pray and attend Friday sermons together. The members of this group volunteer to manage and organize mosque activities. They are supposed to make athan, iqama, lead prays and even open and close the mosque's doors when the Muezzin and Imam are not available. These substantial activities need to be communicated and managed across the members.

Given the forgoing, this project introduces Mehrab mobile application that encourages the use of technology to address miscommunication problems between mosque communities. Mehrab intends to use Internet of Things (IoT) technology, a smart lock, to open and close mosques' doors in such a trackable and monitored way. The application will also offer communication



facilities that allow active communication between Jama'ah Almasjid that may contribute to the active involvement of communities.

The remainder of this chapter is structured as follows. Section 1.1 describes the project goal and the main motive to build the application. This is followed by the main objectives of the project in section 1.2. Next, in section 1.3 and 1.4 the scope and the product vision statement are provided. Section 1.5 briefly discusses the development methodology and tools used in the development process. The main contribution of Mehrab system will be discussed in section 1.6. Finally, Section 1.7 is devoted for report organization.

## 1.1 Goal

The goal of building Mehrab is to create a comprehensive and user-centric Android application that serves as a centralized platform for effective mosque management. Mehrab aims to facilitate seamless communication and interaction among prayers and mosque managers, providing features such as announcements, contact options, and IoT-based control of mosque keys. By addressing the unique needs of mosque communities, Mehrab seeks to enhance the overall experience of prayers and streamline the operational aspects for mosque managers.

## 1.2 Objectives

In general, Mehrab system has the following objectives:

1. Improve the communication between mosque managers (Imam and Muezzin) and prayers for any reason, including complaints, suggestions, and social announcements.
2. Safely delegate the opening and closing of mosque doors using a smart IoT without the need to hand over the ordinary key. Smart keys can be revoked at any time by mosque managers.
3. Provide a user-friendly dashboard that shows all the previous delegation processes.
4. Manage the mosque's religious role in announcing and voting its activities.
5. Provide an opportunity for a community to vote and participate in decision making.
6. Receive notification when announcements are published from the mosques the prayer has joined.
7. The ability to view all announcements of mosques registered in Mehrab, also the ones related to the mosques a prayer joined.

## 1.3 Scope

Mehrab is an Arabic mobile application for Android smartphones that designed to coordinate mosque affairs in a small district in Riyadh. The application will engage the mosque community (who are adults, sane and Muslim). It is expected that the intended users are familiar with mobile applications and read Arabic. One mosque prototype will be designed to simulate mosques and test the application. The smart lock will be installed on the prototype.



## 1.4 Product Vision Statement

For Muslim communities **who** require establishing a communication between the mosque managers and mosque's surrounding community in regards to mosque affairs and their associated activities **the Mehrab is a mobile application that** offers active communicating channel and interactive delegation in door opening and closing **Unlike** other social and religious networking applications and websites **our product** establishes an effective persistent communication channel that effectively involves the community in decision making with respect to their daily religious activities besides interactively control the delegation of opening mosque doors in a smart, secure and trackable manner.

## 1.5 Development Methodology

Mehrab system was developed using Agile software development methodology, which is an iterative approach to manage the project, by following an agile framework such as Scrum [7]. We commence conducting a requirement elicitation process by publishing a questionnaire for prayers and interviewing mosque managers to understand their needs. We also consulted IoT engineers about the best technologies we can use to implement the solution. One such step that was important was collecting the data, and in an effort to enhance the authenticity of the application and ensure comprehensive mosque coverage. The team has contacted MOIA to obtain database access for all mosques in Riyadh. Confirmation has been received for a small district in Riyadh, which will be the designated target area covered by the Mehrab application. Mehrab team received database contains fifty mosques. For purpose of data privacy preservation, the names of mosque manager were anonymized and thus names were randomly altered. The team consulted architecture to design the mosque prototype using appropriate materials that allow smart lock installation.

After gathering the requirement, data and designing the prototype, team ordered the hardware that we needed, and planned the development phase. In order to accommodate any challenges that may arise during the development process, team adopt an incremental agile approach. Team used Dart language and Flutter framework to build an Android mobile application, as well as using Nuki Smart lock 3.0 pro API to program the Nuki smart lock device. with respect to database, team used Firebase real-time and Firestore NoSQL databases for storing and managing the system data. Several tools have been used during the development, including Android Studio IDE for coding, GitHub for version control, and Jira software for project management. At the end of each sprint, team performed acceptance and integration testing to respectively evaluate the user experience and measure the performance.

## 1.6 Main Contribution

The main contribution of this project is to incorporate IoT technologies and mobile application to facilitate mosque affairs management. The project introduces Mehrab application, an Arabic system for prayers and mosque managers, that provide potential to communicate and manage the delegation of mosque door opening. The application intends to contribute in improving the user experience by providing the mosque community with opportunities for effectively communicate and to participate in decision making with respect to daily religious activities whenever applicable. The experimental evaluation shows that involving the communities not only enhance user experience but also strengthens the sense of community within the mosque.



Mehrab offers the same features and communication channel for both gender while preserving data privacy. Therefore, male and female will have the same opportunity to vote and communicate with mosque managers.

In a smart city, a variety of systems have been interconnected to create an intelligent urban environment. Smart buildings serve as essential building blocks for smart cities including the mosques. In this scenario, different smart solutions have been introduced to address some aspects including: (i) energy consumption [The Smart Mosque of the Arabian Gulf: Solutions from the past for a sustainable, energy-efficient Mosque], (ii) coinbox [SMART MOSQUE COINBOX WITH IOT SYSTEM] and surveillance to ensure the safety and security of worshippers [IoT Safety and Security as Shared Responsibility]. However, these solutions rely on the technologies while ignoring the community's involvement. For example, mosque electricity and water supplies can automatically work during the prayer time and automatically stop after then without human intervention and without notifying the prayers. Moreover, the mosque doors are automatically open during prayers without human interaction but need someone to close it. Certainly, smart buildings address the need for automation, but building intelligence extend well beyond the simple automation and focuses on how the technology is used and managed. Therefore, fully automation is dangerous in many cases specially for door opening. In this scenario, the door will open even when the prayers are combined that raises question who will be responsible for any incident that happens in the mosque on that time. Mehrab committed to ensure a safe use of IoT through trackable delegation processes that comply with the regulations imposed by the mosque operators; in our project MOIA.

## 1.7 Report Organization

This chapter has presented the introduction and main problem underpinning the motivation of this project. In particular the section has presented the project goal, objectives, scope, product vision, development methodology and main contribution. The next chapter (Chapter 2) provides further background to the project that followed by literature review that shows examples for existing solutions. The system design and development are given in Chapter 4. Next, the system is evaluated. Chapter 6, devoted to conclude the report and introduce the future work. Finally, we conclude by acknowledging the contribution.



## 2 Background

This chapter presents a review of detailed descriptions and necessary domain knowledge required for understanding the project. The chapter commences, in section 2.1, by illustrating the mosque management constitution that highlight rule and regulation applied in Saudi Arabia with respect to mosques activities. This is followed by describing the IoT in particular the smart locks that can be used to manage mosque doors; section 2.2.

### 2.1 Mosques Management Constitution

The MOIA manages mosques through imposing regulations and enforcing compliance. This section outlines the regulations enforced by Saudi's MOIA which are applied in Mehrab application.

The mosque managers are key individuals employed by MOIA to play a significant role in mosques. The Muezzin is in charge of proclaims the call to the daily prayer (called Athan) at the proper times and maintaining mosque organization. The Imam leads the congregational prayer, preaches the Friday sermon, and provides spiritual leadership to the neighborhood. Imam plays a key role in planning community-beneficial events, programs, and charitable activities. It is important to note that the Imam and Muezzin have equal importance in the mosque. However, when a problem arises, it falls under the Imam's responsibility [8]. In Saudi Arabia, mosques and mosque managers information are stored in the MOIA database.

There are two categories of mosques: Jami and smaller mosques. The classifications are based on several factors including the size, location, and purpose of each mosque. For example, the Jami mosque, serves as the central hub for community worship and hosts Friday prayer and Friday sermon (khutbah). In contrast, the smaller mosques established by different societal groups are limited to five obligatory prayers [9]. A mosque's religious activities are under the supervision of MOIA, which includes mosque management. Typically, ministry is responsible for organizing and managing all religious activities in the mosques, preparing and maintaining them, supervising the mosque managers, organizing religious lessons, preaching lectures, and mosques religious activities.

In order to ensure the safety and security of mosque property, mosque policies must be in place. Some mosques take additional security measures, such as hiring security personnel, installing surveillance cameras, and implementing access control systems. Implementing these measures can deter potential intruders and improve the mosque's overall security. Usually the mosque managers, and security personnel hold the keys to mosques. They are responsible for securing the mosque and ensuring access to the mosque is restricted to authorized individuals. Typically, the keys are used to lock and unlock the mosque's doors and other areas. Volunteers may also be in possession of the mosque's keys in some cases. In all cases, this is at the discretion of the mosque managers, and it is not commonly done since the ordinal key cannot be revoked. A further enhancement to key security may be achieved by implementing electronic access control systems that keep track of who has accessed the mosque and at what time. The electronic key can be copied and thus mosque managers can revoke the key any time.



Mosques are forbidden to assemble funds or set up donation bins inside mosques or prayer spaces for any reason including, donations to provide breakfast for a fasting person. Therefore, only non-financial donations are allowed such as providing foods, water bottles and other catering services such as tissues, soaps and similar donations. Moreover, it is forbidden to install indoor cameras for the purpose of filming the Imam and worshippers, as well as broadcasting prayers in the media. Moreover, displaying posters or stickers in mosques without official permission from the relevant authorities is considered a violation of the law. Therefore, the traditional communication channels, explained in introduction chapter, do not suite this situation and thus random donations can be received due to lack of communication between communities.

## 2.2 Internet of Things (IoT)

The Internet of Things (IoT) is a concept that has revolutionized the way we live and paved the way for a more technologically advanced future. IoT has enabled innovations such as smart homes, clean energy, and smart transportation. Internet of Things (IoT) enables businesses, governments, and public/private sectors around the world to solve a variety of problems and challenges. The Smart Home System (SHS) concept is one of these developments that integrates home appliances with the internet for remote control [10], [11]. In the following subsection, different forms of smart locks that leverage IoT sensor to control opening and locking doors are introduced.

### 2.2.1 Smart Locks

Locks have been used for centuries and continue to be widely used today. Although they are reliable and easy to use, they have some limitations and drawbacks. One of the major limitations of traditional locks is the possibility of losing keys. This when occurs may compromise your security if they are found by someone else. Moreover, traditional locks make it difficult to track who accesses your property. Smart locks have been developed as an alternative to address these limitations.

In recent years, smart locks have gained significant popularity as part of SHS. They are more convenient to use due to the elimination of physical keys, which can be lost or stolen. Access to properties can instead be gained using alternative ways such as your smartphone, voice commands, and biometric identification. Furthermore, smart locks can be effectively integrated with other SHS devices, such as smart security systems and cameras. The integration of these technologies provides a comprehensive security solution that can be easily controlled from a single device.

The smart lock can be controlled and accessed in various ways, including: (i) biometrics, (ii) numerical PIN pads, (iii) Wi-Fi, and (iv) Bluetooth. The biometric lock uses facial or fingerprint to control opening and locking the doors. The cost of a biometric smart lock ranges from 300SAR to 3000SAR or more, which is considered the most expensive of all types. Factors that affect the cost include the type of lock, the brand, and the features included. For example, a biometric smart lock with additional security features such as intrusion alarms or remote monitoring can cost more than a basic biometric smart lock. Other companies also offer numerical PIN pad smart locks, which cost between 150SAR and 1000SAR and provide an additional level of through the use of a PIN code. However, this type of the lock may be

vulnerable to hacking or guessing of the PIN code. The lock's security may be compromised if the PIN code is simple to figure out or if the user forgets to keep their code secret.

### 2.2.2 Wi-Fi Smart Locks

In recent years, Wi-Fi enabled smart locks have become increasingly popular. With these locks, you can lock and unlock doors remotely without physical keys by connecting to Wi-Fi. A smart lock requires a power source in the form of a battery, they include a small, hidden battery compartment. Furthermore, smart locks incorporate electronic components that enable them to connect to the internet via Wi-Fi. This feature allows remote access to the lock via a smart device with internet connectivity. The Figure 1 below illustrates a Wi-Fi-based smart lock that can be controlled and accessed using smartphone application. A smart lock receives signals from a mobile application that contain specific data that informing it of the action to be taken. The signal is sent over the Wi-Fi network to the smart lock's internal system, which interprets the data and executes the requested action. The smart lock responds to a lock or unlock command initiated via the smartphone application by executing the corresponding action and providing confirmation to the user. It may be necessary to use a hub as a middleman between the Wi-Fi smart lock and the mobile application. The hub serves as a communication link between the two gadgets, enabling communication even when lock and mobile application are not directly linked to the same Wi-Fi network [12] [13].

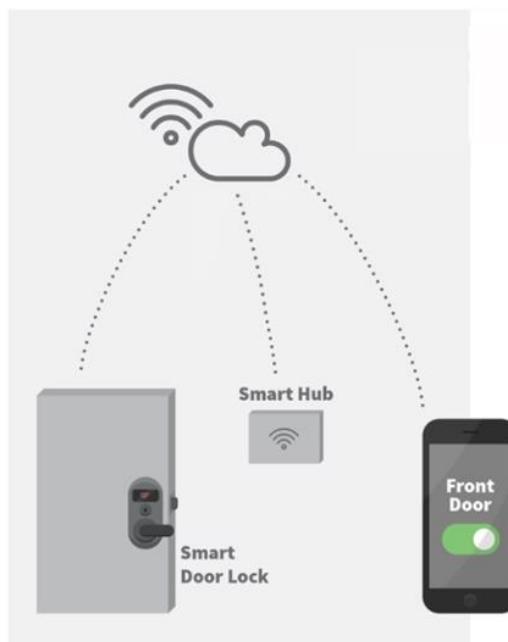


Figure 1: The operation of a smart lock [14]

Wi-Fi enabled smart locks offer a variety of features which can be beneficial to users in various settings. One example of such a feature is the ability to track door activity, such as who opened or closed the door and at what time. Furthermore, Wi-Fi smart locks can alert you in the event of door activity, therefore enhancing security. In addition, spare keys no longer need to be kept in order to share them with family or friends. As an alternative, you can simply grant them control over the key via the application, and then revoke control as necessary. All of these features are

only possible to implement while using Wi-Fi, which is why the Wi-Fi smart lock is the most appropriate choice for the proposed system, as these functions are of primary importance.

There are many famous companies that provide Wi-Fi smart locks such as August, Schlage, and Nuki. They all offer potential for four main features: (i) notifications, (ii) auto-unlock, (iii) remote access, and (iv) compatibility with other smart home systems. In addition, the ability to create and manage up to 200 access codes that can be revoked at any time. They also allow to track the activity of all doors. Table 1 shows a comparison between the three companies on a variety of factors. As the table shows Nuki is the only key that offers free API access to all users. In contrast, August and Schlage can only grant access to their partners or by sending an official request which may take a significant amount of time. Nuki smart locks do not require special configuration and can be installed without the assistance of a professional. Nuki's installation process is as shown in Figure 2 [15].

*Table 1: Comparative analysis between Nuki, August, Schlage*

	Free API	Easy Installation	Cost	Shipment	Weight
Nuki [15]	✓	✓	Affordable	Worldwide	500g
August [16]	✗	✗	Affordable	USA and Canada	500g
Schlage [17]	✗	✗	Expensive	Worldwide	2kg

Other smart locks may require special settings. Smart locks from Nuki and August cost between 500 and 1200 Saudi Riyals, while Schlage locks are priced between 800 and 2000 Saudi Riyals. Despite their high cost, Schlage smart locks are considered heavy compared to Nuki and August. This is due to the materials used for manufacturing the lock and thus is not suited to our application which will be prototyped using a light wooden box that may be too small to carry such a heavy lock.

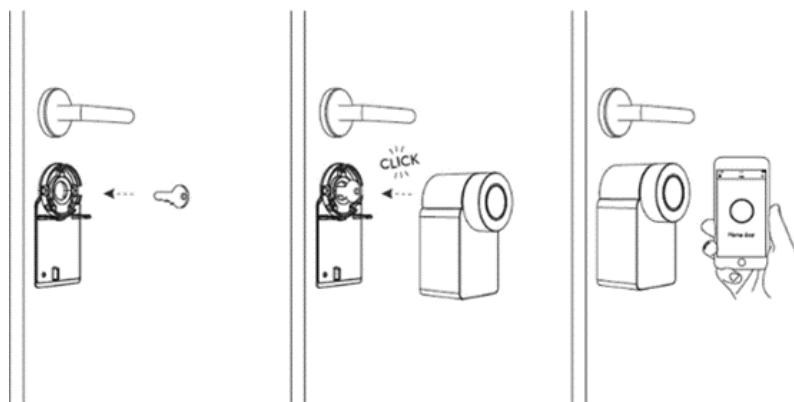


Figure 2: Nuki smart lock installation [15]

The Nuki APIs are well documented [15]. Sample code and tools are provided to help developers in getting started quickly. APIs are also platform-agnostic, meaning they work with a variety of programming languages and frameworks [15]. Nuki Smart Lock and Nuki API require a server or cloud-based service to connect to the Internet and enable remote access. The server or cloud-based service will serve as a connection point between the smart lock and the Internet, allowing remote lock control through APIs. You can remotely manage your Nuki Smart Lock and gain access to it via the Nuki API with Nuki Web, a cloud-based service that Nuki offers. With Nuki Web, you can set up access schedules, track activity, view logs, and receive notifications about lock activity. It is also possible to create and manage users.

## 3 Literature Review

This chapter reviews similar applications, systems, and websites developed to facilitate communication between related communities that share a common interest. Some of these systems are proposed theoretically in a research paper while others are released as products. The chapter is divided into four sections. The first section, Section 3.1, presents related research papers that introduce similar systems. Section 3.2 presents examples for mosques that utilize the smart systems to facilitates mosques operations. Next section discusses competitive applications and websites that offers similar functionality. In the last section, Section 3.4, a comparative analysis summary is presented between Mehrab features and the competitive available features.

### 3.1 Related Research

In this subsection, we will discuss similar systems that are based on theoretical research papers, and related to Mehrab; the Event2U [18] and Access-IoT [19].

#### 3.1.1 Event2U

Event2U is a conceptual e-commerce platform that aims to make mosques more effective community centers and to encourage Muslim society to build an attachment to them [18]. Typically, most people are unaware of the facilities and services provided by mosques. The authors argue that this was due to the assumption that they see mosques as places for religious worship only. Therefore, the system serves vendors, mosque and event planner to promote their services and facilities to the customers and centers to help finding the best and highly quality services and facilities that suited the event requirement. The main objective was to improve the social welfare for the society, enhance the mosque role and generate an income to upgrade the mosque infrastructure. To this end Event2U suggests to incorporate to mosque as many useful and valuable components and facilities as possible. Event2U is expected to foster a stronger connection between the mosque and the Muslims society through encouraging frequent visits to the mosque. The system addresses the problem of mosques lacking specific online platforms to promote their services and facilities, resulting in a lack of awareness of their services. Event2U aims to solve this problem by providing an e-commerce platform for mosques to advertise their offers. The system will address the lack of promotion of mosques' roles on any e-commerce platform, particularly in event management platforms. Although Event2U intends to provide a solution for mosques to advertise and promote their services and events through an online platform, it does not incorporate IoT technology to provide more facilities, such as smart key delegation and revoking the key when needed. This paper addressed sensitive issues that were relevant to our intention to construct Mehrab, therefore it is valuable and beneficial.

#### 3.1.2 ACCESS-IoT

The solution presented in [19] addresses the issue of manually controlling door locks. The proposed system (ACCESS) facilitates remote control and access through the Internet of Things (IoT), which has become a popular method of automating lock-key systems in homes and offices. ACCESS is a controlled extensible security system that improves accessibility and security. The paper represents a mechanism to observe visitors of household machinery, or any

appliance which can be remotely monitored, through an IoT associated with a mobile application, even when they are not present at home. It is possible that the elderly may have difficulty walking frequently to open doors, or even when a security breach, such as theft. Owners or supervisors can watch and know all guests. They can also choose whom to grant access.

An ACCESS system, shown in Figure 3, consists of a number of components that are linked together and controlled by a Raspberry Pi. The system will be connected to an application in order to satisfy three requirements; (i) Doorbell, (ii) Surveillance cameras and (iii) Microphone-speaker provision. In the event that a visitor presses the doorbell, a notification will be sent to the property owner via the application. This feature is accompanied by surveillance cameras that enable the property owner to monitor the visitor. Further, the application is equipped with a microphone and speaker that enables direct communication between the visitor and the owner of the property. Each time a lock or unlock operation is performed, logs are created, which can be accessed by users in order to determine when and who accessed their property.

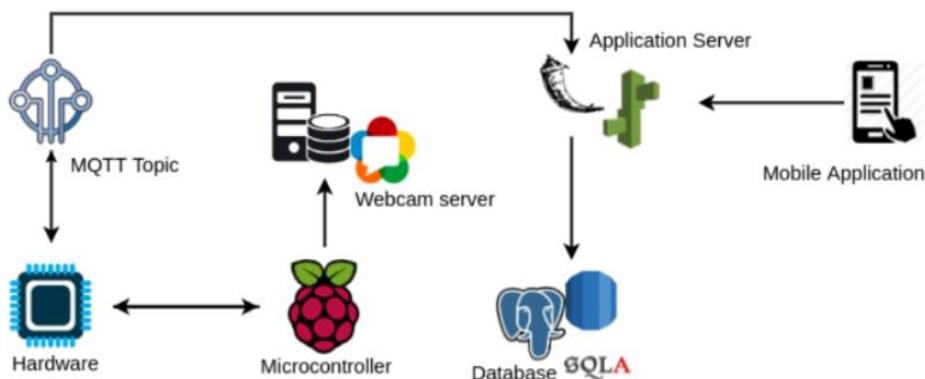


Figure 3: Access system

The hardware and microcontrollers, shown in Figure 3, consist of a solenoid lock, which represents a household lock, that is controlled by a relay connected to the Raspberry Pi. Moreover, it also contains an OLED display which displays the lock status and showing the entered password or any other message. In addition to a doorbell, when it is pressed the Raspberry Pi will notify the owner. Following this, a Web camera streams the live video of the visitor, alongside a speaker that allows the owner to speak through the mobile application. The device also includes a power supply that can be drawn from a power bank, and a database that has been created on the cloud to store data.

In ACCESS system there are three categories of users. The first is the primary owners, who represent users who have entire privileges that include performing lock, unlock operations, add new locks, edit and delete existing keys. In addition to the ability to add secondary users or guests and set time for the key expiration. The second type of user is the secondary owners, who have permissions similar to the primary owner but they cannot edit or delete locks. The last type of user is the guests who only have locking and unlocking permissions that can be executed only when they are in proximity of the lock. This paper is considerably valuable as the ACCESS overcomes the drawbacks of existing systems by implementing and applying IoT smart locks which is quite similar to Mehrab. Therefore, we adopt similar privileges that involve primary and guest privileges only.

