Kingdom of Saudi Arabia
Ministry of Education
Albaha University
Faculty of Computer Science and Information Technology
Department of Computer Information Systems

المملكة العربية السعودية
وزارة التعليم
جامعة الباحة
كلية علوم الحاسب وتقنية المعلومات
قسم نظم المعلومات الحاسوبية

Final Year Project Report

Senior Project for CIS 1

CRN: 10674

Submitted in partial satisfaction of the requirements for the

Degree of Bachelor's in Computer Information Systems

Entitled:

Indoor Map for CS College Building

Computer Information Systems

Albaha University

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FINAL APPROVAL

Certified that we have read this project report submitted by (Students' names), in our judgment it fulfils sufficient standard to warrant its acceptance.

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   (Examiner Name)
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2. Examiner 2 _____
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3. Supervisor _____
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Project Brief

Project Name	Indoor Map for CS College Building
Department Name	Computer Information Systems
Undertaken By	Saif Yahya Alghamdi
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Supervised By	Dr. Mohammed Mardi
	Computer Information Systems
	Albaha University
Started on	February 2023
Completed on	October 2023
Computer Used	Multiple Computers
Source Language	English
Operating System	Windows 10
Tools Used	Android Studio, OpenStreetMap, JOSM, OverPass

Acknowledgements

We would like to acknowledge this work to Dr. Mohammed Mardi, he helped us complete this project, and the Computer Information Systems department as a whole, they provided us with resources and guidance to work on this project.

Dedication

We would also like to dedicate this project to our families, without them we wouldn't be where we are today, they helped us, supported us, and stood by us this whole time, they encouraged us to pursue our dreams and achieve them. So huge thanks to them for their continues support.

……

Abstract

Maps helped humans navigate their ways throughout the years, and still to this day the map is a huge part of our lives, some would say it’s more important now than ever.

This made us think about one of the issues that new students and visitors to our college campus face, which the ability to find your way around it, how to solve such problems?

Will, with today’s advancement in technology, mobile phones and apps are an important part of our lives, it helped us massively in past 20 years, so we decided to combine today’s technology with the ancient technology, the map, to create an indoor map for the college science building.

Using everyday technology means that we have to create something accessible and available for everyone, whether for designing the map or the application, which modern technology is more feasible for our object, and how can we use it to achieve our goals?

We find out through an extensive search for the right tools and technologies, to make the perfect project and solve those problems, satisfy our users, and reach or goals.

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www.OpenStreetMap.org

www.OpenLevelUp.net

www.developer.android.com

www.workspace.google.com

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Chapter I INTRODUCTION

1.1. Background and Motivation

Finding your way around the college campus might be really difficult, especially for new students and visitors, this definitely created many issues that can cause students to be late for their classes, exams, or disturb the flow of classes, creating a map might reduce or even remove these problems.

The map is a simple indoor map to navigate the building and its facilities, but we didn't know how such map would be accomplished? And how it would reach everyone?

In this report we will go in depth about each step in the process of making this project.

1.2. Problem and Research Questions

We decided to start step by step, first identify the problem: we made a simple survey with simple questions aimed towards current and new students, questions like: Did you face any difficulties in finding your classes when you were a freshman? Do you still face those difficulties today?

Surprisingly, the answers were very clear: students do have problems navigating the university.

After finding the problem, we started working on the scope of the project, again by asking some questions, this time to ourselves, is it possible to create such map? which tool do we use for it?

1.3. Aim and Objectives

Our objectives are:

- Create a clear and accessible map for the Computer Science building (number 3)
- Base the map on existing blueprints for the building.
- Make the map available through an app.
- Make the app as accessible as possible, so it can be used by anyone.

1.4. Proposed Solution to Problem

We encountered many problems but thankfully we were able to overcome them:

- **Size and scope of the map**, we decided to focus on one budling and include as much details as possible, instead of multiple maps with less details.
- **Software and API for designing the map,** so may options available, but we chose OSM API for its flexibility, and because it provides us with tools we need for this project, like indoor tagging, and floors.
- **Accessibly** is extremely important for this project, that's why we decided to go for a mobile phone application instead of a website or just the map, to give everyone access to the map from visitors to students and employees.

1.5. Contributions

- Help people find their way around the building.
- Make the map available for everyone.
- Make the map available for anyone who wants to modify it.
- Reduce the confusion that might happen at the beginning of every year.

1.6. Outline

A schedule was created for the project using Gantt chart, the timelines showcase the progress.

