Driving analysis application

College of Engineering and Informatics

Bachelor of Science(Computer Science & Information Technology)

Project Report

Author:

Richard Houston (19365321)

Academic supervisor:

Dr Seamus Hill

Acknowledgements

I would like to extend my sincere appreciation to my project supervisor, Dr Seamus Hill, for his practical support and guidance during the course of the final year project. His early advice with regards to prior experiences of final year project supervision have proven invaluable in the completion of my studies and project simultaneously. I would also like to thank my classmates for their support and friendship throughout the year as we now near the end of the course.

Table of Contents

List of Figures

Chapter 1. Introduction

1.1   Problem Statement

The purpose of this report is to provide an account of the processes and procedures that were implemented to construct my final year project. These included but were not limited to research, planning, external resources, software development, testing and evaluation of results.

The purpose of this project is to convey the workings of a provocative, useful, and innovative data analytics tool. This report centres on the development of a driving/journey analysis application for fleet management; the ultimate end being fleet sustainment and providing data driven decisions to improve efficiency, reduce environmental and cost overheads.

1.2   Project Inspiration

Firstly during the course of my Professional Experience Programme(PEP) placement with Manna.aero, an Irish drone delivery service provider I saw first-hand the importance of data for modern day firms both in terms of regulatory requirements and its' use in driven decision making. An example of data driven decision were the selection of only certain craft which had passed the required number of test flights to be certified for operations i.e. reducing the likelihood of a critical system failure during flight operations. I also saw the importance of the human factor for the successful operation of a logistical system that cannot be fully extrapolated with vehicle journey analytics. From surveys carried for Manna in partnership with Tesco we tailored our product to cater to consumer feedback. For example customers wanted a simple, quick user interface so instead of picking individual items a wide variety of bundle options were implemented e.g. the breakfast bundle which contained bacon, eggs, pudding etc. This experience showed the usefulness of data to a corporate leadership group.

Secondly outside of college I am a commissioned Officer in Irish Defence Forces which has gained me a lot of valuable experience. One of the main challenges I have faced planning any military tasking outside of the base installation is the means of getting your people and equipment to and from that area of operations. For example ferrying recruits to military training area for an exercise or repairing radio equipment located on radio masts which are often located in remote mountain areas. Within the Communication and Information Services(CIS) Corps(Defence Forces, 2023) unit which I help lead we have several types of vehicles from 4x4s, crew-cab jeeps, flatbed truck and large work vans with ladder cages This is a broad spread of vehicles to enable us to tackle any mission we may regularly face. Vehicles are used to varying degrees and as such the unit maintains a log of the timings vehicles were signed out for use, the appropriate tasking and the journey distance as per

the odometer. It is here I first thought about the loss on information regarding the routes taken, duration of journey, load factor. As the saying goes "what's measured get managed" and I believe that digitisation and dissemination of this information could provide insights as to how the unit is functioning and possible better ways to deploy resources.

Final there is a moral and legislative pressure on firms and state bodies to reduce their carbon footprint which has been steading growing since the turn of the millennium and this has been heightened by recent uncharacteristically severe weather events e.g. wildfires in Australia and flooding closer to home. Fortunately there is a synergy between the two goals of becoming more environmentally friendly and reducing and or managing operational overheads which in this case will be automotive vehicles (Department of the Taoiseach, 2022)

1.3   Project Idea

I have built a web application called "smartHaul" to encompass the above inspiration. The web application aims to streamline and simplify the process of storing and managing user journey analytics that encompasses a strong emphasis simplicity and data security. SmartHaul empowers users and corporate entities to easily keep track of their travel information in a secure and organised manner which is superior to paper based approaches as described above. By leveraging firebase functionality such as hosting and authentication smartHaul and intuitive mapping software from MapBox; smartHaul practically solves the hassle of manually recording the data and provides digital accessibility for data driven decisions at the corporate level.

1.4   Project Management

Project management is essential for successfully planning, executing, and completing projects within a specified timeframe and budget. It helps organizations achieve their goals and objectives by systematically organizing resources, tasks, and stakeholders.

As a result of being a single person project I choose test driven development as my project management methodology. Agile which was which I had be accustomed to was not suitable as matching my abilities to an estimated difficulty of a project facet was often a fruitless exercise when on many occasions I would leave a sticking point and then come back to it at a later occasion with a fresh approach. The heavy workload of final semester as played a part in this choice in that it was easier to use the snowball methodology by picking facets from my list of tasks and desired functionality that could be completed quicker thus keeping motivation higher and thus avoid the sense of being overwhelmed or trudging through a never ending functionality issue.

Wrike

For the purposes of tracking my test driver development tasks I made use of Wrike which split taskings on a board much like Trello into:

- New
- Planned
- In Progress
- Review
- Completed

It also catered for the use of gantt charts as a means of scheduling the taskings. Other functionality with Wrike includes priority grading and due dates. If there were other members of a development team there is a means of delegating taskings.
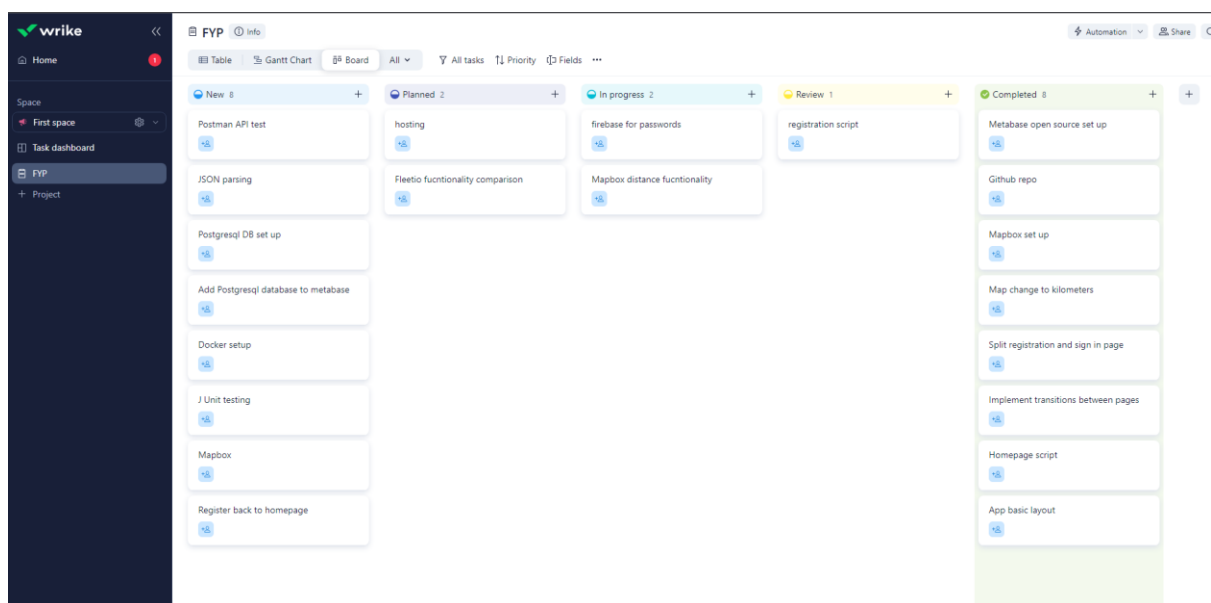

Figure 1.1 Wrike dashboard

Git

GitHub is a widely used platform for version control and collaboration that allowed me to work on the smartHaul web application more efficiently. By utilizing Git, a distributed version control system, GitHub enabled me to track changes, collaborate with those offering help, and manage the project's source code effectively.