### 3.2 Smart Mosques

SCADA system is a system used in various industries, including infrastructure, manufacturing, and utilities, to monitor and control processes and equipment remotely [20]. The SCADA system combines hardware and software components to gather real-time data, provide visualization of operational status, and allow for control and management of monitored devices and processes. The system automatically opens the doors, controls the lighting, and performs other tasks before the scheduled time. Therefore, SCADA has been used in mosque to allow the fully automated monitoring including the door opening [Monitoring, Surveillance and Control of the Crowds in the Holy Sites Using SCADA System]. The system also supports manual mode when the automatic system is disabled. This manual mode ensures that the mosque can continue to function smoothly even in cases where the automated system might experience technical issues or require maintenance. It provides flexibility and allows for immediate response and adjustments as needed. SCADA has been utilized recently in Haya Alassaf mosque; the smart mosque located in the heart of Mecca, 1 kilometer away from the Holy Mosque. The mosque includes several features, including lighting control, air conditioning control, fan control, door lock control, surveillance camera control, automatic and manual Adhan broadcasting, and several other features. When the automatic mode is activated, the mosque is controlled through a SCADA system. However, the fully automated process is dangerous with respect to worship places as the scenario does not comply to MOIA. Although SCADA provides an entire smart system, it does not involve the communities and does not address the communication issues identified in the literature.

Ma'amor is a mosque constructed in Riyadh as part of an integrated mosques corporation initiative aimed at enhancing the quality of life in the city. It embodies ambitious goals, creative vision, innovative architecture, and modern technologies that prioritize eco-friendly systems. It is an authentic mosque architecture model, meticulously designed to comply with Islamic teachings. The primary objective of the mosque is to meet the needs of the community, embracing a holistic approach to sustainability. Ma'amor incorporates electronic door control, which enhances security. Moreover, the mosque provides dedicated areas for preaching and recitation lectures, promoting a sense of spiritual engagement. As part of Ma'amor's mission, it is also committed to promoting social interaction among the local mosque community by providing gathering areas for neighborhood residents. As a means of further enhancing the quality of life, Ma'amor incorporates cutting-edge technologies and facilities. Automated air conditioning systems, advanced voice systems, and sensor-based lighting systems are examples of such systems. Ma'amor utilizes modern technology to provide worshippers and visitors with a seamless and comfortable experience.

Given the forgoing, Haya Alasaf mosque fully automates the operational process of mosque without the community involvement. The system allows masque managers to control all the aspect including lightening, door opening, building air condition and automated Athan. However, the community is not involved. The Ma'amor mosque embodies the true essence of Islamic teachings, fostering a sense of community, spirituality, and social responsibility. Mehrab and Ma'amor create a powerful alliance, propelling the mosque into the digital age while preserving its core values, traditions, and role as a center for spirituality, education, and community connection. Social communication, however, is limited to face-to-face contacts, so it does not address the issues raised in the literature. A number of these issues are related to female involvement and persistent announcements.

### 3.3 Competitive Product Analysis

This subsection presents a review of some existing applications and websites that have been developed to offer solution similar to Mehrab.

#### 3.3.1 Competitive Applications

##### 1. Masajid Mobile Application for Smartphones



This application is an official service provided by the MOIA for both iOS and Android users [21]. Among its various services are a list view of all mosques, prayer times, and religious activities. The application was developed in order to ensure development procedures and the provision of modern technical services for the Ministry.

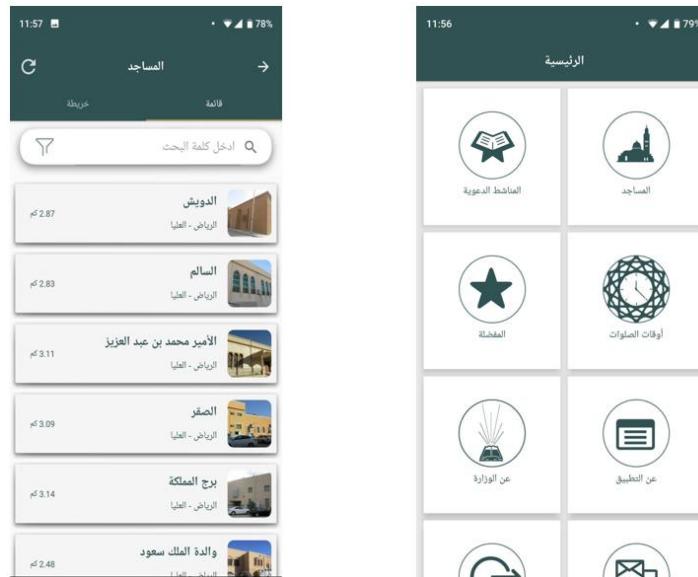


Figure 4: Masajid interfaces



##### 2. Masjidna Live Mobile Application for Smartphones

Masjidna Live application caters to both iOS and Android users [22]. There are numerous features within the application that simplify users' daily routine, thereby

saving them both time and effort. It is worth noting that since its initial launch, Masjidna Live is considered one of the applications that seeks continuous development to enhance its functionality and to address any issues through regular maintenance [22]. Masjidna Live users can join a particular mosque community and receive relevant notifications. However, the application does not support remote delegation of smart keys or electronic control mosques doors.

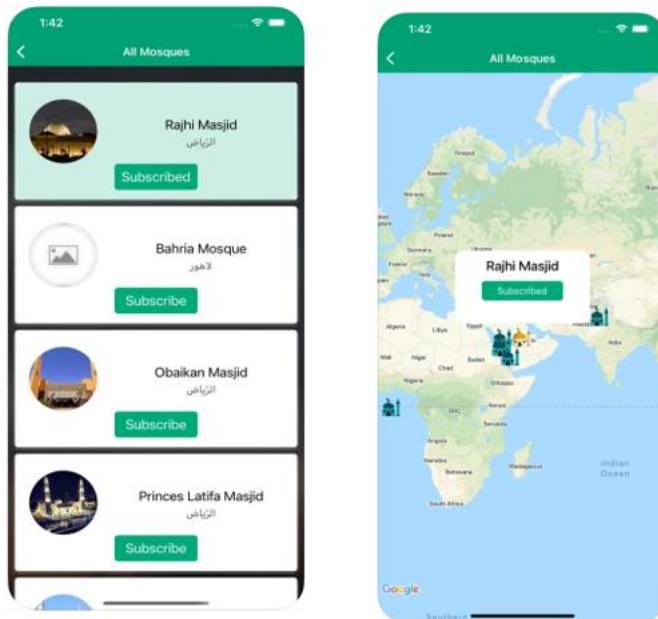


Figure 5: *Masjidna live interfaces*



### 3. Masjididi Mobile Application for Smartphones

Masjididi mobile application is exclusively available to iOS users [22]. The primary objective of the application is to enhance user experience by offering a wide range of services that support users in improving a dimension of their daily life. Masjididi provides the ability of viewing all mosques in a list. Moreover, the application features a map that displays all the available mosques with unique icons to indicate their locations. When clicking this icon, the application responds by providing the name of the corresponding mosque. Masjididi application has been thoughtfully designed which satisfies the user experience principles. Moreover, the application's usability and accessibility have been given priority to satisfy the user experience guidelines. These two concepts are reflected in the users' positive experience with the application. Masjididi application does not provide a communication channel between mosque managers and the mosque community.



Figure 6: *Majidi* interfaces



#### 4. Boyout Allah Mobile Application for Smartphones

Boyout Allah mobile application is exclusively available for iOS users [22]. It offers various services similar to those provided by the Mehrab application, such as displaying a list of all available mosques, contact the mosque supervisor (mosque managers) and thus enables users to convey messages, opinions, and even complaints. Similar to the feature in the Mehrab, Boyout Allah application also enables the Imam to announce mosque activity details and send the announcements to members of the mosque community. However, Boyout Allah application goes one step further by providing the Imam with the ability to add mosque activities to the mosque calendar. The application does not offer a means of engaging the mosque community in decision-making processes, such as voting. Finally, Boyout Allah provides users with the opportunity to contact the support team to address any issues that they might encounter while using the application as was the case with Mehrab.

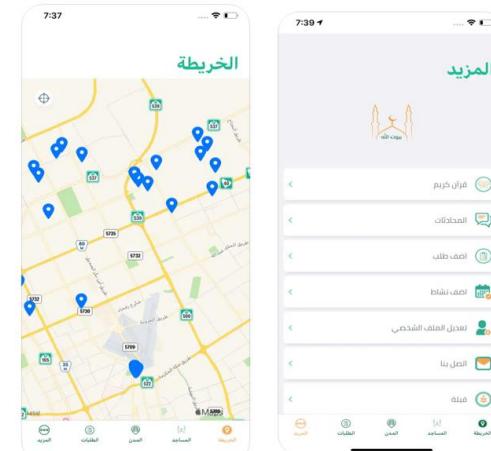


Figure 7: *Boyout Allah* interfaces

### 3.2.2 Competitive Websites



#### 5. Muslims Association of Canada

The Muslim Association of Canada (MAC) is a Canadian charitable organization and grassroots social movement [23]. This association offers various information, programs, events and activities through a website. MAC focuses on serving Canadians by educating and motivating Muslims by creating spaces and programs for holistic education and personal development, in order to build communities and strengthen neighborhoods. Moreover, MAC provides a list of all institutions, such as schools, centers and mosques. The MAC website provides information about each mosque in the province of Canada, including prayer times, the latest news, and events. Furthermore, they allow prayers to donate to a specific mosque, and volunteer to achieve their goals and objectives. MAC gives its intended users the ability to register for Friday prayer and attend its sermons. Moreover, MAC offers the ability to share their experience at MAC centers through comments. However, it does not provide a way to contact mosque managers.

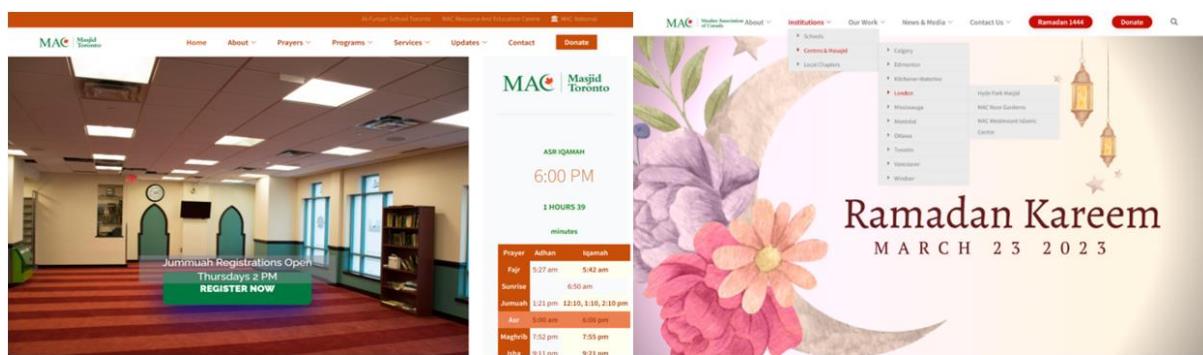


Figure 8: MAC web page



#### 6. Prayers Connect

Prayers Connect is US based non-profit organization that provides a website and tools to allow community leaders and their members to remain reciprocally connected [24]. The Prayers Connect application keeps users informed about their services and events around the clock. The application provides features and services that enhance and facilitate Muslims' experience abroad, including prayer and Iqama times. Moreover, the Prayers Connect website allows users to search for nearby mosques and Islamic events which might include Qur'an classes and other activities with all the details for both mosques and events. Prayers Connect offers the opportunity to donate to mosques through its donation platform. Users, however, cannot receive announcements or updates regarding Islamic events.

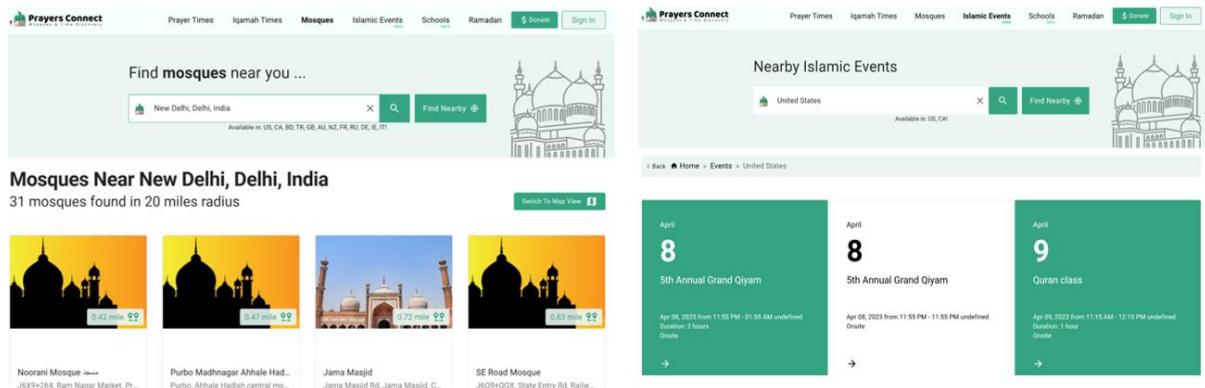


Figure 9: Prayers connect pages

### 3.4 Competitive Analysis Summary

The key features of mosque affairs management systems including applications and websites have been summarized in Table 2. The table indicates that not all competitors offer Arabic support. It may be due to differences in user characteristics and the language of the target audience. As an example, MAC and Prayers Connect provide services to individuals outside of Saudi Arabia, while the other competitors provide services to individuals within Saudi Arabia. Only Masjidna Live offers the ability to send announcements and allow users to join specific mosque communities. So far, none of the systems discussed have included a feature that enables users (not a specific user) to use a smart key to open and close mosque doors.

Furthermore, no competitor seeks to engage mosque communities in decision-making. Boyout Allah is the only application that allows users to contact mosque managers. Unlike its competitors, Masjidna Live does not display mosque information other than their names. Only Mehrab and Boyout Allah provide different privileges to mosque managers and users, while the other systems are exclusive to mosques.

Based on the information presented, Mehrab appears to be an Arabic-friendly mobile/IoT application that offers features not found elsewhere. Using the Mehrab application, mosque managers can control mosque door opening and closing, as well as effectively delegate door control responsibility without offering an ordinary key. Mehrab also permits mosque managers to revoke smart keys of anyone previously been delegated. Furthermore, mosque managers will be able to send announcements to users regarding mosque activities or any other information they wish to share with users. Apart from all the features provided by the Mehrab, mosque managers offered potential to allow the mosque community engagement in decision-making for significant decisions. This protentional fosters a sense of belonging and facilitating participation in the process. Moreover, mosque managers will be able to respond to users' questions, complaints and opinions via private chat.

*Note that:* ✓ means the feature is available, ✗ means the product does not offer the feature and NA means that the information is not available

Table 2: Key features comparison

Product	Masajid	Masjidn a live	Masjidi	Boyyut Allah	MAC	Prayers connect	Mehrab
Feature							
Arabic language	✓	✓	✓	✓	✗	✗	✓
receive announcements	NA	✓	✗	NA	✗	✗	✓
smart key to control mosques doors	✗	✗	✗	✗	✗	✗	✓
join a specific mosque community	NA	✓	✗	NA	✗	✗	✓
the ability to be engaged in decision making	NA	✗	✗	✓	NA	NA	✓
contact with mosque managers	NA	✗	✗	✓	✗	✗	✓
Details about each mosque	✓	✗	NA	✓	✓	✓	✓
Outside/inside Saudi Arabia	Inside	Inside	Inside	Inside	Outside	Both	Inside
System type	Application	Application	Application	Application	Website	Website	Application
Targeted users	Prayers	Prayers	Prayers	mosque managers, prayers	Prayers	Prayers	mosque managers, prayers, admin



## 4 System Design and Development

The purpose of this chapter is to describe the design and methodology used to collect system requirements. Furthermore, the chapter presents the core design and implementation details.

### 4.1 Methodology

During the development of Mehrab, we employed an agile development approach, which is characterized by its adaptability. This methodology enabled us to meet the changing needs of prayers and mosque managers. As part of the design process, we engaged closely with users to ensure that we designed the product based on their individual needs. We delivered functional features on a regular basis by breaking down the project into manageable increments. The continuous integration and delivery pipelines ensured a smooth development and release process. Our collaborative team maintained transparent communication, allowing quick adaptation to changes and prioritization of features based on user value. Following agile principles, we delivered an early minimum viable product and iteratively enhanced Mehrab to meet the evolving needs of our mosque community.

In adopting the Scrum Framework, our team adhered to distinct roles, events, and artifacts. The framework involved three key roles, shown in Table 3: (i) the product owner, (ii) the scrum master, and (iii) the development team. The product owner is responsible for defining priorities, the scrum master facilitates the processes and removes impediments. The developer's team develops the system throughout self-organizing the cross-functional. The stakeholders are the expected system users when the system is released.

There are three Scrum artifacts, namely the product backlog, the sprint backlog, and the product increment. A product backlog consists of a prioritized list of user stories; this will be presented in Section later in this chapter. Developers team create the Sprint backlog, which contains the selected user stories for this sprint. Our product increment is the output of the sprint that takes us a step forward in the direction of our product's goals.

*Table 3: Scrum team*

Scrum Team	
<b>Product Owner:</b>	Dr. Nawal Almutairi
<b>Developers:</b>	Nouf Alsadhan Aljawharah Alzamil Lama Alshaya Jumanah Aldawsari
<b>Scrum Master (SM):</b>	Dr. Maha Alyahya



<b>Stakeholders:</b>	Mosque managers, Prayers, Admins, and people who will be benefiting from our solution (people who are interested in mosque activities and workshops) for a small area in Riyadh.
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Throughout Mehrab development we embraced agile principles, prioritizing flexibility, quick response to changing requirements, and fostering continuous communication within our team. A Scrum framework guides our regular sprint cycles, which involve collaborative product backlog refinement and sprint planning sessions. Daily Scrum meetings-maintained team alignment and promptly addressed challenges. Sprint reviews and retrospectives facilitate feedback gathering and continuous process improvement.

In developing Mehrab, we utilized tools such as Jira to manage agile projects and GitHub to maintain version control. Jira simplifies task tracking, sprint management, and backlog organization, ensuring clear communication and alignment within the team. The GitHub environment facilitates collaborative coding, allowing us to work simultaneously, and provides features such as pull requests and code reviews in order to facilitate the development of code. The combination of these tools plays a vital role in improving project organization, collaboration, and version control throughout the development process.

Jira link - [Mehrab](#)



GitHub link - [Mehrab](#)



## 4.2 System Requirements

To define the system requirements, we focused on selecting the essential functionalities and specifications necessary for the successful development and deployment of the project. It involved a comprehensive analysis to ensure that the software would meet the identified needs and objectives.

### 4.2.1 System Users

Mehrab is designed for three types of users: (i) mosque managers (Imam and Muezzin), (ii) mosque members (prayers and Jama'ah Almasjid), and (iii) an administrator (admin). The mosque managers are expected to have a medium level of technical knowledge in order to use and benefit from the application. To navigate and interact with the application interface, they should be able to read and write Arabic. Community members (prayer/Jama'ah Almasjid) should also have a medium technical background and ability to read and write in Arabic. The prayers and Jama'ah Almasjid are expected to know how to use their smartphones. The admin is expected to know Arabic and have a medium to high level of technical knowledge to use the system and access the admin interface.



#### 4.2.2 Requirements Elicitation and Analysis

In order to gather user requirements, questionnaires and interviews were conducted. A questionnaire is used to collect information regarding prayers and jama'ah almasjid requirements, whereas an interview is used to determine the requirements of mosque managers. The results of the questionnaires and interviews are discussed in the following headings.

#### Requirements Elicitation using Questionnaires

The survey was conducted to elicit the user's requirements. We distributed the survey electronically using Google Forms, and we received responses from 400 participants; 229 males and 171 females. The survey questions and detailed results are given in Appendix A.

According to our survey, 75.6% of respondents visited a mosque (at least once) and found it closed at times when it should have been open, such as ten minutes before or after prayers. It is interesting to note that 82% of respondents have visited a mosque to pray Tahajjud or Taraweeh and discovered that the prayers have already finished. This indicates that the prayers time is not communicated widely to the intended audience. Therefore, it may be difficult to plan and attend mosque prayers in this situation. In terms of the means used to contact mosque managers, 50.5% agreed that they always contact mosque managers physically (in person), or if they could not, they send someone on their behalf. A total of 30.3% of the respondents reported that they had no means of communication. This illustrates that most people rely on traditional methods, which are often difficult and unreliable. Therefore, a large percentage were unsatisfied with the current communication methods. The results encourage Mehrab team to contribute toward improving the community experience through finding suitable means that facilitate communication between community and mosque managers.

Survey indicts that community often learn about Qur'an sessions (Tahfeed and recitation) through advertisements and posters posted inside mosques. The majority of those interested in religious lessons receive information about the lesson time and location from social media groups such as WhatsApp and Telegram.

Regarding the Tahajjud and Taraweeh prayers during Ramadan, 55% of respondents received information about the start time through the Imam after the prayer. According to the survey, 21.3% of respondents found it difficult to find such information. This indicates the difficulty of obtaining information, especially for individuals who do not reside in the mosque vicinity. Female respondents commented that they knew the times from their male relatives. Respondents to a questionnaire stated that they would only know the start time of prayer after several mosque visits, which is considered a disadvantage. 84% of those who were supposed to attend the lecture did not attend because they were unaware of the details. The Mehrab team has worked diligently to develop an application that provides such information to a broad audience. Especially when we find that 72.8% of respondents expressed substantial interest in the Mehrab application.

There is a majority (51.2%) of respondents who prefer to join mosques from the mosque list. This means they might join mosques in the surrounding areas or in distance. According to the survey, 77.8% of respondents do not currently participate in decision-making. For this reason, working on Mehrab will solve the inconvenience of the mosque community in a way that



allows them to take part in decision making. Further, 58.9% of respondents expressed an interest in being part of the decision-making process when voting on mosque activities. As a result of this high percentage, we will certainly consider finding an effective means of enabling users to participate in decision making. It was found that 64.7% of respondents liked and supported the idea of having smart keys for mosque doors in order to make it easier for Jama'ah Almasjid to open the doors during prayers. 62% of participants are willing to open or/and close mosque doors on their own one day once they earned the trust of the Imam and Muezzin. The majority of respondents (78%) indicated that they would be interested in having a mobile application for mosque affairs management that would allow them to keep up to date with the activities and events of the mosques they prefer, as well as be able to communicate with mosque managers. We also asked participants if they preferred communicating with Jama'ah Almasjid and mosque managers, or wanted to limit the communication with mosque managers. The results show that 58.3% would like to communicate with Jama'ah Almasjid and mosque managers. The foregoing results motivated us to create an application that incorporates the features discussed in the questionnaire, in order to improve the experience of mosque communities.

Lastly, users commented about the features and functions they would like Mehrab to provide. Many users would like to know the number of funerals in particular mosques and to view updated information regarding each mosque, including: mosque name, Imam, Muezzin, and location. It is also important to announce religious lectures and their details, including: the time of the lecture, the name of the speaker, and the topic of the lecture beside prayer time. In addition, they would like the announcements to be made on Hijri dates and would like to contact mosque managers in order to share comments, suggestions, and complaints.