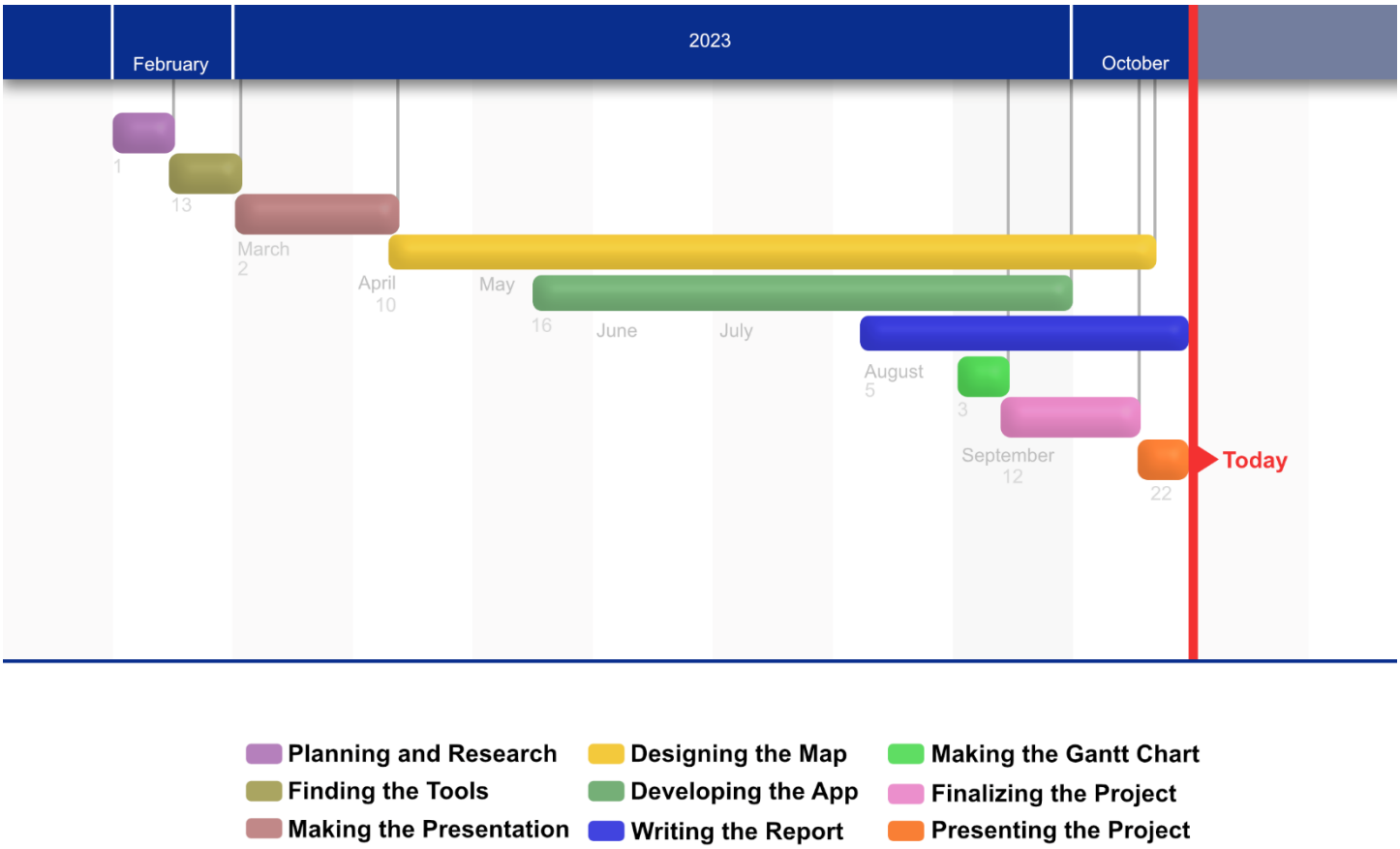

Figure 13- Gantt Chart for the Project

Chapter 2 LITERATURE REVIEW

2.1. Introduction

Indoor maps are becoming more and more popular today, especially with mobile phones, this heavily inspired us to start working on our project, but also made it easier for us to find similar projects that could help us in a way or another to achieve our vision.

2.2. Similar Maps/ Systems

Many similar projects exist, from official indoor maps, like airports and universities, to much smaller and unofficial maps like the one we found for our college, done by previous student, you might think what's the point of creating map if there's one already? What makes your map special and how can it differ from the previous one?

Will the answer to these questions is easy: the work done by previous students is extremely inaccurate and lacks any information that could make it a functional map.

Many details such as boarders, rooms, tags, and locations are inaccurate or missing, making the map unreliable.

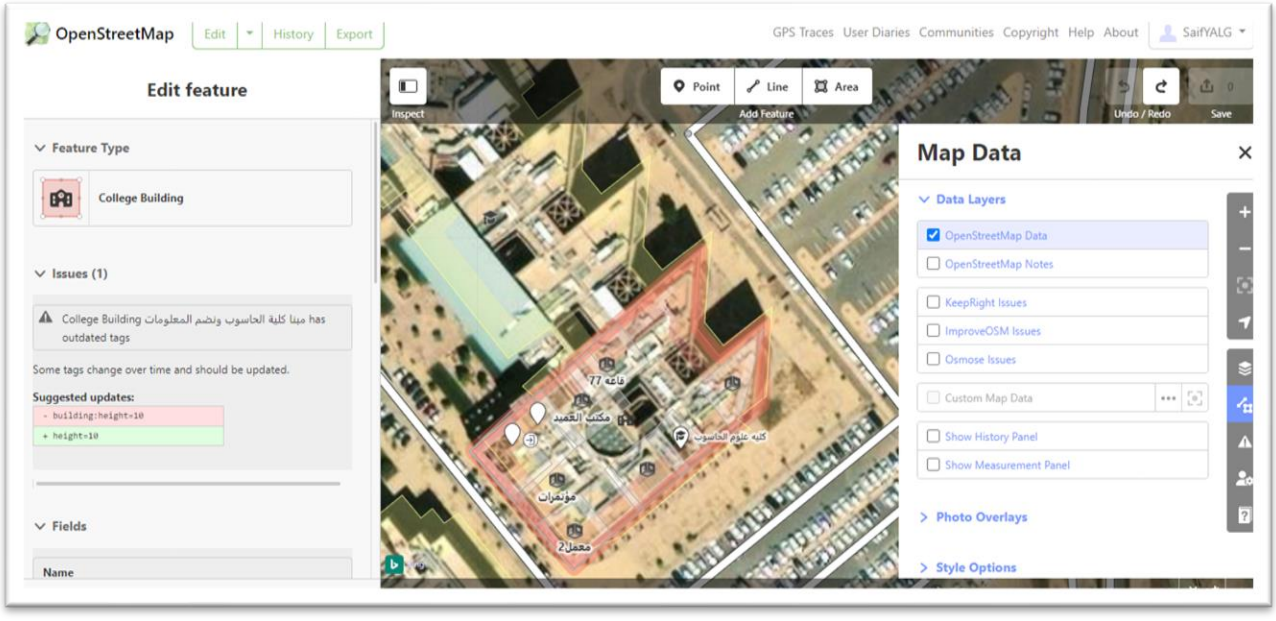

Figure 14 - Similar Map to ours, Notice the Inaccuracy

Not to demeans their work, but it inspired us to redesign the map from scratch and make it as accurate as possible.

A higher quality map is our aim, because simplifying maps is not a good thing, maps should have 1:1 accuracy, the previous map is just a general idea of where the building is located.
The map is also not available anywhere outside of OpenLevelUp (Open Streets Map indoor maps viewer) making it less accessible than our map.

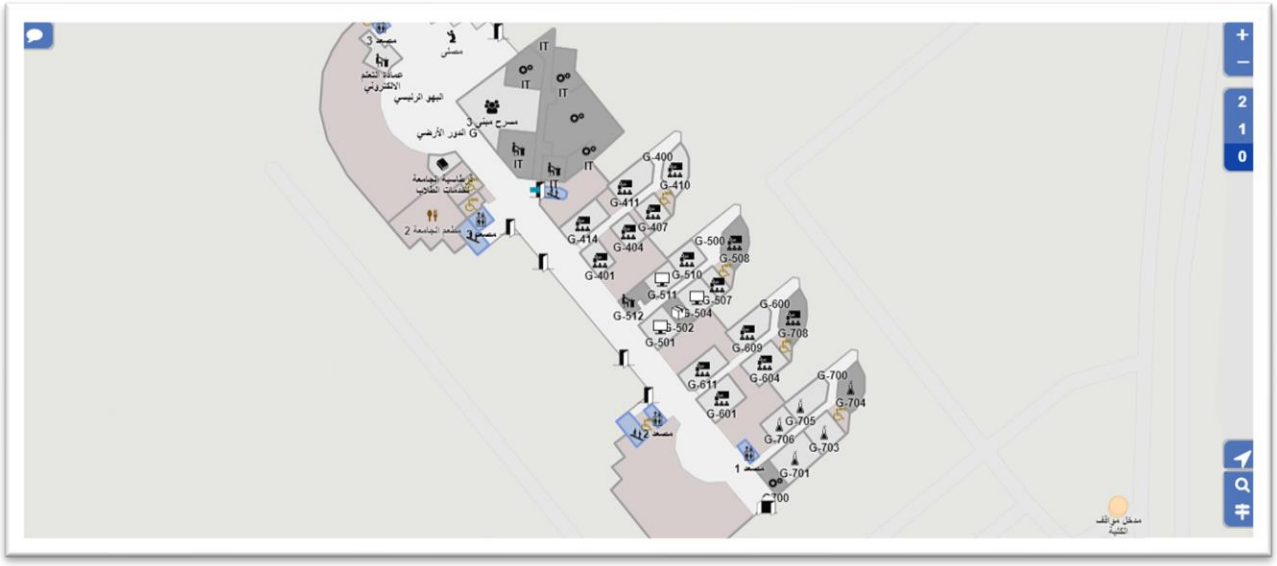

Figure 15 - Our Map

A Comparison table between our map and a previous map:

Criteria	Previous Map	Our Map
Accuracy	No accurate information, all the rooms are misplaced	All the information is accurate and from the official building blueprint
Borders	No building borders	All building borders are designed accurately
Building coverage	Only a handful of rooms are available	The entirety of the building is covered
Accessibility	Only availabe on OpenLevelUp, not conncetd to an app or a website	Available on a mobile phone application
Availability	Available all the time	Available all the time
Limitations	Only available on OpenLevelUp	The application is only available on Android phones
Scalability	Scalable (Open Source)	Scalable (Open Source)

Table 1 - Comparison to a Similar Project

2.3. Summary

Indoor maps are very popular today, and a similar map to our map already exists, however it's extremely inaccurate and lacks all the important details, that's why we decided to redesign the map from scratch.

Chapter 3 Feasibility Study

3.1. Introduction

Before starting the project, we wanted to know if such map is useful for the majority of students, we decided to make a survey and ask some questions:

First, we anted to know if new students actually struggle to find their way, we asked a group of students if they encountered any difficulties to find their way around the map when they were new, the answer is in this pie chart:

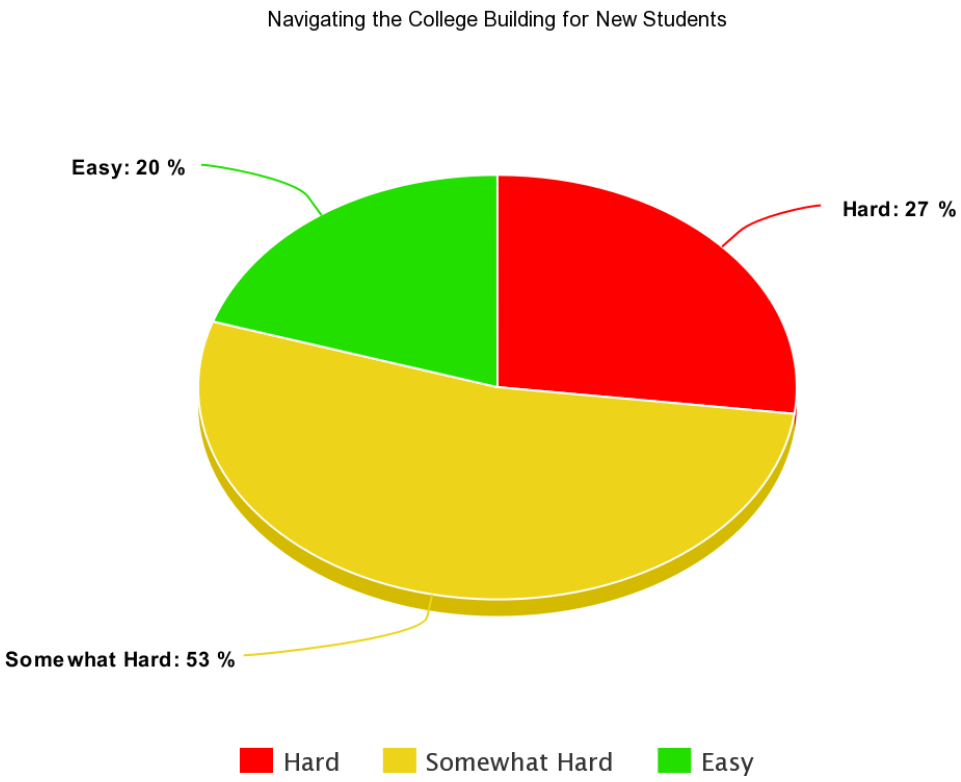

Figure 16 - New Students Survey

Over 80% of the students encountered some difficulties this has further proved our point; new students are our main target for this project:

Then we asked the current students the same question:

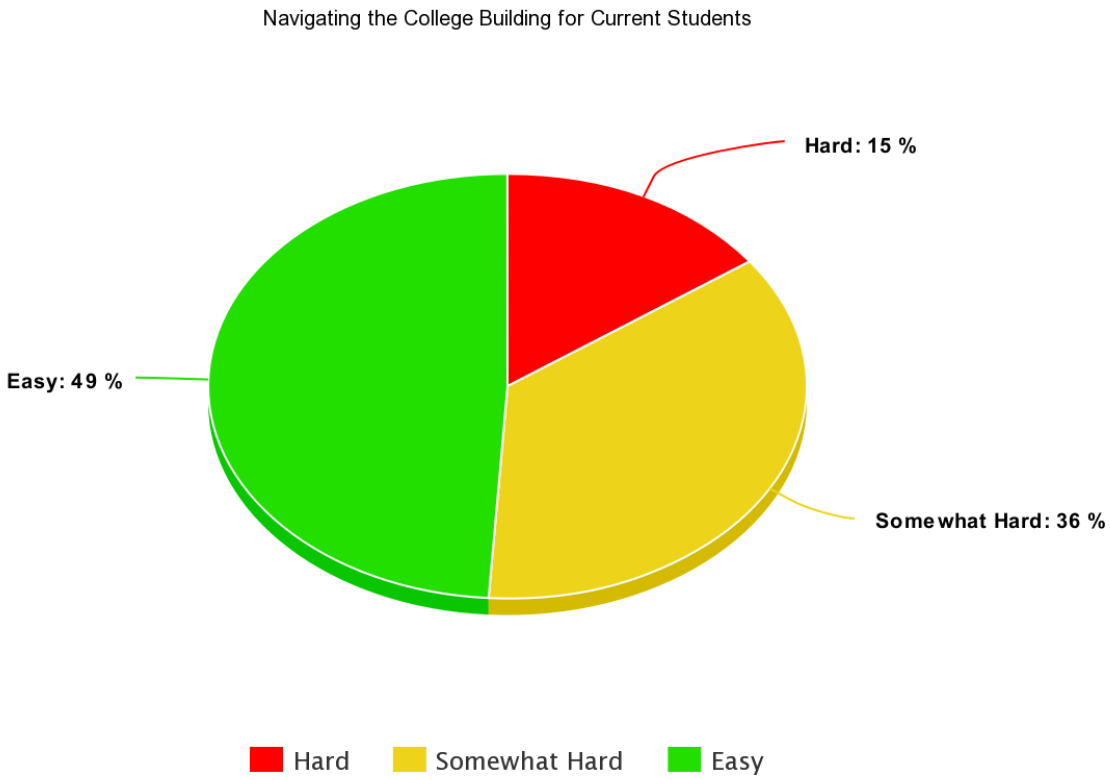

Figure 17 - Current Student Survey

Current students still face some problems even after spending time inside the building, this mainly happens during the exams period, when finding new classrooms that are not assigned to the department may cause some issues for students.

