**Qatar University**

**College of Engineering**

**Department of Computer Science and Engineering**

# QU BUDDY: SMART University Information System

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**Co-Supervisor** This project report is submitted to the Department of Computer Science and Engineering of Qatar University in partial fulfillment of the requirements of the Senior Project c

# Declaration

This report has not been submitted for any other degree at this or any other University. It is solely our work except where cited in the text or the Acknowledgements page. It describes work carried out by us for the senior project. We are aware of the university policy on plagiarism and the associated penalties and we declare that this report is the product of our own work.

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# Abstract

An increasingly high consensus comprised of students, faculty, staff and visitors at Qatar University face difficulties reaching a desired location efficiently due to the vast architecture and layout of the campus. Contending to this issue a campus wide survey conducted in October 2019, shown that out of 163 respondents approximately 80% required some sort of guidance to their destination. As of currently the university is working on a navigation feature for those individuals that need assistance in reaching their designated area but have yet to come up with a viable solution. The current issue at hand seems even more problematic for foreign exchange students, incoming freshman, and increasing number of visitors that come and go from the campus where a map provided in a university pamphlet is unsuitable for most individuals nowadays. In addition to this, the same consensus of individuals face other issues that involve a lack of communication between students and faculty/staff. This gap in effective communication have students unable to relate a certain message or status in due time when the respective faculty member is not present in his or her office. To provide an overall solution regarding the mentioned issues, a proposed android based information system software navigating users over various parts of the campus as well as providing the communication interface needed by different users to communicate with the respective members in a timely manner.

# Acknowledgment

First and foremost, we would like to express our sincere gratitude and praise to Allah almighty for giving us the courage to undertake and complete this project. We would also like to thank the Department of Computer Science and Engineering, for providing us the opportunity to be a part of this reputed institution, gain some experience and groom ourselves for the future professional responsibilities. We are very grateful to our Supervisor Dr. Mohammed Saleh, Head of Department Dr. Sumaya Al-Maadeed, and our family and friends for their continuous help, support and time during the entire course of our project. We feel great pride and pleasure on the accomplishment of this project.

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# 1. Introduction and Motivation

Location mobility and awareness has been a challenge for quite some time with regards to open and vast areas that are covered. Initially, the incentive behind producing such an application came from personal encounters with various individuals associated with Qatar University whether they be faculty, staff, visitors, or students. The interest to continue with such a venture was backed by the survey that was conducted revealing the obvious issues that have not been catered by Qatar University as of the time being. There are many instances that can be illustrated where individuals have quite the difficulty finding a location efficiently often times going off route and having to be redirected to the location of choice whether it be a building, classroom, or office. There is no debate that there should be system present that members can rely on which provides features that solves the various issues faced by individuals associated with the campus.

## 1.1. Problem statement

It is clear that most people feel the inconvenience of searching for a point of interest or spending a significant amount of time typing a desired location that may not be recognized by the applicable search engines due to a lack of a dedicated database for the campus. In such a situation individuals more than often become frustrated due to being delayed by spending the allocated time searching ambiguously, or relying on misinformation. These situations are applicable to any environment whether a mall, University campus, or unfamiliar area that has adverse effects depending on the situation. A considerable amount amounting to 40 percent of individuals that have been to the Qatar University campus have not been able to reach their destination directly according to the survey conducted in the prior year. Problems that are also consistent with the results of the survey include a lack of information regarding professor's schedule, office hours, building or classrooms. Information as such is regarded as vital towards the everyday needs for members of Qatar University. Therefore, it is vital for a reliable, informative, and precise guidance and information system to be present in a technological and digital era.

## 1.2. Project significance

Smart phones and devices have become a necessity with the usage of smartphones have increased significantly specifically in Qatar. For a majority of residents and citizens of Qatar smart devices are affordable, where the use can range from business, weather, education, health, social, travel, transportation, and navigation to facilitate their daily habits. Based on a recent Northwestern study, 100% of Qataris use smartphones providing a basis for the scope of the project that covers a major

portion of Qatar University[1]. Although there is exists a variety of outdoor navigation systems such as Google Maps, Waze, Sygic, or Papago GPS Navigation with advanced developments in relaying information based on traffic or best route for the user these applications lack to provide the precise routes as well as information relative to a building or indoor space where faculty, staff, and guests may face the same problem while they are visiting other faculty members office, or guests visiting other faculty members, or staff checking to see whether a room is occupied or will be occupied in the future. of losing their way in university waste a great deal of time finding a classroom or office eventually leading them to their classes or meetings. The system has a significant importance in maximizing the efficiency of navigating the university cohesively by having a single interface to facilitate easier access to the university for each user. The developed application presents an information system with some advanced features catering all the discussed demands of users associated with Qatar University. The enhanced navigation routing system around campus will confront the previously stated, issues from an individual not being able to reach their location in the shortest amount of time causing an causing a distress among students with high academic performance due to entering a lecture late, missing an important part of a lecture, portraying a negative initial impression on the professor, or missing a quiz or midterm exam. The campus navigation is also applicable to professors, invited academic scholars, professionals from other universities, or invited event guests. The implemented system makes full use of its functionalities making it efficient and user-friendly for all users. The final deliverable, a technologically advanced system assisting university staff access certain information related to the campus efficiently and at their convenience. The scope of this project enhances the quality of navigation around various areas of the campus as well as provide a concrete foundation for reliable information of the university that can be furthered and developed for different areas of education as a completely cohesive enterprise system.

## 1.3. Project objectives

The overview of the objectives this project provides a template for future information systems that will complement the initiatives put in place by Qatar University by providing a reliable guidance mobility system to facilitate the user's navigation around the university saving them time and effort. The specific objectives of the project include:

- Enabling users to navigate through the campus using real time locations and data.
- The system provides a client side in which the user can retrieve accurate information regarding a certain building or location by scanning the nearest QR code.
- Allowing the users to leave a message to the professors, see the professor's information or schedule by scanning QR code on the office door.
- Allowing the users to see the schedule or information of any room in the campus.

# 2. Background and related work

## 2.1. Background

The system is going to embed indoor navigation inside the campus. Different algorithms have been considered to be integrated within the system. With regards to GPS systems, positioning is the first step in using GPS. Essentially, the GPS system receiver chip running on a handheld device receives satellite positioning signals and measures the receiving device's coordinates. GPS satellite signals are poorly penetrated and are often obscured by the building of buildings. In addition, map information on which most navigation applications depend is not widely available for indoor scenarios, even with accurate positioning results. Therefore, indoor GPS-based real-time navigation is out of the question. Another relatively well-known approach to navigation is based on positioning the Bluetooth beacon. Using Apple's iBeacon as an example, using signals from one or more iBeacons, a smartphone app can essentially figure out the location of the device on a map. The app can then determine a path on the basis of this data and direct the user to their destination. Nonetheless, this approach only works in buildings where there are iBeacons and the restricted Bluetooth transmission range results in high installation and maintenance costs in large indoor environments. Another popular approach to indoor navigation is based on Wi-Fi positioning. For indoor environments, Wi-Fi signals are more common than Bluetooth beacons. This form of solution, similar to the Bluetooth system, determines the approximate location of mobile devices through radio frequency (RF) signal characteristics and processes of triangulation. Similar positions are dependent on signatures. Such systems can also use signal propagation models and learning algorithms to construct a fingerprint map of indoor areas, and then train the system for positioning with, let's say, radio signal strength data. Wi-Fi signals are easily affected by interference, however, due to the complexity of indoor environments, and can fluctuate widely. Maintaining up-to-date Wi-Fi signal data can result in high maintenance costs. Other factors such as the deployment density of Wi-Fi routers, how frequently the indoor environment changes, and the effort required to train and calibrate the system also limit the positioning accuracy. There are also solutions focused on specialized equipment in various indoor locations that include the installation of a number of special-purpose sensing devices, including cameras, visible light communication systems, RFID, Ultra-Wideband (UWB), infrared, ultrasound, or even laser-based gears. These solutions can greatly improve system accuracy, but with high hardware and labor costs, widespread deployments are severely constrained. Indoor navigation is generally based on indoor maps, but map processing, data representation and data manipulation in large indoor spaces are exceptional and expensive problems, raising a huge question mark over the universal application of indoor navigation technologies. And owners may not have the means for collecting and exposing the

necessary data for smaller buildings. So, we need to build an efficient approach to indoor navigation for this project.

## 2.2. Related work

The projects done earlier had a quite basic functionality of a university information systems such as maintaining [20] attendance records, managing the grading system, managing admissions and helping staff and professor work. They did not provide any functionality to enhance the navigation inside the campus.

1- Steerpath:

Steerpath Campus Guide is a solution to activity-based workspaces, cross-disciplinary research, group work, productive learning, and working methods for modern university campuses. This helps students as well as staff and campus guests to identify every unique space within the campus as well as to locate the closest workspace accessible for any ad-hoc space needs. With the Steerpath Campus Guide, one can find a space for your staff and students wherever and whenever, rush hour or not. Campus Guide uses the Steerpath virtual campus platform which communicates with various data sources such as:

- Google G Suite room booking status
- Microsoft Office 365 room booking status
- Real-time occupancy sensors
- Proprietary systems via open REST API.

Steerpath offers skilled indoor navigation and positioning through sectors and venue types. Their indoor navigation and wayfinding-based Bluetooth beacon works reliably in various environments. The indoor tracking system operates without wires and lets one monitor real-time property and individuals inside a house. Organizations ranging from airports to schools, from university campuses to offices using their indoor navigation system, asset tracking and analytics solutions.

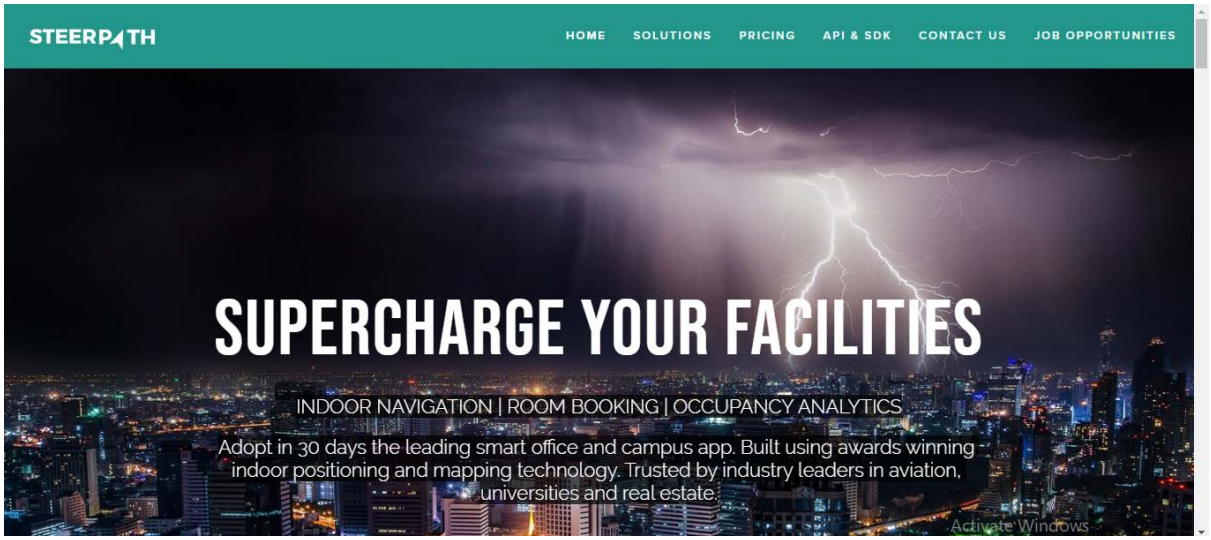



*Figure 1. Steerpath website interface*

2- Path Guide:

Path Guide is an indoor navigation plug-and-play device that functions like the "Follow the Leader" player. Once a building map is created by one user, it is uploaded to the cloud and available for use by others. Path Guide will maximize the advantages of every single path obtained by compiling data from many different users. GPS signals are not used in this device. The visualization is done manually in the building by the movement. This uses the barometer and magnetometer of the user's device to measure distances and display the position the user. It is possible to use the Path Guide software in many situations. For example, if the user first attends a client meeting in a large office building, a colleague who knows where the meeting room is can serve as a "path master" and record a trace from the building's entrance to the meeting room using Path guide. Path Guide users can also record a trace and track it back to its point of departure. The user can record a trace from his/her parking spot to the elevator in an unknown garage, for example, and then follow it in reverse to locate his/her vehicle. Another aspect of the Path Guide is its provision for trace recording annotations. It is possible to add text, audio and images along a path, providing more information and interactivity. In addition, all traces downloaded to the cloud can be accessed from a web browser using a special trace ID and shared with others.


*Figure 2. RIO Interface design*

### 3- HERE Indoor Radio Mapper

HERE Indoor Radio Mapper is a resource for HERE Indoor Positioning to allow any venue. HERE Indoor Positioning is similar to GPS but offers a precise location within a few meters for inside a house. HERE Indoor Wireless Mapper produces inside buildings wireless maps that are sets of geo-referenced wireless information (Wi-Fi and BluetoothTM). In order to create this conceptual map, Wi-Fi access point and Bluetooth beacon signal strengths are leveraged. HERE Mobile SDK, which provides accurate indoor location and floor data, consumes the radio map generated. There are four basic steps and one optional step to deploy HERE Indoor Positioning to a location.

In compliance with the HERE guidelines, the location must have either Wi-Fi or Bluetooth beacon (EddystoneTM or iBeacon compliant) infrastructure in place.

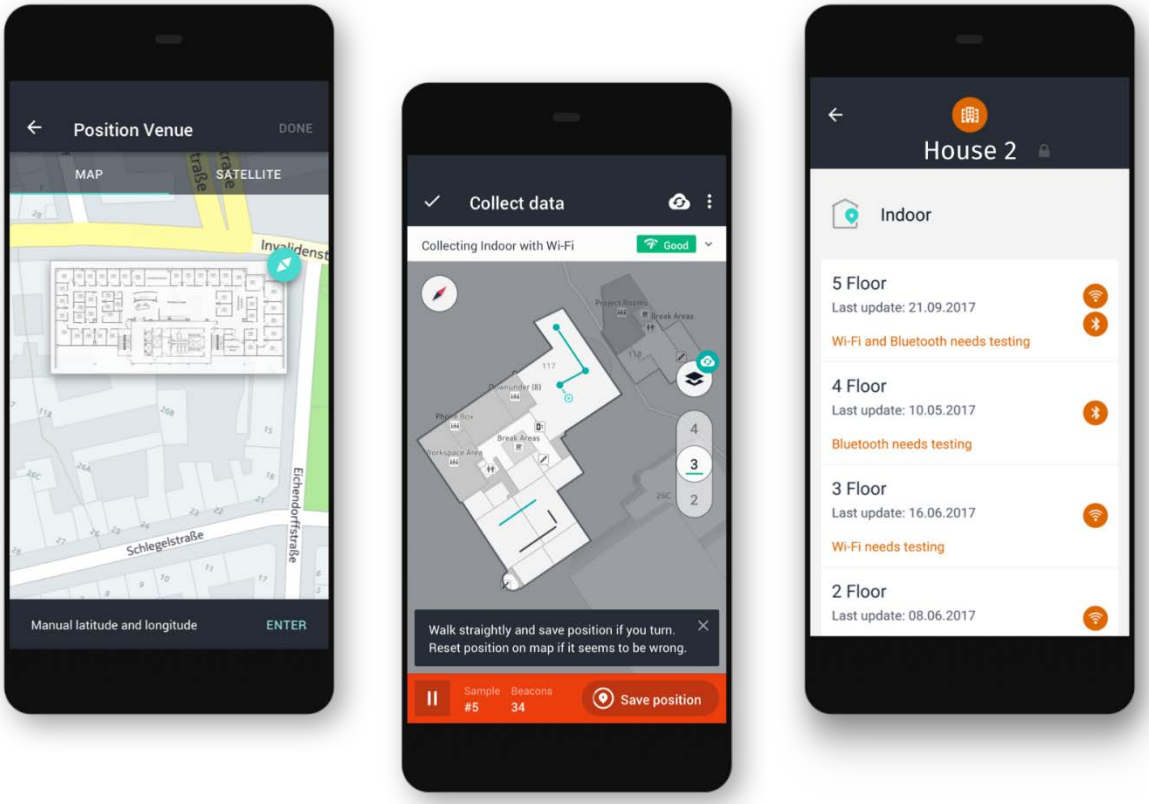



*Figure 3. Interface of HERE indoor radio map*

## 4- HERE Locator:

HERE Locate is a reference framework that illustrates the HERE Tracking cloud's features and capabilities. This can be used in conjunction with the HERE Tracker app to check how to locate, geofence and control connected devices. The users can see the position and sensor data in real time and analyze the history of the app on a map that provides their current location background. The following features are provided by this app:

- Sign in and sign linked tracking devices to your HERE account
- Display the user's registered device's last known location and historical position trace
- Build and manage geofences and receive push notifications when tracking devices reach or leave geofences
- Update the user's tracking device's name and how often it monitors and records its location and other telemetry (e.g., battery le).