## Requirements Elicitation using Interview

Four interviews were conducted with two imams and two muezzins. Appendix B contains the interview questions. The interviewees shared with us what mosque activities they are currently managing such as organizing and supervising all mosque lectures and workshops, most of which are handled by different organizations such as the MOIA and some offices. We learned from mosque managers what difficulties they have encountered with regard to management, and the importance of developing a more effective method of management is highlighted. Their experience is that they usually receive complaints and questions directly from the congregation after prayer, and that they either respond to them directly with the issue that can be resolved, or they delay responding until they have an answer. Mosque managers expressed dissatisfaction with the current method. There was a comment about how difficult it was to get back to the person who requested an answer. The interviewees described their methods of announcing mosque activities and other announcements, including posters, meetings, and mosque screens. They showed interest in adopting a better communication method. The responses indicate that they contact Jama'ah Almasjid primarily for complaints and inquiries. As the primary objective of the application is to organize and manage the mosque activities, they oppose the existence of conversations among Jama'ah Almasjid. They argued that significant information may be missed by Jama'ah Almasjid due to unimportant communications.



Several argued that the authority should be equal between the Imam and Muezzin, while others argued the opposite, since the Imam considers himself responsible to the Ministry. To avoid these problems, it is important to show who has made each announcement. They are in favor of involving all prayers in decision making, and they believe that voting using an application is the most effective way to do so. If they are unable to attend the mosque, they often ask someone on their behalf to carry out their duties regarding prayer, opening and closing the mosque doors. Therefore, they support the idea of the smart lock. The participants agreed that the existence of a program such as Mehrab might be useful, and that it is a solution that should have been developed years ago.

#### 4.2.3 User Interactions

The use case diagram (Figure 10) shows Mehrab actors, their use cases and functionalities provided by Mehrab application. As shown in the figure and for the purpose of better understanding the system and the incoming sections, a new general category of users is established for those who share the same role. Therefore, the term user refers to all kinds of users, including admin, prayers, and mosque managers. Recall that mosque managers refer to both the Imam and Muezzin. The prayers can be a Jama'ah almasjid member or just anyone who attends prayers in the mosque.

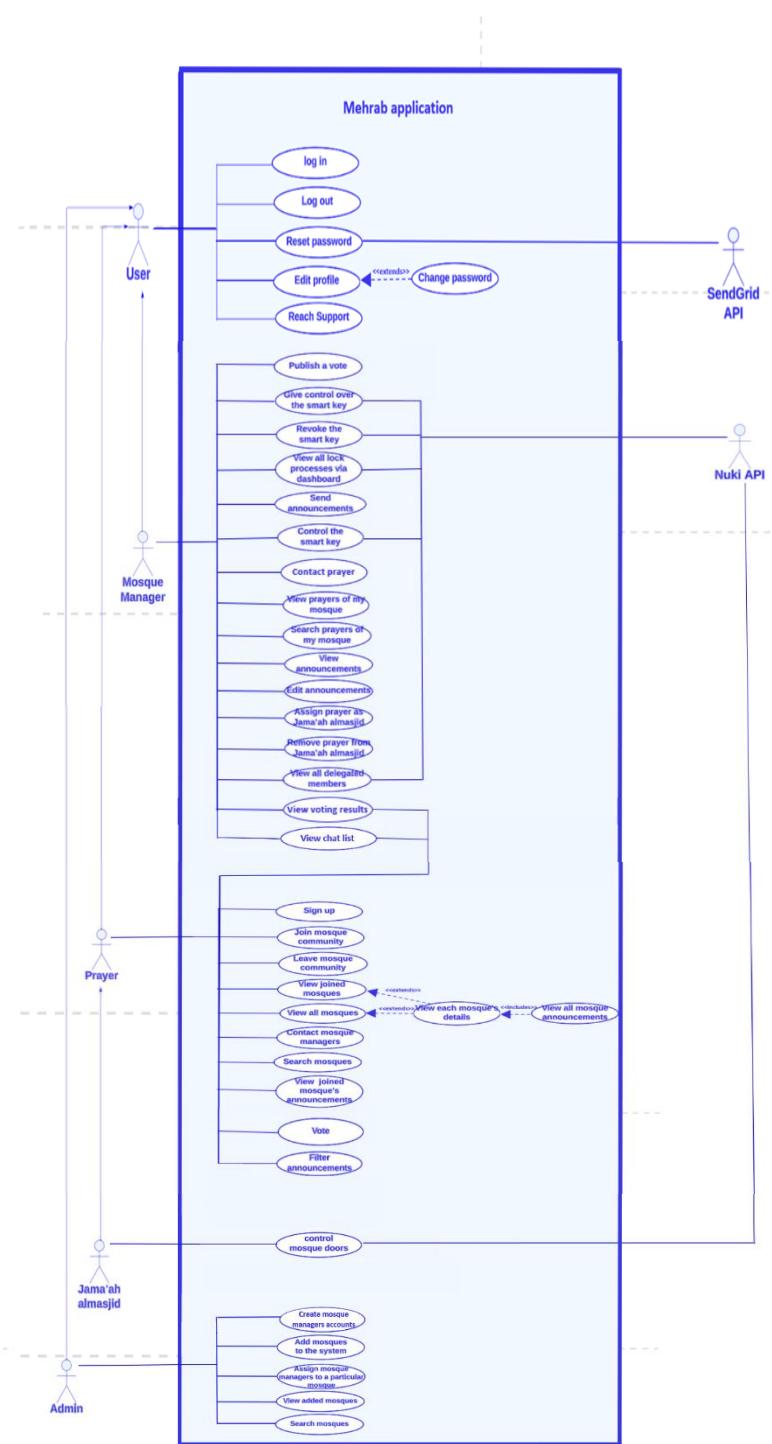


Figure 10: Use case diagram

#### 4.2.4 Roadmap and Product Backlog

In this project, there are two releases each of which has three sprints. The first release was conducted in the third trimester of academic year 2022-2023 and the second release was conducted in the first trimester of academic year 2023-2024. Releases 1 and Releases 2 are as shown in Figure 11 which is further explained in Table 4.

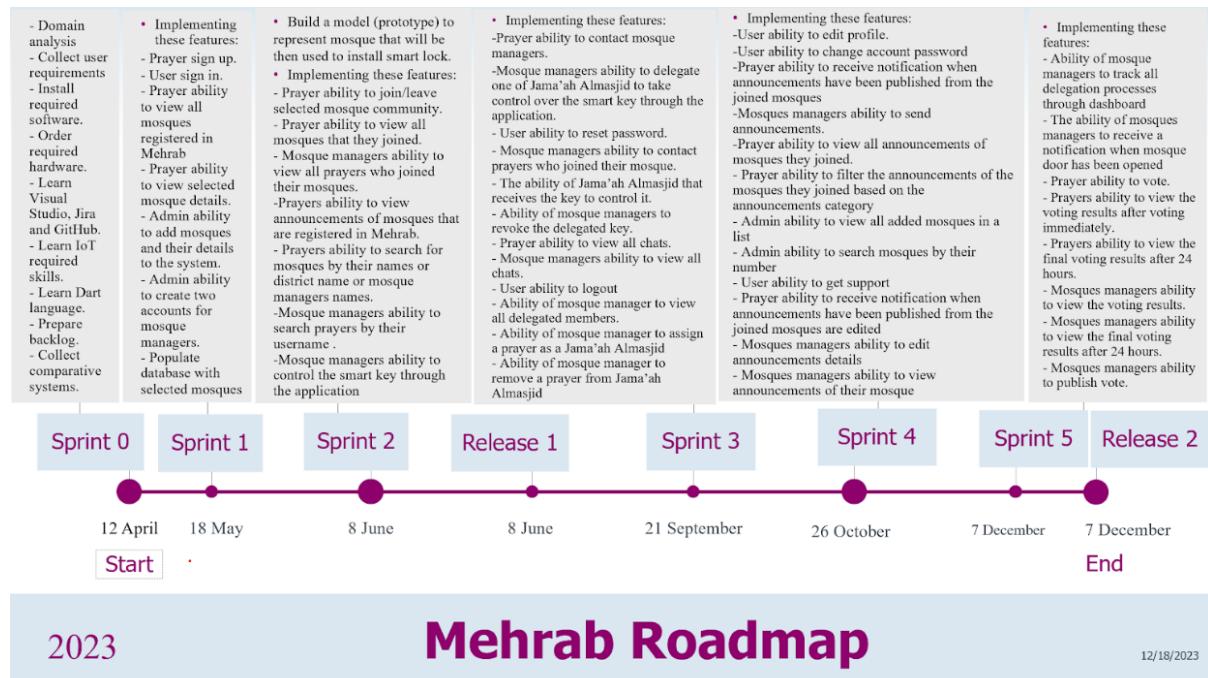


Figure 11: Mehrab Roadmap

Table 4: Detailed Mehrab project roadmap

Release-1	Start: 26 March 2023, End: 8 June 2023	
Sprint #	Outcomes	Delivered date
Sprint-0	This sprint is dedicated to understanding the fundamental technologies and selecting the key design decisions. Thus, the following goals were set for sprint-0: <ul style="list-style-type: none"> <li>● Domain analysis.</li> <li>● Collect user requirements.</li> <li>● Install required software.</li> <li>● Order required hardware.</li> <li>● Learn Visual Studio, Jira and GitHub.</li> <li>● Learn IoT required skills.</li> </ul>	12 April



	<ul style="list-style-type: none"><li>• Learn Dart language.</li><li>• Prepare backlog.</li><li>• Collect comparative systems.</li></ul>	
Sprint-1	<p>This sprint aims to implement important features that is required for Mehrab to operate correctly and suited schedule of trimester:</p> <ul style="list-style-type: none"><li>• Prayer sign up</li><li>• User log in</li><li>• Prayer ability to view all mosques registered in Mehrab</li><li>• Prayer ability to view mosque details (such as mosque managers names, type of mosques, district name)</li><li>• Admin ability to add a mosque to the system</li><li>• Admin ability to create two accounts for mosque managers for particular mosque and send accounts to mosque managers</li><li>• Populate database with selected mosques</li></ul>	18 May
Sprint-2	<p>Build a model (prototype) to represent mosque that will be then used to install smart lock.</p> <p>The sprint implements the following features:</p> <ul style="list-style-type: none"><li>• Prayer ability to join/leave selected mosque community</li><li>• Prayer ability to view all mosques that they joined</li><li>• Mosque managers ability to view all prayers who joined their mosques</li><li>• Prayer ability to search for mosques by their names or district name or mosque managers names.</li><li>• Prayers ability to view announcements of mosques that are registered in Mehrab.</li><li>• Mosque managers ability to search prayers by their username</li><li>• Mosque managers ability to control the smart key through the application</li></ul>	8 June
Release-2	<p><b>Start: 20 August 2023, End: 18 December 2023</b></p>	
Sprint-3	<p>The objective of this sprint is to implement the following features:</p> <ul style="list-style-type: none"><li>• Prayer ability to contact mosque managers (complaints, suggestions and social announcements)</li><li>• Mosque managers ability to contact prayers who joined their mosque.</li><li>• Prayer ability to view all chats.</li><li>• Mosque managers ability to view all chats.</li><li>• Mosque managers ability to delegate one of Jama'ah Almasjid to take control over the smart key through the application.</li><li>• User ability to reset password</li><li>• The ability of Jama'ah Almasjid that receives the key to control it</li></ul>	21 September

	<ul style="list-style-type: none"> <li>● Ability of mosque managers to revoke the delegated key</li> <li>● User ability to logout</li> <li>● Ability of mosque manager to view all delegated members.</li> <li>● Ability of mosque manager to assign a prayer as a Jama'ah Almasjid</li> <li>● Ability of mosque manager to remove a prayer from Jama'ah Almasjid</li> </ul>	
Sprint-4	<p>This sprint aims to implement the following features:</p> <ul style="list-style-type: none"> <li>● User ability to edit profile</li> <li>● User ability to change account password</li> <li>● Prayer ability to receive notification when announcements have been published from the joined mosques</li> <li>● Mosques managers ability to send announcements (belongs to different categories such as preaching lectures, recitation lectures, etc.)</li> <li>● Prayer ability to view all announcements (in timeline) of mosques they joined</li> <li>● Prayer ability to filter the announcements of the mosques they joined based on the announcement's category</li> <li>● Admin ability to view all added mosques in a list.</li> <li>● Admin ability to search mosques by their number.</li> <li>● User ability to get support</li> <li>● Prayer ability to receive notification when announcements have been published from the joined mosques are edited</li> <li>● Mosques managers ability to edit announcements details</li> <li>● Mosques managers ability to view announcements of their mosque</li> </ul>	26 October
Sprint-5	<p>This sprint aims to implement the following features:</p> <ul style="list-style-type: none"> <li>● Ability of mosque managers to track all lock processes through dashboard.</li> <li>● The ability of mosques managers to receive a notification when mosque door has been opened.</li> <li>● Prayer ability to vote.</li> <li>● Mosques managers ability to publish a vote.</li> <li>● Mosque managers ability to view the voting result.</li> <li>● Mosque managers ability to view the final voting results after 24 hours.</li> <li>● Prayers ability to view the voting results</li> <li>● Prayer ability to view the final voting results after 24 hours</li> </ul>	18 December

In this section, the PBIs are illustrated, their sizes, types, acceptance criteria, and the highest priority user stories at the top of the Product Backlog Table as below in Table 5.



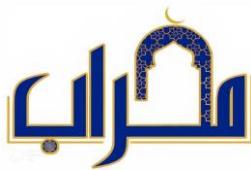
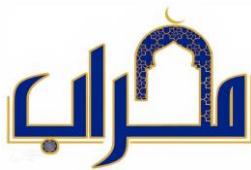
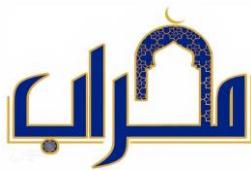


Table 5: Product backlog

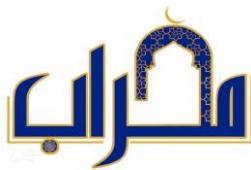
ID	PBI (user story)	Size (Story points)	Type	Status	Acceptance Criteria
1	As a prayer, I want to be able to sign up, so that I can use the application.	2	Feature	Done	As a prayer, if I open the registration page, I should fill all required fields in the correct formats, then I will be able to start using my account.
2	As a user, I want to be able to log in, so that I can access my personalized account.	2	Feature	Done	As a user, if I open the log in page, I should fill all required fields in the correct format, then I will be able to access my personalized account.
3	As a prayer, I want to be able to view all mosques registered in the application, so that I can choose the mosque that I would like to join.	3	Feature	Done	As a logged-in prayer, if I open the list of all mosques page, then I should be able to view all mosques in a list view with their name and district.
4	As a prayer, I want to be able to view each mosque's details, so that I can know more information about the mosque.	3	Feature	Done	As a logged-in prayer, if I open the list of all mosques page, and I click on a specific mosque, then I will be able to view that mosque's details such as its name, district, location, Imam name, Muezzin name and latest announcements.
5	As an admin I want to be able to add mosques and their details to the system, so that I can guarantee they are authorized mosques.	3	Feature		As a logged-in admin, if I want to add a new mosque, I should fill out all required fields, then the mosque will be added to the system.
6	As an admin, I want to be able to create	3	Feature	Done	As a logged-in admin, if I need to create a



	two accounts for mosque managers for a particular mosque, so that I can guarantee that they are authorized.				mosque managers account, I should fill in the fields of the form with the required mosque information, and I click on create <b>then</b> a success message should appear telling that the accounts are created successfully and credential details should be sent to respective users.  As a logged-in admin, <b>if</b> I want to create mosque manager accounts where mosque is already associated with active mosque manager accounts, and I click on create then system will display an alert message that clarify that there is an active account and ask me to select whether to create new account or cancel the process. When create new account is clicked then new account will be created and send to respective user and previous account will be deleted. In case cancel is clicked nothing will be changed.
7	As a prayer, I want to be able to join a mosque community, so that I can receive announcements, voting, and communicate with mosque managers.	3	Feature	Done	As a logged-in prayer, <b>if</b> I open the list of all mosques page, I can join a specific mosque community, <b>then</b> I will receive any updates that are related to that mosque.



8	As a prayer, I want to be able to leave a mosque community, so that I no longer receive any announcements related to that mosque.	3	Feature	Done	As a logged-in prayer, if I open the list of all mosques page, and I left that mosque community, then I will not receive any updates related to that mosque.
9	As a prayer, I want to be able to view all mosques that I joined, so that I can preview them easily in a separate list.	3	Feature	Done	As a logged-in prayer who joined a specific mosque community, if I open the list of joined mosques, then I should be able to view all joined mosques in a list view with their name and district.
10	As a mosque manager, I want to be able to view all prayers who have joined my mosque, so that I can be up to date with my mosque community members.	3	Feature	Done	As a logged-in mosque manager, if I open the list of community members page, then I should be able to see all prayers that have joined the mosque.
11	As a prayer, I want to be able to search for mosques by their names, district, Imam or Muezzin names, so that I can find them easily.	4	Feature	Done	As a logged-in prayer, if I open the home page, and searched for a specific mosque, district, Imam or Muezzin names then all mosques with the term I searched with will be displayed.
12	As a mosque manager, I want to be able to search for prayers in my mosque by their usernames, so that I can find them easily.	4	Feature	Done	As a logged-in mosque manager, if I want to search for a specific prayer, I can write their username, then they will be displayed.
13	As a prayer, I want to be able to view all announcements of mosques in Mehrab, so that I can know the latest announcements.	3	Feature	Done	As a logged-in prayer, if I open mosque details page, then all the latest announcements of that mosque should be displayed.



14	As a mosque manager, I want to be able to control the mosque smart key through the application, so that I can open/close the mosque doors by myself.	5	Feature	Done	As a logged-in mosque manager, <b>if</b> I open the key page and click on the button, <b>then</b> the door will open or close depending on its state.
15	As a user, I want to be able to logout, so that I can prevent unauthorized actions on my current log in session.	2	Feature	Done	As a logged-in user, <b>if</b> I clicked on the logout button <b>then</b> the application should log me out, end my session, and redirect me to the root page.
16	As a mosque manager, I want to be able to contact prayers who joined the mosque that I manage, so that I can reach them out when needed.	4	Feature	Done	As a logged-in mosque manager, <b>if</b> I open the list of prayers who joined my mosque, <b>then</b> a chat interface will be displayed to contact prayers.
17	As a prayer, I want to be able to contact mosque managers, so that I can convey any complaints, comments, or questions.	4	Feature	Done	As a logged-in prayer who joined a specific mosque community, <b>if</b> I open the details page of a mosque I have joined, <b>then</b> a chat interface will be displayed to contact mosque managers.
18	As a prayer, I want to be able to view all chats that I initiate or receive, so that I can view all chats in one page.	4	Feature	Done	As a logged-in prayer, <b>if</b> I open the chats page <b>then</b> I will be able to view all chats in one page.
19	As a mosque manager, I want to be able to view all chats that I initiate or receive, so that I can view all chats in one page.	4	Feature	Done	As a mosque manager, <b>if</b> I open the chats page <b>then</b> I will be able to view all chats in one page.
20	As a mosque manager, I want to	5	Feature	Done	As a logged-in mosque manager, <b>if</b> I chose one

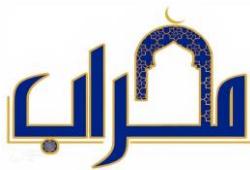


	be able to delegate one of Jama'ah Almasjid to take control over the smart key through the application, so that I can ensure the opening and closing of the mosque door when I am unable to do so.				of the Jama'ah Almasjid from the list and gave them the control over the key, <b>then</b> the key will be displayed to the selected account and they will be able to open/close mosque doors.
21	As a user, I want to be able to reset my password, so that I can get back into the application if I forget my password.	2	Feature	Done	As a user <b>if</b> , I want to reset my password, I should write the email I used in a registration step <b>then</b> I should receive an email with a link to reset my password.
22	As a member of Jama'ah Almasjid, I want to be able to control opening/closing doors through the application, so that I can perform the task that I have been delegated to do.	5	Feature	Done	As a logged-in member of Jama'ah Almasjid, <b>if</b> I open the joined mosques page, and I click the smart key indicator of the mosque that I intend to control its key, <b>then</b> I can lock and unlock that mosque doors.
23	As a mosque manager, I want to be able to view all delegated members, so that I can keep track of the delegation process.	2	Feature	Done	As a logged-in mosque manager, <b>if</b> I opened the lock page and clicked on the message that indicates the number of delegated members, <b>then</b> I can see all delegated members.
24	As a mosque manager, I want to be able to revoke the smart key from anyone who I delegated before, so that I can remove the authority to open and close the mosque door.	5	Feature	Done	As a logged-in mosque manager, <b>if</b> I choose one of Jama'ah Almasjid from the list and remove from them the control over the key, <b>then</b> they will no longer be able to open/close mosque doors.



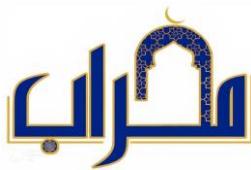
25	As a mosque manager, I want to be able to assign a prayer as jama'ah almasjid so that I can differentiate between them and other prayers.	3	Feature	Done	As a logged-in mosque manager, <b>if</b> I choose one prayer and assign him/her as jama'ah almasjid, <b>then</b> I can differentiate between prayers when I want to delegate the key to them.
26	As a mosque manager, I want to be able to remove a prayer from jama'ah almasjid so that they are no longer part of the jama'ah almasjid.	3	Feature	Done	As a logged-in mosque manager, <b>if</b> I remove prayer from jama'ah almasjid, <b>then</b> I can no longer delegate him/her to take control over the key.
27	As a user, I want to be able to edit my profile, so that I can change my information.	2	Feature	Done	As a logged-in user <b>if</b> I open my profile, I can view and edit any of my current information <b>then</b> the fields should be updated.
28	As an admin, I want to be able to view all added mosques, so that I can keep track of the added mosques in the system.	2	Feature	Done	As a logged-in admin, <b>if</b> I clicked the button of list of mosques, <b>then</b> all mosques that have been already added to the system will appear in a list.
29	As a user, I want to be able to get support, so that I can seek assistance and resolve any issues or queries I may have.	3	Feature	Done	As a user, <b>if</b> I clicked the support button, <b>then</b> I will have access to support options (email and phone number).
30	As an admin, I want to be able to search for mosques that have been added to the system by their number and name so that I can find them easily.	4	Feature	Done	As a logged-in admin, <b>if</b> I open the list of added mosques, and search for a specific mosque by their number, <b>then</b> the mosque will be displayed.
31	As a user, I want to be able to change my password, so that I can increase	2	Feature	Done	As a logged-in user <b>if</b> I want to change my password, I should write my current password, new password, and the

	my account's security.				confirmation of the new password, <b>then</b> I should receive a confirmation that my password has changed successfully.
32	As a prayer, I want to be able to receive notifications when announcements have been published from the joined mosques, so that I can be informed with mosque updates.	4	Feature	Done	As a logged-in prayer, <b>if</b> I joined a specific mosque community and that mosque sends an announcement, <b>then</b> I should be able to receive notification.
33	As a mosque manager, I want to be able to send announcements of different categories, so that I can Inform the whole community of any important information.	4	Feature	Done	As a logged-in mosque manager, <b>if</b> I want to send an announcement, I should be able to click a button and add all announcement details, <b>then</b> I should be told that the announcement has been sent successfully.
34	As a prayer, I want to be able to view all announcements of mosques that I joined, so that I can view all announcements in one page.	3	Feature	Done	As a logged-in prayer who joined a specific mosque community, <b>if</b> I open the announcements page, <b>then</b> I will be able to view all announcements of mosques that I joined.
35	As a prayer, I want to be able to filter the announcements of the mosques that I joined based on its category, so that I can view the announcements of interest.	4	Feature	Done	As a logged-in prayer who joined a specific mosque community, <b>if</b> I open the announcements page, <b>then</b> I will be able to select a category of interest to view all announcements under that category.
36	As a prayer, I want to be able to receive notifications when any announcements	4	Feature	Done	As a logged-in prayer, <b>if</b> I joined a specific mosque community and that mosque edited an announcement, <b>then</b> I



	published by the mosques I have joined are edited, so that I can be informed with mosque updates.				should be able to receive notification.
37	As As a mosque manager, I want to be able to edit announcements so that I can change the announcement's details.	3	Feature	Done	As a logged-in mosque manager, <b>if</b> I want to edit an announcement, I should be able to click a pen icon and update all announcement details, <b>then</b> I should be told that the announcement has been updated successfully.
38	As a mosque manager, I want to be able to view all announcements that were sent before so that I can keep track of all announcements of my mosque.	3	Feature	Done	As a logged-in mosque manager, <b>if</b> I want to view all announcements of my mosque, I should be able to click the announcement button in the navigation bar, <b>then</b> I should view all announcements of my mosque.
39	As a mosque manager, I want to be able to track all lock processes through a dashboard, so that I can be aware of the names of the authorized persons and the times of their entry and exit.	5	Feature	Done	As a logged-in mosque manager, <b>if</b> I want to track all delegation processes, I can click on the log button, <b>then</b> all key lock processes details such as time and names will be displayed.
40	As a mosque manager, I want to be able to receive a notification when a mosque door has been opened, so that I can be completely aware of my mosque door operations for security manners.	5	Feature	Done	As a logged-in mosque manager, <b>if</b> the mosque door has been opened, <b>then</b> a notification banner should appear.