The final question is the most important one, we asked the same group of students if having and mobile application with an accessible indoor map would help them?

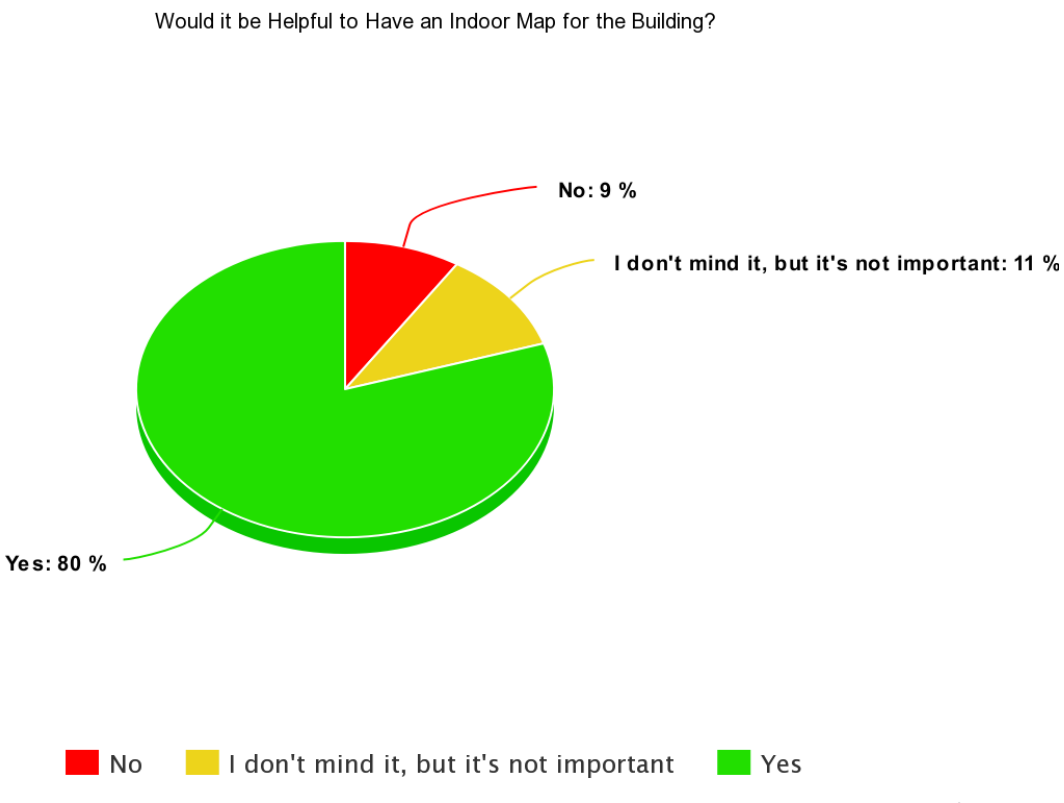

Figure 18 - Mobile Phone Survey

Based on these results, we decided that our project is going to be successful at helping students navigate the building.

3.2. Summary

Most of the students encounter issues at finding their way around the map, even after spending time in the building, and we reached the conclusion that a mobile phone app with an indoor map for the building is the perfect solution.

Chapter 4 SYSTEM ANALYSIS

4.1 Introduction

When we started, we wanted a solid foundation for our system, we looked for an open-source system that should give us the flexibility to build a system for the map and the application.

4.2 Map Requirements

For the map, we looked for a system that supports indoor maps, and the ability to design and modify the maps without any restrictions, OSM was the perfect choice for its open-source API and superb tools for developers.

4.3 App Requirements

For the app, Android system is our choice, for its open-source system and free IDE such as Android studio, it was the obvious and right choice for our project, especially if you look at the alternatives.

4.4 Stakeholders (users)

When we look at the feasibility study, it's obvious that our target users want an app for this project, so that's why we focused on delivering a solid experience for them, meaning that we focus on an accessible and user-friendly app, instead of just creating an app that cannot be accessed by users in an intuitive way.

4.5 Functional Requirements

The app will function on any Android phone, and any device with a browser can run the map. A GPS system is needed to access the location.

4.5.1 Map System Requirements

The map itself can be accessed on any system, it's designed and stored on OSM, can be viewed on OpenLevelUp which is the official indoor maps viewer for OSM, so any system with a basic browser that can parse Java, XML, and HTML can access the map with no issues.

4.5.2 Application System Requirement

The application is only available on Android phones, due to its open-source API.
Developing the app on other systems such as IOS is possible but the restrictive IDE for Apple devices and the developer license to access the IDE is way beyond our budget.

4.6 System Qualities and Limitations

Qualities:

- The system is light and compact.
- The code is efficient, with no excessive code that could cause memory leaks.
- The map is designed to include as much information as possible with the least number of nodes and polygons possible, making it quick to load.
- The application is straight forward, no extra clutter in the UI.
- Any Android device can run the app, even the less powerful and old devices.

Limitations:

- The application is only available on Android.
- Only building 3 (computer science building) is available on the map.
- Systems with no GPS cannot access the location.