Branching when combined with debugging data allowed me to quickly identify areas of code which were causing bugs and/or were not interfacing with other external resources such as MapBox, Firebase and mySQL. Meaningful comments also help identification of certain project facets that were being worked on at that time.

Github also provided a mean of data redundancy in the case of an accident with my device and so ensured that not all was lost in such a scenario.
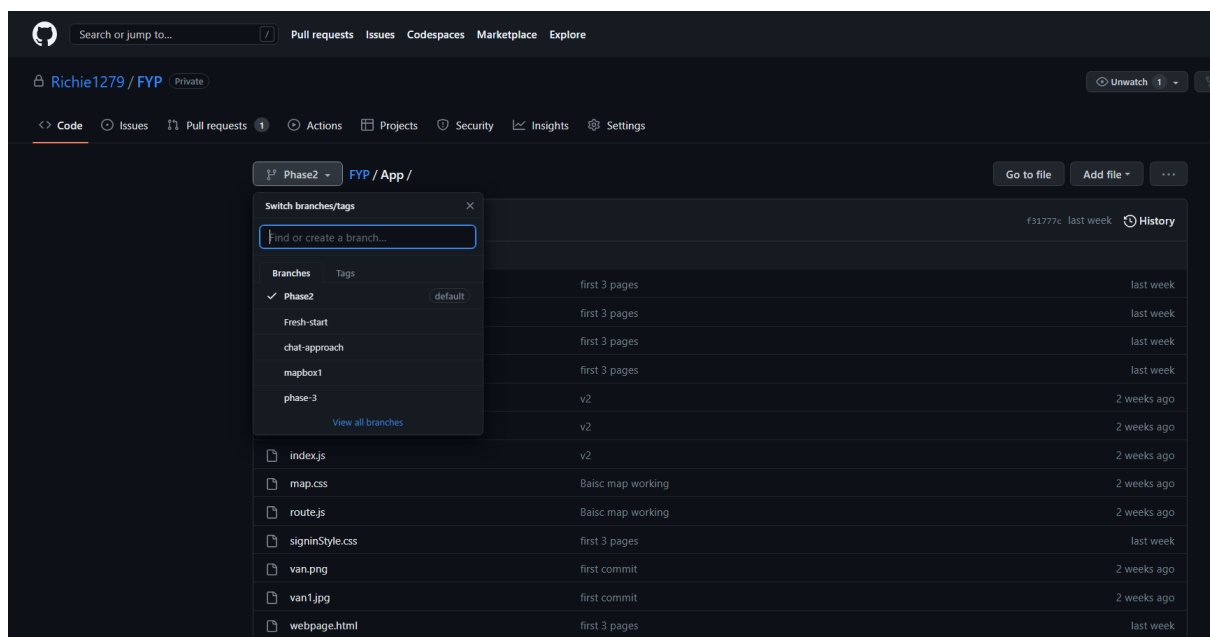

Figure 1.2 Github dashboard

Chapter 2. Research

2.1 Introduction

This chapter details the sources behind the research alongside analysis of competitors application in the markets. The sources will include snippets of functionality we are trying to recreate but also will point how our application differs.

2.2 Research sources

Research into this project began with discussing the problems of fleet management with logistics Officers in the 2nd Brigade Transport unit in Cathal Brugha Barracks in Rathmines, Co Dublin who are the brigade's lead unit with regards to heavy logistics tasks along with the vehicle maintenance and driver training which are part in parcel of these activities. They employ a wide range of vehicle with different capabilities and roles. Fleet management apparatus does exist in headquarters but it based on manually collated information by unit personnel. Details for a logistics trip which are mostly brief with point of origin, destination, vehicle and registration used, distance travelled as per odometer and the amount of litres of fuel required to return the tank to full.

Secondly in conjunction with this in house research I began to look up how commercial businesses leveraged data driven decisions with regards to their fleet management. Fleetio is one example of a company providing this service to companies such as Coca Cola and Uber. Their product has a very broad functionality with fleet management, fleet maintenance, fuel management and equipment management being their core solutions upon which other features are built. They state on their website the many different industries which they could benefit (Fleetio, 2023) and also their solution is web app and mobile application based. I undertook a free trial to obtain a greater insight into a their product which is mature and also has a proven track record.

Control the chaos of fleet management in any industry

Amazon Delivery
Reduce wasted time and costs by managing your Amazon delivery fleet with a centralized fleet management software.

Amazon Delivery Fleet Software →

Aviation Fleet
Take control of your maintenance workflow including expenses while reducing downtime for all of your aircraft fleet assets.

Aviation Fleet Software →

Construction
Automate construction fleet operations to reduce asset downtime, lower fuel costs and ensure compliance.

Construction Fleet Software →

Contractor & Electrician
Charge up your contractor fleet management solutions with digital vehicle inspections, tracking and automated maintenance workflows.

Contractor Fleet Software →

Delivery
Maximize uptime and visibility with a reliable fleet management software to keep your delivery fleet on track.

Delivery Fleet Software →

Education
Better solutions for education fleets that allow you to seamlessly track spending and improve driver safety.

Education Fleet Software →

Farm Equipment
Simplify your maintenance program and effectively manage your fleet to maximize the lifespan of your farm equipment and vehicles.

Farm Equipment Fleet Software →

Food & Beverage
Streamline food & beverage fleet operations through mobile app-based inspections and streamlined route efficiency.

Food & Beverage Fleet Software →

Government
Ease the burden on your government fleet while improving vehicle utilization and across-the-board regulatory compliance.

Government Fleet Software →

HVAC

Higher Education

Landscaping

Figure 2.1 Fleetio industry targets

Figure 2.2 Fleetio dashboard and mobile application mockup

Thirdly since from the outset I knew that I was going to implement a web application and a survey via Typeform which is an online survey provider. I also from my ideation phase of the project definition document knew that I wanted to implement a map interface which gives routing data and can act as a navigation aid.
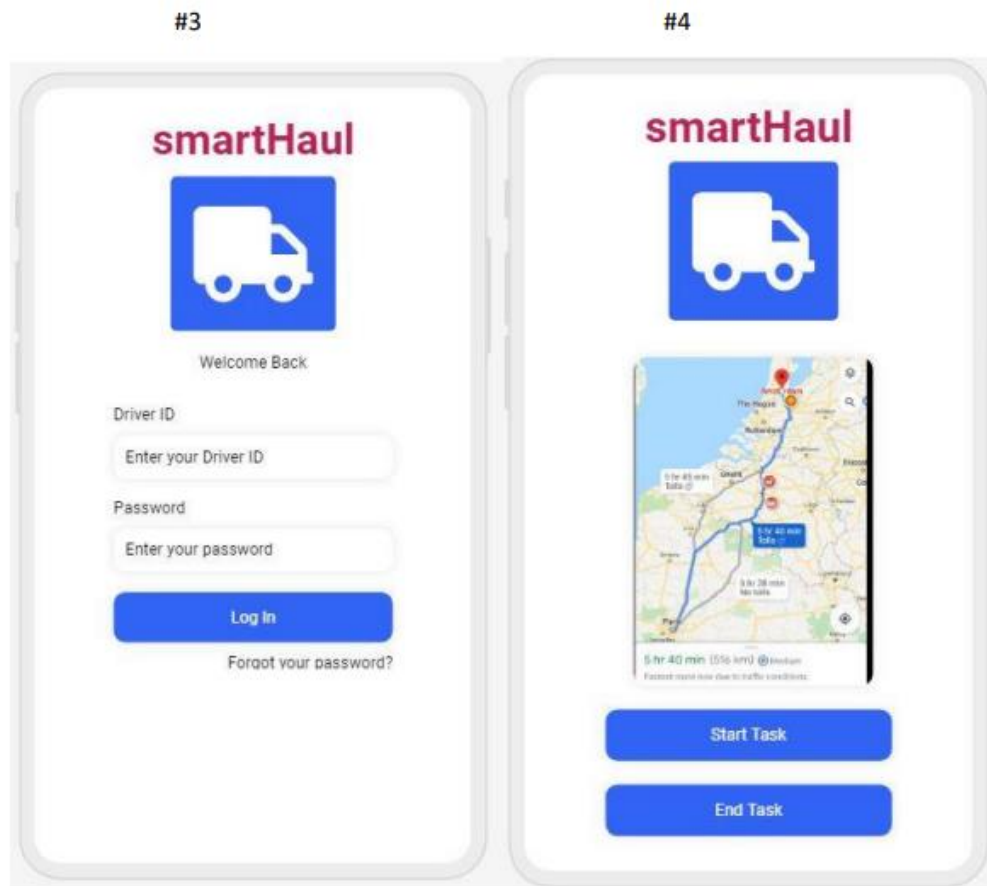