41	As a prayer, I want to be able to vote, so that I can participate in decision making.	4	Feature	Done	As a logged-in prayer who joined a specific mosque community, <b>if</b> I open the announcement page, I can view and cast my vote for all available voting choices, <b>then</b> my vote should be sent to whoever is responsible.
42	As a mosque manager, I want to be able to publish a vote, so that I can see the community's opinions.	4	Feature	Done	As a logged-in mosque manager, <b>if</b> I want to publish a vote, I should be able to click a button and add all vote details, <b>then</b> I should be told that the vote has been sent successfully.
43	As a prayer, I want to be able to view the final voting results after 24 hours, so that I can see the majority opinion.	4	Feature	Done	As a logged-in prayer who joined a specific mosque community, <b>if</b> I open the announcement page and vote toward a specific announcement, <b>then</b> I should be able to see the final voting results after 24 hours of publishing the vote by mosque managers.
44	As a prayer, I want to be able to view voting results after voting immediately, so that I can see the community's opinion.	4	Feature	Done	As a logged-in prayer who joined a specific mosque community, <b>if</b> I open the announcement page and vote toward a specific announcement, <b>then</b> I can view the voting results immediately and clearly.
45	As a mosque manager, I want to be able to view the final voting results after 24 hours, so that I can decide fairly.	4	Feature	Done	As mosque manager, <b>if</b> I open the list of all vote page after 24 hours of publishing, <b>then</b> I will be able to view the final voting results.



46	As a mosque manager, I want to view the voting results, So that I can see the community's opinion.	4	Feature	Done	As mosque manager, <b>if I open the list of all vote page, then I will be able to view the voting results.</b>
47	As a user, I want Mehrab application to be available all days except four hours for maintenance every two weeks, so that I can access it at any time unless it's maintenance time.	NA	Feature	Done	-
48	As a user I want to log-in within 10 seconds or less, so that I can gain fast access to Mehrab application and benefit from its services.	NA	Feature	Done	-
49	As a user, I want Mehrab interfaces to be easy and simple, so that I can understand how to use it properly in less than 15 minutes.	NA	Feature	Done	-
50	As a mosque manager when I delegate one of Jama'ah Almasjid to take control over the key, I want the application to respond to my delegate request in less than 10 seconds, so that I can use it effectively.	NA	Feature	Done	-



51	As a mosque manager I want to receive notification in less than 10 seconds when the mosque door opens, so that I can get notification fast enough and I can ensure the mosque security.	NA	Feature	Done	-
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### 4.3 System Design

This section introduces design used in this project that includes the system architecture in Section 4.3.1, class diagram in Section 4.3.2, the core component level in Section 4.3.3.

#### 4.3.1 Smart Lock Selection

As discussed in background chapter there are different types of smart locks. The Wi-Fi smart lock is what Mehrab intends to use, since this category offers potential features that Mehrab require. Nuki stands out as the most suitable choice. Not only does Nuki offer all the necessary features, but it is also cost-effective and can be conveniently delivered to Saudi Arabia.

#### 4.3.2 Architectural Diagram

The system architecture of our project is given in Figure 12. Mehrab system utilizes a client-server architecture that caters to three types of users: (i) prayers, (ii) mosque managers, and (iii) the admin. All the users can access the application through Mehrab interfaces which are connected to the internet to request services from the server. The server maintains a database containing users and mosque information. Multiple users can access the server's information concurrently, each with their own unique view. In addition, Mehrab system integrates with external entities, namely the Nuki API, Nuki smart lock, and SendGrid API to satisfy the system requirements. The two former entities are used to control the smart lock whereas the last is used to send emails to intended users.

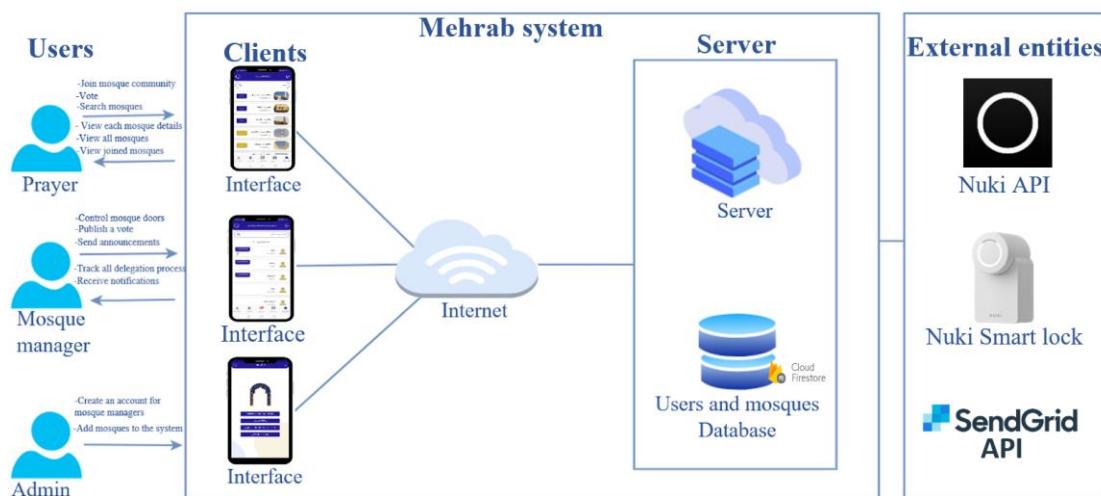


Figure 12: Mehrab system architectural

### 4.3.3 Class Diagram

Mehrab class diagram, that shows ten classes, interrelationships between these classes, and class attributes and methods, is given in Figure 13.

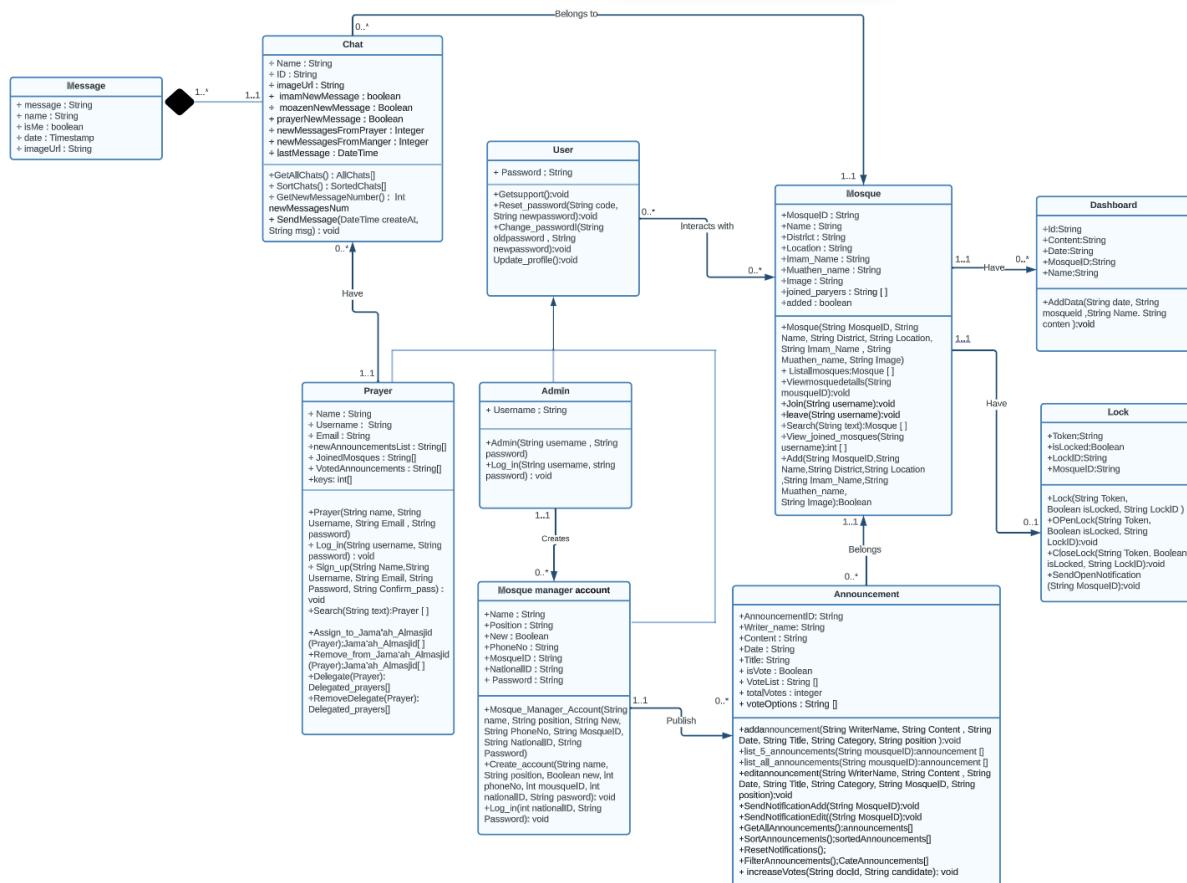


Figure 13: Mehrab Class Diagram

### 4.3.4 Component Level Design

This section explains the design of core components. First, we will consider the process to create mosque manager accounts that include authentication, validation, and authorization. The second component is joining a particular mosque that is instantiated by a prayer user. The third component is the sending an announcement and the last is the door opening and locking.

### Create Mosque Managers Accounts

The mosque manager accounts creation flowchart starts with adding the required fields then system will ask if the accounts have already been created. If yes, the system will ask to remove previously created accounts. In the event that any existing accounts have been deleted, the user will have to select the account and confirm the creation of the new one at the end of the process. In the case admin chooses to not delete the accounts, admin should fill the required fields. If the accounts are not already created, it will check if the information is valid and complete. In

the event that they do not, an error message will appear and the user will be prompted to complete the required fields. Otherwise, an error message will appear asking for verification of the information provided. If they are, a success message will appear and the process will end with the message Exist; otherwise, the process will end without creating an account for the mosque manager.

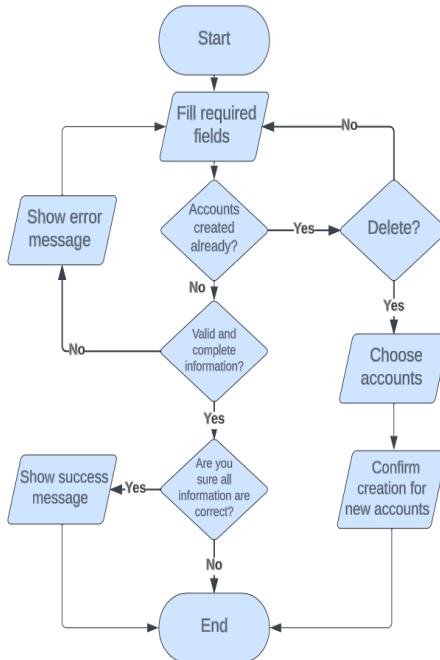


Figure 14: Create mosque managers accounts flowchart diagram

### Join a Certain Mosque

The Join a particular mosque flowchart begins with a list of all mosques that have an account in Mehrab. Then user will choose a certain mosque to join and click on the join button. A message will appear confirming the successful completion of the join process.

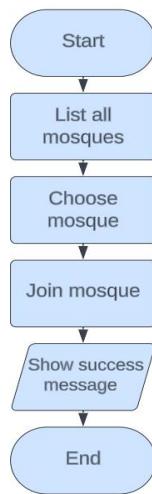


Figure 15: Join a certain mosque flowchart diagram

### Sending an announcement

Sending an announcement flowchart starts with filling the required fields, if the fields are complete and valid the announcement will be added successfully to the announcement list and a notification will be sent to the joined prayers. If the fields are not complete the user will be asked to correctly fill-in the required fields.

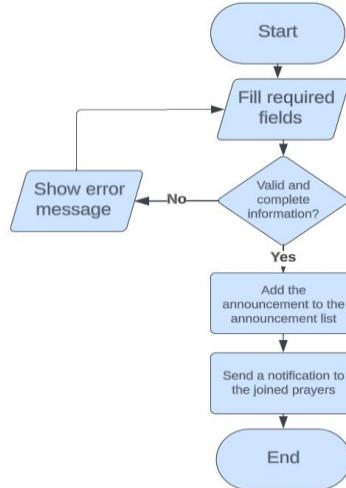


Figure 16: Sending announcement flowchart diagram

### Delegating a prayer

The process of delegating a prayer flowchart begins with selecting the prayer to be delegated. If the prayer is one of Jamaah almasjid, a button will appear, and once clicked, a confirmation message will be displayed. Clicking Yes will delegate the key to the prayer, otherwise it will not.

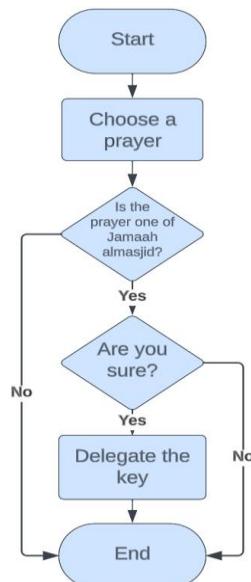


Figure 17: Delegate a prayer flowchart diagram

## 4.4 Data Design

In this section data design used in this project is introduced. The data design includes the data models and the data collection and preparation that are described in subsection 4.4.1 and subsection 4.4.2 respectively.

### 4.4.1 Data Models

Mehrab is intended to run under the supervision of MOIA. Therefore, Mehrab introduces an admin user who should be a MOIA employee, whose responsibility is to add mosques to Mehrab and establish credentials for mosque managers. In order to clarify Mehrab's idea, the team contacted MOIA to gain access to the database of all mosques in Riyadh. However, we received confirmation for a small district in Riyadh. This will represent the target area covered by Mehrab application.

The ER diagram describes the work of this project in Figure 18.

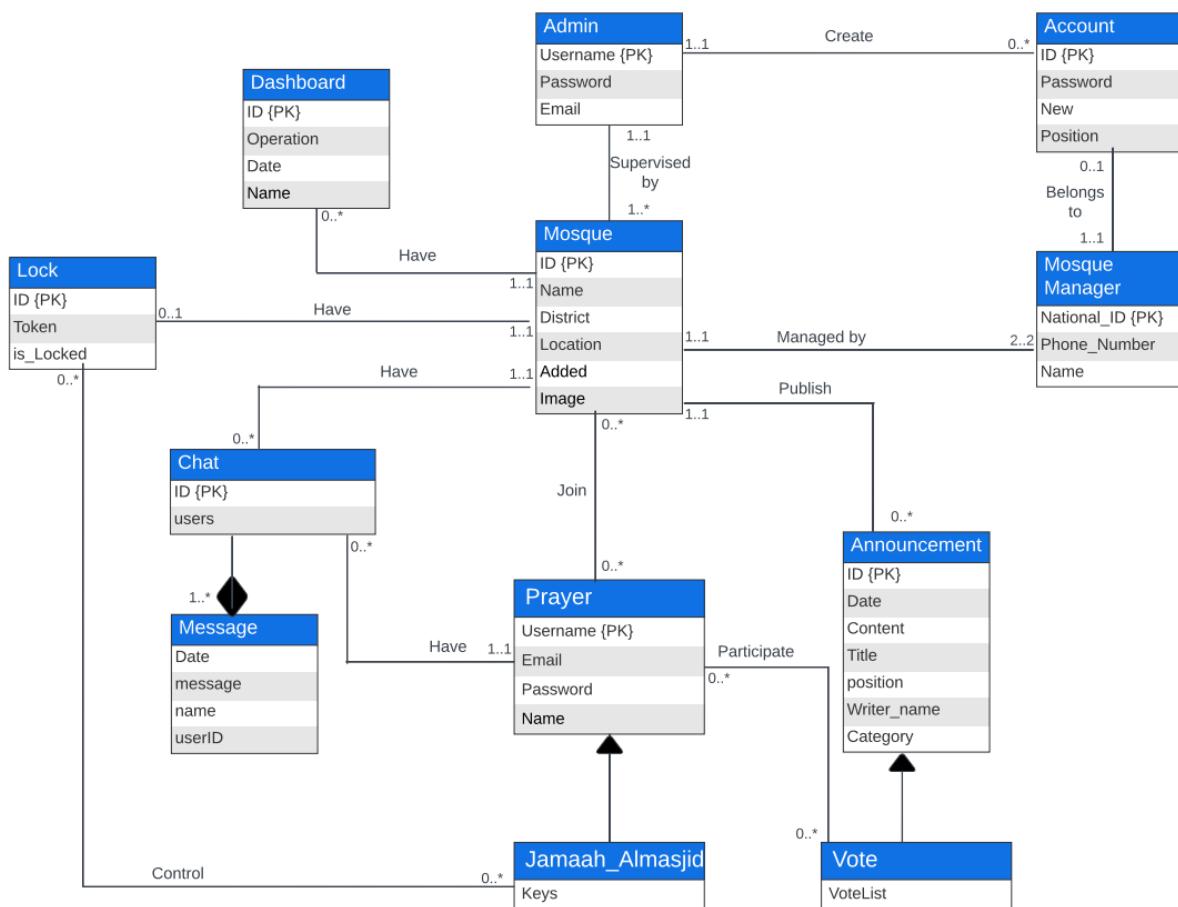
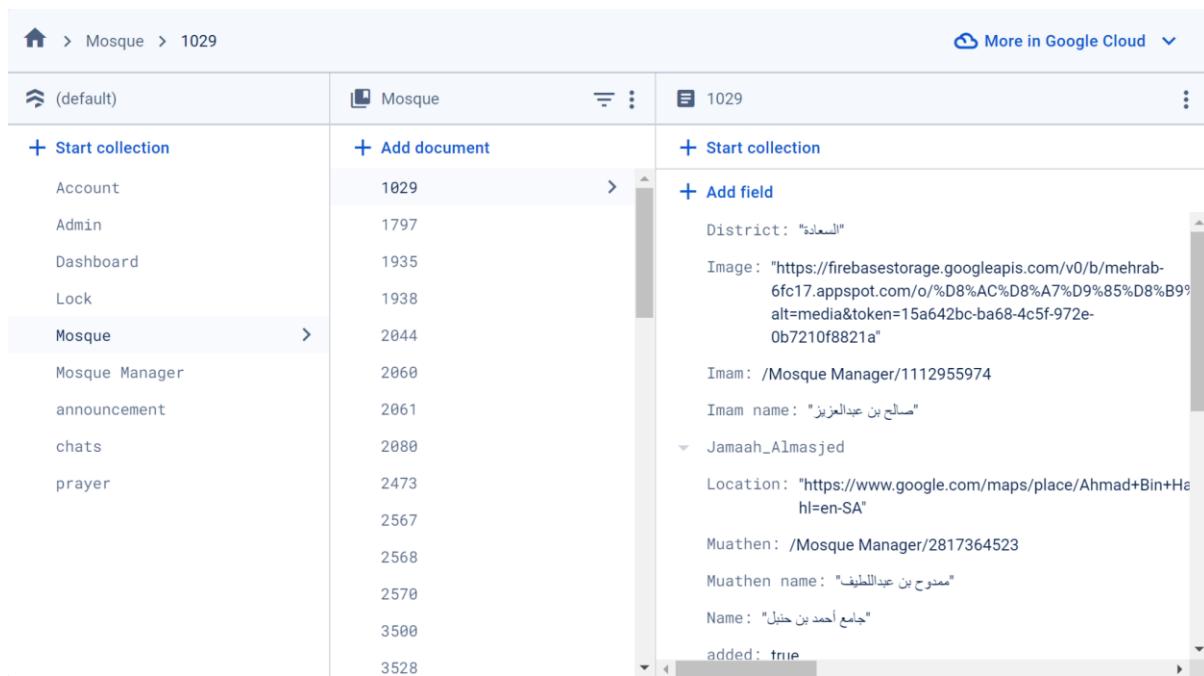


Figure 18: Mehrab ER diagram

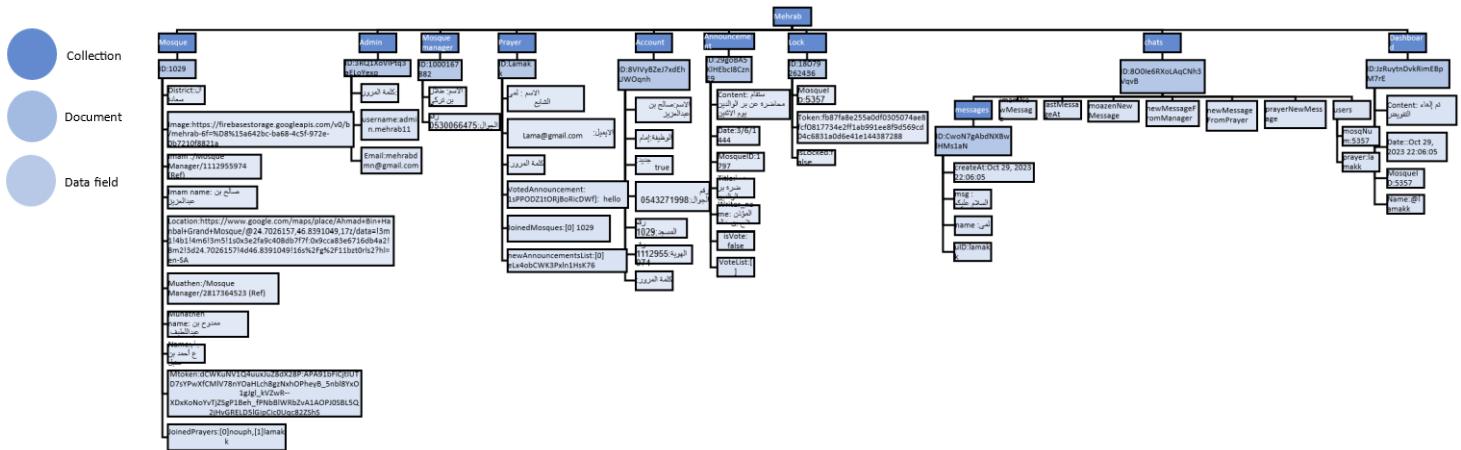
In Figure 19, we used referencing in table Mosque to refer to table Mosque Manager, in order to retrieve the data from mosque manager table.