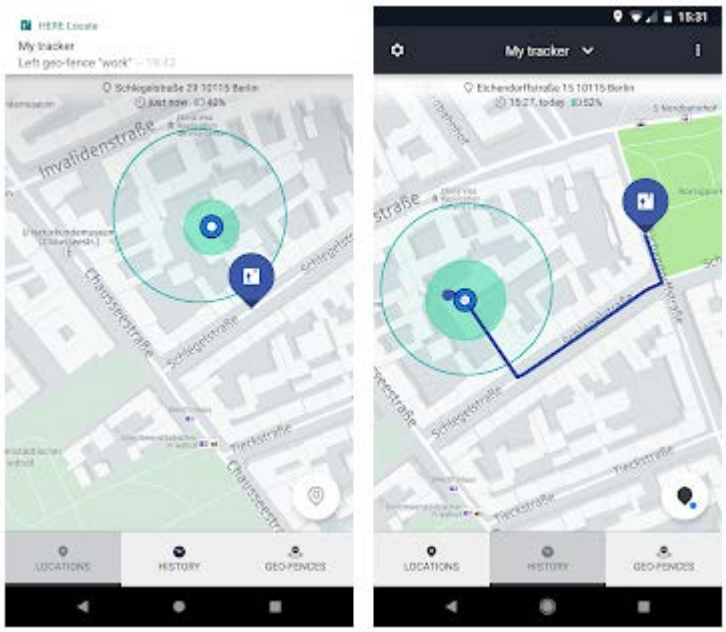



Figure 4. HERE Locate app interface

Of all the systems explained above in Figure 1, Figure 2, Figure 3 and Figure 4, it can be presumed that these systems indirectly entertained all the issues of the users, but they lacked many features which the users actually required which we will be carting in our system. We learnt that these systems were saving their data on cloud which is a good option nowadays because we cannot afford data centers because of multiple issue out of which physical security and cost are the main ones. The distinguishable feature in our system from other system is navigation feature which will help students to find their friends by enabling and sharing location in the university. This feature will be helping the foreign students to get familiar with the institution in a very short time. Also, there will be a unique feature in this proposed system that is not present in the earlier systems that is QR code scanner system which will help staff and teachers in getting updated about the students who visit their office in their absence. The students will also be assisted through this functionality because they will be able to notify their presence/visit.

# 3. Requirements analysis

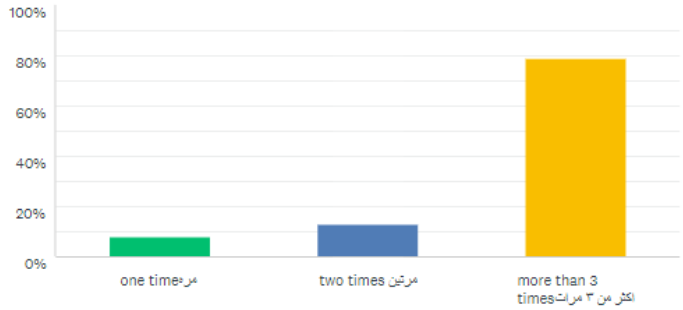
To correctly assess the problem at hand a through analysis must be conducted of the functionalities that are required to be part of the developed project. The first task in the process is to research the existing systems, while the other activity is to understand the new system's specifications and domain. Both activities are equally important, but the first activity serves as a basis for supplying the operational requirements and then implementing the proposed system successfully. Learning the features and specifications of a new system is more difficult and requires creative thinking and learning of the current running process is also challenging. Once that phase is over, the review of requirements and the planning of projects begins. The design starts after completion of the specification analysis and the coding begins after completion of the design. After completion of the coding, the testing is done. The series of tasks carried out in a software development project in this model is:

- Requirement Evaluation
- Evaluation of risks
- System design
- Project Development
- Unit testing
- System integration and evaluation

An online university wide survey to analyze and specify the features was conducted showing specific features that are essential towards this project. The following are some of the significant results of the survey, which helped finalize the set of features to be included in the application:

How many times someone asked you to guide him in University ?كم مره طلب منك شخص ان ترشده في الجامعه؟

Answered: 100 Skipped: 0

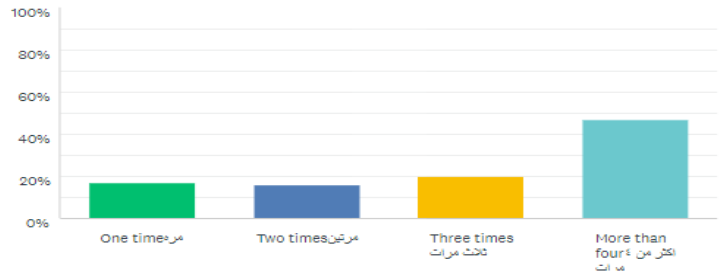



| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| one timeمره | 8.00% | 8 |
| two times مرتين | 13.00% | 13 |
| more than 3 timesاكثر من ٣ مرات | 79.00% | 79 |
| TOTAL | | 100 |

*Figure 5: Survey result for Findme/Location feature*

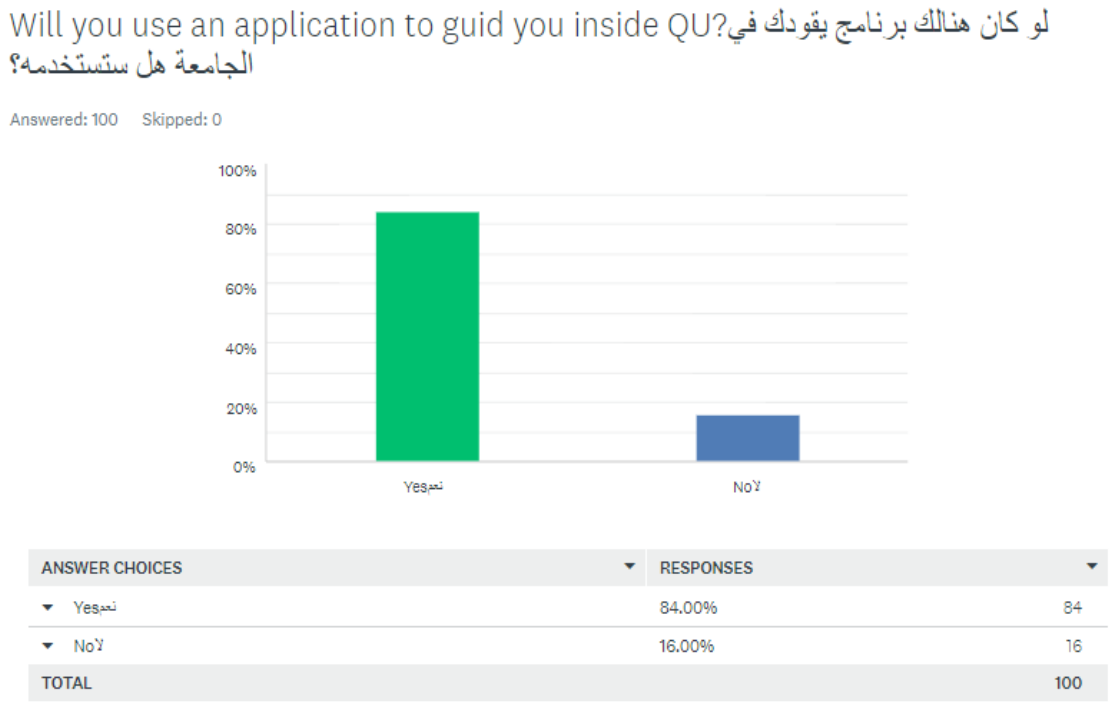
How many time you got lost inside the university?كم مرة ضعت في الجامعة؟

Answered: 100 Skipped: 0



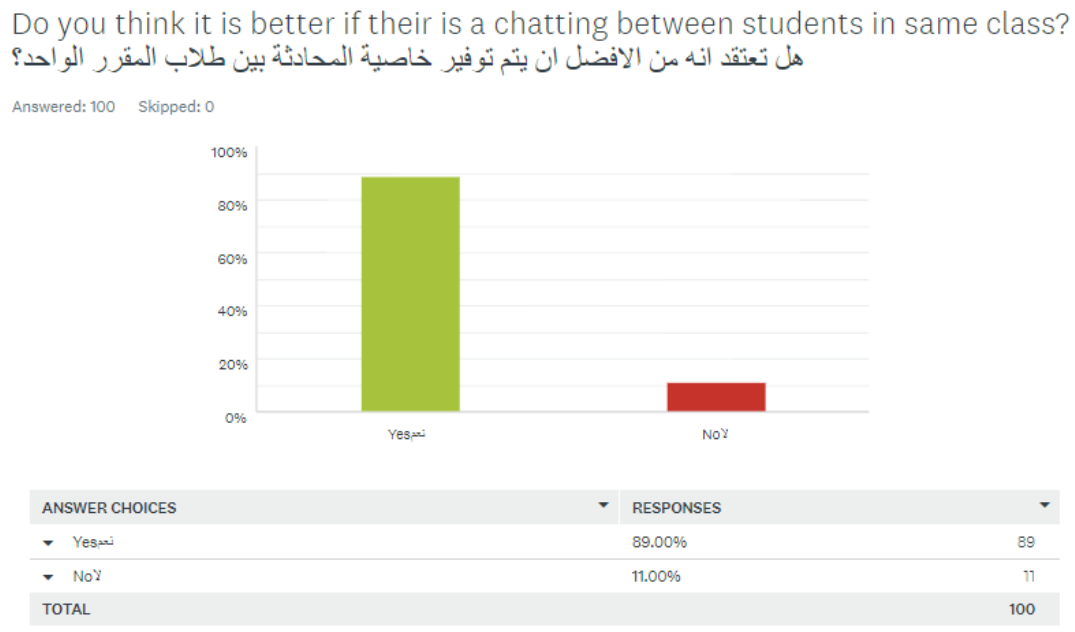

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| One timeمره | 17.00% | 17 |
| Two timesمرتين | 16.00% | 16 |
| Three times ثلاث مرات | 20.00% | 20 |
| More than fourاكثر من ٤ مرات | 47.00% | 47 |
| TOTAL | | 100 |

*Figure 6: Survey result for Campus Navigation feature*




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yesنعم | 84.00% | 84 |
| Noلا | 16.00% | 16 |
| TOTAL | | 100 |

*Figure 7: Survey showing importance of Campus Navigation feature*

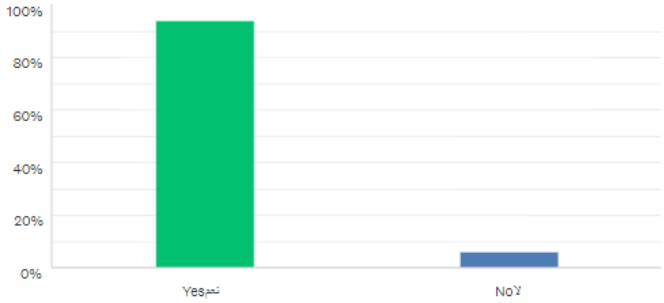



| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yesنعم | 89.00% | 89 |
| Noلا | 11.00% | 11 |
| TOTAL | | 100 |

*Figure 8: Survey result for Community Chat feature*

If there is an application to notify the professor that you came to the office instead of waiting in front the office you can leave a message , will you use it?
لو كان هنالك برنامج ينبه الدكتور بانك قد زرت المكتب وبدلاً من الانتظار تستطيع ترك رسالة ، هل ستستخدمه؟

Answered: 100 Skipped: 0




| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Yesنعم | 94.00% | 94 |
| Noلا | 6.00% | 6 |
| TOTAL | | 100 |

*Figure 9: Survey result for Notification feature for faculty*

## 3.1. Software development process

Waterfall model is being chosen because all requirements were known beforehand, and the objective of the software development is the computerization/automation of an already existing manual working system.

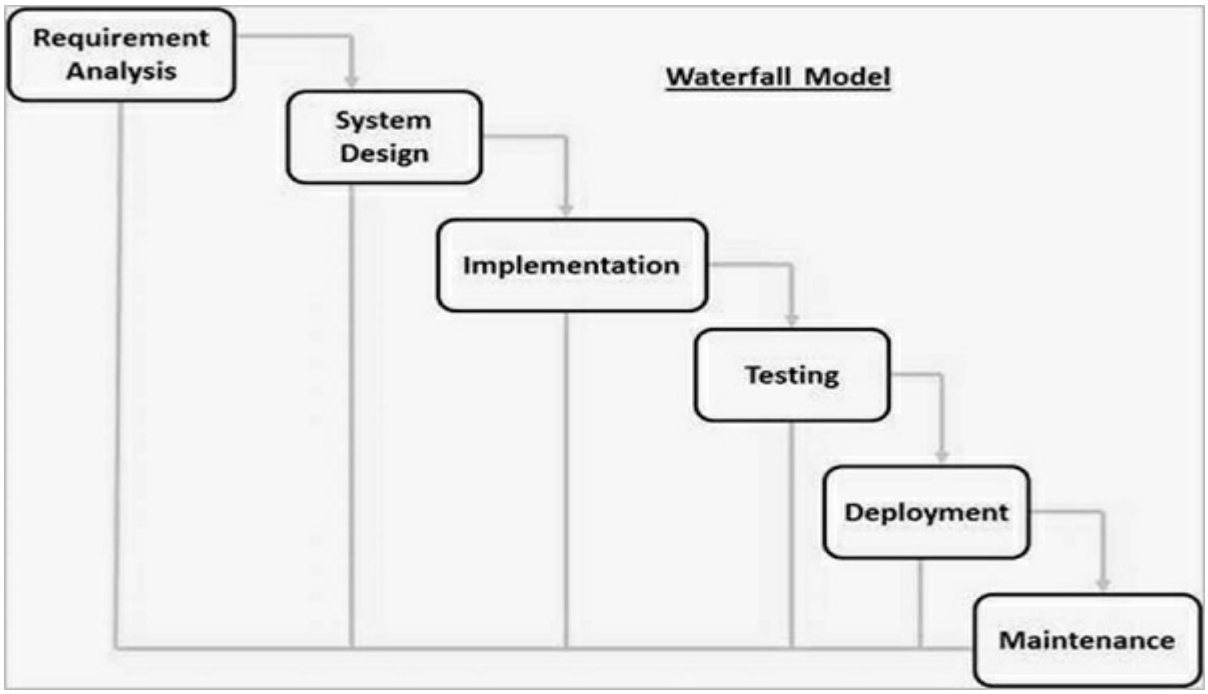



*Figure 11. Waterfall model*

## 3.2. Functional requirements

- The users have the ability to login and register through the system.
- Users will be able to update their personal information.
- The user should be able to obtain a view of Qatar University campus map
- The user will have the ability to obtain their current location
- Users will have the option to use the developed navigation and the google maps navigation.
- Users will be able to view requested information on a building on the campus
- User will have the ability to navigate from their current location to any building from the available buildings
- Administrator will validate new user's information
- The system will be able to retrieve the location coordinates of the user.

- after informing the user of conditions and regulations made by the application and the user agrees to terms and conditions, the system shall be able to save all the previously visited locations inside the campus of a registered user of the application.
- The system shall allow the students to send office visit notifications to the faculty member by scanning the QR code imprinted in front of that particular office.
- The system shall allow the students to send office visit notifications to the staff member by scanning the QR code imprinted in front of that particular office.
- The office visit notification will contain the time and date of the visit along with the details of the visited student.
- The registered faculty member will be able to check the office visit notifications sent by the students.
- The registered staff member will be able to check the office visit notifications sent by the students.

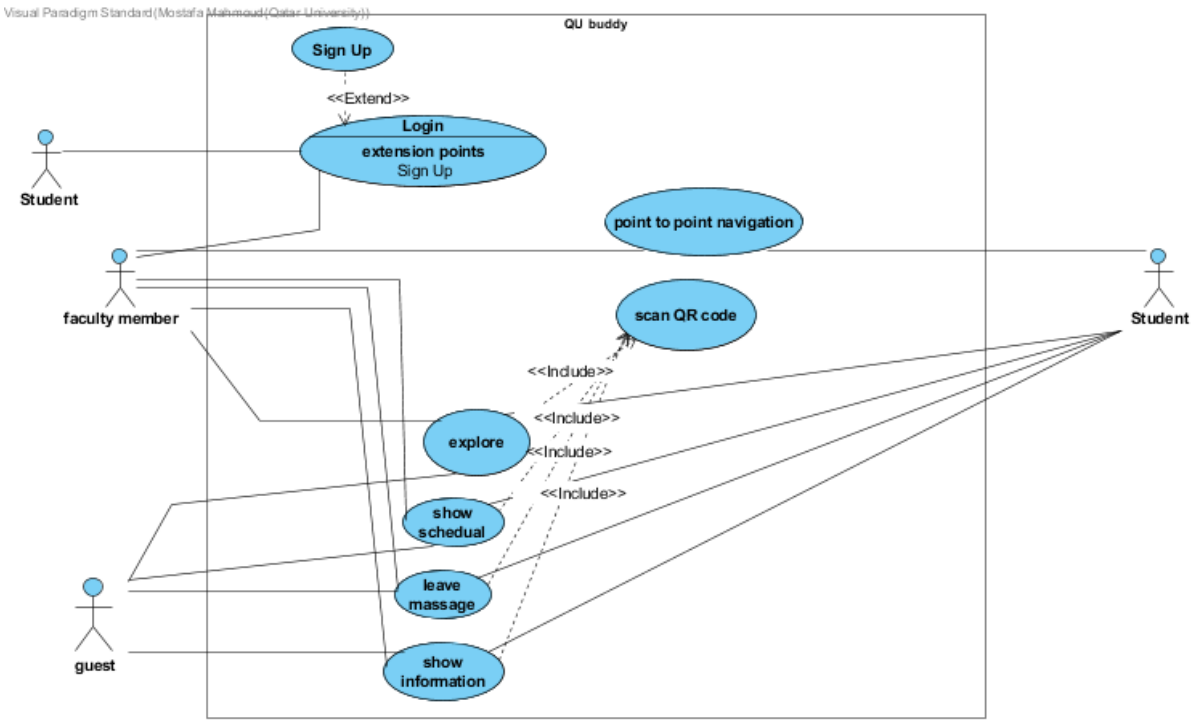



Figure 1. Use cases diagram

Table 1 use case summary

| Use case | Actor/User | Brief description |
|---|---|---|
| Signup | Student, Visitor | User is able to register a new account |
| Login | Student, Visitor, Faculty, QU Staff | User is able to login to our application |
| Leave message to Faculty and QU Staff. | Faculty, QU Staff, student | User can receive notifications in their absence from their office if another user wanted to visit their office |
| Send office visit notifications | Student | User can send notifications to the staff or faculty member whom office the user visited in their absence from their office and notify them about his/her visit |
| View nearby places | Student, Visitor, Faculty, Staff | User can view nearby places to their current location such as nearby classrooms, offices, restaurants and cafes |
| Share location | Student, Visitor, Faculty, Staff | User can share his/her location to the desired other users inside the campus |
| View visited locations | Student, Visitor, Faculty, Staff | User can view the previously visited locations inside the campus. |