Figure 2.3 UI mock-up from initial final year project project definition document

I had assumed that following on from my aim during ideation to use Google's firebase services that naturally I would their 'Maps' services also. However upon further research and interaction I began to run into issues. I sought out alternatives as a result and selected Mapbox for the following reasons:

- Customization: Mapbox API allows for extensive customization of the map appearance, such as colors, icons, and styles, enabling developers to create unique and visually appealing maps that match their application's design.
- Cost: Mapbox API generally offers more competitive pricing than Google Maps API, especially for high-volume applications. This can be an essential consideration for startups and businesses with limited budgets.
- Data privacy: Mapbox is known for having a stronger focus on data privacy than Google Maps API. This can be important for applications handling sensitive data or for organizations with strict privacy requirements.

- Performance: Mapbox API is optimized for performance, with features such as vector tiles, which can lead to faster load times and a smoother user experience.
- Offline capabilities: Mapbox API provides better support for offline maps, which can be useful in applications that need to function without an internet connection.

Chapter 3. Requirements and methodology

3.1   Introduction

The project requirements originally set out have been achieved. This is to say that the core user web application has been implemented with a third party navigations provider service as described and portrayed in the mock-up frames of the definition document. The technologies which I set out to use have remained consistent with Javascript, HTML and CSS being the mainstay of the web application and SQL database present as stated. One major change from my project definition document is that I envisoned Java being my primary server side language but in order to leverage Express.js I used Javascript instead for server side functionality.

3.2   Functional requirements

Core requirements of the app are as follows:

- Home page navigation links
- User registration
- User Sign in
- Implementation of mapping API
- Data redundancy via typeform survey and insights
- Database storage
- Metabase display for business applications

Home Page Navigation Links

The home page serves as the primary entry point for users, providing an intuitive and user-friendly interface. Navigation links are essential for guiding users to different sections of the web application, such as registration, sign in, and other features, ensuring a seamless experience.
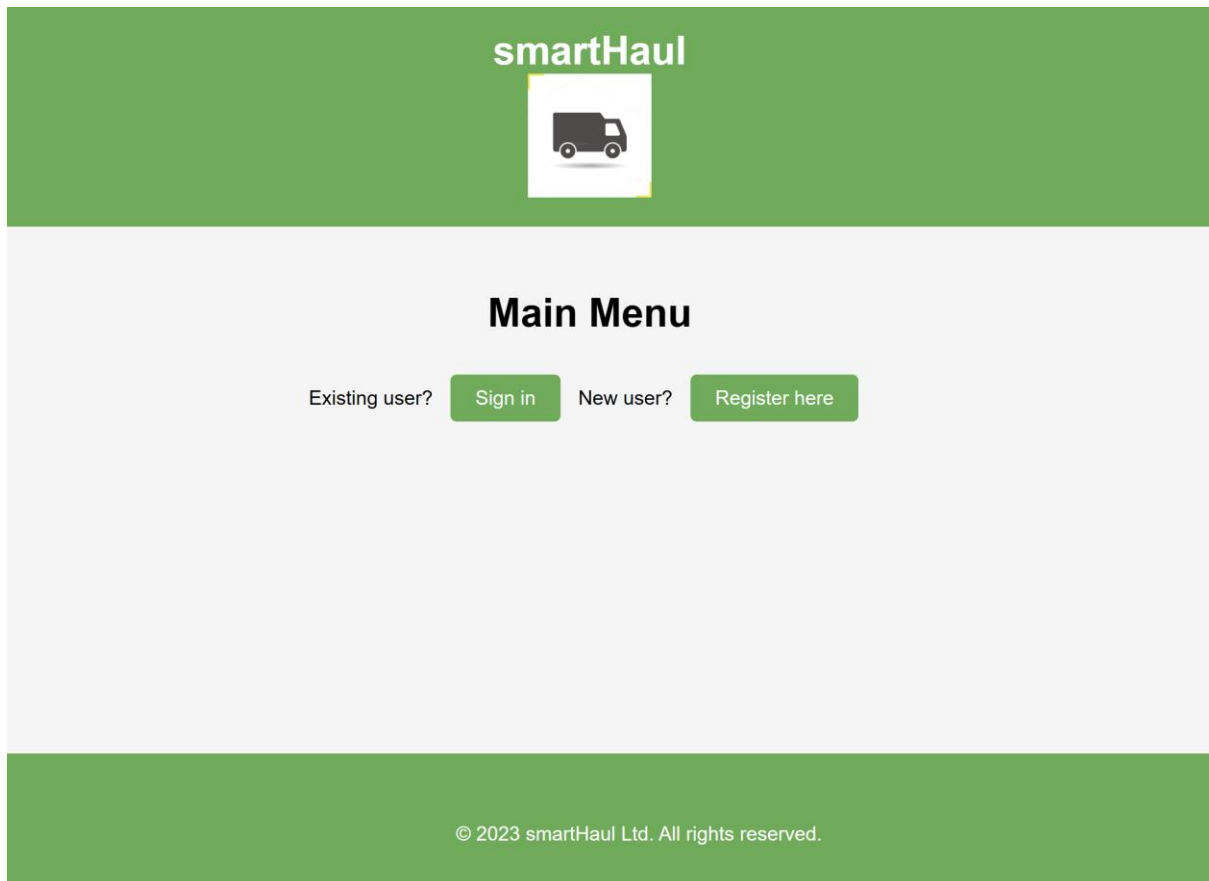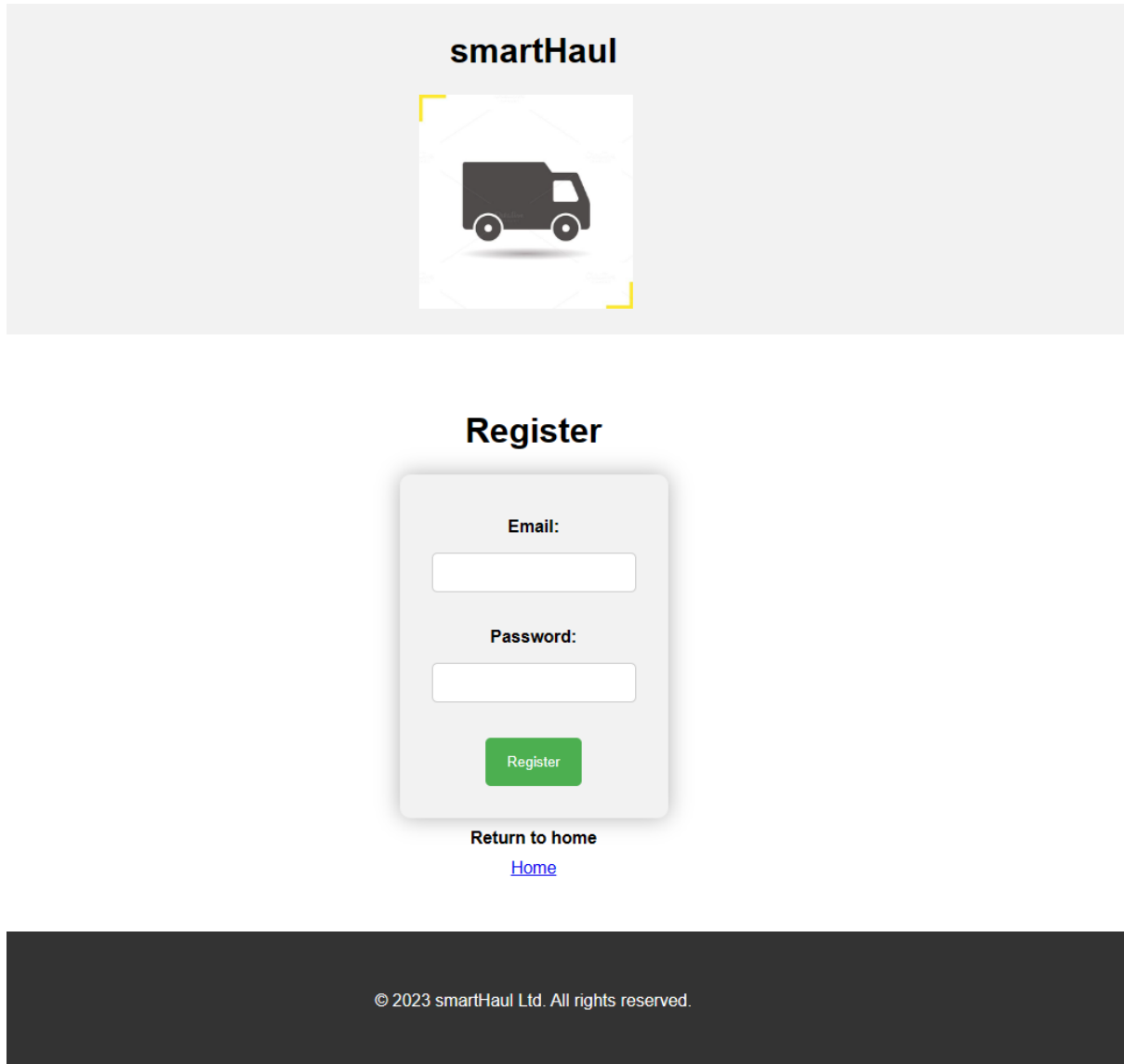