*Figure 19: Database referencing*

The non-relational data model describes the implemented part of the ER in the firebase firestore for release-2.

As an example, we provided in Figure 20 the content for each document available in Mehrab database.



*Figure 20: Mehrab non-relational data model*



Data dictionary of all entities:

Table 6: Data dictionary of all entities

Entity name	Description	Occurrence
<b>Admin</b>	Admin is the one who supervises Mehrab system.	There is only one admin that control Mehrab App and thus there is only one uniquely identifiable object of type Admin. With respect to relationship occurrence admin creates zero to many accounts and supervises one to many mosques.
<b>Mosque</b>	A mosque is a religious community or institution where prayers take place and prayer can join.	There are multiple mosque uniquely identifiable object of type Mosque that will be supervised by one and only one admin. Mosque can be joined by zero to many prayers. Mosque can publish zero to many announcements. Mosque is managed by exactly two mosque managers. The mosque is expected to have at most one lock or no lock if it does not install smart locks on its doors. Mosque can have multiple dashboard records. Mosques can have many chats.
<b>Mosque Manager</b>	A mosque manager is the one who manages the prayers, makes the announcements and delegates door open to a one entity from a certain community. Each mosque will be managed by two mosque managers which are Imam and Muezzin.	There are many mosque manager objects in Mosque manager entity. Mosque manager has one and only one account. Mosque manager manages one and only one mosque.
<b>Prayer</b>	A prayer is the one who joins mosques communities and receives announcements about mosques.	There are many Prayers object who can join zero to many mosques. Prayers can have many chats.



<b>Announcement</b>	Announcement will be sent by mosque managers to prayers about certain mosque.	There are many announcement objects that belong to one and only one mosque. One special type of announcements is a vote.
<b>Account</b>	Account allows the mosque manager to be authorized to use Mehrab system.	There are many accounts object that is created by one and only one admin. Account belongs to one and only one mosque manager.
<b>Lock</b>	Each mosque registered in Mehrab may or may not have a smart lock that can be connected via the application.	It is expected to have multiple lock object each of which is associated with one mosque. Mosque can have zero or one lock. The lock can be controlled by many of Jama'ah Almasjid.
<b>Chat</b>	A chat that takes place between the mosque (Imam and Muezzin) and a specific prayer.	The chat is linked between prayer and mosque. The mosque can have many chats as well as prayers. Chats belongs to one mosque and one prayer. Chats consist of many messages.
<b>Dashboard</b>	The dashboard shows the operations that occurred on the key, whether it was Imam, Muezzin, or delegated prayers.	The dashboard is associated with one mosque. Mosque can have multiple delegation processes in the dashboard.
<b>Message</b>	The message takes place in chats where it is the message between mosque and a specific prayer	Chat consists of many messages.



The relationships between entities are described in the below data dictionary table.

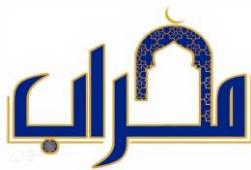
Table 7: Data Dictionary of all relationships

Entity Name	Multiplicity	Relationship	Entity Name	Multiplicity
Mosque	1..*	Supervised by	Admin	1..1
Mosque	1..1	Managed by	Mosque Manager	2..2
Prayer	0..*	Join	Mosque	0..*
Mosque	1..1	Publish	Announcement	0..*
Admin	1..1	Create	Account	0..*
Account	0..1	Belongs to	Mosque Manager	1..1
Mosque	1..1	Have	Lock	0..1
Mosque	1..1	Have	Dashboard	0..*
Mosque	1..1	Have	Chat	0..*
Prayer	1..1	Have	Chat	0..*
Jamaah_Almasjid	0..*	Control	Lock	0..*
Message	1..*	Belongs to	Chat	1..1
Prayer	0..*	Participate	Vote	0..*

Data Dictionary showing description of all attributes:

Table 8: Data Dictionary of all attributes

Entity Name	Attribute	Description	Data type	Length	Null	Multi valued	Default value	Range	PK
Mosque	District	District name	String	-	No	No	None	-	
	ID	Mosque ID	String	4	No	No	None	-	Yes
	Image	Mosque image	String	-	No	No	None	-	



Mosque	Location	The location of the mosque	String	-	No	No	None	-	
	Name	Mosque name	String	-	No	No	None	-	
	added	Verifies if the mosque is added to Mehrab or not	Boolean	-	No	No	False	True False	
Admin	اسم المستخدم	Admin username	String	-	No	No	None	-	Yes
	الإيميل	Admin email	String	-	No	No	None	-	
	كلمة المرور	Admin password	String (Hashed)	-	No	No	None	-	
Account	كلمة المرور	Mosque password (Hashed)	String	-	No	No	None	-	
	الوظيفة	Imam or Muezzin	String	-	No	No	None	-	إمام- مؤذن-
	جديد	wether the account is new or not	Boolean	-	No	No	Yes	-	
	رقم الهوية	National Identification Number	String	10	No	No	None	-	Yes
Mosque Manager	الاسم	Mosque Manager name	String	-	No	No	None	-	
	رقم الهوية	National Identification Number	String	10	No	No	None	-	Yes
	رقم الجوال	Mosque Manager mobile phone	String	10	No	No	None	-	Unique



Prayer	اسم المستخدم	Prayer username	String	-	No	No	None	-	Yes
	الاسم	Prayer name	String	-	No	No	None	-	
	الإيميل	Prayer Email	String	-	No	No	None	-	
	كلمة المرور	Prayer password	String (Hashed)	-	No	No	None	-	
Announcement	Category	announcement category	String	-	No	No	محاضرات	- محاضرات حلقات تحفيظ القرآن الكريم أخرى	
	Content	Announcement content	String	-	No	No	None	-	
	ID	Auto generated id	String	-	No	No	None	-	Yes
	Date	The date of the announcement	String	-	No	No	None	-	
	Title	Announcement title	String	-	No	No	None	-	
	Writer_name	The name of the writer of the announcement	String	-	No	No	None	-	
	position	Imam or Muezzin	String	-	No	No	None	- إمام - مؤذن	
	Lock	isLocked	Check the lock	Boolean	-	No	Yes	True False	



	ID	Lock id	String	11	No	No	None	-	Yes
	Token	lock token	String	-	No	No	None	-	
Chat	ID	Auto generated id	String	-	No	No	None	-	Yes
	users	map	-	No	Yes	None	-		
Message	Date	time of message	timestamp	-	No	No	None	-	
	message	message content	String	-	No	No	None	-	
	name	name of imam or Muezzin	String	-	No	No	None	-	
	userID	user id	String	-	No	No	None	-	
Dashboard	ID	Unique identifier of the mosque	String	4	No	No	None	-	Yes
	Operation	The status of the mosque key and who performed the act	String	-	No	No	None	-	
	Name	Mosque Manager name	String	-	No	No	None	-	
	Date	The date of the operation	String	-	No	No	None	-	
Vote	VoteList	Choices of the voting	String	-	No	Yes	None	-	
Jamaah_Almasjid	Keys	Delegated keys	String	4	No	Yes	None	-	



#### 4.4.2 Data Collection and Preparation

The first step was to search for existing datasets contained comprehensive information about all mosques in Riyadh. As we could not locate a suitable dataset, we contacted the department responsible for monitoring and managing Riyadh mosques in MOIA. The MOIA provided us with information about 50 mosques located in 9 districts in the eastern part of Riyadh. It contains mosque numbers, districts, mosque types, and mosque names.

Although the dataset contained relevant information for our project, it had three major issues. It was necessary to clean the data in order to eliminate duplicate entries and ensure accuracy before using it. A second problem is that it does not contain some critical information, such as images of mosques and their locations. Therefore, the team independently searches for and obtains images and locations of mosques. Furthermore, due to data confidentiality issues, the dataset leaks Imam and Muezzin names. Therefore, the names are randomly altered by a team.

#### 4.5 Interface Design

The interface design is discussed in this section through presenting the site map that holds the key navigations. The section also introduces the user experience guidelines follows with respect to designing this project.

## Site Map

Mehrab site map shown in Figure 21 provides a visual representation of the architecture of the application.



*Figure 21: Mehrab site map*



## User Experience (UX)

There are five UX guidelines adopted in this project; as discussed below [25].

1. **Learnability (Consistency):** all pages in Mehrab are consistent by using the same consistent interface style such as: colors, background, and fonts.
2. **Learnability (Predictability):** In Mehrab, we used well known icons such as the home, announcements and back arrow icons that helps user to recognize the features rather than recall the place and icon of features.
3. **Synthesizability (Feedback for error messages):** Providing the user with the ability to assess the impact of past operations on the current state. In the event that a problem occurs, Mehrab will display a clear and informative message that aids in understanding and resolving the issue.
4. **Learnability (Familiarity):** in Mehrab we used metaphors from real world because users are familiar with them such as the lock, key and profile icons.
5. **Observability (Reachability):** Mehrab provides a back and next button so that the system can be considered reachable. Also, system provides a navigation bar so that users can reach the pages anywhere.

### 4.6 Implementation

The Mehrab application is developed using Android Studio and a variety of software and hardware tools. This chapter explains the implementation aspects, including configuration, coding, and the GitHub repository associated with the application.

#### 4.6.1 Implementation Configuration

Flutter is a popular framework used recently for developing mobile applications and Dart is its primary programming language. The Dart's features fast and efficient applications and easy-to-learn syntax, thus it was an excellent choice for our development team. Therefore, Mehrab system was developed using the Flutter UI framework version 3.3.0 and the Dart programming language version 2.19.4.

The first step was to download the Flutter SDK from the official website, depending on our operating system. We then extracted the files and added the Flutter tool path to our environment variables. The Flutter Doctor was then run to determine if any additional dependencies needed to be installed. We tested the application's interface and functionality on an Android mobile device. The mobile device provided an excellent representation of how the application would perform on other Android devices. We used GitHub as a version control system to ensure our code was well-organized and easy to manage. We created a repository to store all Mehrab files, images, and other resources. In this manner, we were able to maintain a record of codebase



changes and collaborate effectively. We were able to see who changed what, when and where by using GitHub, which greatly simplified the process of managing our codebase.

Mehrab uses Firebase as a database repository that provides rich and secure access to client-side code. The Firebase platform provides a variety of tools and services for developing mobile and web applications. It offers a NoSQL database that stores and synchronizes data in real-time, making it ideal for collaborative applications like Mehrab. For Mehrab to connect to Firebase cloud, we installed the Firebase SDK and Firebase CLI (Command Line Interface). We then added the Firebase configuration file to the project in order to configure the application to use Firebase. Firebase was initialized in the application and plugins were added to provide access to various Firebase services. As a result of using Firebase as the database, Mehrab became a rich, collaborative application that allowed secure access to the database directly from the client-side code. Moreover, Firebase's NoSQL database is optimized for fast-paced agile development and handling large volumes of data, making it an ideal choice for Mehrab.

#### 4.6.2 Implementation Details and Code

Mehrab application offers a variety of functionalities developed and tested for release-2. Sending SMS messages, integrating with the smart lock API, chatting and sending email for resetting passwords in addition to sending notifications were the most challenging features to develop. The code for these functions is shown in Table 9.

Table 9: code and implementation details

Function	Description
sending_SMS()	It is called by the admin when he fills in the required fields and clicks on the button to create accounts. The function will receive the message that needs to be sent, as well as the phone numbers of the recipients. By using sendDirect, messages could be sent directly without being redirected to the SMS application.

```

void sending_SMS(String msg, List<String> list_recipients) async {
    //Sending the sms without redirecting to the sms app
    if (await Permission.sms.request().isGranted) {
        String send_result = await sendSMS(
            message: msg, recipients: list_recipients, sendDirect: true)
            .catchError((err) {
                print(err);
            });
        print(send_result);
    }
}
  
```



Function	Description
_toggleLock()	This function is called once the lock button is clicked. <code>_isLocked</code> represents the lock state as it has been obtained from the database; whether the lock is open or closed. Depending on the state, an HTTP post request will be sent to open or close the mosque door. Actions will be reflected directly in the Dashboard.



```
Future<void> _toggleLock() async {
    if (_isLocked == false) {
        var url = 'https://api.nuki.io/smartlock/$lockID/action/lock';

        final response = await http.post(
            Uri.parse(url),
            headers: {'Authorization': 'Bearer $accessToken'},
        );

        setState(() {
            _isLocked = !_isLocked;
        });

        final querySnapshot = await FirebaseFirestore.instance
            .collection('Lock')
            .where('Mosque_ID', isEqualTo: widget.mosqueId)
            .get();

        for (final doc in querySnapshot.docs) {
            await doc.reference.update({'isLocked': _isLocked});
        }

        FirebaseFirestore firestore = FirebaseFirestore.instance;
        CollectionReference collectionReference =
            firestore.collection('Delegation');
        await collectionReference.add({
            'Content': 'قام بفتح باب المسجد ${!position}',
            'MosqueID': widget.mosqueId,
            'Name': managerName,
            'Date': DateTime.now().toString(),      You, 1 minute ago • Uncommitted ch
                // Add more fields as needed
        });
    } //The door was opened, closing the door
```



```
else {
    var url = 'https://api.nuki.io/smartlock/$lockID/action/unlock';

    final response = await http.post(
        Uri.parse(url),
        headers: {'Authorization': 'Bearer $accessToken'},
    );

    setState(() {
        _isLocked = !_isLocked;
    });

    final querySnapshot = await FirebaseFirestore.instance
        .collection('Lock')
        .where('Mosque_ID', isEqualTo: widget.mosqueId)
        .get();

    for (final doc in querySnapshot.docs) {
        await doc.reference.update({'isLocked': _isLocked});
    }

    FirebaseFirestore firestore = FirebaseFirestore.instance;
    CollectionReference collectionReference =
        firestore.collection('Delegation');
    await collectionReference.add({
        'Content': 'قام بإغلاق باب المسجد ${position}',
        'MosqueID': widget.mosqueId,
        'Name': managerName,
        'Date': DateTime.now().toString(),
        // Add more fields as needed
    });
}
```

Function	Description
mailer.send()	The user calls this function when he wants to reset his password. SendGrid API was used to send the reset password email. A secure OTP number will be included in the email so that we can verify the prayer and change its password.



```
// Generate a random 4-digit code
final random = Random();
final resetCode =
    random.nextInt(9000) + 1000; // generates a number between 1000 and 9999
// new API KEY: SG.Uc7xNlxtSm-5HCvj1E6oHQ.5sYwSs9Ip4FmjKHhveuVrw2BSanJN79HSNcCc42FkA
final mailer = Mailer(
    'SG.Uc7xNlxtSm-5HCvj1E6oHQ.5sYwSs9Ip4FmjKHhveuVrw2BSanJN79HSNcCc42FkA');
final toAddress = Address(email1);
final fromAddress = Address('Mehrab.ksu@gmail.com');
final content = Content('text/plain',
    'لا تشارك الرمز $resetCode : الرمز الخام يك لإستعادة كلمة المرور الخاصة بك هو ' +
    '؛ إعادة تعيين كلمة المرور لتطبيق محراب');
final subject = final personalization = Personalization([toAddress]);

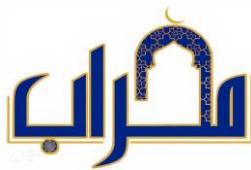
final email =
    Email([personalization], fromAddress, subject, content: [content]);
mailer.send(email).then((result) {
    print(result.isValue);
});

try {
    print('send successfully');
    // final result = await mailer.send(email);
    // Handle the result here
} catch (e) {
    // Handle any errors that occur during email sending
    print('Error sending email: $e');
}
```

Function	Description
getAllMyChats()	This function is called when a prayer or mosque manager opens the chat page. The function initializes an empty list called newChats to store instances of ChatModel, and makes an asynchronous request to retrieve data from the chatsCollection. If the condition isPrayer is true, it filters the response documents based on a specific criterion related to the user's prayer data, and it iterates over the filtered list of documents and extracts relevant information. If the newChats list does not already contain a chat with the same ID as the current mosque, it creates a new instance of ChatModel and adds it to the newChats list, and if the newChats list already contains a chat with the same ID as the current mosque, it updates the corresponding chat's attributes. The function also sorts the accounts list based on the lastMessage attribute in descending order.



```
40  Future<void> getAllMyChats() async {
41      List<ChatModel> newChats = [];
42      try {
43          final response = await chatsCollection.get();
44          if (isPrayer) {
45              log("Response: ${response.docs.length}");
46
47          if (response.docs.isNotEmpty) {
48              final list = response.docs
49                  .where(
50                      (element) =>
51                          element.data()['users']['prayer'] == prayerData!.userName,
52                  )
53                  .toList();
54
55              log("List: ${list.length}");
56              for (var element in list) {
57                  final mosqNum = element.data()['users']['mosqNum'];
58                  final imamNewMessage = element.data()['imamNewMessage'];
59                  final moazenNewMessage = element.data()['moazenNewMessage'];
60                  final prayerNewMessage = element.data()['prayerNewMessage'];
61                  final dateLastMessage = element.data()['lastMessageAt'];
62                  final prayerNewMessagesNum =
63                      element.data()['newMessagesFromPrayer'];
64                  final mangerNewMessagesNum =
65                      element.data()['newMessagesFromManger'];
66
67                  log("imamNewMessage: $imamNewMessage , moazenNewMessage: $moazenNewMessage , prayerNewMessage: $prayerNewMessage");
68                  final mosqResponse = await mosquesCollection.doc(mosqNum).get();
69                  log("mosqResponse: ${mosqResponse.data()}");
70                  final currentMosq = MosqueModel.fromJson(mosqResponse.data());
71                  if (newChats.firstWhereOrNull(
72                      (element) => element.id == mosqResponse.id,
73                      ) ==
74                          null) {
75                      newChats.add(
76                          ChatModel(
77                              name: currentMosq.name,
78                              id: mosqResponse.id,
79                              imageUrl: null,
80                              imamNewMessage: imamNewMessage,
81                              moazenNewMessage: moazenNewMessage,
82                              prayerNewMessage: prayerNewMessage,
83                              newMessagesFromPrayer: prayerNewMessagesNum,
84                              newMessagesFromManger: mangerNewMessagesNum,
85                              lastMessage: dateLastMessage?.toDate(),
86                          ),
87                      );
88                  } else {
89                      newChats
90                          .firstWhere((element) => element.id == mosqResponse.id)
91                          .imamNewMessage = imamNewMessage;
92                      newChats
93                          .firstWhere((element) => element.id == mosqResponse.id)
94                          .moazenNewMessage = moazenNewMessage;
95                      newChats
96                          .firstWhere((element) => element.id == mosqResponse.id)
97                          .prayerNewMessage = prayerNewMessage;
98                      newChats
99                          .firstWhere((element) => element.id == mosqResponse.id)
100                         .lastMessage = dateLastMessage?.toDate();
101                  }
102              }
103          }
104      } else {
105          if (response.docs.isNotEmpty) {
106              final list = response.docs
107                  .where(
108                      (element) =>
109                          element.data()['users']['mosqNum'] ==
110                          managerData!.mosqueNum,
111                  )
112                  .toList();
113
114              for (var element in list) {
115                  final prayerId = element.data()['users']['prayer'];
116                  final imamNewMessage = element.data()['imamNewMessage'];
```



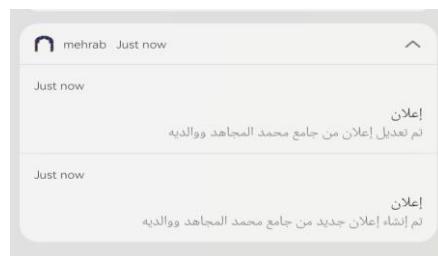
```
117     final moazenNewMessage = element.data()['moazenNewMessage'];
118     final prayerNewMessage = element.data()['prayerNewMessage'];
119     final dateLastMessage = element.data()['lastMessageAt'];
120     final prayerNewMessagesNum =
121         element.data()['newMessagesFromPrayer'];
122     final mangerNewMessagesNum =
123         element.data()['newMessagesFromManger'];
124     final prayerResponse = await prayerCollection.doc(prayerId).get();
125     final currentPrayer = PrayerModel.fromJson(prayerResponse.data()!);
126     if (newChats.firstWhereOrNull(
127         (element) => element.id == currentPrayer.userName,
128     ) ==
129         null) {
130         newChats.add(
131             ChatModel(
132                 name: currentPrayer.name,
133                 id: currentPrayer.userName,
134                 imageUrl: null,
135                 imamNewMessage: imamNewMessage,
136                 moazenNewMessage: moazenNewMessage,
137                 prayerNewMessage: prayerNewMessage,
138                 newMessagesFromPrayer: prayerNewMessagesNum,
139                 newMessagesFromManger: mangerNewMessagesNum,
140                 lastMessage: dateLastMessage?.toDate(), NoufAlsadhan, 2 months ago • Sprint 3 push
141             ),
142         );
143     } else {
144         newChats
145             .firstWhere((element) => element.id == currentPrayer.userName)
146             .imamNewMessage = imamNewMessage;
147         newChats
148             .firstWhere((element) => element.id == currentPrayer.userName)
149             .moazenNewMessage = moazenNewMessage;
150         newChats
151             .firstWhere((element) => element.id == currentPrayer.userName)
152             .prayerNewMessage = prayerNewMessage;
153         newChats
154             .firstWhere((element) => element.id == currentPrayer.userName)
155             .lastMessage = dateLastMessage?.toDate();
156     }
157 }
158 }
159 }
160 accounts = newChats;
161 accounts.sort((a, b) => b.lastMessage!.compareTo(a.lastMessage!));
162 } catch (error) {
163     log("Error: $error");
164 }
165 setState(() {
166     isLoading = false;
167 });
168 }
```

Function	Description
sendNotification2()	This function is written in JavaScript to send notifications to joined prayers when one of the mosque managers adds or edits an announcement in the mosque.

```

34
35 exports.sendNotification2 = functions.firestore()
36   .document("announcement/{notificationId}")
37   .onWrite(async (change, context) => {
38     // Check if a new document is created
39     if (!change.before.exists) {
40       const afterData = change.after.data();
41       const MosqueID = afterData.MosqueID;
42       const mosqueSnapshot =
43         await admin.firestore().collection("Mosque").doc(MosqueID).get();
44       const mosqueData = mosqueSnapshot.data();
45       const mosqueName = mosqueData["Name"];
46       const tokens = mosqueData["token"];
47       const message = {
48         notification: {
49           title: "إعلان",
50           body: `تم إنشاء إعلان جديد من ${mosqueName}`,
51         },
52         tokens: tokens,
53       };
54       try {
55         const response = await admin.messaging().sendMulticast(message);
56         console.log("Notification sent successfully:", response);
57       } catch (error) {
58         console.error("Error sending notification:", error);
59       }
60     } else {
61       const beforeData = change.before.data();
62       const afterData = change.after.data();
63       const fieldsToUpdate = ["Title", "Content", "Category"];
64       const hasFieldsUpdated = fieldsToUpdate.some((field) => {
65         return beforeData[field] !== afterData[field];
66       });
67       if (hasFieldsUpdated) {
68         const MosqueID = afterData.MosqueID;
69         const mosqueSnapshot =
70           await admin.firestore().collection("Mosque").doc(MosqueID).get();
71         const mosqueData = mosqueSnapshot.data();
72         const mosqueName = mosqueData["Name"];
73         const tokens = mosqueData["token"];
74         const notificationSent = afterData.notificationSent || false;
75         if (!notificationSent) {
76           await change.after.ref.update({notificationSent: true});
77           const message = {
78             notification: {
79               title: "إعلان",
80               body: `تم تعديل إعلان من ${mosqueName}`,
81             },
82             tokens: tokens,
83           };
84           try {
85             const response = await admin.messaging().sendMulticast(message);
86             console.log("Notification sent successfully:", response);
87           } catch (error) {
88             console.error("Error sending notification:", error);
89           }
90         }
91       }
92     }
93   });

```





## 5 System Evaluation

The purpose of this chapter is to present the evaluation of the Mehrab mobile application. First, the user acceptance test is discussed, followed by the NFR test, and finally the results are discussed.