## 3.3. Use case specification:

| **Use case Id: UC01** | **Sign Up** |
|---|---|
| **Brief Description** | User sign up to the QU Buddy system |
| **Primary actors** | Student, faculty member. |
| **Preconditions:**<br>1- User have an active Qatar university account. | |
| **Post-conditions:**<br>If the use case was successful, the system will create account for the actor and send to him a verification email. If not, the system state is unchanged. | |
| **Main Success Scenario:** | |
| **Actor Action** | **System Response** |
| 1. Enters name, QU user, password, re-type the password | 2. validates the entered name (See 2.a. for alternative flow) |
| | 3. sends a verification email to the user. |
| | 4. shows a dialog to notify the user about the verification email |
| | 5. send the user to <<Login>> |
| **Alternative flows:**<br>**2.a. Invalid name**<br>If the user does not enter a name or enters an invalid name, the system displays an error message. And ask the user to re-enter the name. | |

Figure 2 Register use case diagram

| Use case Id: UC02 | Login |
|---|---|
| **Brief Description** | User login to the QU Buddy system |
| **Primary actors** | Student, faculty member. |
| **Preconditions:**<br>User have an active Qatar university account. | |
| **Post-conditions:**<br>If the use case was successful, the actor is logged into the system. If not, the system state is unchanged. | |
| **Main Success Scenario:** | |
| **Actor Action** | **System Response** |
| **1.** Enters username and password | 2. validates the entered username and password and logs the user into the system (See 2.a. for alternative flow) |
| | 3. checks if the user account had verified (See 3.a. for alternative flow) |
| **Alternative flows:**<br>**2.a. Invalid Username/Password**<br>If the user enters an invalid username and/or password, the system displays an error message. The user can choose to either return to the beginning of the basic flow or cancel the login, at which point the use case ends.<br>**3.a. Not Verified Account**<br>If the user, no verify his account yet the system will show an error message to the user and ask him to check his email or resent the verification email. | |

Figure 3 Login use case diagram

| Use case Id: UC03 | Point to Point navigation |
|---|---|
| **Brief Description** | Users navigate from point to point |
| **Primary actors** | Student, faculty member. |
| **Preconditions:**<br>1. The user has entered the valid destination location. | |
| **Post-conditions:**<br>The user has been successfully navigating through the campus. | |
| **Main Success Scenario:** | |
| **Actor Action** | **System Response** |
| 1. Select the distention point | 2. finds the corresponding latitude and longitude of the user point. |
| | 3. finds the corresponding latitude and longitude of distention point. |
| | 4. checks the range of the distention point. **(**See 4.a. for alternative flow**)** |
| | 5. guides the user to the distention using google map API. |
| **Alternative flows:**<br>**4.a. External distention**<br>If the user chooses a distention out the university, the system displays an error message. The user can choose to either for word to other navigation application or cancel the navigation. | |

Figure 4 navigate use case diagram

| Use case Id: UC04 | Leave message |
|---|---|
| **Brief Description** | Users leave note for the professor if he is not in his office. |
| **Primary actors** | Student, faculty member. |
| **Preconditions:**<br>The user had already logged in. | |
| **Post-conditions:**<br>The message is sent successfully. | |
| **Main Success Scenario:** | |
| **Actor Action** | **System Response** |
| 1. Scanned the QR code. | 2. validates the scanned QR code.<br>**(**See 2.a. for alternative flow**)** |
| | 3. display a dialog to input the message. |
| 4. Enter the message. | 5. forward the message to the scanned account.<br>(See 3.a. for alternative flow) |
| | |
| **Alternative flows:**<br>**2.a. No such QR code**<br>If the user scanned a QR code that is not a part of the system, system displays an error message.<br>**3.a. No message Entered**<br>If the user does not enter a message, the system displays an error message. The user chooses either to re-renter a message or cancel. | |

Figure 5 leave message use case diagram

| Use case Id: UC05 | Show information |
|---|---|
| **Brief Description** | Users see the professor information. |
| **Primary actors** | Student, faculty member. |
| **Preconditions:**<br>User is already logged in | |
| **Post-conditions:**<br>The professor information is shown to the user successfully. | |
| **Main Success Scenario:** | |
| **Actor Action** | **System Response** |
| 1. Scan the QR code. | 2. validates the scanned QR code.<br>**(**See 2.a. for alternative flow**)** |
| | 3.Show the information of professor.<br>**(**See 3.a. for alternative flow**)** |
| | |
| | |

**Alternative flows:**

**2.a. No such QR code**

If the user scanned a QR code that is not a part of our system, the system displays an error message.

**3.a. No Schedule**

If the room has no information, the system displays an error message.

Figure 6 show information use case diagram

| Use case Id: UC06 | Show information for Classrooms |
|---|---|
| **Brief Description** | Users show the professor schedule. |
| **Primary actors** | Student, faculty member. |
| **Preconditions:**<br>User is already logged in | |
| **Post-conditions:**<br>The schedule is shown to the user successfully. | |
| **Main Success Scenario:** | |
| **Actor Action** | **System Response** |
| 1. Scan the QR code. | 2. validates the scanned QR code.<br>**(**See 2.a. for alternative flow**)** |
| | 3. Show the schedule of room.<br>**(**See 3.a. for alternative flow**)** |
| | |
| | |
| **Alternative flows:**<br>**2.a. No such QR code**<br>If the user scanned a QR code that is a not part of our system, the system displays an error message.<br><br>**3.a. No Schedule**<br>If the room has no schedule, the system displays an error message. | |

Figure 7 show information of class use case diagram

## 3.4. Non-functional requirements

- Registered user's data is synchronized, and changes are appropriately allocated with the local and online database server
- All buildings data is localized in the database and is not hardcoded in the source code of the application
- All uploaded messages to professors or office visits should be stored and retrieved from the SQL cloud-based database server on the demand of the specific user.

## 3.5. Assumptions

- End users will be able to navigate with provided route that the application has precalculated and is assumed as the best route disregarding the user's opinion.
- Training rooms will be available for the training of the complete product as needed.

## 3.6. Ethics

Ethical choices reduce risk, promote positive outcomes, increase confidence, assess long-term success and create reputations. Leadership depends entirely on ethical choices.

- The delivery of this application aims to provide all associated members of Qatar University whether faculty, staff, students, or guests the ease and facilitation of exploring the campus and its facilities. The intellectual property as well as any copyrights are intended to be preserved and instilled with respect to an individual's work.
- The system will ensure the quality, effectiveness and dignity as stated by the ACM code of ethics by taking into consideration each user's feedback regarding the system as well as regular updates and a public release of the application.
- Confidentiality and securement of information respecting privacy of the students and professor's data will be upheld with the utmost regard. Administrators will be made aware of any flags of unintentional use of the system as well as safeguards being put into place for unauthorized use. The confidentiality will be obtained through a level of abstraction between the different users.
- The system will share all technological information with Qatar University as well as the terms and conditions will be stated clearly for the public to agree to providing for awareness, and facilitate computing understanding, as relevant to the context and one's abilities. The system will follow this rule of ethic in our project because it has to create awareness of the system in the university.

# 4. Solution Design

## 4.1 Overview

The project will essentially be an information system for Qatar University that will assist students, teachers, staff, and visitors with mobilizing and interacting within the campus. The final delivery facilitates a number of complications faced by various members associated with the university when dealing with different facilities localized on campus. Essentially the system deals with four categories of users shown different features based on the roles assigned to them by the administrator for instance, student and faculty members when logging in to the system with the registered username and specified password will enable a respective profile and account that differ from each other.

**End user's View Application**

For the intended users who are using the QU Buddy application for the first time, they will register their name, email, and a preferred password. The application will register the student by sending a verification email to the student's QU email. Once confirmed the student will be registered in the constructed MySQL database. In the case that the student is an already registered user the application will verify the required fields of email and password where the student will be granted access to the application. The system will be able to distinguish between a student, professor, or guest by user login ID granting the different parties' access to respective rights to the system. The domain name as well as the linked database is integral to the verification and distinguishing feature of the application in which a student will have a domain name of @student.qu.edu while a professor will not for example. Simultaneous access to the same account to the same student account will also be handled through the system. In the case of a guest, their registration will be different where their access to the application will be timestamped and will be given limited access to the functionalities where only on campus navigation, exploring, and leaving message will be granted accessing other functionalities of the applications will be denied accordingly. The functionalities of the application is the distinguishing factor when speaking on the design solution for the End user's view which is the main intent of the whole project.

Assuming that the user is registered and a member of the application, or a logged in guest the following functionalities are applicable:

- On campus navigation: A campus map will be uploaded pinpointing the obtained the current location of the user and allow the user to choose a point of interest from a drop down menu of a list of building or zooming in and dropping a point of interest on the map where the application will calculate a specified and efficient route from the current location to the point of interest. A predetermined route will be displayed time will be calculated, and the user will be given the option of using google maps if the desired route is not suitable for them.

The rest of the functionalities fall under the QR codes that would have been installed on Campus:

- Exploring a building: Will display associated information regarding a specified building when the linked QR code is scanned. Information regarding which classrooms are inside the building, latitude, longitude, nearby places such as food courts and such will be displayed.

- Scanning a building's QR code: The user simply scans the placed QR code placed on the building. The system will fetch and send a query to the database obtaining all information stored regarding the specified building. Of course, details of this building will come back as a JSON object or unformatted data, but the system will take care of that and format the data accordingly in a user-friendly manner.
- QR code of a classroom is scanned by the user: the user will scan a QR code placed beside the classroom in the same manner of the building, the system will retrieve the appropriate information from the required database the difference will be the latitude and longitude obtained will only be of the building not the classroom itself.
- Leave Message: Users will scan a QR code of certain faculty member or departments office, the system will verify if the scanned QR code pertains to a faculty or staff office space if so the user will have the option to leave a message that will be sent to the associated party as an email, SMS, or message left within the application message inbox.

**Administrator and Backend View**

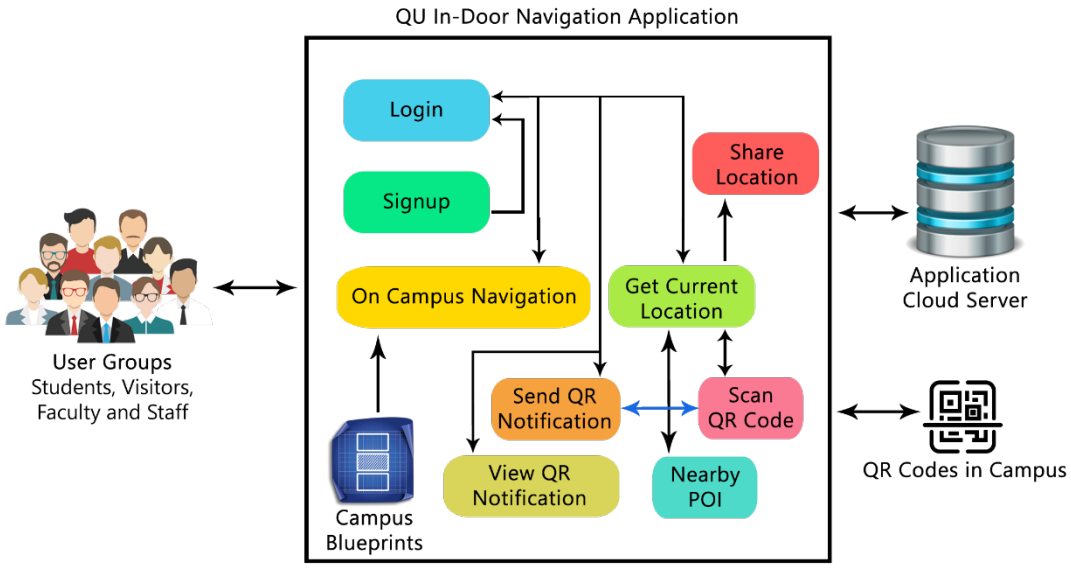
The relationships developed between the backend of the application and the frontend of the user interface through the preferred architectural pattern makes the application cohesive in which all the associated components act as one entity efficiently and cooperatively with no instances of associated implications that is shown in the testing section of the project. The NoSQL Firebase server, SQL database server, and the localized database work hand in hand where the firebase server works as middle-man component between the different functionalities and is synchronized in such a way where updates are made regularly to ensure the adaptability of the application.

- On-Campus Navigation:
    - The tracking of the navigation functionality through the localized database will retrieve the latitude and longitude of the user's device from the GPS location capabilities of the developed system.
    - The user will send the point of interest to the system
    - The system will retrieve the desired location and save it in the applicable database
    - The user will receive the pinpointed location on the map, the route to the point of interest, time required to arrive at the location, and the option to use a different method of arriving to their destination whether driving or by bus (future application).
- Exploration of campus buildings or classrooms:
    - User will scan the QR code through the application

- The system will connect to the SQL server to obtain the required information through the preceded queries that will be sent to the database to retrieve all required information
- The system will present the user all information regarding the building or classroom based on the information present in the database.
- The system will also acquire relevant information regarding nearby places based on the user's request
- Administrators have the ability to connect to the server and update the information regarding a building or classroom based on changes made by the university or classroom offerings being changed from semester to semester.

- Leave message or Send message:
  - User will scan an office space's QR code through the application
  - The application will connect to the firebase server where information regarding the person of interest is obtained and displayed
  - The user will inform the system of the message that is to be sent and the method of delivery.
  - The message and its delivery method will be saved in the database.
  - Once the message is delivered the status of the message is changed in the database and the user is informed of the message status

## 4.2. Architecture Diagram




The implemented architectural pattern used to develop the application is a Model View Controller or (MVC).

**The MVC has the advantage that reigns a presentation across several platforms specifically the facilitation of setting up the project on the android platform by having three divisions of classes consisting of:**

- **Model:** consists of the data classes whether the User or Product objects which model the real-world applications which is consistent to the system.
- **View**: The visual sector of the classes where the front-end of the system becomes visible.
- **Controller:** plays the role as the "glue" between the two components which has the functionality of updating the view, taking the user input, and applying the appropriate changes to the model.

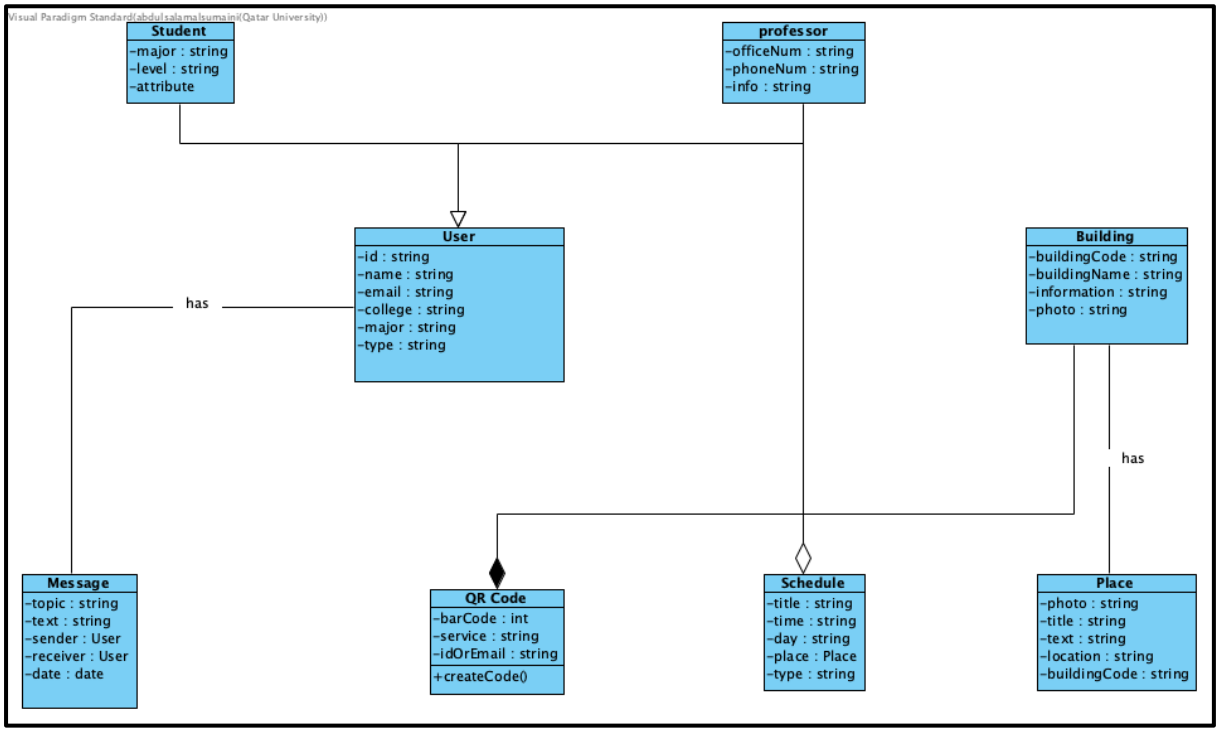
Dividing the applications code into these three different categories allows the implemented code to be decoupled and reusable.

As part of future developments requests from the client or user feedback to add an additional screen to the existing application will become an easy aspect where the existing data will not need to be changed or transported in any way to make the necessary changes for the client or user.

Simply put, the MVC model paradigm will allow the developers to re-use the pre-existing models and only make changes to the views. In the case that feedback is received, or a client requests a fancy widget to be moved from the home screen to the detail screen the separation of the logic and other sections of the code has made the developmental process an easy task to perform such an action.