Figure 3.1 web application home page

User Registration

A user registration feature allows new users to create an account within the web application. By entering their email and password, users can securely establish their credentials, which will be used for future access and to associate their journey data with their account.
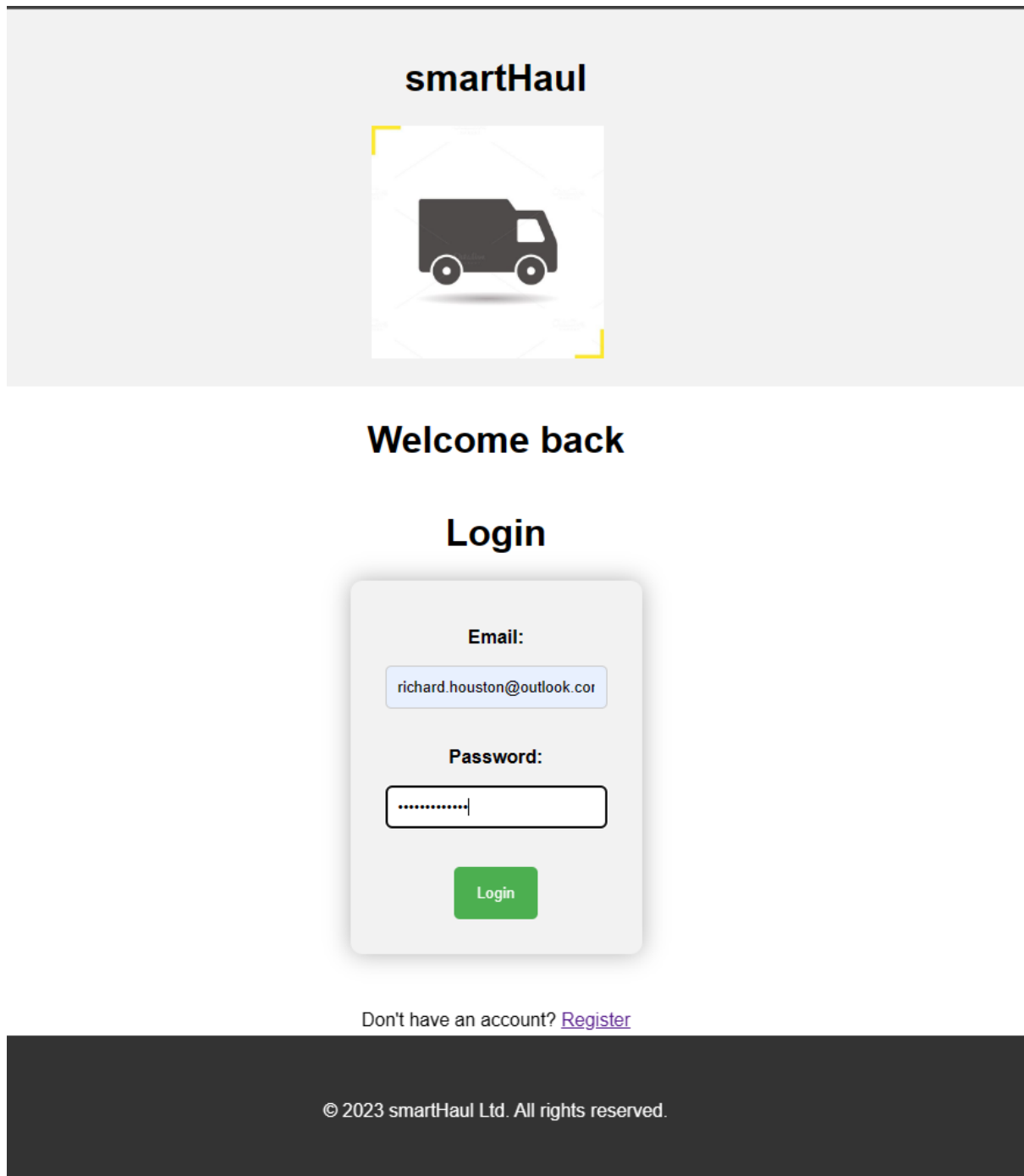
Figure 3.2 web application registration page

User Sign In

The user sign-in feature enables registered users to securely access their accounts using their email and password credentials. This authentication process ensures that only authorized users can access and manage their journey data, contributing to a secure and personalized user experience.