### 5.1 User Acceptance Testing (UAT)

We used System Usability Scale (SUS) to measure users' perception of a system's usability [26]. We also conducted a comprehensive survey that focus on Mehrab's objectives to measure user satisfaction with the final release. In order to obtain accurate and measurable responses for Mehrab's objectives, the survey uses a Likert scale. In this respect the participants will first try the application and then asked to provide their level of agreement from 1 to 5, where 5 strongly agree [27]. The surveys were sent electronically for those who use and interact with Mehrab application, and 40 responses were received. The results are discussed in the following sections.

#### 5.1.1 Demographics of Participants

The demographics of the users who participated in the UAT are represented in Table 10.

Table 10: Demographics of Participants

Variable	Value	Number of participants (Total is 40)
Role	Prayer	20
	Mosque manager	11
	Admin	9
Gender	Male	29
	Female	11
Age	16-20	6
	21-26	10
	27-35	10
	+36	14

Technical background	High	8
	Medium	28
	Low	4

### 5.1.2 Questionnaire Results

Following each test session, we asked participants questions to learn more about their experience. Therefore, we have two surveys; SUS and Mehrab objective surveys. This section discusses the questionnaires results.

The SUS questions and number of users who chose a certain answer for each question are given in Table 11. The SUS score ranges from 0 to 100, with higher scores indicating better ease of use [26]. To measure the SUS score answers are given in points ranging from 1 to 5, where strongly disagree is given 1, and strongly agree is assigned 5. The individual users SUS scores are given in Table 12. To calculate, SUS score for each participant we use the formula  $(X + Y) \times 2.5$ ; where  $X = \text{Sum of the points for all odd-numbered questions} - 5$ , and  $Y = 25 - \text{Sum of the points for all even-numbered questions}$ . Table 13 shows the general guidelines on SUS score interpretation.

Table 11: SUS Questions and Results

Question	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. I think that I would like to use this system frequently.	0	0	1	5	34
2. I found the system unnecessarily complex.	30	10	0	0	0
3. I thought the system was easy to use.	0	0	0	6	34
4. I think that I would need the support of a technical person to be able to use this system.	26	14	0	0	0
5. I found the various functions in this system were well integrated.	0	0	0	4	36

<b>6. I thought there was too much inconsistency in this system</b>	33	7	0	0	0
<b>7. I would imagine that most people would learn to use this system very quickly.</b>	0	0	2	7	31
<b>8. I found the system very awkward to use</b>	35	5	0	0	0
<b>9. I felt very confident using this system.</b>	0	0	0	10	30
<b>10. I needed to learn a lot of things before I could get going with this system.</b>	26	12	1	0	1

Table 12: Participant's SUS scores and their interpretation

<b>Response no</b>	<b>SUS score</b>	<b>Grade</b>	<b>Adjective Rating</b>
User 1	97.5	A	Excellent
User 2	90	A	Excellent
User 3	92.5	A	Excellent
User 4	100	A	Excellent
User 5	87.5	A	Excellent
User 6	95	A	Excellent
User 7	80	B	Good
User 8	82.5	A	Excellent
User 9	80	B	Good
User 10	87.5	A	Excellent
User 11	100	A	Excellent
User 12	100	A	Excellent
User 13	100	A	Excellent
User 14	100	A	Excellent
User 15	95	A	Excellent
User 16	95	A	Excellent
User 17	96	A	Excellent
User 18	92.5	A	Excellent
User 19	100	A	Excellent
User 20	100	A	Excellent
User 21	87.5	A	Excellent
User 22	87.5	A	Excellent
User 23	92.5	A	Excellent

User 24	87.5	A	Excellent
User 25	100	A	Excellent
User 26	77.5	B	Good
User 27	87.5	A	Excellent
User 28	100	A	Excellent
User 29	100	A	Excellent
User 30	100	A	Excellent
User 31	100	A	Excellent
User 32	95	A	Excellent
User 33	100	A	Excellent
User 34	97.5	A	Excellent
User 35	100	A	Excellent
User 36	97.5	A	Excellent
User 37	100	A	Excellent
User 38	100	A	Excellent
User 39	100	A	Excellent
User 40	100	A	Excellent
<b>Average</b>	<b>94.4</b>	<b>A</b>	<b>Excellent</b>

Table 13: Interpretation of SUS score

SUS Score	Grade	Adjective Rating
>80.3	A	Excellent
68-80.3	B	Good
68	C	Okay
51-68	D	Poor
<51	F	Awful

The average SUS score for all the participants, the result was 94.4. Therefore, users view the system as intuitive, efficient, and easy to learn. The system design and functionality are well aligned with user expectations and requirements. Therefore, based on the above-mentioned guidelines, this means that the system's usability is “excellent”.

There are three surveys that aim to measure Mehrab objectives achievements with respect to admin, prayers and mosque manager. In Mehrab’s objectives survey, we received responses from 20 prayers, 11 mosque managers, and 9 admins the results and questions are shown in Table 14. In the question we ask participants to measure the extent to which they agreed whether Mehrab, as described in the question, fulfilled its intended purpose.

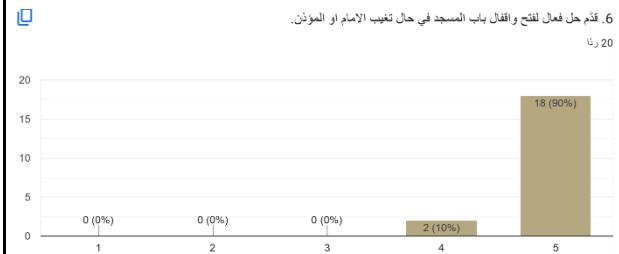
Table 14: Usability Testing Questions and Results

Usability Testing Questions and Results
Prayer

Question	Chart and results																		
To what extent do you think the Mehrab is:																			
1. Make mosque activities easier to access through the announcements.	<p>٦. سهل الوصول إلى أنشطة المسجد من خلال الإعلانات.</p> <table border="1"> <thead> <tr> <th>Response</th> <th>Count</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>2</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>3</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>4</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>5</td> <td>20 (100%)</td> <td></td> </tr> </tbody> </table>	Response	Count	Percentage	1	0 (0%)		2	0 (0%)		3	0 (0%)		4	0 (0%)		5	20 (100%)	
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2. Facilitate communication with the imam or muezzin.	<p>٢. سهل التواصل مع الإمام أو الموزن.</p> <table border="1"> <thead> <tr> <th>Response</th> <th>Count</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>2</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>3</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>4</td> <td>3 (15%)</td> <td></td> </tr> <tr> <td>5</td> <td>17 (85%)</td> <td></td> </tr> </tbody> </table>	Response	Count	Percentage	1	0 (0%)		2	0 (0%)		3	0 (0%)		4	3 (15%)		5	17 (85%)	
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3. Provided an effective and more efficient solution for managing mosque affairs.	<p>٣. قدم حل فعال وأكثر كفاءة لإدارة شؤون المساجد.</p> <table border="1"> <thead> <tr> <th>Response</th> <th>Count</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>2</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>3</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>4</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>5</td> <td>20 (100%)</td> <td></td> </tr> </tbody> </table>	Response	Count	Percentage	1	0 (0%)		2	0 (0%)		3	0 (0%)		4	0 (0%)		5	20 (100%)	
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5	20 (100%)																		
4. Enhance my participation by contributing to making some decisions related to the mosque.	<p>٤. عزز لدى المشاركة عن طريق مساهمي في اتخاذ بعض القرارات التي تخص المسجد.</p> <table border="1"> <thead> <tr> <th>Response</th> <th>Count</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>2</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>3</td> <td>1 (5%)</td> <td></td> </tr> <tr> <td>4</td> <td>1 (5%)</td> <td></td> </tr> <tr> <td>5</td> <td>18 (90%)</td> <td></td> </tr> </tbody> </table>	Response	Count	Percentage	1	0 (0%)		2	0 (0%)		3	1 (5%)		4	1 (5%)		5	18 (90%)	
Response	Count	Percentage																	
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3	1 (5%)																		
4	1 (5%)																		
5	18 (90%)																		
5. An effective solution was provided to the problem of using traditional locks to open and close mosque doors by using smart locks.	<p>٥. قدم حل لمشكلة استخدام الأقفال التقليدية لفتح واقفال أبواب المسجد عن طريق استخدام الأقفال الذكية.</p> <table border="1"> <thead> <tr> <th>Response</th> <th>Count</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>2</td> <td>0 (0%)</td> <td></td> </tr> <tr> <td>3</td> <td>1 (5%)</td> <td></td> </tr> <tr> <td>4</td> <td>2 (10%)</td> <td></td> </tr> <tr> <td>5</td> <td>17 (85%)</td> <td></td> </tr> </tbody> </table>	Response	Count	Percentage	1	0 (0%)		2	0 (0%)		3	1 (5%)		4	2 (10%)		5	17 (85%)	
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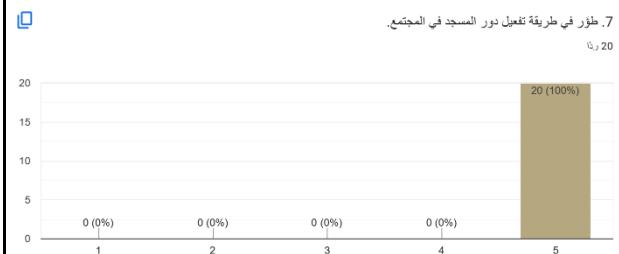
6. An effective solution was provided for opening and closing the door of the mosque in the event of the absence of the Imam or muezzin.

6. قدم حل فعال لفتح وغلق باب المسجد في حال تغيب الإمام أو المؤذن.



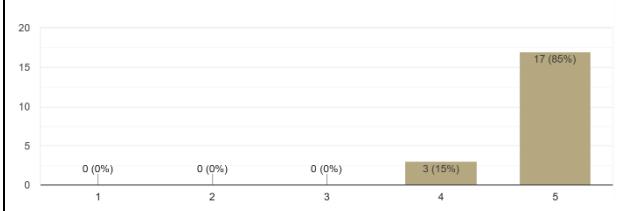
7. Developed the method of activating the role of the mosque in society.

7. ملئ في طريقة تعزيز دور المسجد في المجتمع.



8. Assuming that you are a member of the mosque community, to what extent do you think that the Mehrab strengthened your belonging to the mosque community and activated your role.

8. على افتراض انك من جماعة المسجد, الى اي مدى تعتقد ان محراب جرز انتهاك لمجتمع جماعة المسجد وقلل دورك.



### Usability Testing Questions and Results

#### Admin

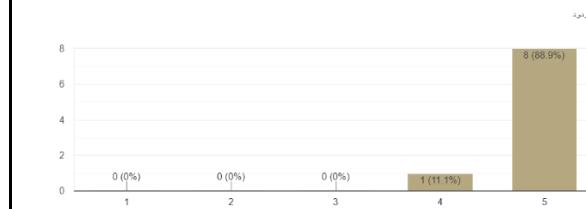
##### Question

##### Chart and results

To what extent do you think the Mehrab is:

1. Provided an effective and more efficient solution for managing mosque affairs.

1. قدم حل فعال و أكثر كفاءة لإدارة شؤون المساجد.

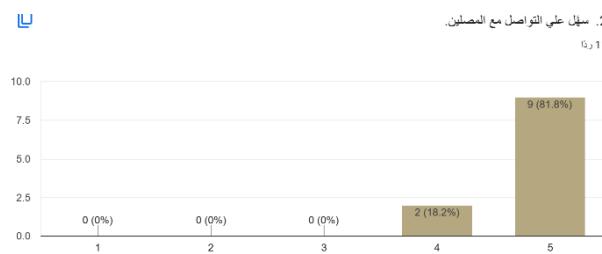


2. Guarantee that all mosques that have been added and their details are correct.	<p>٢. يضمن ان جميع المساجد المضافة وتفاصيلها صحيحة.</p> <table border="1"> <thead> <tr> <th>Rating</th> <th>Count (%)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> </tr> <tr> <td>2</td> <td>0 (0%)</td> </tr> <tr> <td>3</td> <td>0 (0%)</td> </tr> <tr> <td>4</td> <td>1 (11.1%)</td> </tr> <tr> <td>5</td> <td>8 (88.9%)</td> </tr> </tbody> </table>	Rating	Count (%)	1	0 (0%)	2	0 (0%)	3	0 (0%)	4	1 (11.1%)	5	8 (88.9%)
Rating	Count (%)												
1	0 (0%)												
2	0 (0%)												
3	0 (0%)												
4	1 (11.1%)												
5	8 (88.9%)												
3. Guarantee that the mosque managers accounts are legitimate and not fake.	<p>٣. يضمن ان حسابات الامام والمؤذن خاصة بهم وليس حسابات زهاده.</p> <table border="1"> <thead> <tr> <th>Rating</th> <th>Count (%)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> </tr> <tr> <td>2</td> <td>0 (0%)</td> </tr> <tr> <td>3</td> <td>0 (0%)</td> </tr> <tr> <td>4</td> <td>0 (0%)</td> </tr> <tr> <td>5</td> <td>9 (100%)</td> </tr> </tbody> </table>	Rating	Count (%)	1	0 (0%)	2	0 (0%)	3	0 (0%)	4	0 (0%)	5	9 (100%)
Rating	Count (%)												
1	0 (0%)												
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3	0 (0%)												
4	0 (0%)												
5	9 (100%)												

Usability Testing Questions and Results													
Mosque Manager													
Question	Chart and results												
To what extent do you think the Mehrab is:													
1. It made it easy for me to place announcements regarding the activities and news of my mosque.	<p>١. سهل علي طرح اعلانات تخص انشطة و اخبار المسجد الخاص بي.</p> <table border="1"> <thead> <tr> <th>Rating</th> <th>Count (%)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0 (0%)</td> </tr> <tr> <td>2</td> <td>0 (0%)</td> </tr> <tr> <td>3</td> <td>0 (0%)</td> </tr> <tr> <td>4</td> <td>3 (27.3%)</td> </tr> <tr> <td>5</td> <td>8 (72.7%)</td> </tr> </tbody> </table>	Rating	Count (%)	1	0 (0%)	2	0 (0%)	3	0 (0%)	4	3 (27.3%)	5	8 (72.7%)
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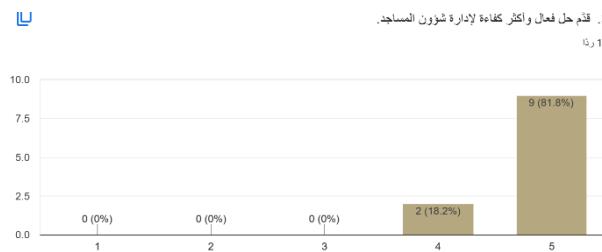
2. It made it easier for me to communicate with the prayers.

2. سهل على التواصل مع المصليين.  
رنا 11



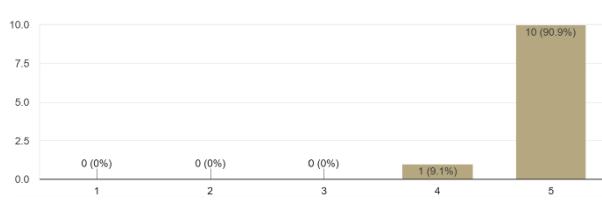
3. Provided an effective and more efficient solution for managing mosque affairs.

3. قدم حل فعال وأكثر كفاءة لإدارة شؤون المساجد.  
رنا 11



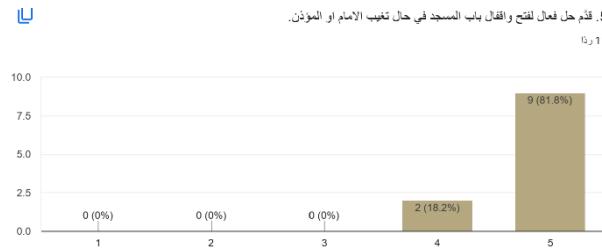
4. An effective solution was provided to the problem of using traditional locks to open and close mosque doors by using smart locks.

4. قدم حل لمشكلة استخدام الأقفال التقليدية لفتح واقفال أبواب المسجد عن طريق استخدام الأقفال الذكية.  
رنا 11



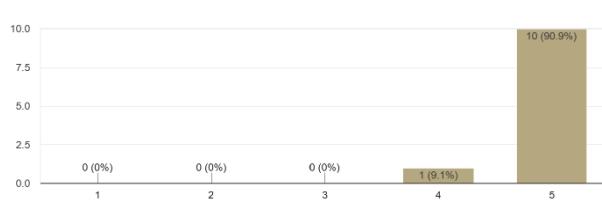
5. An effective solution was provided for opening and closing the door of the mosque in the event of the absence of the Imam or muezzin.

5. قدم حل لفتح واقفال باب المسجد في حال غياب الإمام أو المؤذن.  
رنا 11



6. Provided an effective solution to the problem of the lack of monitoring for mosque door opening and closing operations.

6. قدم حل لمشكلة عدم توفر مراقبة لعمليات فتح واقفال باب المسجد.  
رنا 11





For prayers, they all strongly agree that Mehrab facilitates access to mosque activities through announcements. It provides an effective and more efficient solution to managing mosque affairs, and develops a way to activate the mosque's role in society. In total 17 of prayer participants strongly agree that Mehrab facilitates communication with the Imam or Muezzin. They believe that Mehrab smart lock provides an effective solution to address the problem of using traditional locks to open and close mosque door. Moreover, the participants respond that if they were a member of Jama'ah Almasjid Mehrab would strengthen their sense of belonging to the mosque community and activates expected role. Moreover, 18 of prayers strongly agree that Mehrab enhances their participation by contributing to making some decisions related to the mosque.

For Imam and Muezzin, 9 of participants strongly agree that Mehrab provides an effective and more efficient solution for managing mosque affairs. They believe that Mehrab provides an effective solution for opening and closing the mosque doors in case of the absence of the Imam or Muezzin, and facilitates the communication with prayers. Moreover, 10 of Imam and Muezzin strongly agree that Mehrab smart lock is an effective solution that addresses the problem of using traditional locks to open and close mosque doors. Moreover, they believe that it offers an effective solution to address the issue of insufficient monitoring of opening and closing operations. Furthermore, 8 of participants strongly agree that Mehrab facilitates an easy way to send announcements regarding the activities and news of their mosque.

Admins agree that Mehrab ensures the authenticity of accounts belonging to the Muezzin and the Imam, ensuring that they are genuine accounts and not fakes. Also, 8 admins strongly agree that Mehrab provides an effective and more efficient solution for managing mosque affairs and ensures that all added mosques and their details are correct.

## 5.2 Quality Attributes (NFR Testing)

NFR testing was conducted to ensure that our system meets the non-functional requirements specified earlier in Table 15. The NFR testing is shown in **Error! Reference source not found.** to evaluate the system's: (i) availability, (ii) performance, and (iii) usability (that was evaluated in terms of time required to understand Mehrab application). The table below provides a summary of our NFR testing results for each user story, along with the quality attribute and measure we used for each. In addition, we have included the test scenarios we used to test each non-functional requirement.

Table 15: NFR testing results

User story	Quality Attribute	Measure	Results
As a user, I want Mehrab application to be available all days except four hours for maintenance every two weeks, so that I can access it at any	Availability How often is Mehrab application available for users to access, accounting for scheduled	The percentage of time Mehrab application is available, accounting for scheduled	Test scenario: 1-A group of users was selected. 2-During their testing sessions, we calculate the percentage of time the application is available

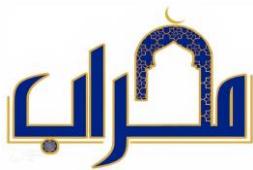
time unless it's maintenance time.	maintenance windows?	maintenance windows.	<p><b>Results:</b>            Mehrab application was available 100% of the time, since the testing was done out of scheduled maintenance windows.</p>
As a user I want to log-in within 10 seconds or less, so that I can gain fast access to Mehrab application and benefit from its services.	<p><b>Performance</b>            What is the time it takes for the system to respond to user log in to Mehrab system?</p>	The time it takes for the system to respond to log in request to Mehrab system.	<p>Test scenario:            1- A group of users was selected.            2-The users provided login credentials and instructions on how to access the system.            3-The users asked to log in to the system, and we used a stopwatch timer to compute the response time of the system.</p> <p><b>Results:</b>  <b>Minimum time:</b> 1.28 seconds.  <b>Maximum time:</b> 6.72 seconds.  <b>Average time:</b> 2.5257 seconds.</p>
As a user, I want Mehrab interfaces to be easy and simple, so that I can understand how to use it properly in less than 15 minutes.	<p><b>Usability</b>            What is the time it takes for the user to understand how to use Mehrab interface?</p>	The time it takes for the user to understand how to use Mehrab mobile interface.	<p>Test scenario:            1- A group of users was selected.            2- Introduced the test and explained the purpose of the test to the users.            3- Provided the users with the mobile device and the list of different tasks.            4- Instructed the users to complete each task using the mobile interface and timed how long it took for them to understand how to perform the task.            5- Recorded the time taken for each user to complete each task.</p> <p><b>Results:</b>  <b>Minimum time:</b> 1.52 minutes.  <b>Maximum time:</b> 9.49 minutes.  <b>Average time:</b> 5.2 minutes.</p>
As a mosque manager when I delegate one	<b>Performance</b>	The time it takes for Mehrab system	Test scenario: 1- A group of users was

of Jama'ah Almasjid to take control over the key, I want the application to respond to my delegate request in less than 10 seconds, so that I can use it effectively.	What is the time it takes for the system to respond to the delegation request?	to respond to the delegation request.	selected. 2- Provided the users with access to the system and the instruction of the request. 3- Asked the users to make the request, and we compute the response time of the system.
As a mosque manager I want to receive notification in less than 10 seconds when the mosque door opens, so that I can get notification fast enough and I can ensure the mosque security.	<b>Performance</b> What is the time it takes for the system to notify the mosque manager?	The time it takes for Mehrab system to notify the mosque manager.	Test scenario: 1- A group of users was selected. 2- Provided the users with access to the system and the instruction of the request. 3- Asked the users to make the request, and we compute the response time of the system.

## 5.2 Discussion

The UAT and NFR tests were conducted with respect to prayers, mosque managers and admins, and the results were satisfactory for them as expected users. The majority of the participants reported good experiences with Mehrab, and most agreed that the system was convenient and easy to use, and that it met their expectations. In light of the evaluator's observations during the test, as well as the answers of the questionnaires that were presented before, it appears that most of the participants are interested in using Mehrab in the future.