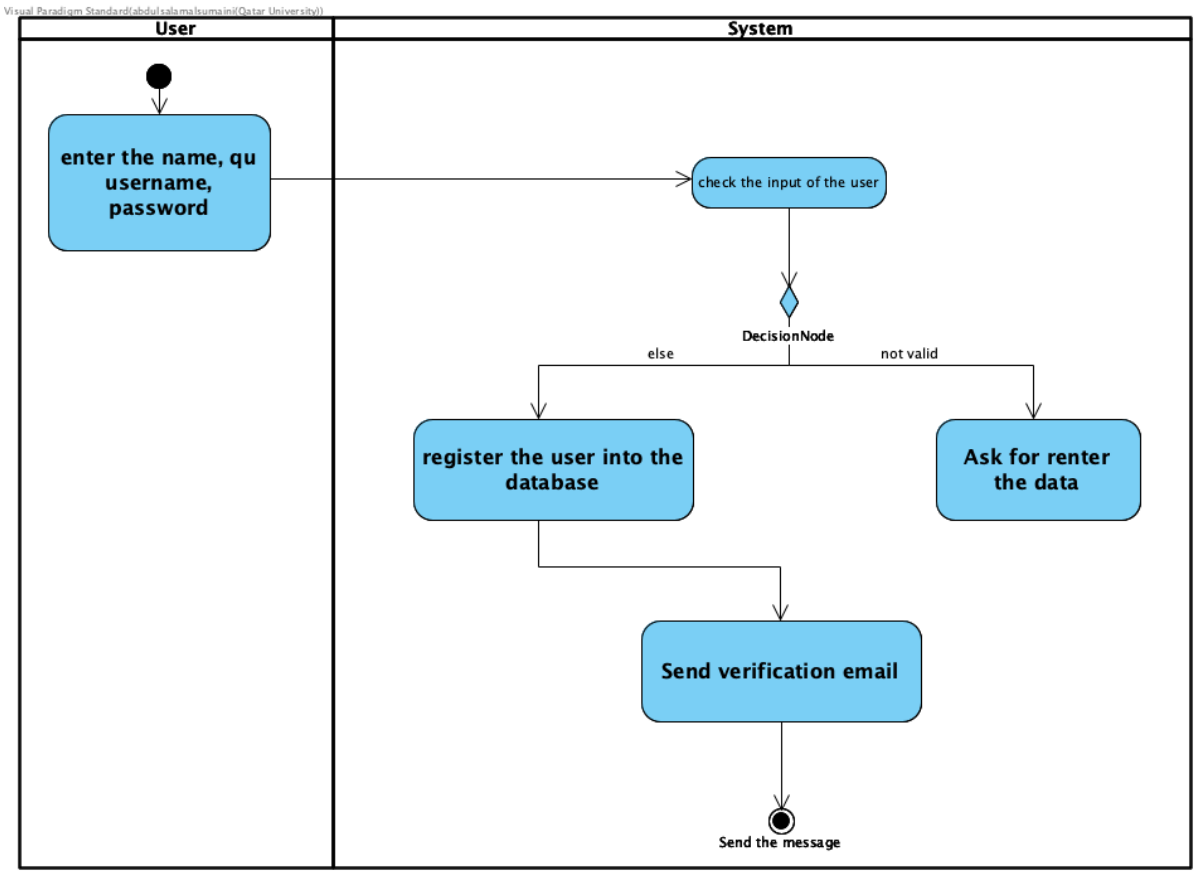
In addition, the layout and resource logic being placed in the Android XML allows the view layer to be understood by any developer and keeps the code clean as well as relevant. Cases may arise where Kotlin will be of good use to make further developments in which the drawing operations and activities classes are kept separate.

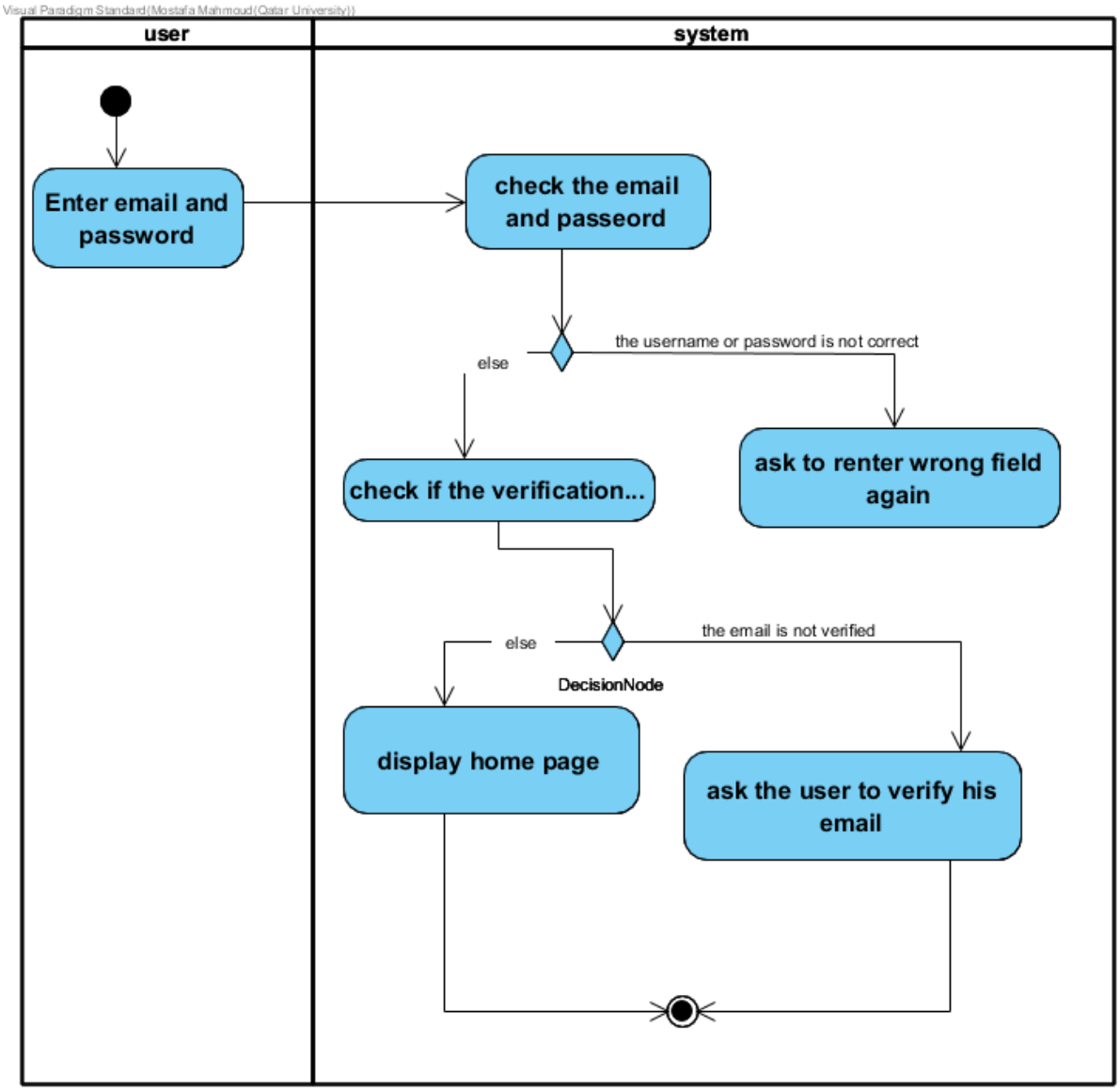
## 4.3. Structural model

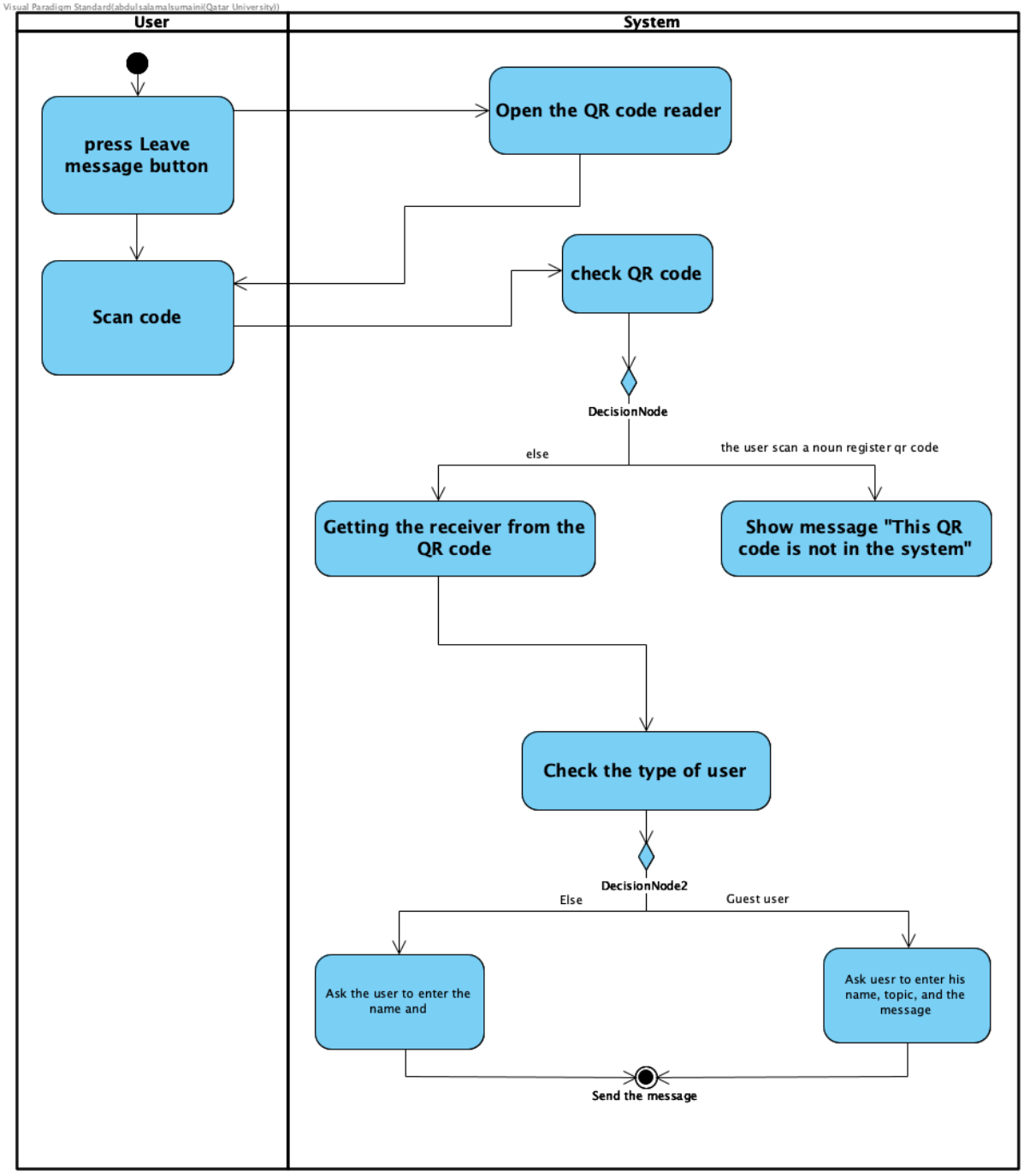


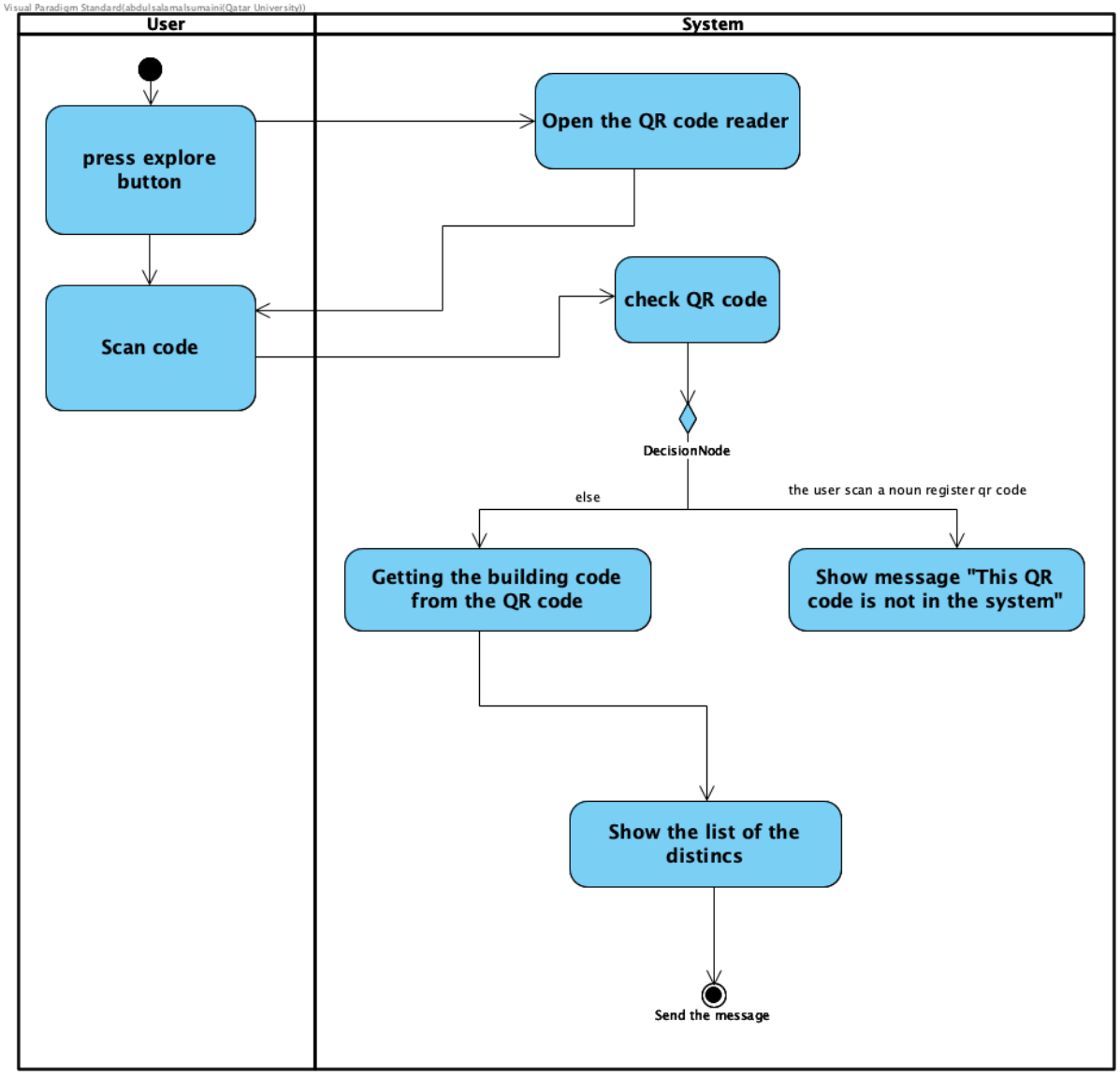
## 4.4. Behavioral model

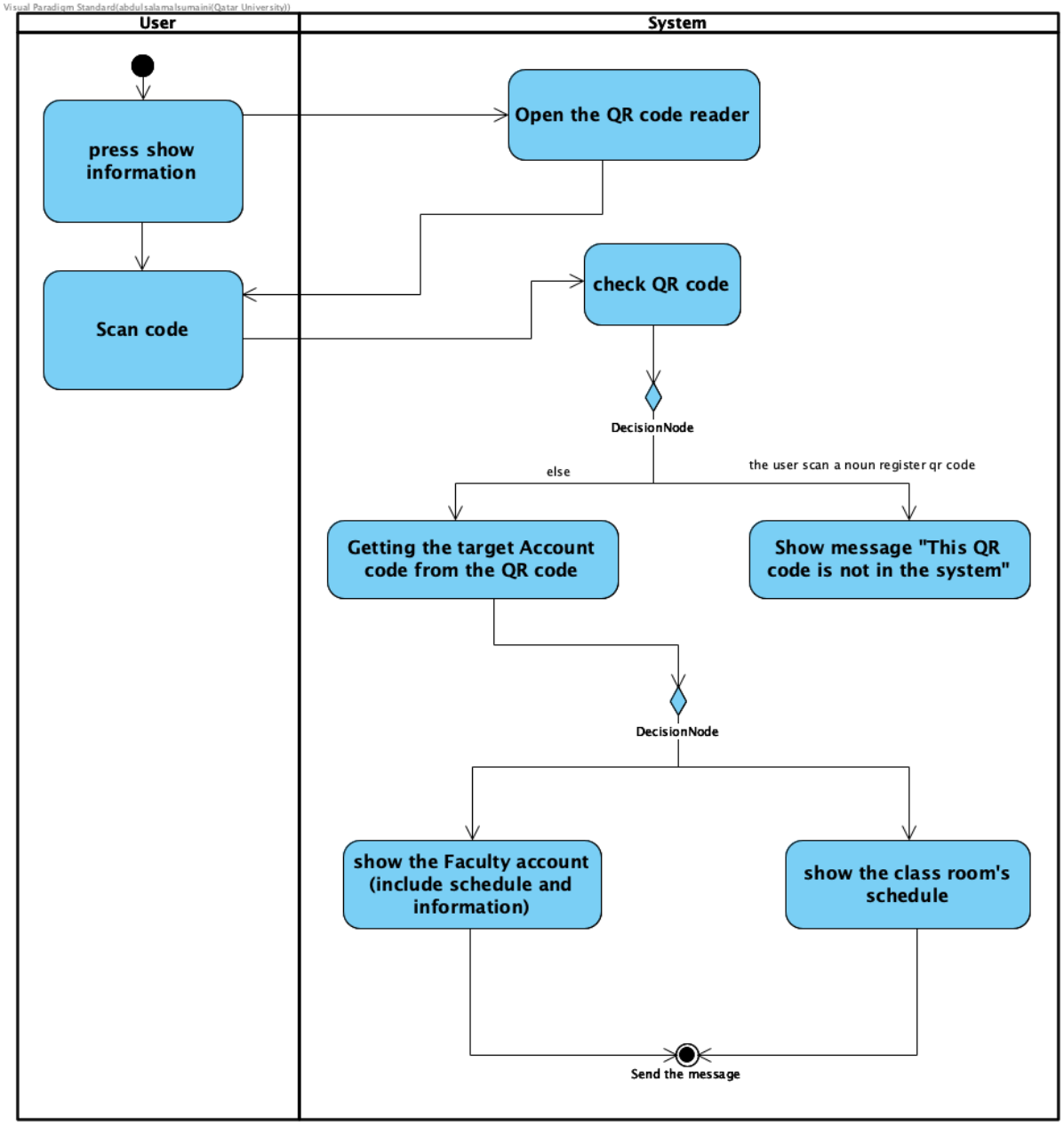
### 4.4.1. Activity diagrams:




Visual Paradigm Standard(Mostafa Mahmoud(Qatar University))
user
system
Enter email and password
check the email and passeord
else
the username or password is not correct
check if the verification...
ask to renter wrong field again
else
the email is not verified
DecisionNode
display home page
ask the user to verify his email