Figure 3.3 web application sign in page

Implementation of mapping API

Integrating the MapBox Directions API into the web application allows users to access detailed route information and navigation instructions for their journeys. By leveraging this API, the application can provide valuable insights into factors such as distance, travel time, and route efficiency, enabling users to make data-driven decisions for fleet management and resource allocation.
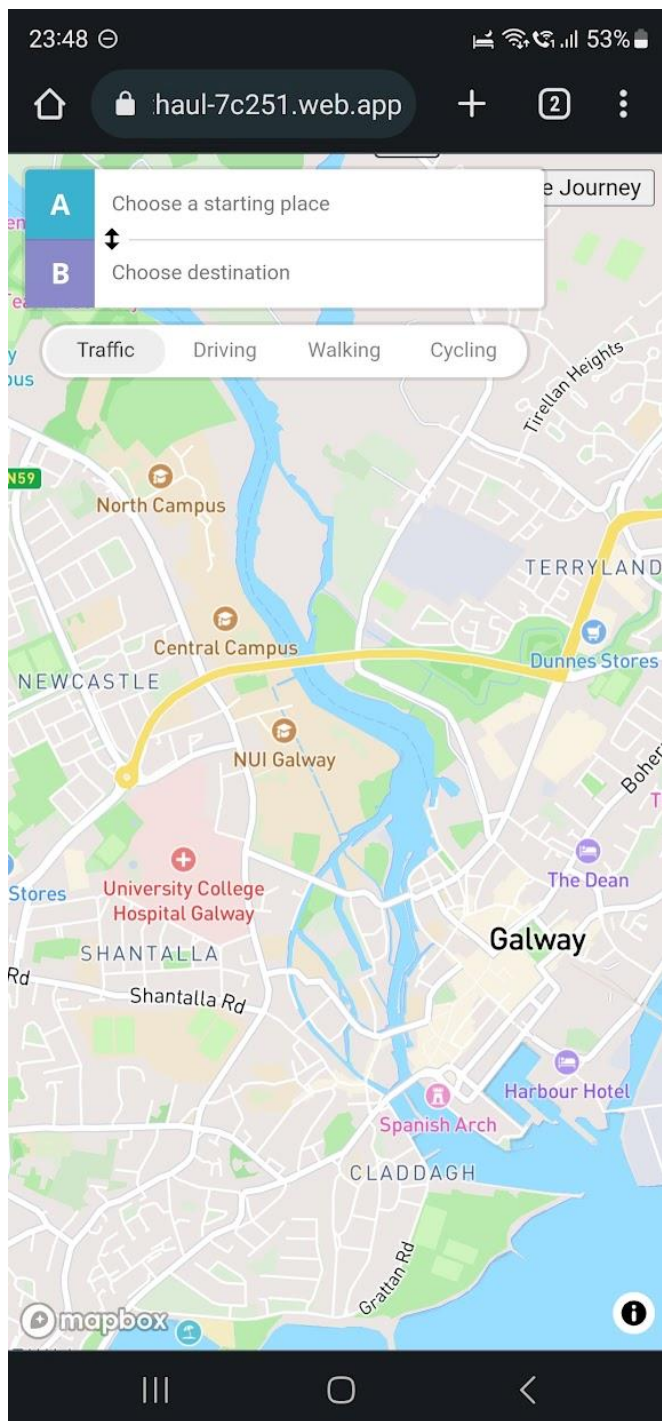
Figure 3.4 web application map