Considering the high SUS results, positive user feedback, high task completion rates, and comprehensive user support, we can conclude that Mehrab is a user-friendly system. These factors collectively demonstrate that users find the system intuitive, efficient, and accessible, enhancing their overall experience and supporting the claim of its user-friendliness. In addition, most of our users expressed an interest in using Mehrab in the future when we asked them in the objectives survey. The majority of prayers strongly agree that Mehrab would strengthen their sense of belonging to the mosque community and activate their role if they were members of Jama'ah Almasjid. Mehrab encourages the participants to actively participate in the mosque's various activities. This is one of the major goals of Mehrab. Mehrab also has the goal of implementing a decision-making process that enables prayers to contribute to certain mosque decisions. According to the findings of the published survey, this goal has been achieved since



most of the prayers strongly agree that Mehrab enhances their participation by helping them to make some decisions related to the mosque. Furthermore, the majority of Imams and Muezzins strongly agree that Mehrab facilitates communication with prayers as well as through sending announcements to their mosques. This demonstrates that Mehrab is successfully implementing social networking features. Moreover, most of them strongly believe that Mehrab is an effective solution that addresses the problem of using traditional locks to open and close mosque doors by providing smart locks and it offers an effective solution to address the issue of insufficient monitoring of opening and closing operations. This proves that Mehrab successfully resolves the key problem. Finally, Mehrab users find it convenient, and we ensure that users can easily use its features without any difficulties.

NFR testing revealed that the Mehrab system was available 100% of the time during the testing period since there were no scheduled maintenance windows during the period of testing. The system availability may vary, however, when maintenance windows are scheduled every two weeks for four hours. The test scenario and results indicate that the system's availability meets the user story's requirements. Furthermore, the system meets the performance requirements set by the user story, enabling users to log in within the specified timeframe. It is important to note that the application interfaces met the usability requirement set by the user story, so users were able to understand how to use the application quickly and efficiently, ensuring a good user experience. Finally, the system meets the performance requirement for response time, ensuring that users can gain access to Mehrab system and benefit from its services and use it effectively.



## 6 Conclusions and Future Work

Mehrab is an Arabic-friendly mobile application that supports IoT utilization and contributes to the Kingdom's 2030 vision. It is designed to be an effective application for prayers, helping them keep track of information published by mosques and enabling them to contact mosque managers whenever necessary. The Mehrab system also provides mosque managers with tools to efficiently organize mosque affairs, including the ability to control mosque locks and delegate such control in a trackable manner. Furthermore, an administrator can create accounts for mosque managers and add mosques to be viewed by a large number of audiences. In the following sections, global and local impacts are discussed followed by introducing the challenges, limitations, contributions and future work of the project.

### 6.1 Global and Local Impact

In a local setting, the Mehrab application can improve communication between mosque managers and prayers, enhancing the overall experience. It is also possible for the application to contribute to the safety of the mosque by enabling mosque managers to control access to mosque doors more effectively. In addition, the application may increase engagement among prayers, encouraging them to become more active participants in mosque events and activities. In addition to the user-friendly interface of the application, it is expected to lead to a more positive experience for mosque managers and prayer. Globally, widespread adoption of such an application could contribute to the development of best practices in mosque management and administration, resulting in more efficient and well-organized mosques. Moreover, the application can be used to promote the adoption of technology in other aspects of religious life, thus fostering innovation and progress within religious communities. By using the application, mosques and their activities can be made more visible to a global audience, highlighting their contributions to society and promoting a positive image of Islam.

### 6.2 Problems and Challenges Encountered During the Software Development

The development of Mehrab system has been accompanied by many complications and challenges. The following subsections highlight the most significant challenges.

#### 6.2.1 Implementation Difficulties

One of the challenges we encountered was when implementing the creation of accounts by the admin, since the credentials were sent via SMS. The first challenge was sending SMS from a Flutter application with the flutter\_sms package. Our problem with this package was that once the admin filled out all the required fields and clicked the button to create an account, it was redirected to the default SMS application on the phone, and the admin had to click the sending icon himself, which we considered unhelpful. However, we fixed the problem by downloading permission\_handler. This allows and gives permission for the Flutter app to send SMS messages instead of forcing it to be redirected to the SMS app. Moreover, since the Samsung phone we were using did not have a SIM card, we could not test whether the SMS message actually reached the expected users. Therefore, we bought a SIM card and used it with the same phone we were utilizing, which is the admin phone.



The Nuki smart lock and its API presented another challenge. Nuki offers free APIs [28], and using their APIs to control our smart lock required several steps. The first step was to obtain an OAuth2 API key in order to use the APIs. In order to obtain this key, we created an account on web.nuki [29], and after gaining permission to use the APIs, we began working on the code, and we had to provide the smart lock ID and API token in our HTTP post request to get access to the API. The API token was created using the same website as the OAuth2 API key, but the smart lock ID was the problem. Each smart lock bought from Nuki has its own ID printed on the box. We used this ID to access the API but it did not work. We tried searching for other ID's by downloading the Nuki app and linking our smart lock with it. We also tried contacting Nuki support about this problem, but none of these attempts worked. However, web.nuki has a feature to add the smart lock to the system, so we tested adding our lock to see if any ID's rather than the one that comes with the lock appeared. We noticed that once we clicked on the added lock, an 11-digit number appeared in the URL, so we experimented using this number to link the smart lock to the application, and it worked.

We also encountered a problem related to sending SMS messages to mosque managers, when we wanted to send a message via SMS to allow mosque managers activate their accounts. However, it turned out that it was not being sent because some of the terms in the content of the message had banded because SMS have treated the message we used to send as a spam, so we had to change the content of the message, and then we were able to send the message.

In order to add notifications to the system, we encountered a problem dealing with JavaScript because it requires careful handling and attention to detail due to its dynamic nature and potential for unexpected behavior. Since we have more than one situation to send the notifications, we had to test the system multiple times and change the JavaScript code as well, which required deployment for the cloud function and it usually takes 5 minutes for each change.

One last problem we faced is while sending emails to the user when resetting password, we couldn't log in to our Gmail account using coding in order to send the emails. Gmail had a restricted role regarding this issue. Therefore, we tried to contact Google team in order to give us the access, but they didn't respond, so to solve this solution we used SendGrip API [30].

### 6.2.2 Construction Difficulties

To test the smart lock functions, we had to attach it to an actual door. For the smart lock to work, the door's lock must be built with a Euro profile cylinder lock [31]. For better testing of smart lock functionality, a prototype based on a Euro profile cylinder lock was built. This, however, presented a challenge. A Euro profile cylinder lock is designed to fit real doors and has a fixed size that may not fit smaller or non-standard doors. For our prototype, the Euro profile cylinder lock we needed was larger than the door we had constructed. Therefore, we had to find a way to accommodate the lock without compromising the prototype's integrity. In order to solve this problem, we had to visit multiple stores and carpenters. Various options were explored, including customizing the door to fit the lock and modifying the lock to fit the door, but none of them proved feasible. Several attempts and consultations with experts led us to find a solution that worked for our prototype. The lock was modified to fit the door by making some minor adjustments to the lock itself, cutting pieces that weren't necessarily for testing. This allowed us to test the smart lock and validate its performance. The process of finding a solution, however, was frustrating and time-consuming. We had to spend a lot of time



visiting different stores and consulting with carpenters to discover a solution that worked for our prototype.

### 6.3 Limitations of The System

Mehrab offers a centralized system that is accessible to all users, promoting social interaction and enhancing mosque accessibility. Additionally, the system provides support to mosque managers by enabling delegation of tasks using IoT technology and special smart locks with trackable features. However, due to the time and scope constraints, Mehrab does not support any other language other than Arabic. Moreover, for some sort of mosque the cost of acquiring the smart lock could be a limitation, especially for those with limited financial resources. We address this issue by allowing communities to use the remaining features, and automatically disabling the smart lock when it is not installed.

### 6.4 The Main Contribution of The Project

Mehrab is designed to revolutionize mosque activities management and communication with the Imam, Muezzin, and Prayers. Traditional communication methods often fail to reach a wide audience, making congregational mosque access more difficult. A centralized system makes Mehrab accessible to all mosque members, increasing social interaction and making access to the mosque more efficient. It also supports mosque managers who delegate tasks in a trackable way using IoT technology and smart locks.

Ultimately, Mehrab will provide a user-friendly, innovative, and effective solution to the problems associated with traditional methods of organizing mosque activities and communicating with the mosque community. Through improved communication and management of mosque activities, the application can increase community engagement, transparency, and accountability. This results in more efficient and effective mosque management.

### 6.5 Future Work

Mehrab team is looking forward to their upcoming journey to enhance the project by introducing a range of new features such as supporting not only mosques in Riyadh, but also mosques all over the world, and for that supporting different languages to help different nationalities. In addition to controlling the entrance and access to the mosque by mosque managers, the application will also allow them to remotely control the lighting, air conditioning, and other electronic devices within the mosque. The application could offer a virtual reality experience or a live streaming of the mosque for prayers who are unable to physically attend due to distance or other reasons. In addition to notifying the prayers when calling for Athan or Iqamah by sending them a notification from Mehrab application. This would allow them to participate in the prayers and feel a sense of connection to the mosque community. To make it easier for the user, we will consider using phone numbers instead of email in the future, as well as adding more authentication steps for more security.



## 7 Acknowledgements

We would like to begin by expressing our utmost praise and gratitude to Allah, the Almighty, the Most Gracious, and the Most Merciful, for granting us the opportunity, courage, and strength to successfully complete our graduation project.

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We consider ourselves immensely fortunate and blessed to have had such an exceptional support network. We extend our heartfelt gratitude to everyone who has played a role, big or small, in the successful completion of this project.

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## Appendix

## A Questionnaire Questions and Results

**3.** سبق وأن أتيت إلى المسجد لصلاتي التراويح أو التهجد وتفاجأت أن الصلاة قد بدأت بالفعل \*

نعم

لا

**4.** إذا احتجت إلى التواصل مع الإمام أو المؤذن لأي سبب كان، فما هي وسائلك في التواصل معهم؟ \*

اتصال مباشر (مكالمة)

استخدم برامج التواصل الاجتماعي كالواتس آب ، تليغرام الخ...

حضورياً (بشكل مباشر)

ليس لدي أي وسيلة تواصل

غير ذلك...

**5.** إلى أي مدى أنت راضٍ عن الطريق ، أو الطريقة المستخدمة في التواصل؟ \*

راضٍ تماماً

راضٍ

محايد

غير راضٍ

غير راضٍ أبداً

**6.** ما هي الطريقة التي تفضلها للتواصل مما سبق؟ \*

اتصال مباشر (مكالمة)

استخدم برامج التواصل الاجتماعي كالواتس آب ، تليغرام الخ...

حضورياً (بشكل مباشر)

ليس لدي أي وسيلة تواصل

7. إذا كنت ترغب في الانضمام إلى حلقات تعليم القرآن (التحفيظ والتلاوة)، أين تجد تفاصيل هذه المعلومات عادةً؟ \*

- مجموعات وسائل التواصل الاجتماعي (واتس اب، تليغرام .. الخ)
- إعلانات المسجد الورقية (ورقة ملقة داخل المسجد)
- يعلن عنها بعد أو قبل وقت الصلوات الخمس
- يصعب على الحصول على المعلومة
- غير ذلك...

8. إذا كنت مهتم بحضور الدروس الدينية و المحاضرات كيف تعلم بوقت و مكان إقامة المحاضرة ؟ \*

- مجموعات وسائل التواصل الاجتماعي (واتس اب، تليغرام .. الخ)
- إعلانات المسجد الورقية (ورقة ملقة داخل المسجد)
- يعلن عنها بعد أو قبل وقت الصلوات الخمس
- يصعب على الحصول على المعلومة
- غير ذلك...

9. خلال شهر رمضان المبارك كيف تعلم بموعد إقامه صلاة التهجد والتراويح؟ \*

- مجموعات وسائل التواصل الاجتماعي (واتس اب، تليغرام .. الخ)
- إعلانات المسجد الورقية (ورقة ملقة داخل المسجد)
- يعلن عنها بعد أو قبل وقت الصلوات الخمس
- يصعب على الحصول على المعلومة
- غير ذلك...

10. إلى أي مدى أنت راضٍ عن الطريقة المتبعة حالياً للاطلاع على أنشطة المسجد؟ \*

- راضٍ تماماً
- راضٍ
- محايد
- غير راضٍ
- غير راضٍ أبداً

\* 11. سبق أن أقيمت محاضرة في المسجد ووددت أن أحضرها، ولكن لم أحضرها لعدم علمي بالتفاصيل مثل المكان والوقت

 دائمًا

 غالباً

 أحياناً

 نادرًا

 أبداً

\* 12. إلى أي مدى تعتقد أن تطبيق محراب والذي يوفر شبكة تواصل خاصة بين الإمام والمؤذن ومرتادي المسجد، والتي يتم فيها إضافة مستجدات أنشطة المسجد (أوقات دخول صلاة المزدوج، عنوان المحاضرات وأوقاتها الخ..) تطبيقًا جيداً؟

حيث إن رقم (5) يعبر عن تأييده القائم.

5

4

3

2

1

 مؤيد جداً





غير مؤيد أبداً

\* 13. ما هي نوعية الإشارات التي تفضلها في تطبيق محراب و التي تخص تفاصيل أنشطة المسجد ومستجداته و أوقات الصلاة؟ \*

 أقرم أنا باختيار المساجد من قائمة المساجد

 إشارات تخص مساجد الأحياء القرية فقط

 إشارات من مساجد مجاورة (القريبة من بيتي)

 لا أفضل أن تصلكي أي إشارات

\* 14. في الوقت الحالي، هل يتم إشراكك في التصويت لاختيار المواعيد المناسبة لإقامة المحاضرات الدينية في المساجد التي تهتم بها؟

 يتم إشراكي دائمًا

 غالباً ما يتم إشراكي

 نادرًا ما يتم إشراكي

 لا يتم إشراكي أبداً

\* 15. ما مدى أهمية أن تكون جزءاً من عملية اتخاذ القرار في المسجد (في حال طرح التصويت في أمر يخص المسجد)؟

- شایة في الأهمية
- مهم جداً
- مهم
- مهم نوّطاً ما
- غير مهم

\* 16. إلى أي مدى تؤيد أن يكون هناك مفتاح ذكي لباب المسجد و الذي يسهل لجماعة المسجد فتح باب المسجد خلال أوقات الصلوات الخمس فيما لو تأخر الإمام و المؤذن بفتح الباب ؟

- مؤيد بشدة
- مؤيد
- محاب
- معارض
- معارض بشدة

\* 17. إذا وثق بك الإمام أو المؤذن وطلب منه يوماً ما أن تقوم بفتح و إغلاق المسجد باستخدام القفل الذكي ، هل ستقبل ذلك؟

- نعم
- ربما
- لا

\* 18. هل أنت مهتم بالحصول على تطبيق محراب و الذي يدير شؤون المساجد، و يجعلك على اطلاع بنشاط المسجد، ويسمح لك بالتواصل مع الإمام والمؤذن؟

 نعم

 ربما

 لا

\* 19. هل ترغب في أن تكون على تواصل مع جماعة المسجد من خلال تطبيق محراب، أم تفضل أن يقتصر التواصل مع المؤذن والإمام؟

 التواصل مع جماعة المسجد

 التواصل يكون مقتصر مع المؤذن والإمام

20. ماذا تمني أن يوفر لك تطبيق محراب من مميزات و خصائص؟ سواء كنت من جماعة المسجد أو زائراً لأحد المساجد؟

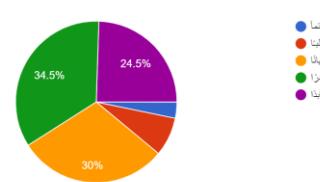
نص الإجابة الطويلة

## Results

Mosque prayers							
Question	Chart and results						
1. Select your gender:	<p>اختار الجنس : 400 رد</p> <ul style="list-style-type: none"> <li>• Female</li> <li>• Male</li> </ul> <table border="1"> <thead> <tr> <th>جنس</th> <th>النسبة المئوية</th> </tr> </thead> <tbody> <tr> <td>ذكر</td> <td>57.3%</td> </tr> <tr> <td>إناث</td> <td>42.8%</td> </tr> </tbody> </table>	جنس	النسبة المئوية	ذكر	57.3%	إناث	42.8%
جنس	النسبة المئوية						
ذكر	57.3%						
إناث	42.8%						

2. Have you ever came to the mosque and found it closed (at times when it is supposed to be open, such as ten minutes before/after the prayer)?

- Always
  - Often
  - Sometimes
  - Rarely
  - Never

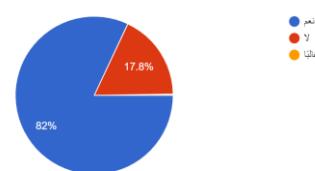


2. سبق وأن أتيت إلى المسجد ووجده مغلقاً في أوقات يفترض أن يكون فيها المسجد مفتوحاً، مثل (عشر دقائق قبل أو بعد الصلاة) 400 رم

- 400

3. Have you ever arrived at the mosque to pray Taraweeh or Tahajjud and discovered that the prayer had already begun?

- Yes
  - No



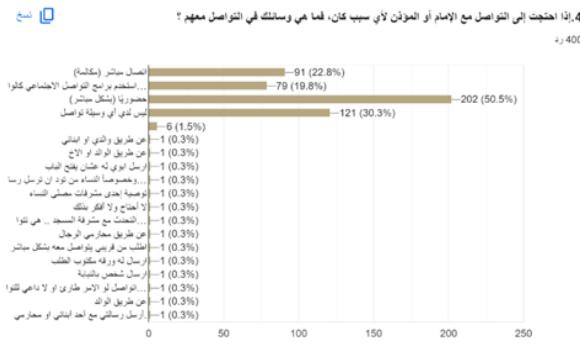
3. سبق وأن أتيت إلى المسجد لصلاتي التراويح أو التهجد وتقاجأت أن الصلاة قد بدأت بالفعل

23400

4. How do you communicate with an Imam or Muezzin if you need to?

- Phone call
  - Social media applications like WhatsApp, telegram, etc.
  - Physically
  - I do not have any communication method
  - Other

**Write the other:**



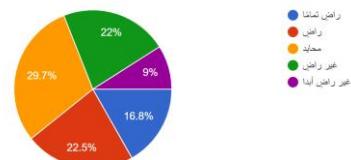
٤- إذا احتجت إلى التواصل مع الإمام أو المؤذن لأي سبب كان، فما هي وسائلك في التواصل معهم؟

3,400

5. What is your level of satisfaction with the method/methods used for communication?

- Strongly satisfied
- Satisfied
- Neutral
- Dissatisfied
- Strongly dissatisfied

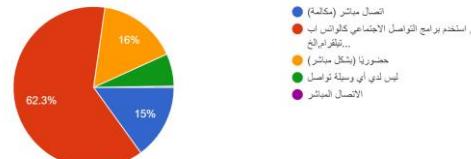
5. إلى أي مدى أنت راض عن الطرق ، أو الطريقة المستخدمة في التواصل؟  
رد 400



6. What method do you prefer for communication from the above?

- Phone call
- Social media applications like: WhatsApp, telegram, etc.
- Physically
- I do not have any communication method

6. ماهي الطريقة التي تفضلها للتواصل مما سبق؟  
رد 400



7. If you are interested to join any of: Qur'an educational sessions (Tahfeed), Qur'an recitation sessions, where do you usually find the session details?

- In social media groups (WhatsApp, telegram, etc)
- Paper mosque advertisements (on posters inside the mosque)
- Announced after or before the time of the five daily prayers
- It is hard for me to find the information
- Other (write it):

7. إذا كنت ترغب في الانضمام إلى حلقات تعليم القرآن (التحفيظ والتلاوة)، أين تجد تفاصيل هذه المعلومات عادة؟  
رد 400



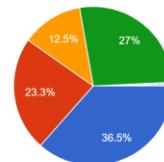
- ...مجموعات وسائل التواصل الاجتماعي (واتس اب، تليغرام...)
- اعلانات المسجد الورقية (ورقة ملحة داخل المسجد)
- يعلن عنها بعد أو قبل وقت المسافرات الحسين
- تصبح على المسؤول على المعرفة
- من التويتر وموقع التواصل ومرانك ودور التحفيظ إذا من القرآن
- ما ذكرت
- لا أزيد الإجابة بشكل متشوّش لأنني لم أخوض مثل هذه

▲ 1/2 ▼

8. If you want to attend a religious lecture or session, how do you know about the lecture time and location?

- In social media groups (WhatsApp, telegram, etc.)
- Paper mosque advertisements (on posters inside the mosque)
- Announced after or before the time of the five daily prayers
- It is hard for me to find the information
- Other (write it):

8. إذا كنت مهتم بحضور المدروس الدينية والمحاضرات كيف تعلم بوقت و مكان إقامة المحاضرة؟ رد 400

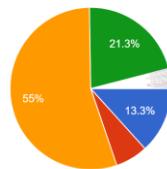


- مجموعات وسائل التواصل الاجتماعي (واتس آب، تليغرام، إلخ)
- إعلانات المسجد الورقية (ورقة ملطة داخل المسجد)
- يعلن عنها بعد أو قبل وقت المنشرات الجبس
- يسحب على الحصول على المعلومة
- كما في السؤال السابق
- مسجدة لا يوفر محاضرات دينية
- من الاستاذ

9. During Ramadan, how do you know when to pray Tahajjud and Taraweeh prayers?

- From social media groups (WhatsApp, telegram, etc.)
- Paper mosque advertisements (on posters inside the mosque)
- Announced after or before the time of the five daily prayers
- It is hard for me to find the information
- Other(write it):

9. خلال شهر رمضان المبارك كيف تعلم بموعد إقامته صلاة التهجد والتراويح؟ رد 400



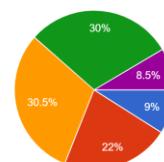
- ...، مجموعات وسائل التواصل الاجتماعي (واتس آب، تليغرام، إلخ)
- إعلانات المسجد الورقية (ورقة ملطة داخل المسجد)
- يعلن عنها بعد أو قبل وقت المنشرات الجبس
- يسحب على الحصول على المعلومة
- برنامج المصلى
- من الواد
- ...، ينبه الأئم عليها المسلمين قبل رمضان بيام و المسلمين
- كالعتاد بعد اذان المغرب بساعتين

▲ 1/3 ▼

10. What is your level of satisfaction with the current way to view the activities of the Mosque?

- Strongly satisfied
- Satisfied
- Neutral
- Dissatisfied
- Strongly dissatisfied

10. إلى أي مدى أنت راض عن الطريقة المتبعة حالياً للإطلاع على أنشطة المسجد؟ رد 400



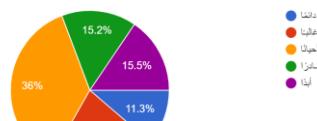
- راضٍ تماماً
- راضٍ
- متأثر
- غير راضٍ
- غير راضٍ أبداً

11. Would you be interested in attending a lecture held at the mosque, but weren't able to attend because you did not know the details, such as the location or time?