Visual Paradigm Standard(abdulsalamalsumaini(Qatar University))
User
System
press Leave message button
Open the QR code reader
Scan code
check QR code
DecisionNode
else
the user scan a noun register qr code
Getting the receiver from the QR code
Show message "This QR code is not in the system"
Check the type of user
DecisionNode2
Else
Guest user
Ask the user to enter the name and
Ask uesr to enter his name, topic, and the message
Send the message


Visual Paradigm Standard(abdulsalamalsumaini(Qatar University))
User
System
press explore button
Open the QR code reader
Scan code
check QR code
DecisionNode
else
the user scan a noun register qr code
Getting the building code from the QR code
Show message "This QR code is not in the system"
Show the list of the distincs
Send the message


Visual Paradigm Standard(abdulsalamalsumaini(Qatar University))
User
System
press show information
Open the QR code reader
Scan code
check QR code
DecisionNode
else
the user scan a noun register qr code
Getting the target Account code from the QR code
Show message "This QR code is not in the system"
DecisionNode
show the Faculty account (include schedule and information)
show the class room's schedule
Send the message

### 4.4.2. Sequence Diagrams:

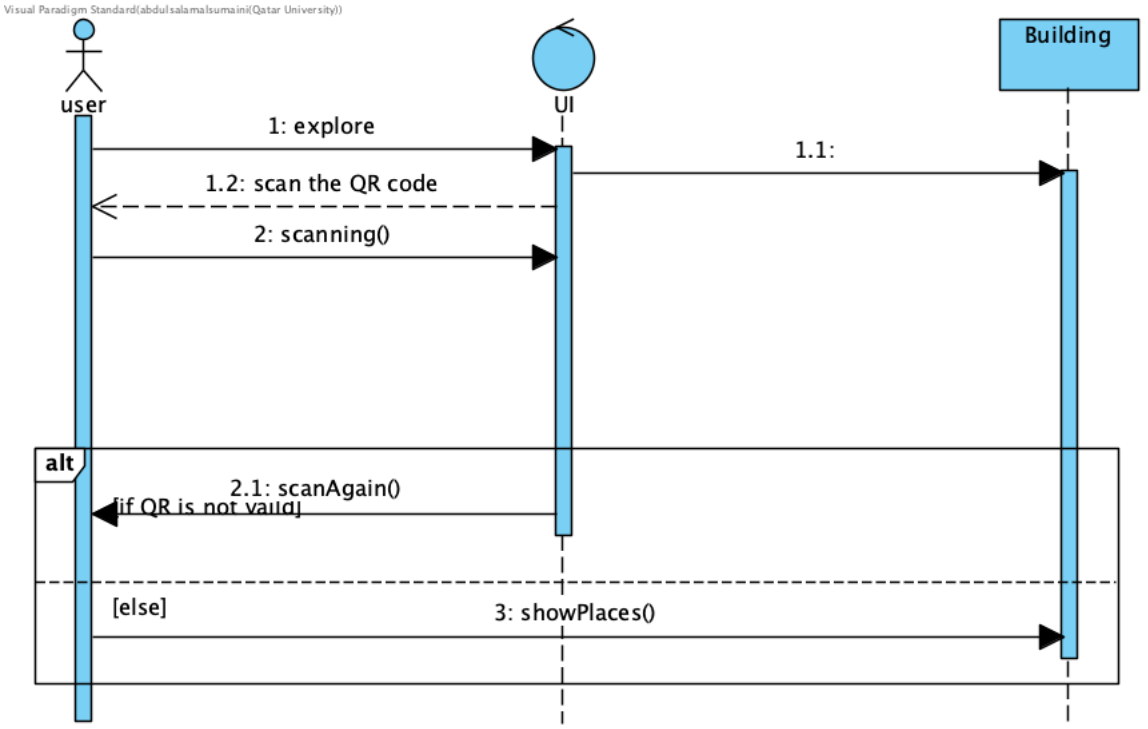



Figure 8 Explore sequence diagram

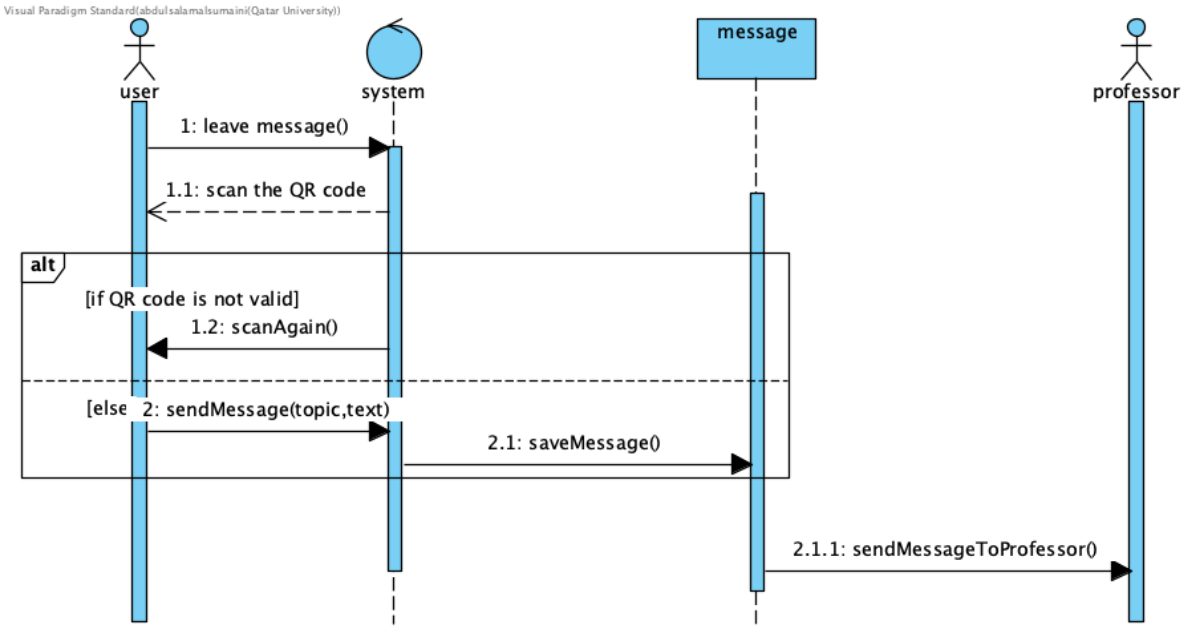



Figure 9 Send message sequence diagram

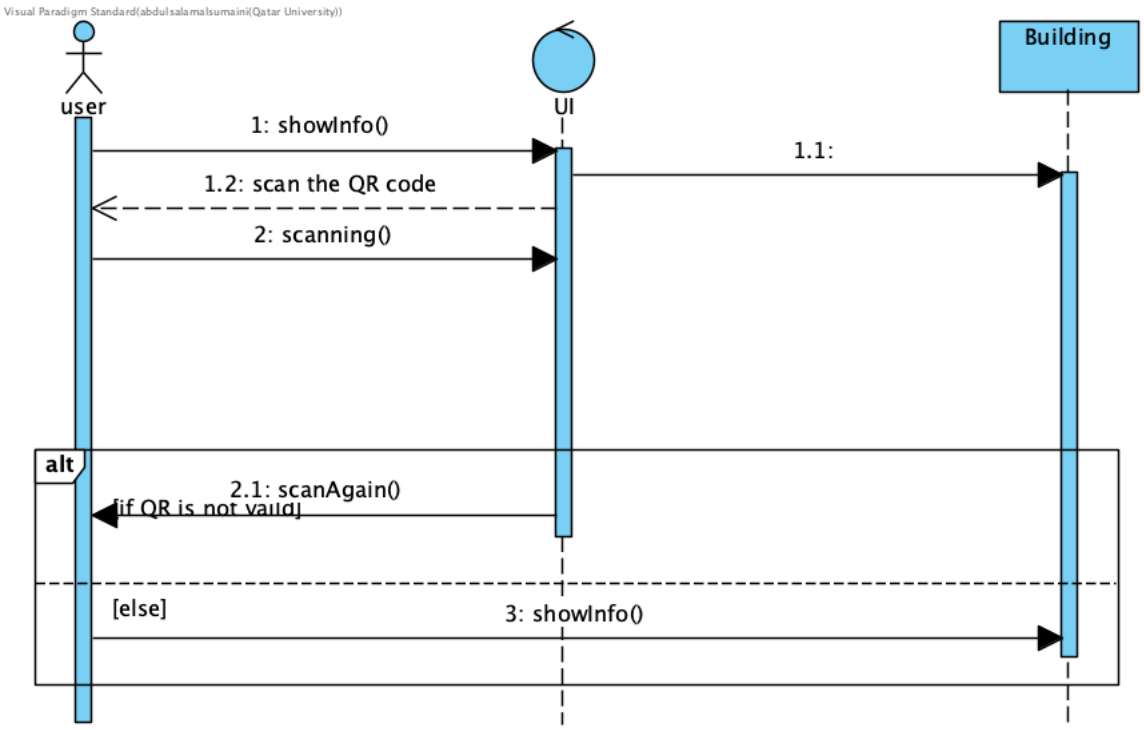



Figure 10 Show information sequence diagram

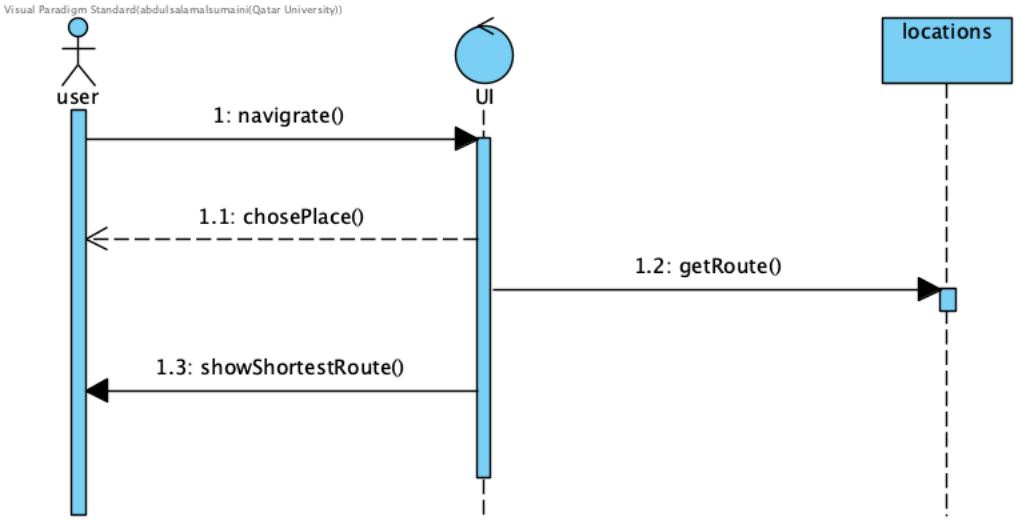



Figure 11 navigate sequence diagram

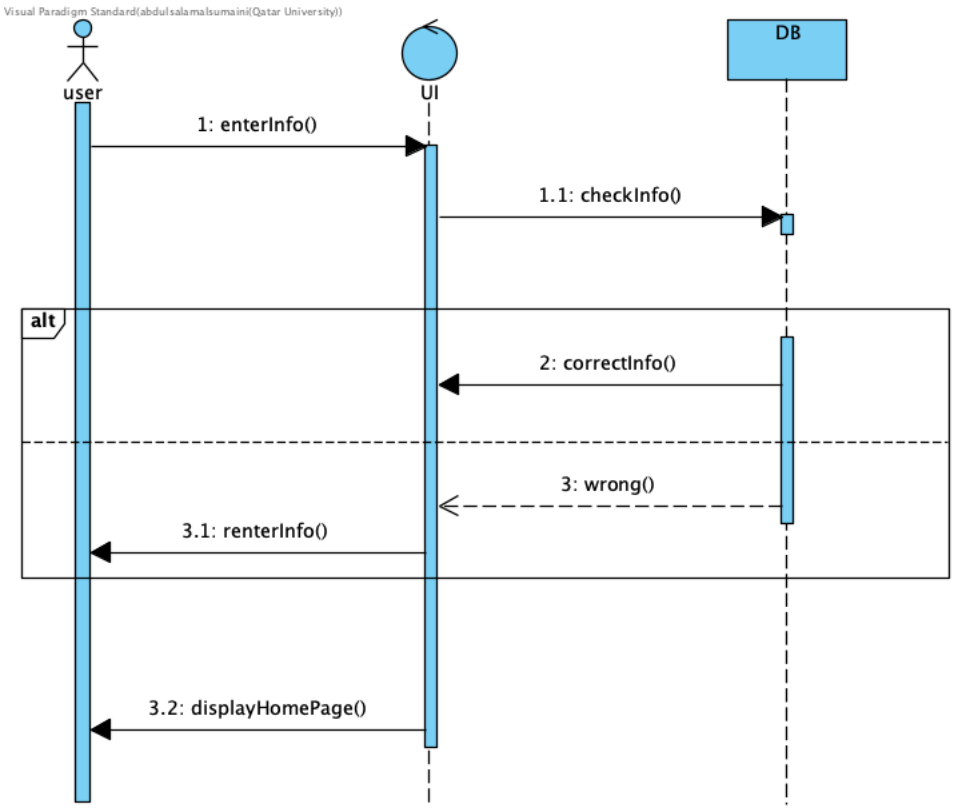



Figure 12 Login sequence diagram

## 4.5. Database design

The appropriate database design applied to the application consisted of two equally powerful and similar databases: SQL, where the tables are used to access and retrieve the data from the acquired flat data files that are propriety information received from the university administration. The SQL database functions as the core to storing and accessing data in an organized fashion enabling the security of storing the data related to courses, buildings, and office space when queries are requested. The Firebase or NoSQL database provided by Google provides the features of authentication, backup, and communication with the necessary data provided by the user.
Finally, with regards to the navigation functionality a database localized within the application with information applicable to the map is stored such as latitude and longitude of certain building. The localized navigation database is linked with each user and is able to calculate the number of visits each user makes to a certain location where the localized database is synchronized in a manner that is updated instantly.

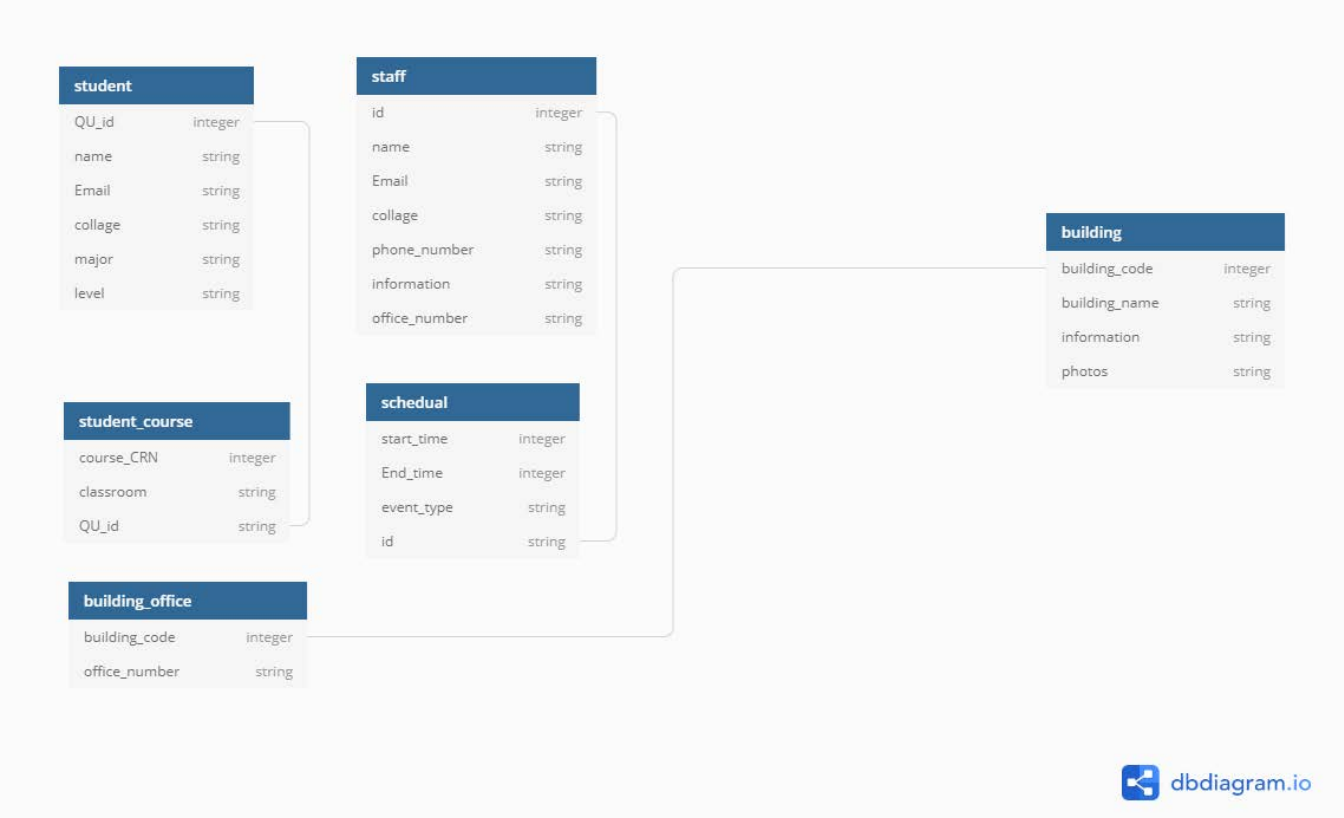
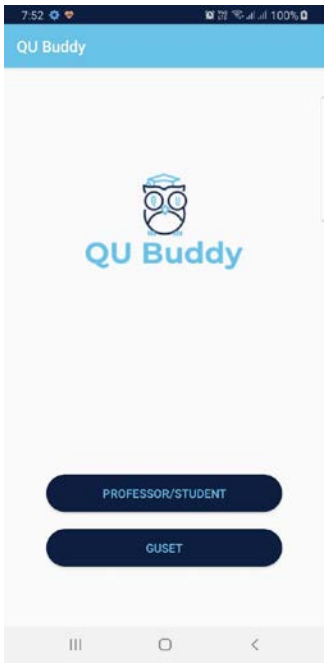
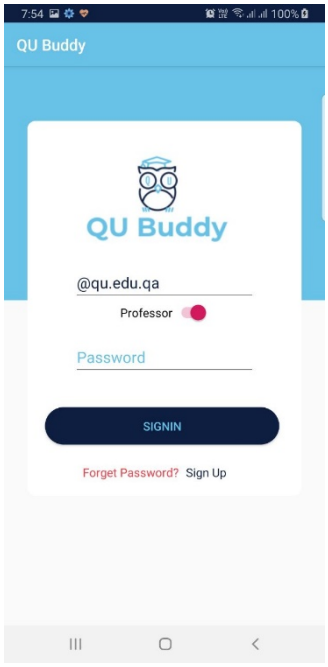