Mobile view
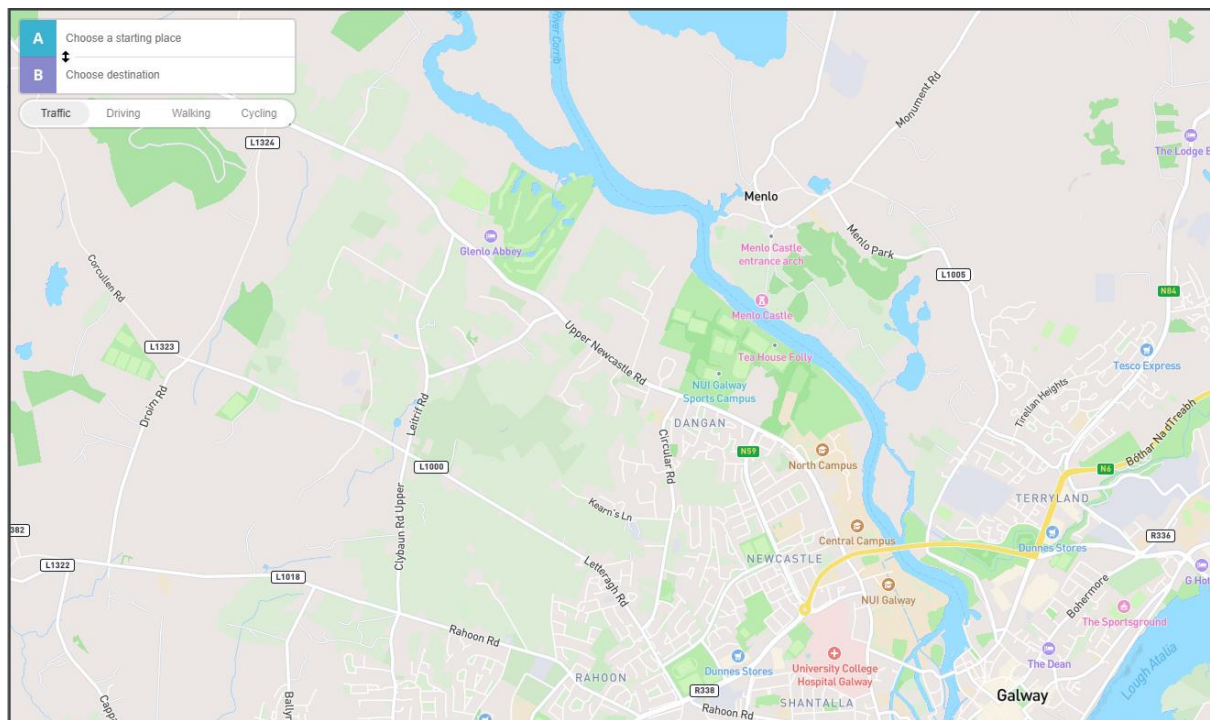
Figure 3.5 web application map (PC view)
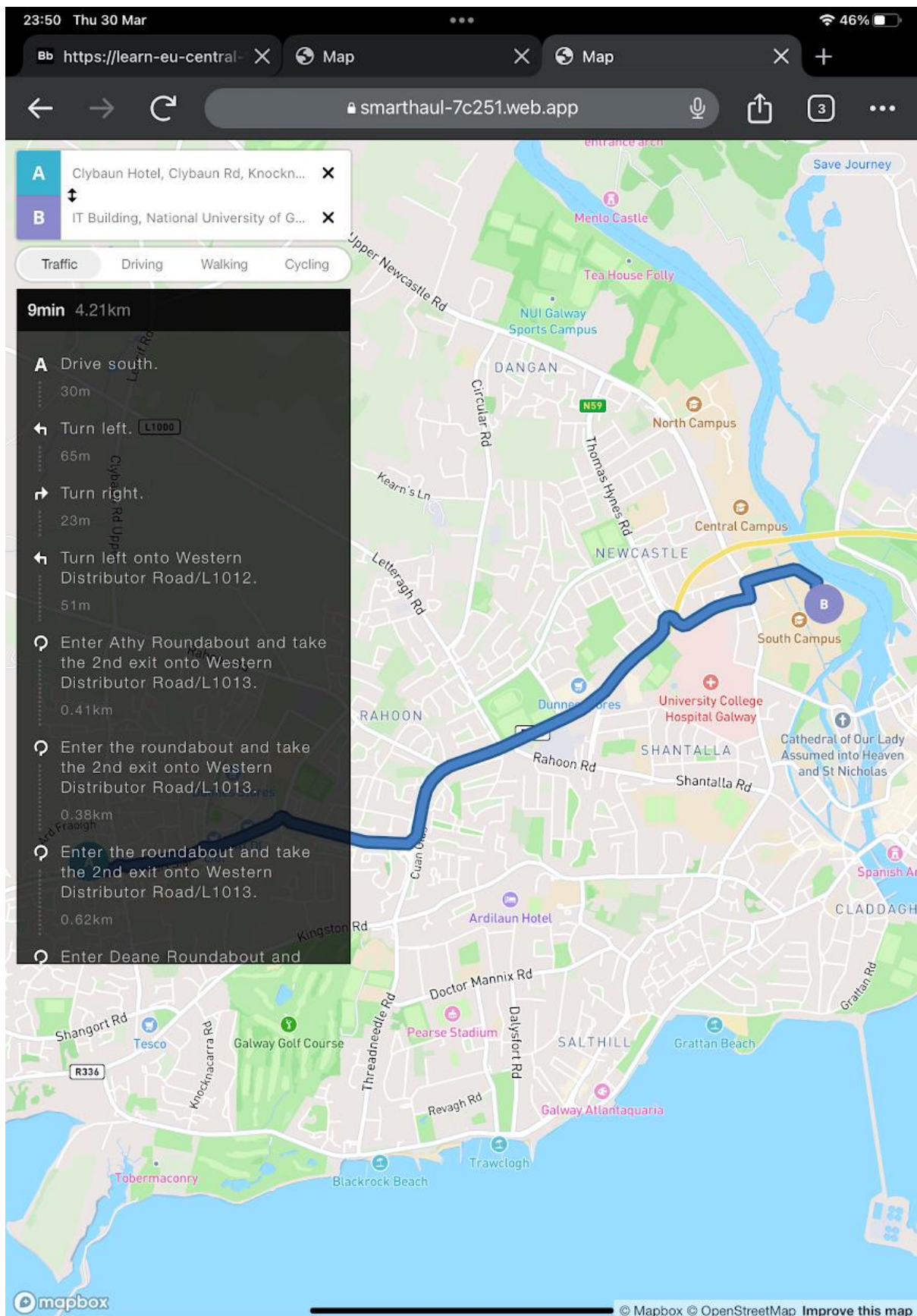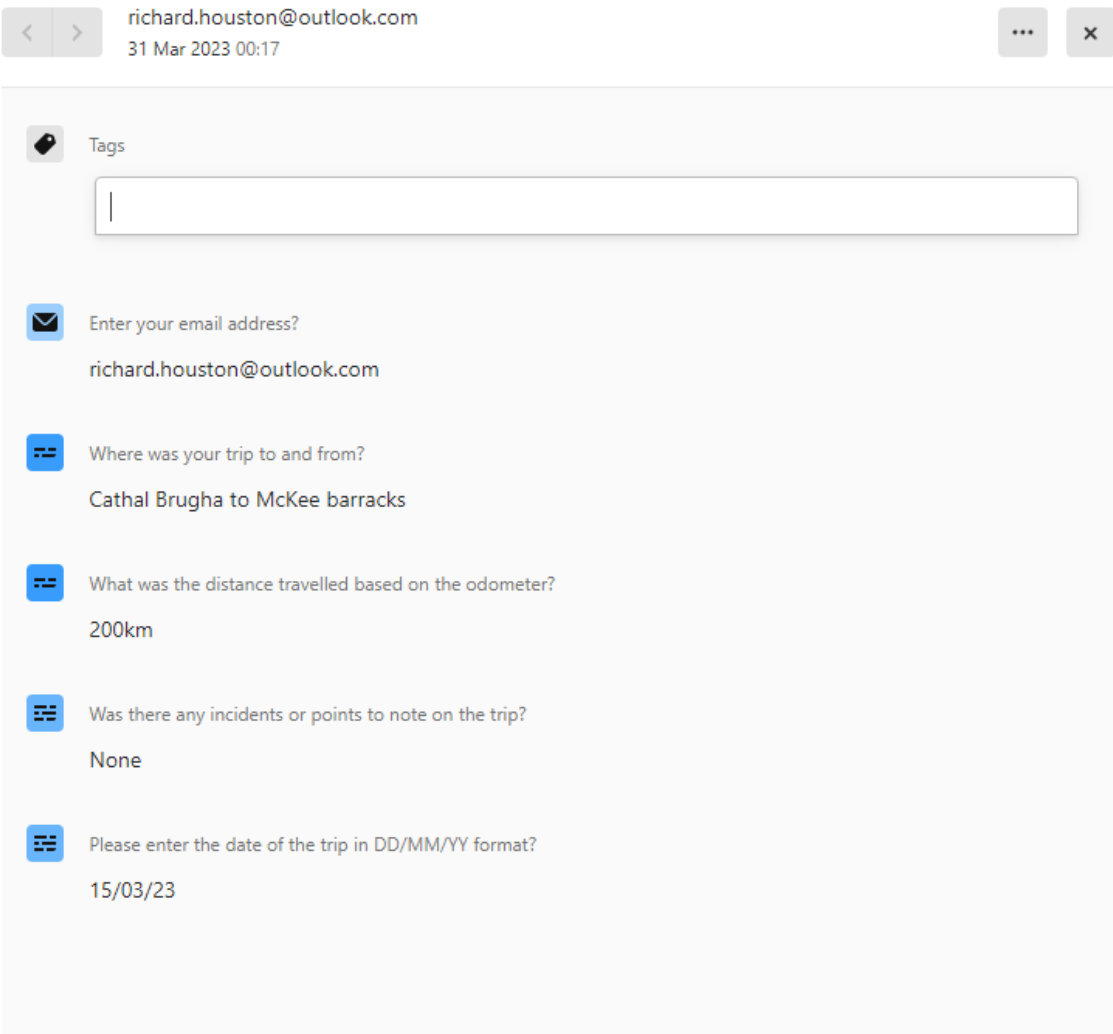
Figure 3.6 web application map with directions (ipad view)

Data Redundancy via Typeform Survey and Insights

Incorporating a Typeform survey into the web application serves as an additional method for collecting user feedback and journey data. This redundancy ensures that valuable information is not lost due to technical issues or user errors. The gathered data can then be analysed to gain insights into user preferences, needs, and pain points, which can be used to further improve and optimize the application's features and user experience.

Figure 3.7 Typeform survey overview

Figure 3.8 Typeform survey results storage

Figure 3.9 survey question 1

Figure 3.10 survey question 2

3 → What was the distance travelled based on the odometer?

200km

OK ✓   press Enter ↵

Figure 3.1 survey question 3

4 → Was there any incidents or points to note on the trip?

Any comments, feedback or suggestions are welcome!

Flat tyre in Athlone

Shift ⇧ + Enter ↵ to make a line break

OK ✓   press Enter ↵

Figure 3.12 survey question 4

5 → Please enter the date of the trip in DD/MM/YY format?

Any comments, feedback or suggestions are welcome!

15/03/23

Shift ⇧ + Enter ↵ to make a line break

Submit   press Ctrl + Enter ↵

Never submit passwords! - Report abuse

Figure 3.13 survey question 5

6 → Please enter the make and model of your vehicle

Any comments, feedback or suggestions are welcome!