- Always
- Often
- Sometimes
- Rarely
- Never

11. سبق أن أقيمت محاضرة في المسجد ووددت أن أحضرها، ولكن لم أحضرها لعدم علمي بالتفاصيل مثل المكان والوقت

ر. 400

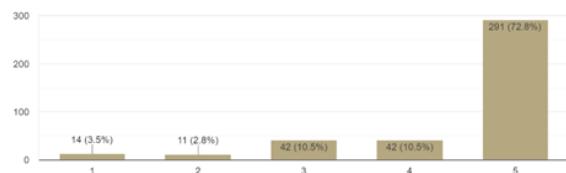


12. To what extent do you believe that Mehrab application, which provides a communication network between mosque managers and mosque prayers, and where updates on mosque activities are added (such as Taraweeh prayer times, lecture titles, and timings, etc.), is a valuable application?

- 1
- 2
- 3
- 4
- 5 (Strongly supportive)

12. إلى أي مدى تعتقد أن تطبيق محراب والذي يوفر شبكة تواصل خاصة بين الإمام والمؤذن ومرتادي المسجد، والتي يدمج فيها إضافة مسجدات أنشطة المسجد (أوقات دخول صلاة التراويح، عشورين المحاضرات وأوقاتها الخ..) تطبيقاً جيداً؟

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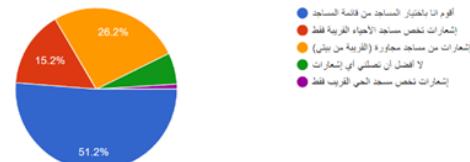


13. What kind of notifications do you prefer in Mehrab application, which are related to the details of the mosque's activities, updates about the mosque, and prayer times?

- I choose the mosques from the list of mosques
- Notifications from nearby neighborhood mosques only
- Notifications from nearby mosques (near my house)
- I do not prefer to receive any notifications

13. ما هي نوعية الإشعارات التي تفضلها في تطبيق محراب و التي تخص تفاصيل أنشطة المسجد ومسجدهاته و أوقات الصلاة؟

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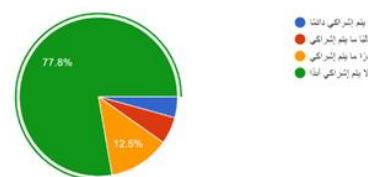


14. Currently, do you participate in the voting process to select the best timings for religious lectures in the mosques that you are interested in?

- I am always involved
- I am often involved
- I rarely get involved
- I am never involved

14. في الوقت الحالي، هل يتم إشراكك في التصويت لاختيار المواعيد المناسبة لإقامة المحاضرات الدينية في المساجد التي تهتم بها؟

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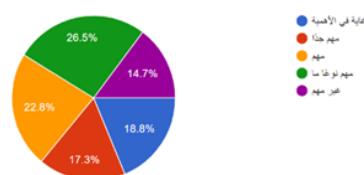


15. How significant is it for you to be a part of the mosque decision making process (when making a decision concerning the mosque)?

- Extremely important
- Very important
- Important
- Kind of important
- Not important

15. ما مدى أهمية أن تكون جزءاً من عملية اتخاذ القرار في المسجد (في حال طرح التصويت في أمر يخص المسجد)؟

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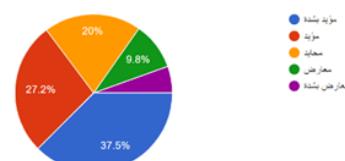


16. To what extent do you support the idea of having a smart key for the mosque door that facilitates opening the door during the five prayer times in case the mosque managers are running late?

- Strongly supportive
- Supportive
- Neutral
- Opposed
- Strongly opposed

16. إلى أي مدى توافق أن يكون هناك مفتاح ذكي لباب المسجد الذي يسهل لجامعة المسجد فتح باب المسجد خلال أوقات الصلوات الخمس فيما لو تأخر الإمام والمؤذن بفتح الباب؟

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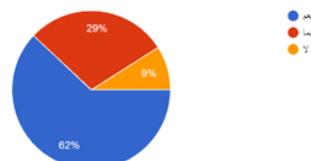


17. If mosque managers trusted you and one day asked you to take the mosque key to open/close the mosque, would you do it?

- Yes
- Maybe
- No

17. إذا وثق بك الإمام أو المؤذن وطلب منك يوماً ما أن تقوم بفتح و إغلاق المسجد باستخدام المفتاح الذكي ، هل ستقبل ذلك؟

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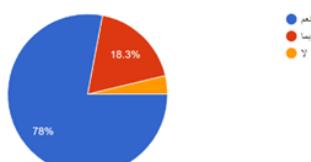


18. Are you interested in getting Mehrab application, which manages mosque affairs, keeps you updated on mosque activities, and enables you to communicate with the mosque managers?

- Yes
- Maybe
- No

18. هل أنت مهتم بالحصول على تطبيق محراب الذي يدير شؤون المساجد، ويجعلك على اطلاع بنشاطات المسجد، ويسمح لك بالتواصل مع الإمام والمؤذن؟

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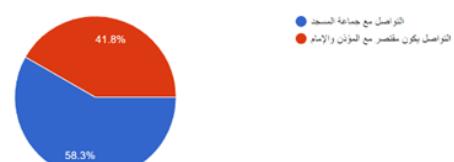


19. Do you want to be in contact with Jama'ah almasjid through Mehrab application, or do you prefer to limit the communication with the mosque managers?

- Contact with Jama'ah almasjid
- Contact with Imam and Muezzin only

19. هل ترغب في أن تكون على تواصل مع جماعة المسجد من خلال تطبيق محراب، أم تفضل أن يتقتصر التواصل مع المؤذن والإمام؟

رد 400





20. What features do you wish Mehrab application to provide for you, whether you are a member of Jama'ah Almasjid or a visitor to one of the mosques?

20. ملأ تتمة أن يوفر لك تطبيق محراب من مميزات و خصائص؟ سواء كنت من جماعة المسجد أو زائر لأحد المساجد؟

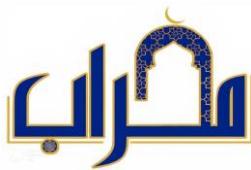
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- مواصفات الميزات
  - الأنشطة في المسجد
  - مساجد الآباء
  - السفر، حفظ، والآراء
- أريد أن أعرف عدد المدارس في الجامع القريب مني
- أتمنى أن يفيد الجميع ويسهل عليهم
- من الأسماء والمؤذن
- اضافة مقالة ، تذكرة خصوصية عائلية، اعطاء شعار بالدرس والوقت وتفاصيل اسم المعلم
- معلومات لكل مسجد عن اسمه وفي أي حي ومن هو الأسلام والمؤذن
- غير قاتلي على بيت العبد يعني يمكن ل المسلمين وخاصة لخواص التربية والذات يمكن تطبيق
- التركيز على فئة النساء من جماعة المسجد حتى تصلهم الإشعارات للمدارس الدينية

## B Interviews Questions and Results

Interview 1: Imam	
Questions	Answers
Q1: What are the mosque activities that you are currently managing?	Organizing lectures with Da'wah and Guidance office to provide religious lectures for muslims in order to improve their knowledge about Islam. Also, fast breaking to anyone who joins us that time. In addition to short speeches after prayers.
Q2: What are your ways of managing these activities?	Coordination between the Ministry Of Islamic Affairs, Da'wah and Guidance, and the Office of Da'wah and Guidance. I manage the fast breaking every day in my mosque, after taking permission from the Ministry, I

	<p>schedule this with a restaurant to prepare meals for the beneficiaries.</p>
Q3: What are the obstacles you face in managing these tasks?	I face difficulty in coordinating between Jama'ah Almasjid to set up activities at an appropriate time, and the difficulty of communicating with them.
Q4: Do you receive questions or complaints from the surroundings of the mosque? How and where do you usually receive them?	Sometimes, I usually receive them through direct communication (face to face).
Q5: How do you respond to these questions and complaints?	I respond to their questions or complaints at the same time.
Q6: In your opinion, do you see the method you mentioned as effective? Why and why not?	It is not enough, perhaps some of Jama'ah Almasjid wants to convey a specific suggestion or complaint and they wouldn't like to reveal it through direct communication with the Imam. It is also not useful in communicating the opinions and complaints of women.
Q7: If you need to announce any updates or anything related to the mosque, such as the time of Taraweeh prayers, cancellation or	We have a periodic meeting in which the suggestions of some of Jama'ah Almasjid are



publishing of a lecture date, how do you usually announce them?	taken, and we inform them of some matters and updates.
Q8: In your opinion, do you see the method you mentioned as effective? Why and why not?	No, I think it is not enough because not all Jama'ah Almasjid and prayers meet in this meeting.
Q9: Do you think that communication through a mini social media application can contribute to improving communication with mosque prayers and make it easier to reach the largest possible segment?	Yes, definitely.
Q10: Do you usually need to communicate with Jama'ah Almasjid? And what do you think about having a place for Jama'ah Almasjid to communicate with each other?	Yes, sometimes. There is no need to have a place for communication between Jama'ah Almasjid.
Q11: Do you think that all the authorities should be available to both the Imam and the Muezzin, or do you prefer to have higher administrative powers, and why?	I prefer to have the same authorities, because I usually delegate the Muezzin to inform Jama'ah Almasjid and prayers of some of the activities.
Q12: Do you think engaging the mosque community (prayers and Jama'ah almasjid) in decision making, toward topics that are chosen by you, is a good idea? why?	Of course, it is necessary because the prayers are the ones concerned and the beneficiaries of all the activities that are held.



Q13: In your opinion, what is the best way to engage prayers and Jama'ah Almasjid in the decision-making process? Is it through voting via a mobile application, conversations, meetings (in person or remote) or paper voting? Why?

I think voting with a mobile application is simpler and more comprehensive, so that we can take the opinion of women.

Q14: Do you prefer to engage everyone with the decision making, or just Jama'ah Almasjid?

I care about Jama'ah Almasjid, then the rest of the prayers.

Q15: Have you ever encountered a situation where you were unable to attend the mosque? How did you authorize a substitute for the leading prayer? What about opening the mosque door?

Yes, I call Muezzin or I try to find someone to act on my behalf, and when I can't find someone, one of Jama'ah Almasjid in the mosque prays. Often the door is opened by the security personnel of the mosque or Muezzin.

Q16: What do you think about using smart locks for Mosques, that can be controlled using a mobile application, you can use these locks to open/close mosque doors, delegate someone you trust to open/close mosque doors?

It is wonderful for many reasons, including if Imam and Muezzin are absent together, and it will also make it easier for us to open and close the mosque.



Q17: What are the features that you want to add to the smart locks? In addition to delegating, tracking all delegate processes(times of opening and closing, and the person who is responsible), remove the delegation and receive announcement when the door is opened?	I think that what you mentioned is wonderful and comprehensive of all the features that should be on the smart lock.
Q18: Do you think that the presence of an application instead of the method you previously mentioned will make it easier for you to manage mosque activities and communicate with the mosque community?	Of course, because it is more comprehensive and the results are faster in voting, it also facilitates communication with prayers.
Q19: What features do you want to add to Mehrab application?	To add in this application the feature of remote control of air conditioners and lights, also that the application be linked to the ministry so that any activity that takes place the ministry is aware of it and the situation is regular and official.

### Interview 2 : Muezzin

Questions	Answers



Q1: What are the mosque activities that you are currently managing?	Adhan(Calling for prayers)  Arrangement of lectures  Tahfeed session arrangement
Q2: What are your ways of managing these activities?	The only way I use is by notifying people in the Mosque.
Q3: What are the obstacles you face in managing these tasks?	Some people after the obligatory prayers leave the Mosque directly, and some of them stay to read some Qur'an or pray Sunnah, I usually wait for them to finish so that i can announce or update things, and here comes the problem that people already left will not receive the information.
Q4: Do you receive questions or complaints from the surroundings of the mosque? How and where do you usually receive them?	Yes I do and actually a lot, I also receive them in the Mosque often after the prayers.
Q5: How do you respond to these questions and complaints ?	I respond to them at the moment once they ask.

<p>Q6: In your opinion, do you see the method you mentioned as effective? Why and why not?</p>	<p>It is not effective, even though I tend to respond at the same time they asked, but some problems and complaints I need to discuss with the Imam or to do an additional search, where in this situation is hard recognize people and to give the response, so I tend to wait for them to come again and ask for feedback, which is a waste of time for them. Some complaints do not require feedback, so I tend to follow-up until it is confirmed to be solved.</p>
<p>Q7: If you need to announce any updates or anything related to the mosque, such as the time of Taraweeh prayers, cancellation or publishing of a lecture date, how do you usually announce them?</p>	<p>Using posters inside the Mosque.</p>
<p>Q8: In your opinion, do you see the method you mentioned as effective? Why and why not?</p>	<p>It is not effective, people tend to come to the Mosque to pray and leave, they do not usually look at the walls, that is why they hardly know anything about lectures because of the way lectures are announced.</p>
<p>Q9: Do you think that communication through a mini social media application can contribute to improving communication with</p>	<p>Yes, and it is actually a solution that should have been created a long time ago. Mosques are such an important place to manage and people should take that into consideration.</p>



mosque prayers and make it easier to reach the largest possible segment?

Q10: Do you usually need to communicate with Jama'ah Almasjid? And what do you think about having a place for Jama'ah Almasjid to communicate with each other?

No, I do not communicate with them unless they have questions or complaints. In an application that wants to improve management, and that is mainly focused on religious manners, I do not think it is a good idea to have a place where Jama'ah Almasjid can communicate with each other. Things will start to get out of context and will take a different path, people will get busy toward things that are not as important as announcements and other main objectives.

Q11: Do you think that all the authorities should be available to both the Imam and the Muezzin, or do you prefer to have higher administrative powers, and why?

Imam and Muezzin often take turns and help each other with responsibilities, no such differentiation should be done.

Q12: Do you think engaging the mosque community(prayers and Jam'ah almasjid) in decision making, toward topics that are chosen by you, is a good idea? why?

Yes, everyone who is in the mosque is a primary beneficiary of the services provided in it, so all opinions should be taken into account if the subject allows it



Q13: In your opinion, what is the best way to engage prayers and Jama'ah Almasjid in the decision-making process? Is it through voting via a mobile application, conversations, meetings (in person or remote) or paper voting? Why?	I think voting with a mobile application is so much easier. For me, groups are not effective, since it is hard to control and see who did vote and who did not, and it is hard to take into consideration all votes, some mistakes can be made. Votes by selecting available options and directly counting is much better.
Q14: Do you prefer to engage everyone with the decision making, or just Jama'ah Almasjid?	Everyone who comes to the mosque.
Q15: Have you ever encountered a situation where you were unable to attend the mosque? How did you authorize a substitute for the call to prayer? What about opening the mosque door?	Yes, using Whatsapp. It is difficult to inform a substitute well in advance, as they are often notified at short notice, making it difficult to confirm their availability. As for the key, if I inform them and they are able to be substitutes, it is very difficult for them to come and take the key from me, as the mosque does not provide a spare key in another place such as under a carpet.
Q16: What do you think about using smart locks for Mosques, that can be controlled using a mobile application, you can use these locks to open/close mosque doors, delegate	It is a good idea.



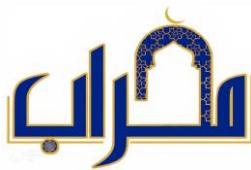
someone you trust to open/close mosque doors?	
Q17: What are the features that you want to add to the smart locks? In addition to delegating, tracking all delegate processes(times of opening and closing, and the person who is responsible), remove the delegation and receive announcement when the door is opened?	I do not have a lot of knowledge about technology, but i think all things you mentioned are enough.
Q18: Do you think that the presence of an application instead of the method you previously mentioned will make it easier for you to manage mosque activities and communicate with the mosque community?	Yes it will.
Q19: What features do you want to add to Mehrab application?	Nothing.



### Interview 3 : Imam

Questions	Answers
Q1: What are the mosque activities that you are currently managing?	The environment of the mosque in terms of its cleanliness, the coolness of the atmosphere, the sounds of the loudspeakers so that they are not disturbing, and the general supervision of the (Tahfeed), Qur'an recitation sessions, preaching lectures and speeches which is held in the mosque from time to time. In addition to sermons and reading a book from Riyadh Alsalheen after Al'Asr prayer. We intend to add, after Al'Isha prayer, after Ramadan, a reading of Ibn Katheer's interpretation
Q2: What are your ways of managing these activities?	Standing directly on it and following up by asking (Tahfeed), Qur'an recitation sessions supervisors about the course of the (Tahfeed), Qur'an recitation sessions and communicating with the official authorities to establish such activities, and following up the mosque servant with regard to the cleanliness of the mosque

Q3: What are the obstacles you face in managing these tasks?	Jama'ah Almasjid does not agree on one opinion, for example, regarding controlling air conditioning, and communicating with Jama'ah Almasjid and informing them of the mosque's activities
Q4: Do you receive questions or complaints from the surroundings of the mosque? How and where do you usually receive them?	Yes, sometimes, mostly through direct communication or via WhatsApp.
Q5: How do you respond to these questions and complaints ?	It depends on the complaint itself, if it is important and logical, we consider it and do our duty. If the complaint was not that important, we only explain the point of view to the complainant, which is enough in our case.
Q6: In your opinion, do you see the method you mentioned as effective? Why and why not?	Yes, I am okay with it.
Q7: If you need to announce any updates or anything related to the mosque, such as the time of Taraweeh prayers, cancellation or publishing of a lecture date, how do you usually announce them?	As for the Taraweeh and Qiyam prayers, they are explained to prayers a night before or on the same night after the Maghrib prayer. Likewise, the Al'Estesqa and Eid prayer are shown after the Fajr prayer. As for (Tahfeed), Qur'an recitation sessions, preaching lectures, speeches and sermons, they are



	published on the mosque screens and in WhatsApp groups.
Q8: In your opinion, do you see the method you mentioned as effective? Why and why not?	There is nothing wrong with it, but it may not meet the full purpose, so we aspire to innovate a better way of communication, especially for women.
Q9: Do you think that communication through a mini social media application can contribute to improving communication with mosque prayers and make it easier to reach the largest possible segment?	Yes, definitely.
Q10: Do you usually need to communicate with Jama'ah Almasjid? And what do you think about having a place for Jama'ah Almasjid to communicate with each other?	Yes, regarding looking forward to their opinions, listening to their observations and criticisms, and working to develop them, as well as informing them of prayers such as Taraweeh and others. I do not support the idea.
Q11: Do you think that all the authorities should be available to both the Imam and the Muezzin, or do you prefer to have higher administrative powers, and why?	The Imam should have higher authorities than the Muezzin, because I am the only one who responsible in front the ministry with



	regard to the general supervision of mosque affairs
Q12: Do you think engaging the mosque community (prayers and Jama'ah almasjid) in decision making, toward topics that are chosen by you, is a good idea? why?	Yes, because we want to know their opinions
Q13: In your opinion, what is the best way to engage prayers and Jama'ah Almasjid in the decision-making process? Is it through voting via a mobile application, conversations, meetings (in person or remote) or paper voting? Why?	Definitely voting through the mobile application because I think it is better and more appropriate than our current method
Q14: Do you prefer to engage everyone with the decision making, or just Jama'ah Almasjid?	The possibility of voting only for the Jama'ah Almasjid, such as periodic meetings, or making it for everyone, such as (Tahfeed), Qur'an recitation sessions.
Q15: Have you ever encountered a situation where you were unable to attend the mosque? How did you authorize a substitute for the leading prayer? What about opening the mosque door?	Yes, I call Muezzin to lead the prayer on my behalf.

<p>Q16: What do you think about using smart locks for Mosques, that can be controlled using a mobile application, you can use these locks to open/close mosque doors, delegate someone you trust to open/close mosque doors?</p>	<p>I do not support because I am satisfied with the current method</p>
<p>Q18: Do you think that the presence of an application instead of the method you previously mentioned will make it easier for you to manage mosque activities and communicate with the mosque community?</p>	<p>Yes it will.</p>
<p>Q19: What features do you want to add to Mehrab application?</p>	<p>There should be a different section for voting and a section for complaints and communication with the prayers.</p>



### Interview 4 : Muezzin

Questions	Answers
Q1: What are the mosque activities that you are currently managing?	Supervision of mosque sessions and supervision of mosque needs and maintenance.
Q2: What are your ways of managing these activities?	The issuance of permits, announcing sessions establishment, supervising the implementation of plans prepared for students, and mostly all of them are done directly in the mosque.
Q3: What are the obstacles you face in managing these tasks?	Lack of support and sometimes lack of cooperation from attendees.
Q4: Do you receive questions or complaints from the surroundings of the mosque? How and where do you usually receive them?	Yes I do, I receive them in the Mosque after the prayers, calls, meetings, and messages.
Q5: How do you respond to these questions and complaints ?	I respond to them at the moment once they ask if it is easy to solve, or after going back to the Imam and discussing all important things to solve the issue.

<p>Q6: In your opinion, do you see the method you mentioned as effective? Why and why not?</p>	<p>It is not that bad, but I think there could be a better way.</p>
<p>Q7: If you need to announce any updates or anything related to the mosque, such as the time of Taraweeh prayers, cancellation or publishing of a lecture date, how do you usually announce them?</p>	<p>By using a panel after receiving the approval from the relevant authorities, or by using mosque screens.</p>
<p>Q8: In your opinion, do you see the method you mentioned as effective? Why and why not?</p>	<p>No, rarely all people receive the information.</p>
<p>Q9: Do you think that communication through a mini social media application can contribute to improving communication with mosque prayers and make it easier to reach the largest possible segment?</p>	<p>Yes, of course.</p>
<p>Q10: Do you usually need to communicate with Jama'ah Almasjid? And what do you think about having a place for Jama'ah Almasjid to communicate with each other?</p>	<p>I do communicate with them when they have questions or complaints. I think there are other platforms where their main focus is chatting, so I do not think it is a great idea.</p>

<p>Q11: Do you think that all the authorities should be available to both the Imam and the Muezzin, or do you prefer to have higher administrative powers, and why?</p>	<p>Both should have authorities that benefit the mosque and that not contradict the authorities granted by the ministry.</p>
<p>Q12: Do you think engaging the mosque community (prayers and Jama'ah almasjid) in decision making, toward topics that are chosen by you, is a good idea? why?</p>	<p>When its related to times of lectures and prayers, I think it is better to evolve all prayers.</p>
<p>Q13: In your opinion, what is the best way to engage prayers and Jama'ah Almasjid in the decision-making process? Is it through voting via a mobile application, conversations, meetings (in person or remote) or paper voting? Why?</p>	<p>Voting with a mobile application is easier.</p>
<p>Q14: Do you prefer to engage everyone with the decision making, or just Jama'ah Almasjid?</p>	<p>Everyone.</p>
<p>Q15: Have you ever encountered a situation where you were unable to attend the mosque? How did you authorize a substitute for the call to prayer? What about opening the mosque door?</p>	<p>Yes, to contact someone on my behalf if qualified.</p>



Q16: What do you think about using smart locks for Mosques, that can be controlled using a mobile application, you can use these locks to open/close mosque doors, delegate someone you trust to open/close mosque doors?	It is a good idea. I have come across a mosque called Masjid Ma'moor in Qurtubah neighborhood in Riyadh that has an excellent experience in controlling the mosque's locks.
Q17: What are the features that you want to add to the smart locks? In addition to delegating, tracking all delegate processes(times of opening and closing, and the person who is responsible), remove the delegation and receive announcement when the door is opened?	It is enough.
Q18: Do you think that the presence of an application instead of the method you previously mentioned will make it easier for you to manage mosque activities and communicate with the mosque community?	Yes, it will.
Q19: What features do you want to add to Mehrab application?	Nothing.