4.7 Diagrams

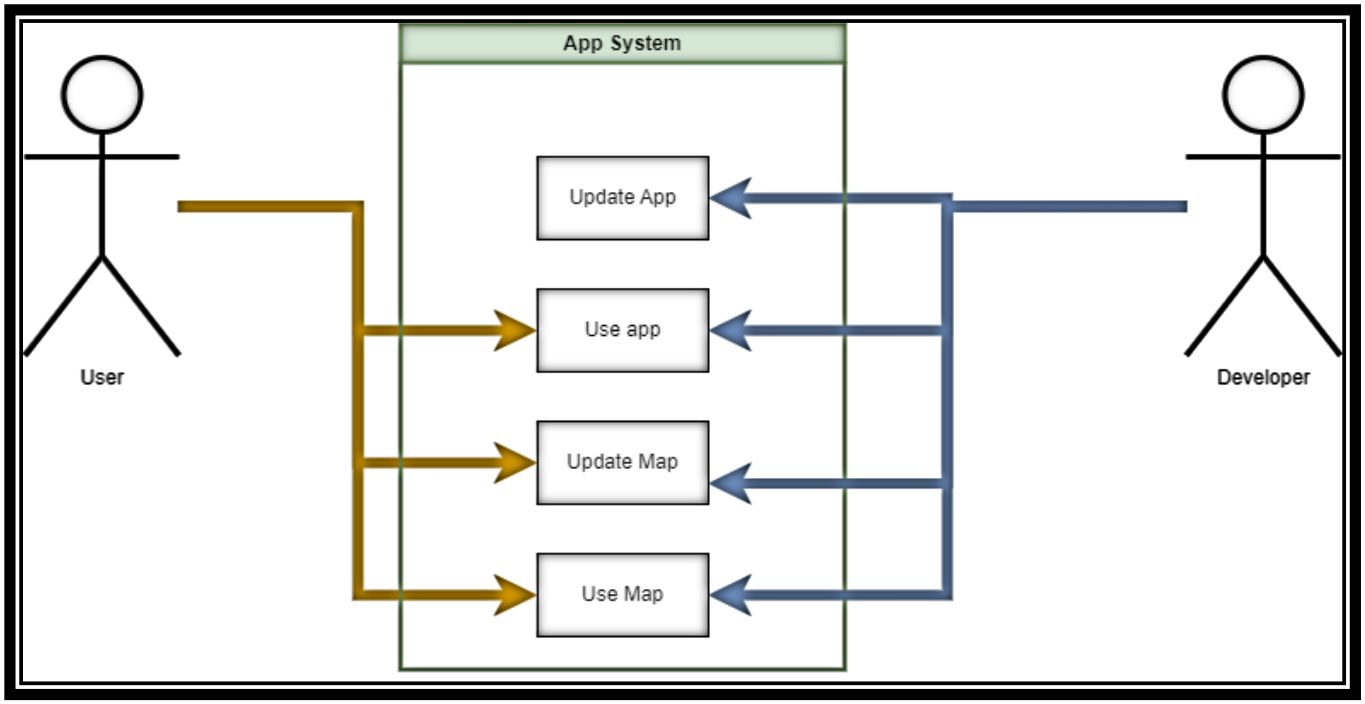

Figure 19 - Use Case Diagram

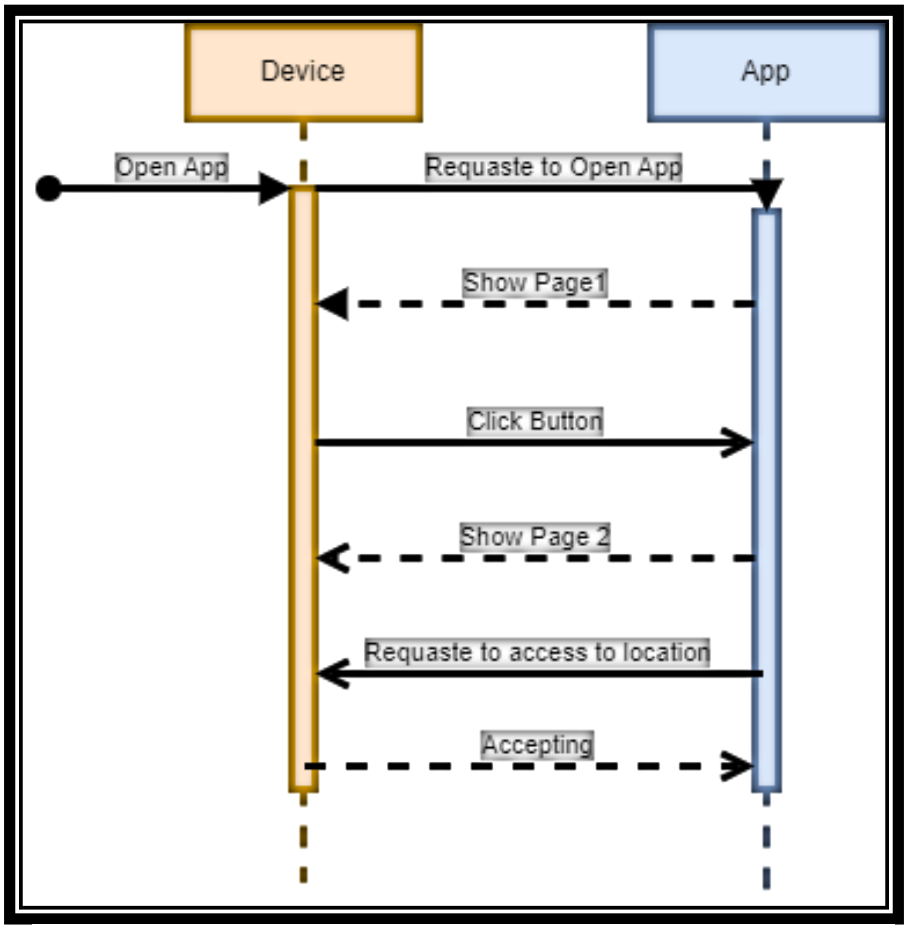

Figure 20 - Sequence Diagram

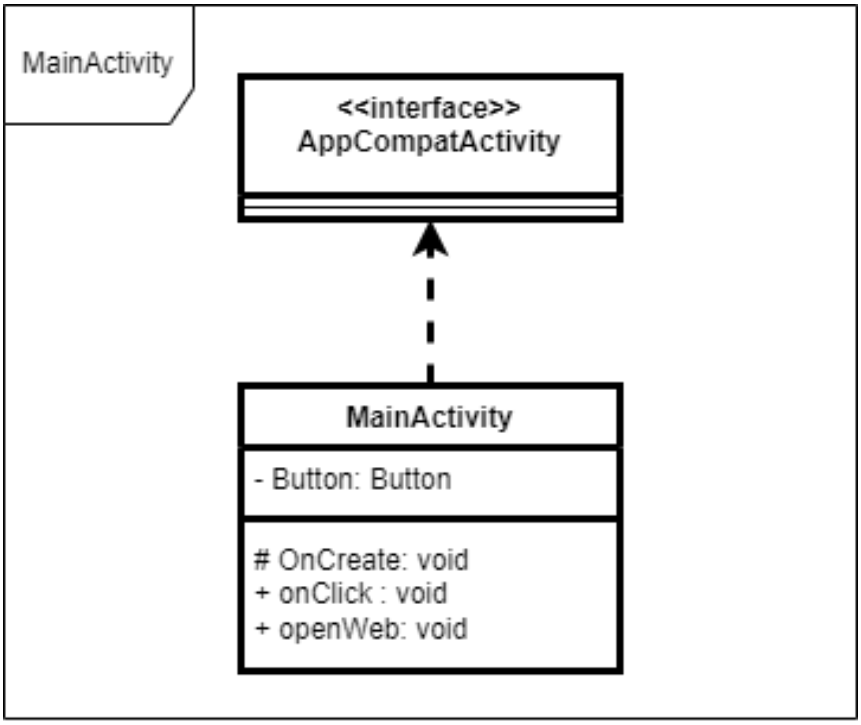

Figure 21 - UML Diagram for Java Code

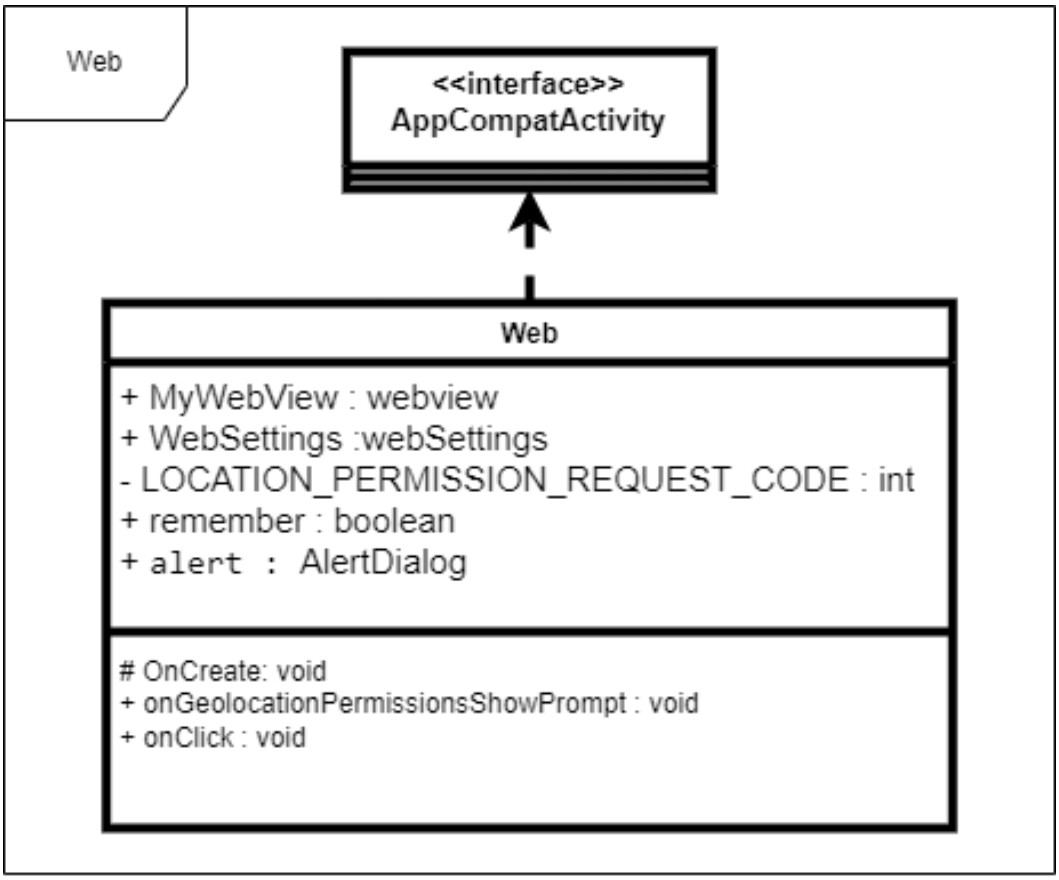

Figure 22 - UML Diagram for Java Code 2

4.8 Summary

The system is light, it was written to run on any devices with an Android operating system, With the aim to please every user, whether they are using a powerful and modern phone or an old one, it'll run smoothly.
The map is also written in and efficient way, to include as much information as possible without affection the systems performance, writing the app on Android made it unavailable on other systems like IOS, the map itself can be accessed on any device.

Chapter 5 System Design

5.1. Introduction

The system design phase is the most crucial phase in our system, it's the foundation for our project, designing a solution for our purposed problems using our expertise.
Starting from designing the map, storing its info to writing the code for the application, for it to run correctly and be able to call in the map.

These are the main functionalities of the program code, we used the **agile** development method, as it proved to be the best for our project.

5.2 Design Constraint

Selecting Android Studio for our IDE made our designing process more focused, same could be said about the map, for each system we focused on quality and ease of access.
The application was designed for Android users, which means it was designed entirely on an Android environment, using Android Studio.

5.3 Architectural Strategies

Here we will take an in-depth look at the code and how it's written, stored, structured, for the application and the map.

5.4 Mobile Application Code

The application is written in XML for the general code and UI elements, and Java for writing different functionalities.

This a program is written to run as efficiently as possible, with the ability to call in and parse JavaScript, and run the map, here's a step by step look at the process:

Check the Appendix

5.11 The map data structure

The map is designed using Open Street Map API, the data structure used here is topological data structure, written in **Java Script Object Notation**, with four core elements:

- **Nodes** or points used as geographical positions stored as coordinates.
- **Ways** or polygons are ordered list of nodes, representing a polyline, or a polygon if the form a closed loop.
- **Relations** are a group of nodes and ways connected to form a relation or a member.
- **Tags** are key value pairs; they are used to store metadata of the maps objects.