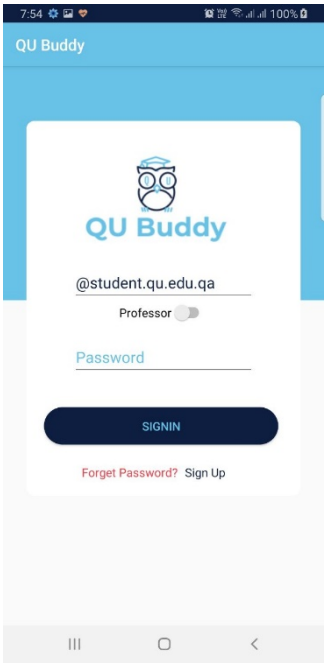

Figure 13 SQL database Design

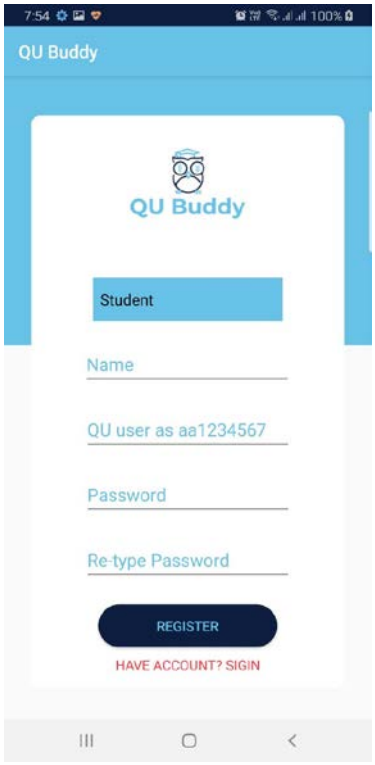
## 4.6. User interface design

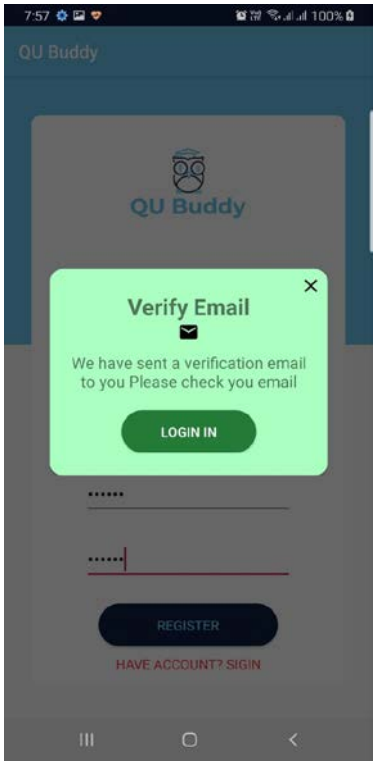
### 4.6.1 Registration Functionality

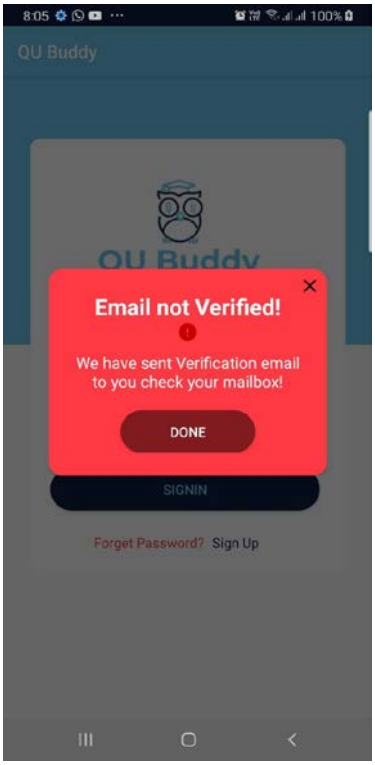


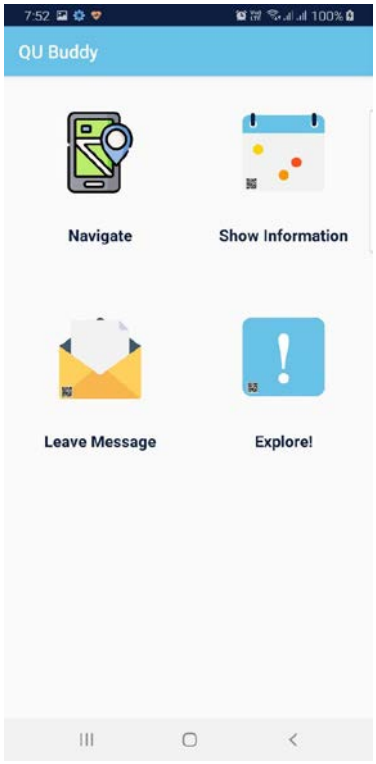



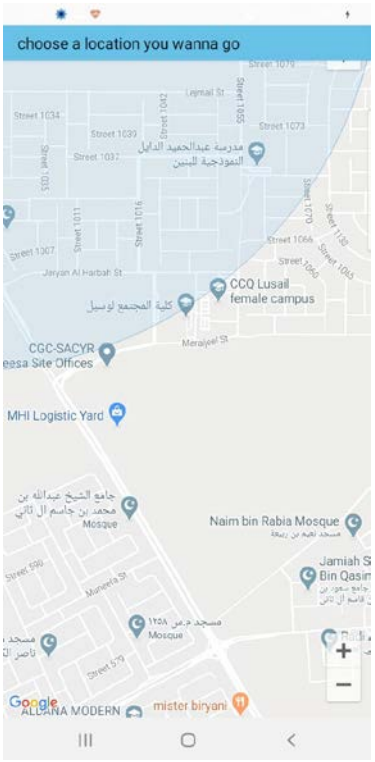



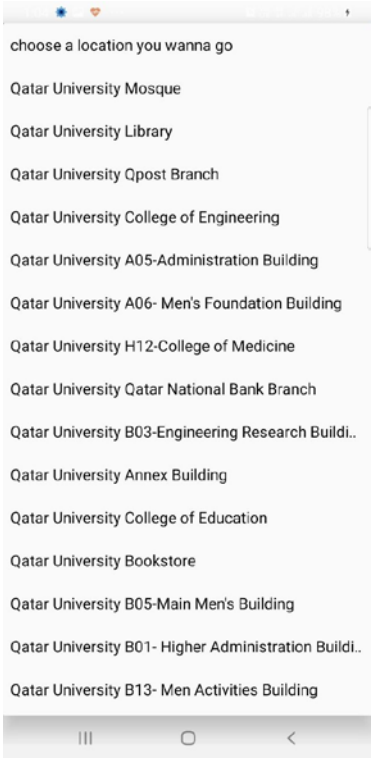



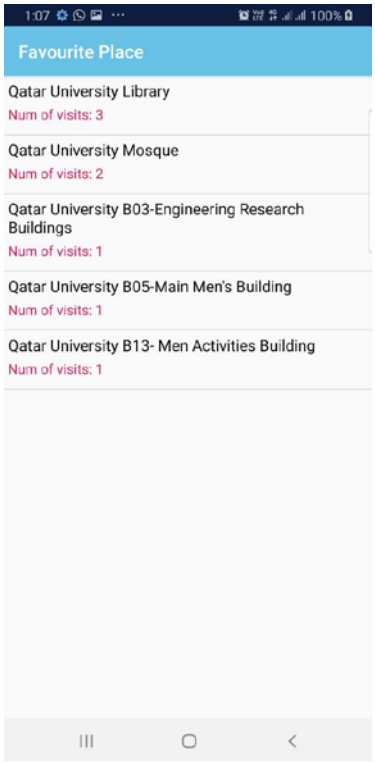



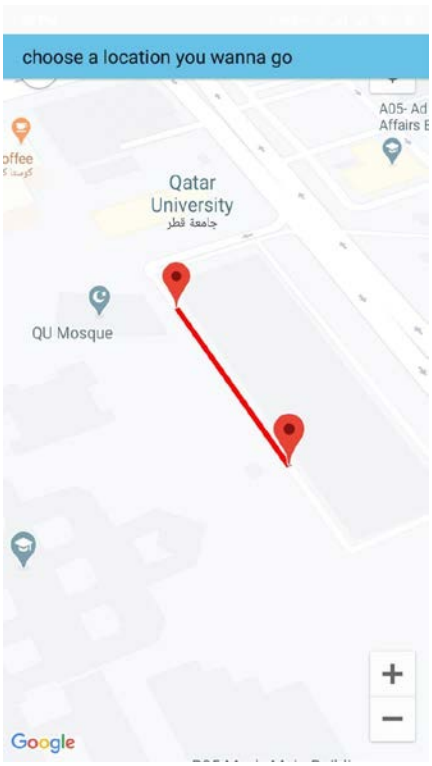
### 4.6.2. Navigation Functionality



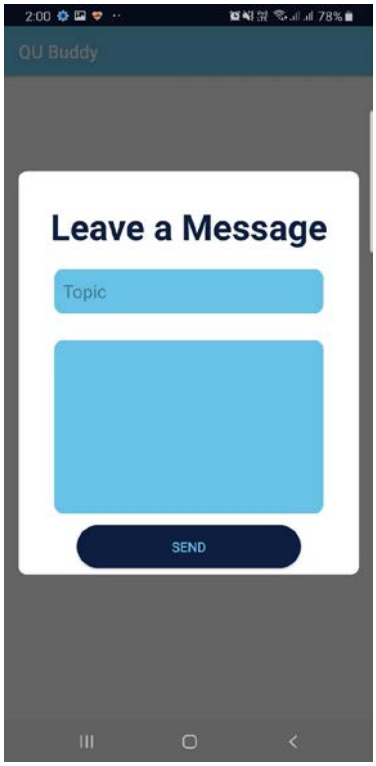



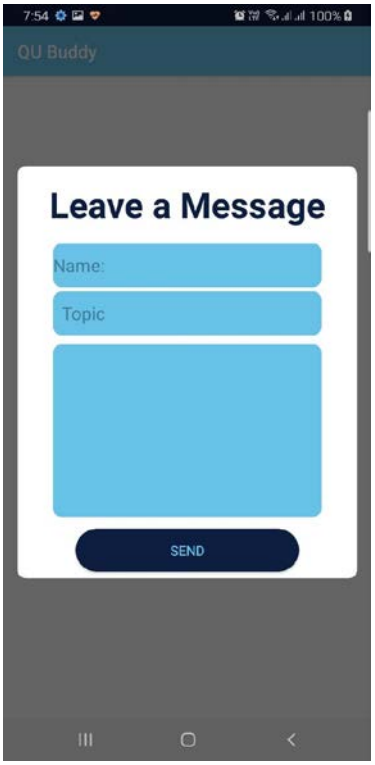




### 4.6.3. QR Code Explore Functionality

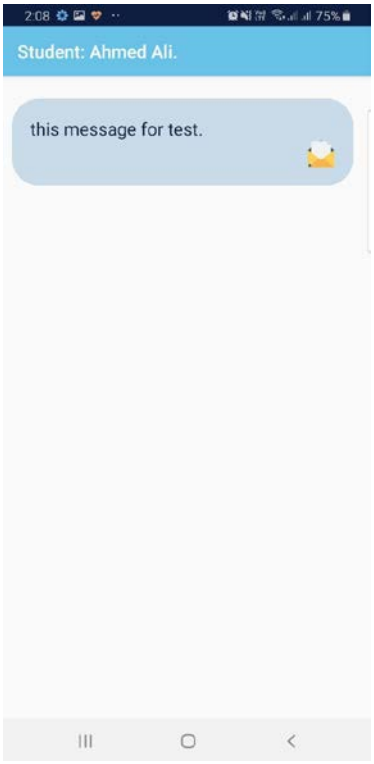


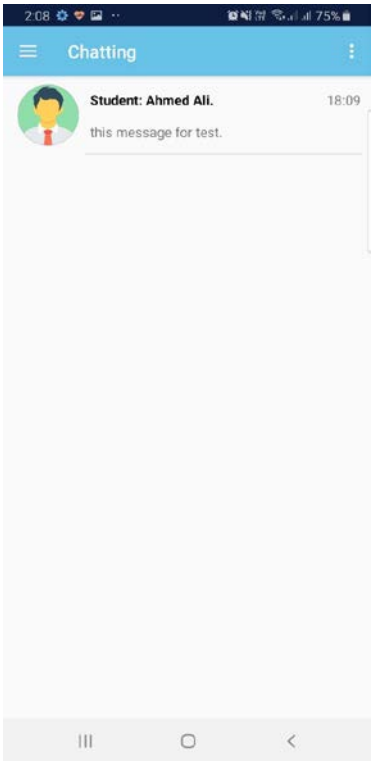
### 4.6.4. Leave Message Functionality

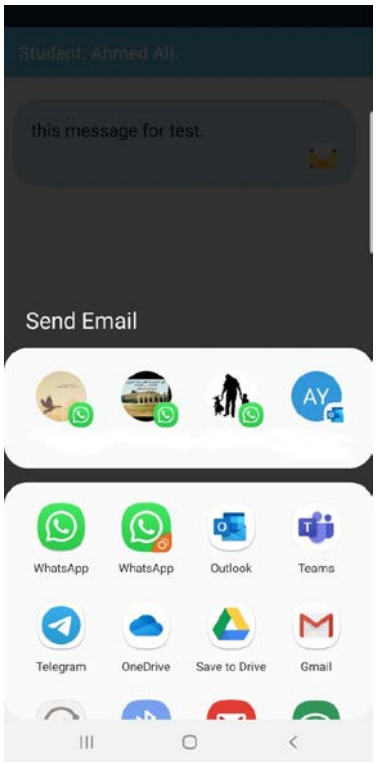



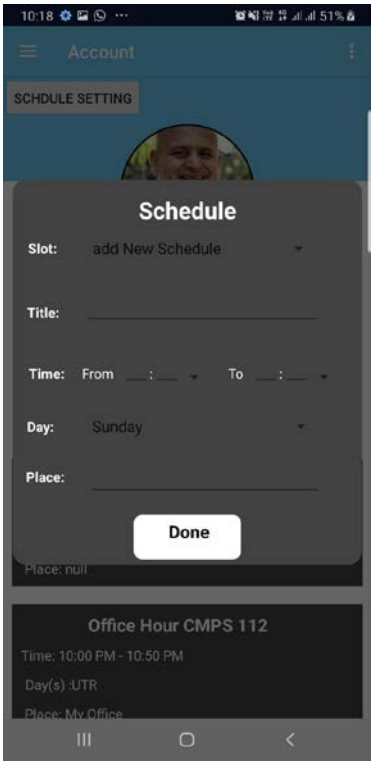

QU Buddy
Leave a Message
test1
this message for test
SEND

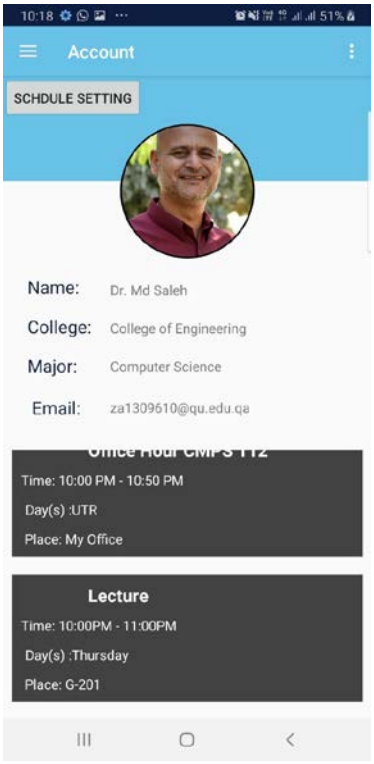

Student: Ahmed Ali.
this message for test.


Chatting
Student: Ahmed Ali.
18:09
this message for test.


this message for test.
Send Email
WhatsApp
WhatsApp
Outlook
Teams
Telegram
OneDrive
Save to Drive
Gmail

### 4.6.5. Show information




## 4.7. Design patterns

The design of the application is constructed in a sensible and well performed manner with a functional interface that is well-suited for any user. Throughout the design process the guidelines and principles were followed to ensure the quality for the intended users where the decomposition of the system into various parts that may overlap in functionality are minimized. The abstraction of the application is present in which the implementation of the functionalities are hidden from the user. The intended user will obtain the data without having to view the complexity and algorithms involved in the implementation. In the same sense, the application is constructed with the consideration of modularity. The concept of modularity within the application is applied by dividing the system into different modules depending on the functionality which in return provides for further developments in the future with great ease as well as manageability. Taking into consideration the coupling and cohesiveness of the app as a whole the developed application performs various tasks where each separated module is not related which leads to the low coupling in the application creating a well-structured design for the developed system. The cohesiveness between the different modules and functionalities are considered high allowing the overall system in favor of maintainability and readability for the user and developer.

In the same sense of the chosen architectural pattern the chosen design patterns that best suited the final developed application are shown below:

**Builder**

A builder pattern separates the different constructs of the application which goes hand in hand with the low coupling. A certain process can create different representations within the application.

**Singleton**

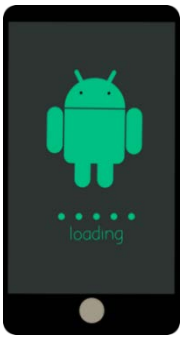
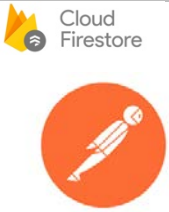
The Singleton Pattern is used for the specification of modularity in which only a single instance of a specific class is present within a global point. This is used for the functionalities of the navigation or in general real-world objects that only have a single instance.