Toyota Land Cruiser

Shift ⇧ + Enter ↵ to make a line break

OK ✓   press Enter ↵

Figure 3.14 survey question 6

7 → Please enter the registration of your vehicle

Any comments, feedback or suggestions are welcome!

16-D-27666

Shift ⇧ + Enter ↵ to make a line break

Submit   press Ctrl + Enter ↵

Never submit passwords! - Report abuse

Figure 3.15 survey question 7

Database storage
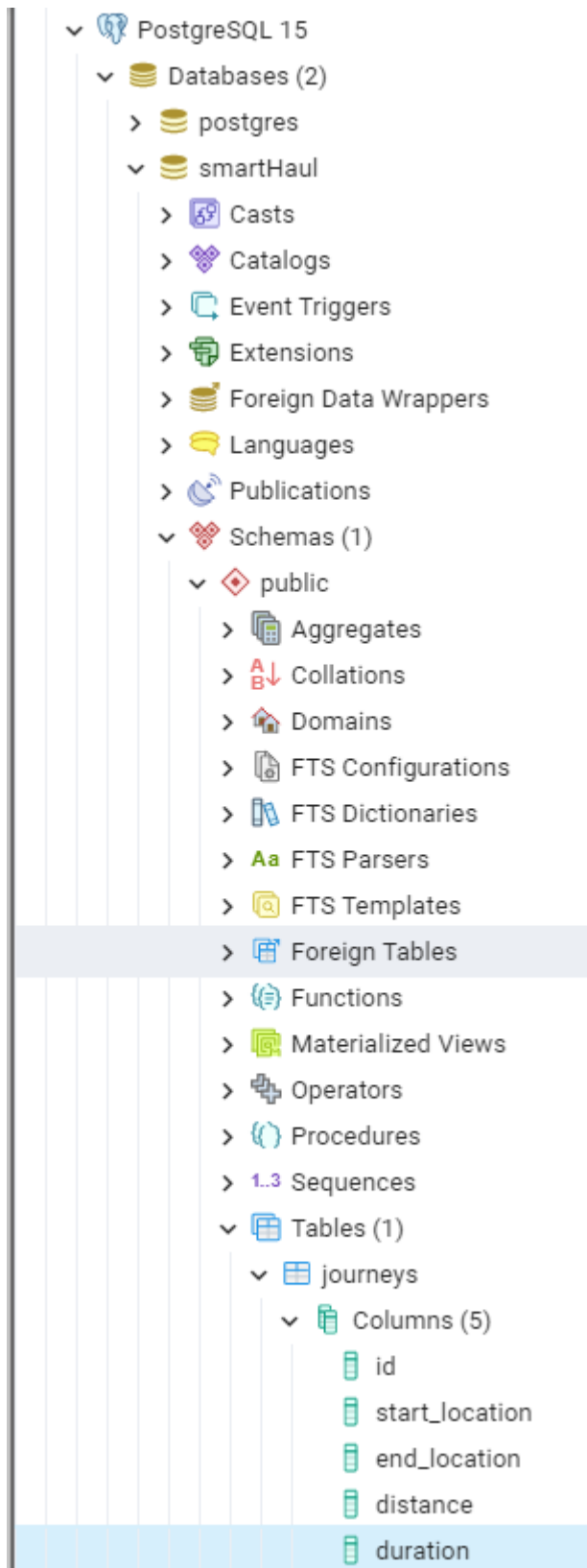
Figure 3.16 PostgreSQL server on pgAdmin 4 GUI

Figure 3.17 details persisted to database from web application

3.3   Non-Functional Requirements

- Simplicity
- Reliability
- Security

Simplicity
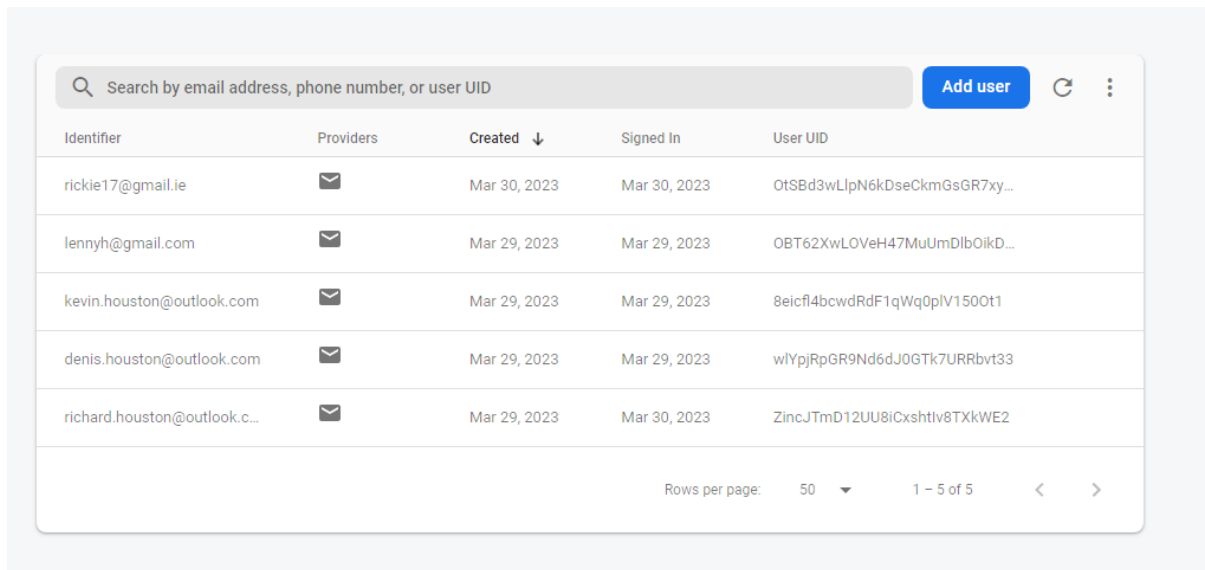
As a non-functional requirement, simplicity refers to an intuitive and user-friendly design of the web applications that allows users to easily navigate and interact with it. By focusing on simplicity, the application can cater to a wide range of users with varying technical expertise, minimizing the learning curve and maximizing user satisfaction and engagement.

Reliability

Reliability is a crucial non-functional requirement that emphasizes the consistency and dependability of the application in providing accurate and up-to-date information. A reliable application builds user trust and loyalty by minimizing errors, ensuring smooth integration of external APIs, and enabling efficient data storage and retrieval.

Security

Security is an essential non-functional requirement that focuses on protecting user data and ensuring the privacy and integrity of the application. This involves implementing strong authentication mechanisms through Firebase verification and authentication service to safeguard sensitive user information and prevent unauthorized access or data breaches. User passwords are not stored shown Firebase authentication table should the firebase console of the company be breached.

Figure 3.18 Firebase authentication storage

3.4   Use case

Use cases describing how the functional requirements would be encountered by a user

Use Case #1

Goal: Person wants to register.

Actor: Brand new employee

Steps:

1   Enter URL: https://smarthaul-7c251.web.app
2   Click 'Register here'
3   Enter email and password and click 'Register'
4   Check browser pop up to see whether registration was successful
5   Click return to home hyperlink.

Use Case #2

Goal: Person wants to sign in and log journey.