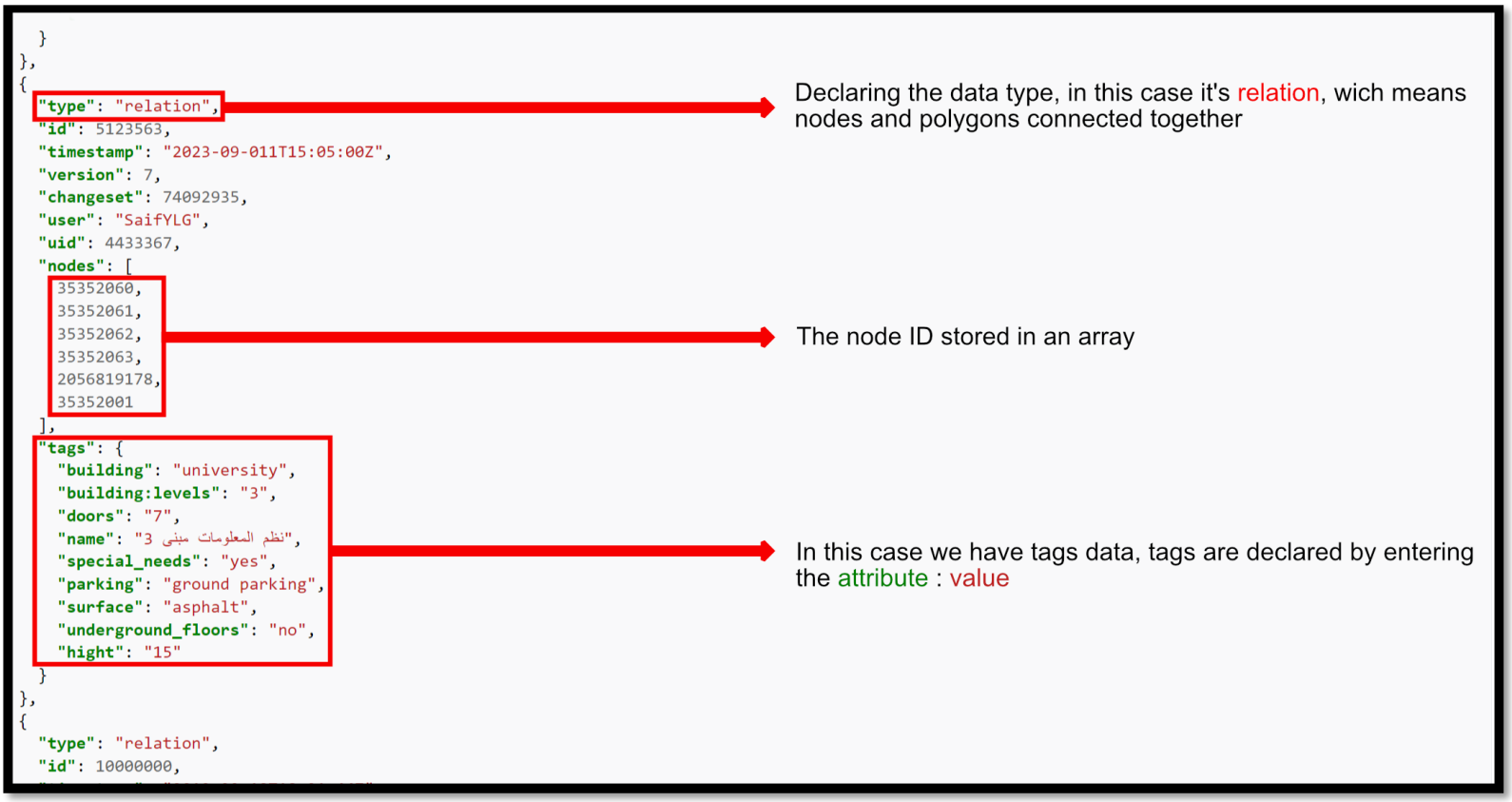

Figure 23 - Map Code Written in JSON

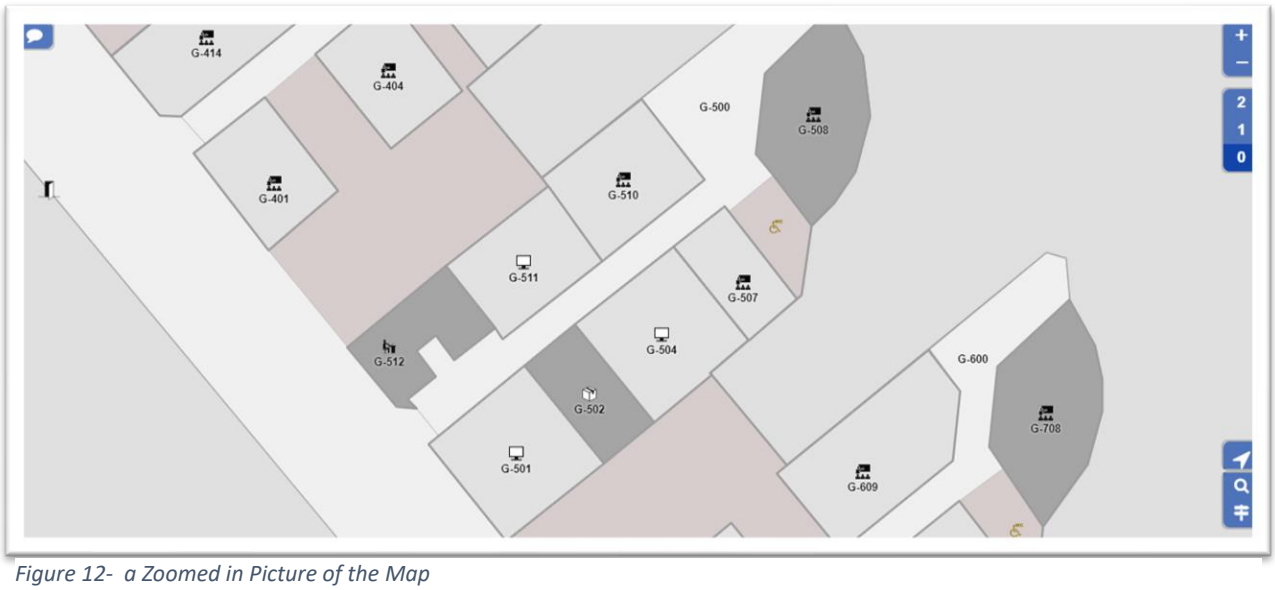

Figure 12- a Zoomed in Picture of the Map

5.12 Summary

The map is written in Java and XML using Android Studio, we gave it the ability to connect to the internet, access location, and open the map.

The map was designed using OSM, written in JSON.

Chapter 6 Implementation and Testing plan

6.1. Introduction

Our approach to testing is based on three criteria:

1- Functionality
2- User friendliness
3- Polish

We met those criteria during the setting phase.

1.2 Testing Plan

We installed the app on multiple android devices, from old to new and powerful, the app worked with now issue.
We also gave the app to multiple users including children and elderly, and our target users the students, everyone was able to access the map and navigate with no issues at all.
For the map we opened the map on multiple OSM viewers including OpenLevelUp, the map worked with no issues at all, marking a success in our testing phase.

1.3 Implantation

The map will be available through a link and barcode that will take the users straight to the map, even without an app.

6.1. Summary

Our simple test proved that everything is working like intended, and the map will be available through a link and a barcode.

Chapter 7 CONCLUSION

7.1. Introduction

Our project started when we decided to solve the main problem, navigating the college building, When we started doing our research, we figured out how to build maps, app, and learned a new language for the project, the final result is a complete map with an application.

7.2. Future Work

Our plan is to build a complete map for the university, including all the buildings and facilities, not just our college, and build an application for all devices not just android.
We also want to add more features, like 3D maps and pictures.

In the long run, we want to build a complete navigation system around the university, one of our ideas is to put QR codes around the college, student can scan the code and get an exact location of where you are, and waypoints to help you find your way.

7.3. Advantages and Disadvantages

Advantages:

- 1:1 accurate map to our building.
- Accessible phone app
- Open Source

Disadvantage:

- Only on android.
- Only building number 3 is available.
- No waypoints.

7.4. What we Learned?

Making maps was a new territory for us, it was really difficult at first, but once we figured it out it got a lot easier.
We learned how maps are built, and how the data is structured for it, for example how it can use languages like JSON to store points and polygons.

We also learned that open source maps exist, OSM was unknown to us before this project.
We also learned that indoor maps are much more complex to make than normal maps, due to the absence of satellite data, unlike exterior maps.

We learned a new language to build the app, which is XML, we knew the basics of it but now we can work with it in the future.