**Adapter**

The functionality of the adapter is to provide the overall cohesiveness within the application which allows for two incompatible modules or classes to function together through an interface of the specific class and the interface of the client which is appropriate for the user.

## 4.8. Hardware/software used

Table 2 Hardware/software used

| Name | Description | photo |
|---|---|---|
| Programming Language | The system will be made using java programming language with Android studio IDE. |   |
| Operating system constraint | The system will be operating on Android systems and will operate as mobile application. |   |
| Database constraint | The application integrates a localized database for navigation, SQL, and NoSQL database for implementation |   |

| | | |
|---|---|---|
| Google map service | The system will include SDK library from android studio to implement the navigation feature. |  |
| GitHub | To use some open source library and to share the project with each other. |  |
| Visual Paradigm (UML) | To create the required diagrams such as class diagrams, use case diagram, sequence diagrams. |  |
| Postman | We Use postman to test the request and retrieve the appropriate data from the respective database. |  |

# 5. Implementation

The novelty in this project exists within the implementation within the region or the education sector whereas previously stated, present systems in the middle east regions do not provide the functionalities that have been developed to educational institutions or even closed campuses such as Qatar University. With all implementations with software development there comes a price and sacrifices that were made to effectively implement the software developed. Due to the current circumstances and sacrifices that were made to implement the solution include: Working from different places where more than one member of the team implemented the functionality without being able to test the integration within the application as a whole. Various online tools were needed to be used on behalf of the team as part to integrate the system correctly without having the code being affected. The challenges regarding the navigation system that included converting blueprints into a software-based map was needed to be stopped due to integration of the functionality within the whole system. The implemented solution included using Google maps API as replacement for this functionality requirement. Scanning and generation of the QR code was done on a small scale for the fact that the university campus has been closed and the QR code was generated and stored in the database accordingly.

Table 3 Implementation

| Name | Usage | Logo |
|---|---|---|
| Android Studio | We chose android studio as a framework for developing the Project |  |
| Java Programming Language | Android Studio offers two programming language as a language for developing: Java and kotlin. However, we use java as a programming language. |   |
| Permissions | Mobile operating system required sort of permissions to allow the app to work or to do the functionalities, we use these permissions:<br>1- ACCESS_FINE_LOCATION<br>2- CAMERA<br>3- ACCESS_COARSE_LOCATION<br>4- INTERNET |  |
| **Desgin:** | | |

| | | |
|---|---|---|
| Navigation Drawer Activity | NDA is a belt in user interface design which offer a Navigation bar for Account details and use fragment to display the different content of the app. | |
| RecyclerView | RecyclerView is used to display a scrolling list of elements based on large data sets with ability to customize each item in the list | |
| Layout | Mainly we user Constrain layout and Linear layout. | |

| | | |
|---|---|---|
| **External Libraries:** | | |
| me.dm7.barcodescanner:zxing:1.9.13 | As a huge part of the project we use QR code in most of the project, so we use "zxing" Library for reading QR code and get the result of it to parse it and show the required data | |
| com.squareup.picasso:picasso:2.71828 | This library used to show the photo into the "ImageView" from URI directly | |
| de.hdodenhof:circleimageview:3.1.0 | This library used to border the photo as a circle | |
| OkHttpClient | Factory for calls, which can be used to send HTTP requests and read their responses. | |
| com.google.android.gms:play-services-maps:17.0.0 | We used Google play service to use google map API which allow the app to show map inside it. | |
| com.google.code.gson:gson:2.8.6 | "GSON" library used for converting JSON object to java object | |
| **Database and user interaction:** | | |
| FirebaseAuth | FirebaseAuth uses for user's authentication without caring about stolen of data. |  |
| FirebaseFireStore | Cloud Database, used for saving some data. |  |

| | | |
|---|---|---|
| FirebaseFireStorage | Cloud Database, used for saving image of the users, places images. |   |
| Restdb.io | |   |

# 6. Testing

## 6.1. Scope of the testing:

We specified the areas that need to be tested and we make it clear by list all of them as a table:

| Areas to be tested | Test |
|---|---|
| Register – Login | Task 1:<br>a- Create an account.<br>b- Login without verifying the email.<br>c- Verify the email and login. |
| Change profile picture | Task 2: Edit your profile picture. |
| View the account profile | Task 3: check your account profile and make sure that your information is correct or not. |
| Navigation | Task 5: try to navigate from your point to (Library, Activity building) |
| Leave message | Task 6: leave message for Dr. Mohammad Saleh. |
| Show class information | Task 7: show the G201 classroom's schedule. |
| Show faculty office information | Task 8: show Dr. Mohammad Saleh's account information. |

## 6.2. Test segment

With current predicament and unprecedented circumstances of the pandemic, there are certain limitations to the type of testing that can be conducted as well as training individuals on how to use the application to be developed. For the most part in-house, automation, and manual testing has been conducted which are common practices in software engineering and is backed by reliable research [21]. The results of each type of testing is shown below but obviously do not portray the true measurements of the University and can be considered bias in some cases which is well considered.

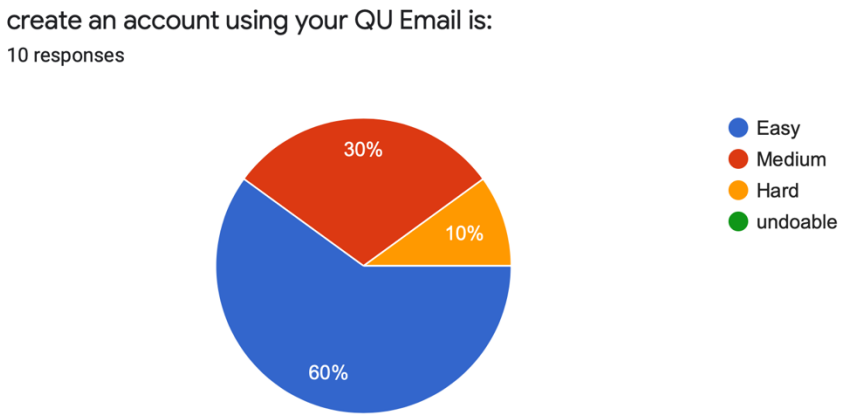



Figure 14 Testing: first question of the survey.

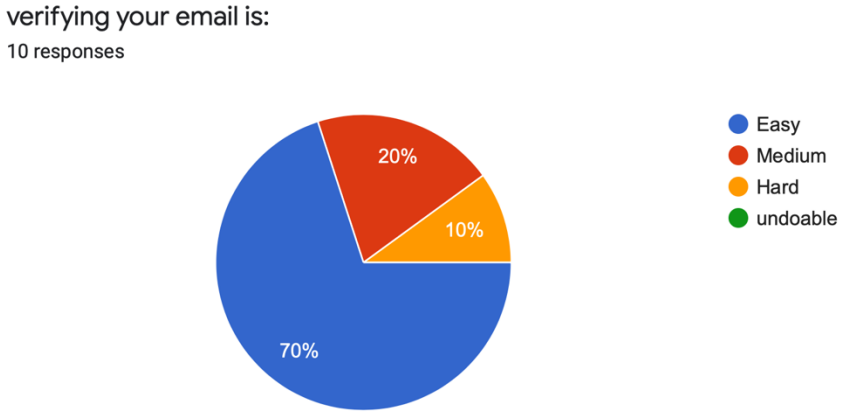



Figure 15 Testing: second question of the survey.

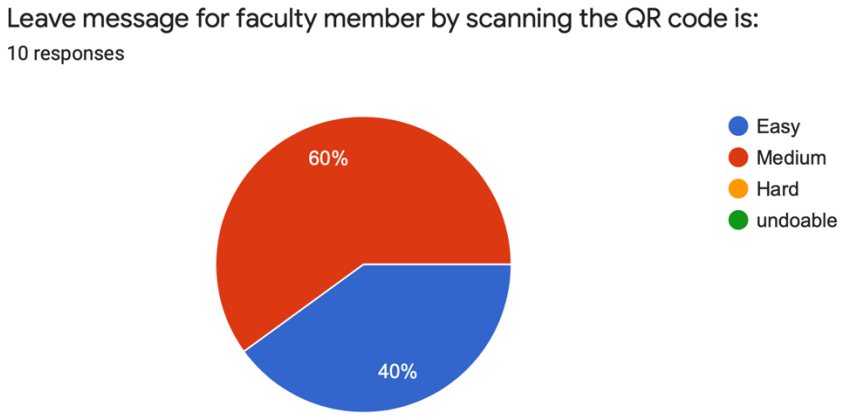



Figure 16 Testing: third question of the survey.

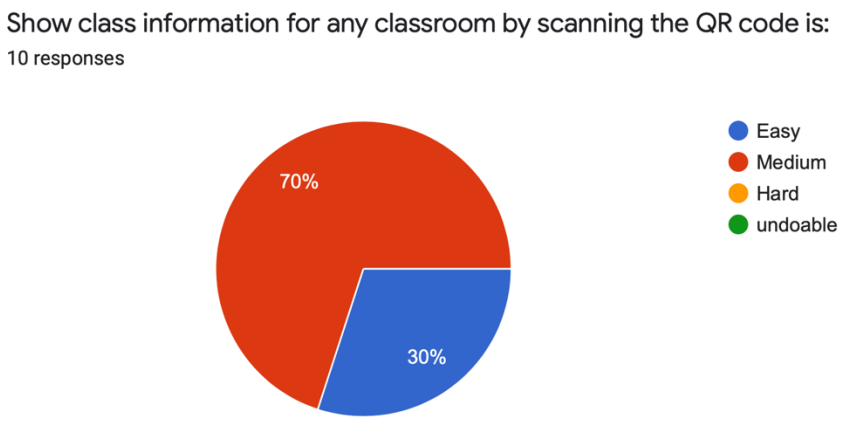



Figure 17 Testing: fourth question of the survey.

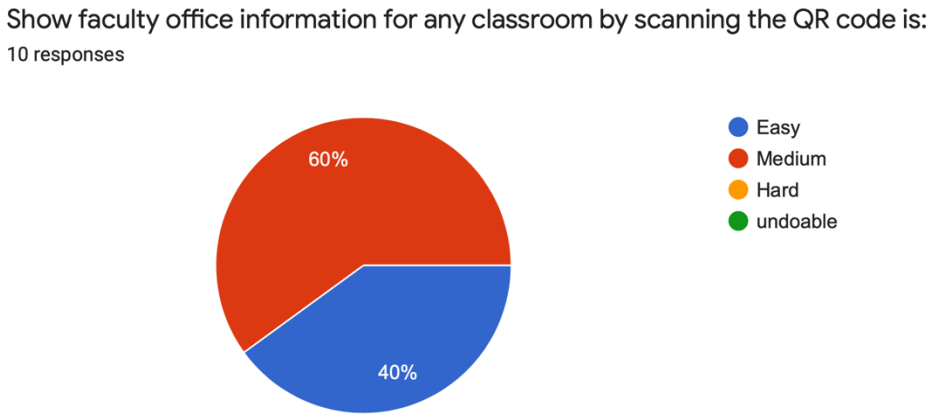



Figure 18 Testing: fifth question of the survey.

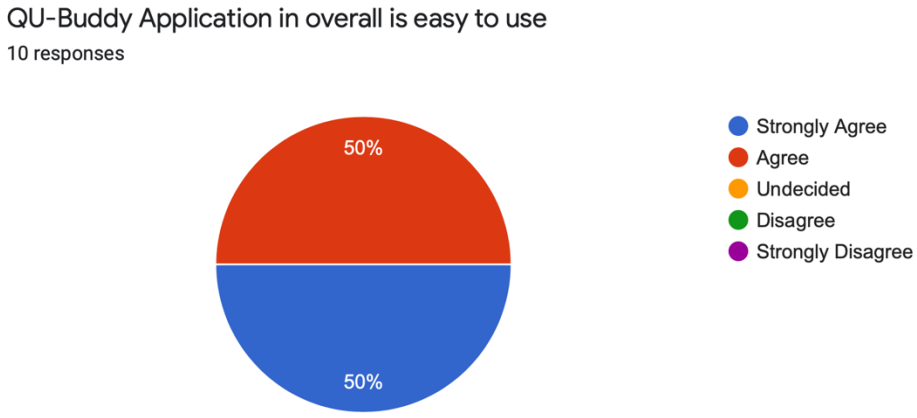



Figure 19 Testing: sixth question of the survey.

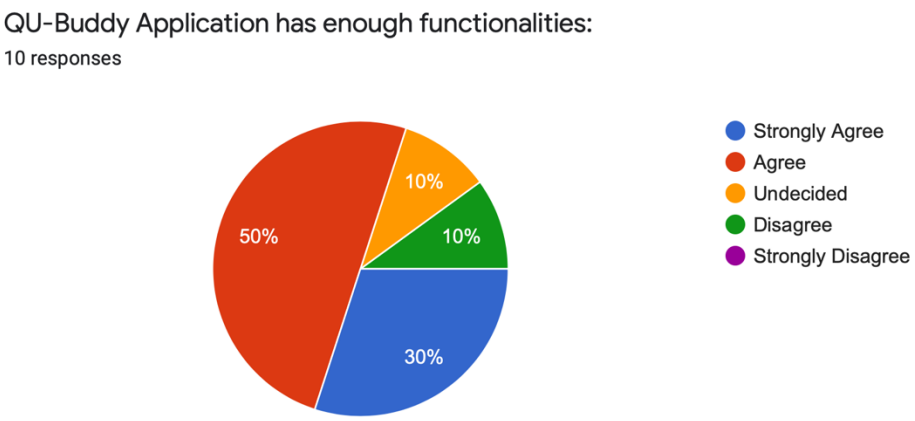
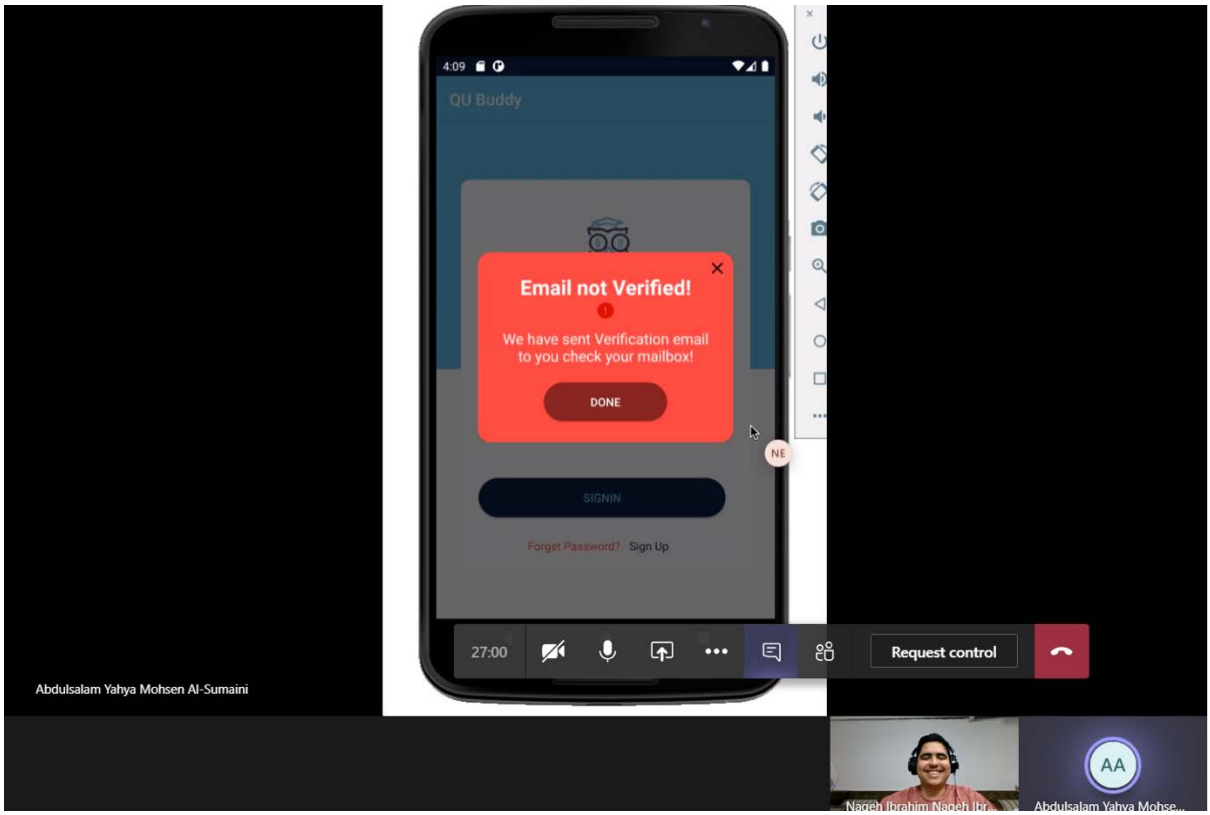
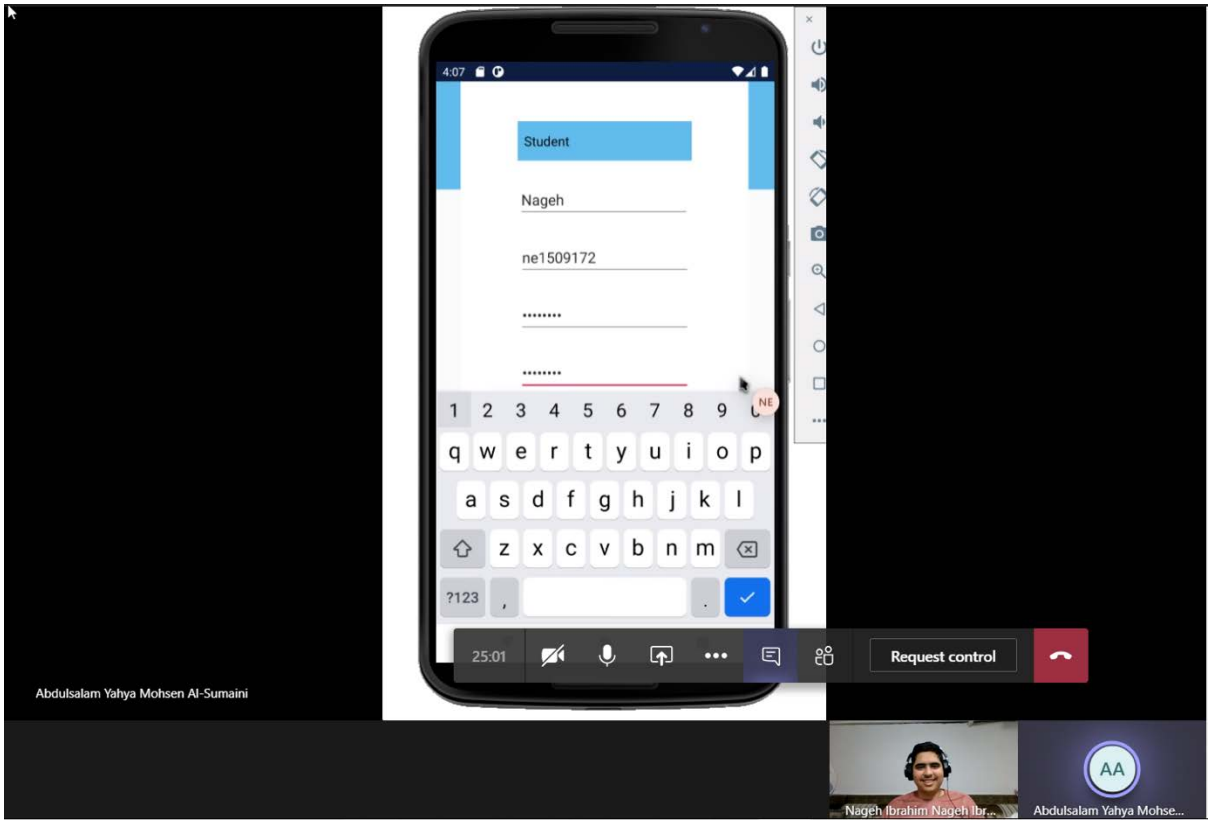
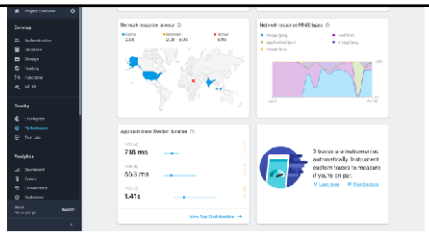
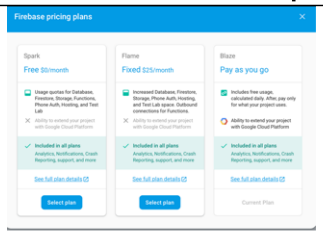
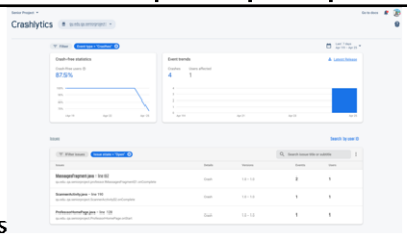