7.5. Summary

We built an Indoor map for the CIS building in our college, we used OpenStreetMap for our map, because it's open source and it gave us the flexibility to work on it.
We built an application alongside the map, in order to give the users access to the map.
We used XML and JAVA for the application, and JSON for the map.
The application was developed using Android Studio, which an IDE developed by Google.
The map can be viewed using OpenLevelUp, which is a tool for indoor maps for OSM.

Appendix

5.5 Basic App functionality

1. This is the how the code starts in Android Studio, first declaring the XML version, and then the encoding, in this case we used UTF-8 to encode binary data to Unicode characters.
2. We gave the program permission to use the internet.
3. We gave the program permission to access the location.
4. Allowing the application to backup the code.
5. This line is written to parse XML data and location of this data.
6. This data includes multiple backup versions, the app icon, the app name, right to left text support, theme, and API version.

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools" >
    <uses-permission android:name="android.permission.INTERNET" />
    <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
    <uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION" />
    <application
        android:allowBackup="true"
        android:dataExtractionRules="@xml/data_extraction_rules"
        android:fullBackupContent="@xml/backup_rules"
        android:icon="@mipmap/ic_launcher"
        android:label="AL_BAHA"
        android:supportsRtl="true"
        android:theme="@style/Theme.AL_BAHA"
        tools:targetApi="31" >
```

Figure 13 - Basic App functionality

5.6 App Layout

1. Add a tag that can call in android schemas and tools, and it'll align everything inside the screen border.
2. We made the height and width match the parent (screen border)
3. We called in a background for the app.

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="@drawable/background"
    tools:context=".MainActivity"
    >
```

Figure 14 - App Layout

5.7 Welcome Screen and Button

1. Add a new tag for the button and the text.
2. Adding value to the button and the text.
3. Aligning the button and the text.

```
    <Button
        android:id="@+id/button2"
        android:layout_width="wrap_content"
        android:layout_height="80dp"
        android:layout_alignParentRight="true"
        android:layout_alignParentBottom="true"
        android:layout_marginRight="180dp"
        android:layout_marginBottom="50dp"
        android:text="Get Started" />
```

Figure 15 - Welcome Screen and Button Code

5.8 App functionality (written in Java)

1. Call in a package.
2. Creating a class and naming it.
3. Creating the button functionality.
4. Calling in and declaring the onCreate class, which a class that can identify users' gestures.
5. Connecting the button functionality to the UI button.
6. When we push the button the next activity will start, which is openeb.
7. Create a class for this activity.
8. Now the button will open the map page.

```java
package com.example.al_baha;
import ...
2 usages
public class MainActivity extends AppCompatActivity {
    2 usages
    private Button button;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        button = (Button) findViewById(R.id.button2);
        button.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) { openWeb(); }
        });
        }
    1 usage
    public void openWeb(){
Intent intent = new Intent( packageContext: this, web.class);
startActivity(intent);
    }
}
```

Figure 16 - App Functionality in Java

5.9 Calling in the map (written in Java)

1. Declaring a class.
2. Creating a default browser.
3. Adding the ability to ask the app for accessing information.
4. Connecting the default browser.
5. Adding the default website, which is OpenLevelUp on our map.
6. The app will ask for the users' location.

```
18  public class web extends AppCompatActivity {
        4 usages
19      public WebView mywebView;
20
21      // Define a constant for your permission request code
        1 usage
22      private static final int LOCATION_PERMISSION_REQUEST_CODE = 1;
23
24      @Override
25      protected void onCreate(Bundle savedInstanceState) {
26          super.onCreate(savedInstanceState);
27          setContentView(R.layout.activity_web);
28
29          mywebView = (WebView) findViewById(R.id.webview);
30          mywebView.loadUrl("https://openlevelup.net/?l=0#20/20.18016/41.63529");
31
32
33          if (ContextCompat.checkSelfPermission( context: this, Manifest.permission.ACCESS_FINE_LOCATION)
34                  != PackageManager.PERMISSION_GRANTED) {
35
36              ActivityCompat.requestPermissions( activity: this, new String[]{
37                      Manifest.permission.ACCESS_FINE_LOCATION}, LOCATION_PERMISSION_REQUEST_CODE);
38          }
```

Figure 17 - Calling in the Map

The welcoming page:

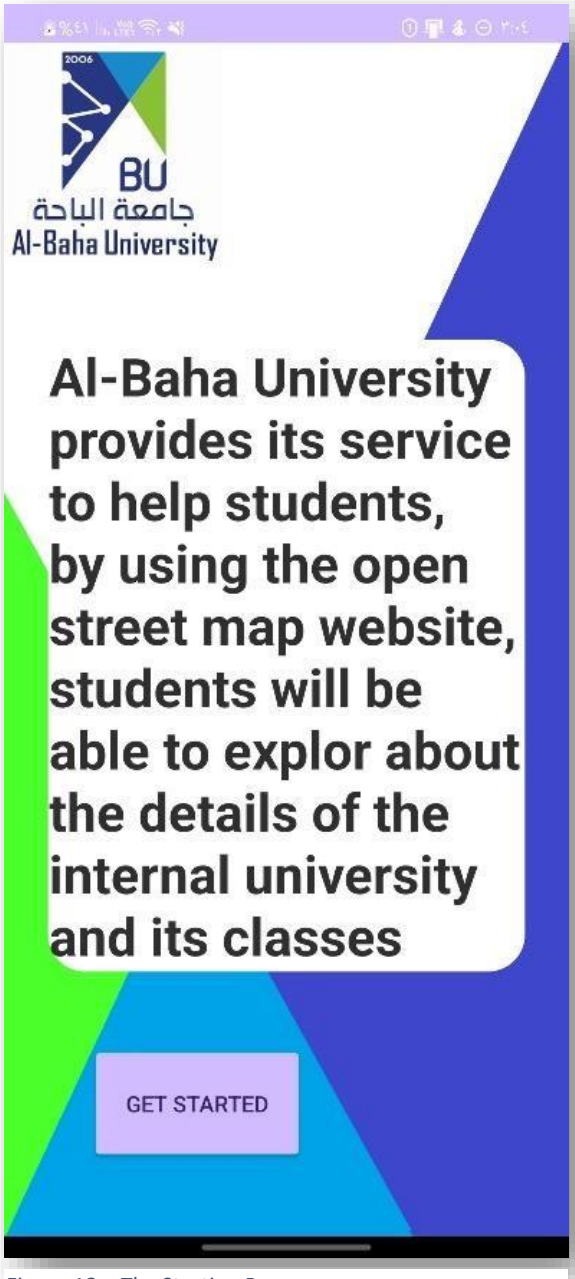

Figure 18 - The Starting Page

The map page:

Figure 19 - The Map Page

References

www.OpenStreetMap.org

www.OpenLevelUp.net

www.developer.android.com

www.workspace.google.com