Figure 20 Testing: seventh question of the survey.




4:07
Student
Nageh
ne1509172
1 2 3 4 5 6 7 8 9 0
q w e r t y u i o p
a s d f g h j k l
z x c v b n m
?123
25:01
Request control
Abdulsalam Yahya Mohsen Al-Sumaini
Nageh Ibrahim Nageh Ibr...
AA
Abdulsalam Yahya Mohse...

| Non-functional requirements | Test evidence |
|---|---|
| **Performance** |  <br>We are monitoring the performance using firebase service to make sure that we have no performance issues and it also monitors the response rate for each version. As we can see from in the photo each update we are decreasing the delay time. |
| **Scalability** |  <br>We have chosen the Pay-as-you-go plan of Google's Firebase, which assures that our application is scalable. |
| **Availability** | Firebase service is offered and runs on Google which assures us 24/7 running service. |
| **Modifiability** | The code designed as the following<br>Model: Object classes that we need<br>View: interface which interacts with the ViewModel<br>ViewModel: which is giving back the result to View from Repository<br>Repository: Data layer<br><br>Which gives us the ability to easily modify and reuse any of the above layers. |
| **Maintainability** |  <br>Crashlytics<br>We are monitoring the bugs from Firebase Crashlytics service which helps us to maintain our application bugs/crashes without users feedback |
| **Usability** | We have made the test to see how our application is useable |

# 7. Impact of the project solution

As the globe keeps moving forward through a digital era technology is becoming more prevalent. An increase in usage of smart devices to facilitate the daily habits of a user has become the norm. The implemented SMART QU Buddy application is introduced to the community of Qatar University allowing the university to enter the technological revolution with regards to the smart technology to enhance the experience all of its associates who come to the campus providing them with an ease of mobility around the campus, providing real-time reliable data for each building and classroom and bridging the communication barrier between a person of interest that might not be present at the expected moment of time. The following impacts are to be expected on a domestic and global basis:

- Providing the new and incoming students a friendly experience of finding their way around campus free of frustration and being misinformed.
- Providing a template for Qatar University's proposal of already planning to develop on a campus GPS system for students.
- Allowing Qatar University to gain more recognition through the furtherment of this project and application to other institutions around Qatar and other parts of the globe.
- Since an application such as the one implemented is not currently available at any institution in Qatar or the Middle East for that matter it will make Qatar University unique and stand out over other institutions in the region.

# 8. Conclusion

The motivation and problem of the project's scope is to develop a user-friendly application to assist members associated with Qatar University with regards to gaining reliable information, navigation around the campus, and facilitating an overall experience for the intended users where preexisting systems do not provide the same functionality efficiently nor with respect to the individual coming to and from the university. The methodology that has been implemented by providing certain routes inside the campus where the user does not need to take a route given to them from the street or known landmarks. The QU Buddy application has filled the gap of the problems associated with the individuals associated with the university whether they be students, faculty, staff, or visitors.

# 9. Future work

Not all the intended features that were originally proposed at the start of this project are implemented in the final delivery of the Android application. Future implementations would broaden the scope of this project which would allow a user to find more buildings on campus whether be food courts, sport centers, or further developments made by Qatar University to expand its campus. Although the navigation feature is suitable for a majority of the intended users currently future work will provide for students with disabilities such as the blind, handicapped, and others where specific routes can be chosen dependent on the user. As explained in section 3.4 the routes are designated by the system without the user's opinion on whether the route is suitable for them which also could be applied in future work. Adding these new features would refine the current dataset provided for the campus and lead to intended users gaining better routes to offices, buildings, or other facilities around Qatar University. Considering the limitation of being able to access the wireless network at Qatar University and the receiving blueprints in a format that was not suitable to be applied to the current application developed furthering the project could include layering these blueprints on certain buildings where floorplans could be provided and datasets regarding latitude and longitude can be associated with floorplans of the building enhancing the overall system across all the functionalities.

From a long term perspective as technology keep making continuous advancements in the digital world accurate location sensors could possibly be integrated as a more improved solution which would offer a relatively accurate and efficient system with regards to all aspects of the current application whether it be sending messages to a certain member of the university, navigation throughout the campus, or gaining information about the schedule of a certain classroom. Indoor mapping included was part of the original proposal of the project but due the circumstances that are currently in place it is nearly impossible to complete such an objective without having direct access to the campus as well as communication with the architectural department to have the .dwg files converted into the appropriate files needed to upload to the map.

The plans for the future work on a large scale will include expanding a proper database to hold the relevant information to support all current functionalities as well as the complete dataset of all registered students within the university. This includes data with regards to students, maps, floor plans, navigation routes whether they may be static or dynamic, and proper servers to relay the information. The current system developed is capable of implementing the provided data as well as displaying it in a user-friendly manner but as with any software development there is always room for improvement.

# 10. Student Reflections

## 10.1. Abdulsalam Yahya Al-Sumaini Reflection:

For the most part I believe that a successful development of the application was delivered that satisfies the problems that are consistent with the university. As part of the development process I learned about the different aspects of developing a user interface that is suitable for a university student through various forms of studying that expanded out of the scope of the project I learned how psychology and overall adaptability plays a major role in the acceptance of this project. A thorough investigation and research was conducted through multiple surveys and various versions of the interface were developed to form the final product this included aspects of the project like the side bar menu or the placement of the profile all these aspects go hand in hand with the delivery of this application. Although a proper marketing technique was not taken into consideration due to the time and unprecedented circumstances, I believe that the delivered application can market itself once it has been integrated within the university. The psychology aspects of developing a proper interface was investigated aspects that include which colors to use to engage the users more or the wording of functionalities that are outside the skills of coding are integral to coming up with an interface that is acceptable among all university students. I also believe during these times where the pandemic came at a very unexpected times we are all at a consensus that all the team members were able to adapt to the circumstances at hand and further develop interpersonal skills in which the team could come with an effective way to deliver the project in time and effective.

## 10.2. Mostafa Mohamed Amin El-Guindy Reflection:

As for me this was definitely an unexpected journey in all aspects of my college years. The learning process throughout this project was beyond intense where I learned about a variety of new topics with regards to the navigation. This goes from using software related to georeferencing like GIS, ARCGIS, QMAPs, MAPBOX studio, etc. which took a lot of my time, but time cannot be measured against the knowledge that was gained throughout this process. Although it was an intense time I learned a great amount of methodologies and through trial and error I had to resort to using the Google Maps API for the implementation but I intend to further this project in the future on my own time where I can broaden the scope in a way where the floor plans can be layered on top of the building and making an impact on Qatar University in the future. As for the unexpected crisis that shut down the university, quarantined and impacted all of us in different ways. I have taken the time to develop my skills further not only working on this project but reading up on different research methods trying to compare them with the implemented solution with regards to the navigation. Due to the circumstances I have been able to adapt and communicate better with my team members versus keeping to myself like last semester. The crisis actually has shown me how the time is very valuable and that every minute should be used efficiently and taken into consideration because as cliché as it sounds time is short and the time that is lost cannot be returned. The shortcomings towards this project is not effectively listening to my team members with regards to their opinions on that certain implementations would not integrate with the application and due to my stubbornness, I had to learn the hard way that their opinion turned out to be true.

## 10.3. Mubarak Mohammed Alaunzi Reflection:

I learned about all aspects of this project I gained knowledge about databases, I learned about different algorithms towards the implementation of the navigation system as well as developing a mobile application. Although my skills might not be as strong as my team members I showed great contributions and towards the end I was a key player towards to this team and management and gathering the necessary data and testing the application overall by risking my health and forcing myself to go to the university and testing the navigation system with its features to see the actual data and localization of the database and whether the simulation was actually reporting the correct data. Like my colleagues have stated the times that have come upon us are very unexpected and they have been at an advantage and disadvantage as well as we are all going through our own circumstances. For the most part we have been able to adapt throughout these times and have all the deliverables producing reliable information and output and I am quite satisfied with the progress we have made through these times. The skills I have learned the most was like I said was reading up on each of my teams part and learning as they go through the necessary my strong suits were my interpersonal skills my shortcoming were more of a software development as I was tasked to get data and relay it to my different members of this group to actually code it without prior knowledge nor having taken courses in the nature of the topics being discussed this was difficult for me but at the same time I was able to code the time counter towards the most visited places by the user.

## 10.3. Mostafa Ahmed Mahmoud  Reflection:

Throughout this senior project from the first semester to the second semester has been an overall rollercoaster with my regards. I faced different obstacles with regards to the task assigned of developing the database and having to come up with alternatives that were suitable for integration of the application. The database developed is crucial to the functionalities of the application and I feel like all my team members played an important role with the development of this whole application. I learned about various databases and which is more suited for the application that is being developed. Some difficulties faced throughout this process was having the massive amount of data fit inside the database and retrieving the data correctly. For the most part I learned a lot through both semesters and have developed a variety of skills throughout this journey from communication with different professionals to reaching out to other colleagues for help in the development even if I was not tasked with the functionality I took it upon myself to research about it and find a proper implementation to offer for my fellow team member. On a professional basis I believe this project has prepared for the real-world environment and getting a feel on how it will work in a software development company and take knowledge based on which aspects of computer science suits me over others.

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# Appendix A – Project Plan

## A.1. Project milestones

A project milestone is a zero-length assignment that indicates a major project achievement. The milestones should be a simple sequence of events that build up incrementally until the completion of any task. Project milestones are a way to know how the project is going, especially if one is unfamiliar with the tasks being performed. These have no length because they are indicative of a task completion, or a point in time. Since the start and end date of a milestone depends on the start and end date of a task, task association is an important feature of a milestone.

The project will be basically delivered in the following number of milestones:

- Requirement analysis
- Design
- Implementation
- Testing
- Deployment

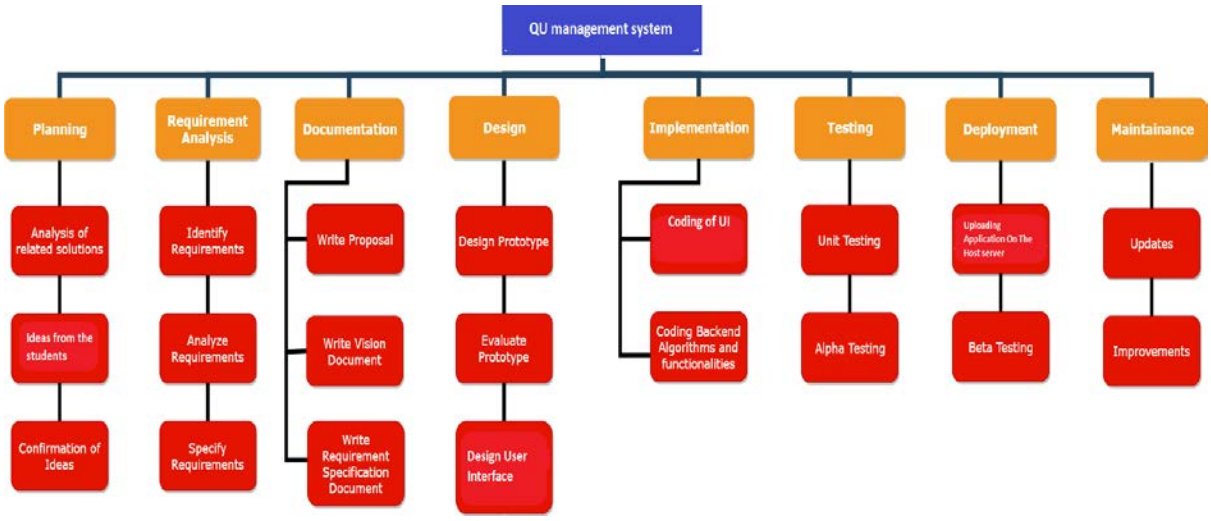
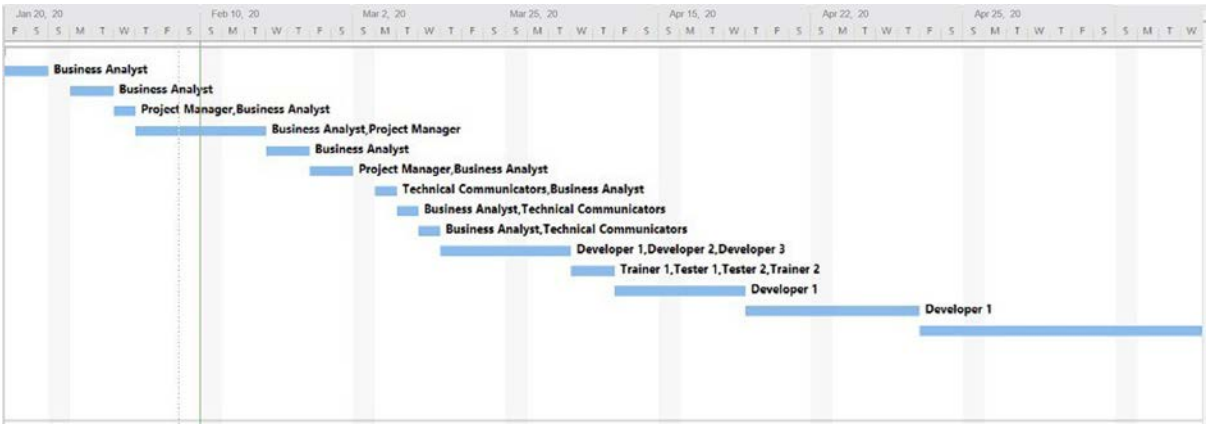



*Figure 14. Work breakdown structure of QU management system*

## A.2. Project timeline

| ID | Task Mode | Task Name | Duration |
|---|---|---|---|
| 0 | | Software Development | 67 days |
| 1 | | Analysis of related work | 2 days |
| 2 | | Ideas from students | 2 days |
| 3 | | Confirmation of ideas | 1 day |
| 4 | | Identify Requirements | 5 days |
| 5 | | Analyze Requirements | 2 days |
| 6 | | Specify Requirements | 2 days |
| 7 | | Write Proposal | 1 day |
| 8 | | Write Vision Document | 1 day |
| 9 | | Write Requirements Spe | 1 day |
| 10 | | Design Prototype | 5 days |
| 11 | | Evaluate Prototype | 2 days |
| 12 | | Design User Interface | 5 days |
| 13 | | Coding UI | 7 days |
| 14 | | Coding Backend Algorith | 20 days |
| 15 | | Unit Testing | 4 days |
| 16 | | Alpha Testing | 2 days |
| 17 | | Uploading Application o | 1 day |
| 18 | | Beta Testing | 4 days |

*Figure 15. Division of work*




## A.3. Anticipated risks

The following risks have been anticipated in this system:

- The developers of the projects must have the necessary skills to develop android application.
- The developers must be able to develop an integrated android system.
- The developers must safely make the use of java in creating different access views for the different users.
- The developers must ensure the successful communication of the application with the apache cordova web server.

- The firebase database must be able to store bulk amount of data of the university.
- The application must be developed in such a way that it should be prone to handle huge number of users without crashing.
- The users must be able to easily use the system without any technical difficulty.
- The system must be able to provide safe data access based on different user roles.
- The application must be able to take automatic data backups and save the university's millions of dollars.