Actor: Existing registered employee

Steps:

1   Enter URL: https://smarthaul-7c251.web.app
2   Click 'Sign In'
3   Enter email and password and click 'Login'

4 Check browser pop up to see whether login was successful
5 Choose starting place and destination
6 Save journey
7 Complete Typeform

4.1 Introduction

In this web application project, there are several technical issues to consider during the development process, ranging from user authentication to the display and interaction with the map. Data storage and management. Display of database and utility of data for non-technical individuals via Metabase. Here is a description of the key technical aspects and specific challenges faced.

4.2 Project technologies

User Registration and Sign In

One of the first technical issues is implementing a secure and reliable user registration and authentication system which in this case was Firebase authentication. This involves setting up a database to store user credentials, implementing user input validation, and integrating a secure password hashing algorithm. Ensuring that the authentication system is robust and secure is essential to protect user data and prevent unauthorized access to the application.

Frontend Development

Another technical aspect is the development of the user interface (UI) for the application. This includes designing an intuitive layout, creating navigation elements, confirmatory transitions and function on various devices as shown earlier.

Website Hosting

Website hosting through Firebase is a technical aspect of web development that offered us a streamlined and scalable solution for deploying web applications. Firebase, a Google-backed platform, provides an array of tools and services tailored to simplify web and mobile app development.

Firebase Hosting, specifically, is a fast and secure web hosting service that caters to static and dynamic web applications. It simplifies the hosting process by allowing developers to deploy their websites with a single command, automatically handling the configuration of SSL certificates and providing a global Content Delivery Network (CDN) to ensure optimal performance and low latency.

Moreover, Firebase Hosting integrates seamlessly with other Firebase services, such as Firestore and Authentication which allowed us to combine together functionality into a predominantly one provider ecosystem notwithstanding the reasons listed previously for not implementing a Google maps API.

Map Integration and Display

One of the core features of the application is the integration and display of an interactive map. This involves using a mapping library or service, such as MapBox to render the map on the frontend. The map is responsive, allowing users to zoom, pan, and interact with the map elements. Additionally, the application needs to handle retrieving and displaying location data such as the start and end location, the route between the points, journey distance and journey duration.

Journey Data Storage and Retrieval

The application stores and retrieves journey data i.e. start location, destination location, distance between these points and how long it took. This involves setting up a database which is PostgreSQL in this case to store the journey data and creating an API to facilitate communication between the frontend and the backend. The API handles the storage and retrieval of journey data in a secure and efficient manner.

Backend Development

The backend development involved creating a server-side application to handle user authentication, data storage, and API requests. This required using a server-side programming language Javascript in this case and a web framework which was Express.js to develop a scalable and maintainable backend.

Data useability

Data usability is a crucial technical aspect of any project, as it ensures that the information gathered and stored can be effectively accessed, analysed, and utilized for informed decision-making. In this project, connecting Metabase to our PostgreSQL server enhances data usability in several ways:

1. Simplified data exploration

Metabase provides a user-friendly interface that allows non-technical users to explore and analyse the data stored in the PostgreSQL server. By offering a simple yet powerful way to access and work with data, Metabase empowers users to gain valuable insights without the need for in-depth technical knowledge or database expertise.

2. Visualizations and dashboards

 Metabase offers a variety of visualization types and dashboard functionalities, enabling users to create clear, engaging, and interactive visual representations of the data. These visualizations make it easier for users to understand complex data patterns, trends, and relationships, leading to more informed decision-making.

4.3   Testing/Debugging

Throughout the course of this project I have made use of many resources in order to tackle software issues and enable functionality. From parsing information provided by the debugger in Visual Studio Code which was my primary IDE I was able to extract key issues which could then be Googled or searched on popular boards sites like StackOverflow where there is a wealth of information.

ChatGPT a relatively new resource also proved extremely helpful in providing practical advice when facets of the project failed or would not work. When attempting to deploy the web application to Firebase ChatGPT proved extremely useful when YouTube videos failed clarify how something relatively straightforward should be done. There is a plethora of other functionality out there which aims to help developers such as Github actions which is a continuous integration tool that is offered when integrating Firebase but can cause issues with deployment if not implemented correctly.

Postman API is very worthwhile tool which I used to test my Typeform survey return. Using my survey URL and unique key I was able to test return the results of my survey in JSON form. It would be further possible to convert the JSON to Java objects before parsing them and persisting to our PostgreSQL database.
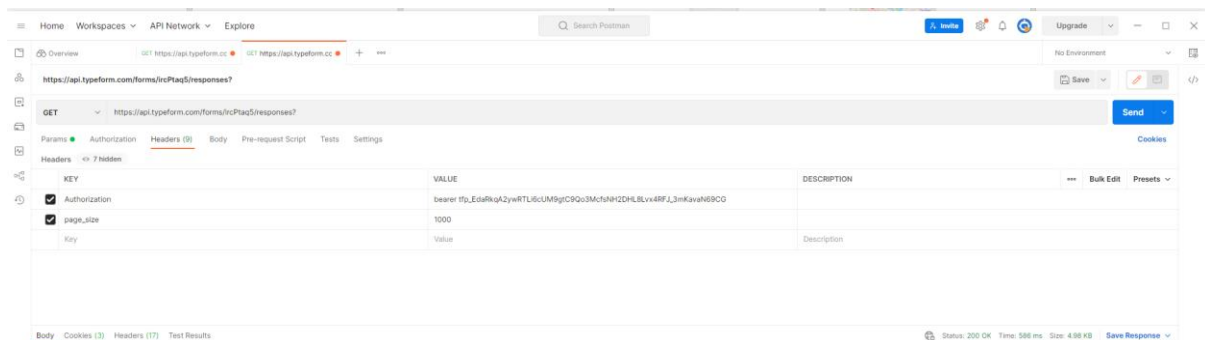
Figure 4.1 Postman API tool

Pretty   Raw   Preview   Visualize   JSON ▾   ⇥

```
  9          "landed_at": "2023-04-01T15:34:26Z",
 10          "submitted_at": "2023-04-01T15:35:08Z",
 11          "metadata": {
 12              "user_agent": "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/111.0.0.0 Safari/537.36",
 13              "platform": "other",
 14              "referer": "https://t8dp4hspnaj.typeform.com/to/ircPtaq5",
 15              "network_id": "97abc42a9b",
 16              "browser": "default"
 17          },
 18          "hidden": {},
 19          "calculated": {
 20              "score": 0
 21          },
 22          "answers": [
 23              {
 24                  "field": {
 25                      "id": "IhvDpc8xKRnL",
 26                      "ref": "ccbeaae1-1857-4078-9114-6f850bf06449",
 27                      "type": "email"
 28                  },
 29                  "type": "email",
 30                  "email": "rickie.bobbie@gmail.ie"
 31              },
 32              {
 33                  "field": {
 34                      "id": "2weBMlhq2jmt",
 35                      "ref": "cb2c8ce4-15a6-4fc4-8bed-6bf0147ff0ea",
 36                      "type": "short_text"
 37                  },
 38                  "type": "text",
 39                  "text": "Custume Barracks to McKee Barracks"
 40              },
 41              {
 42                  "field": {
 43                      "id": "ukkDobYn06lW",
 44                      "ref": "876e8d34-59a4-4365-8e24-4bc1d58a76ad",
 45                      "type": "short_text"
 46                  },
 47                  "type": "text",
 48                  "text": "120km"
 49              },
 50              {
 51                  "field": {
 52                      "id": "prZqxkgrentI",
 53                      "ref": "fe9eabc6-099f-4b4d-bf3b-fda52497fc0d",
 54                      "type": "long_text"
 55                  },
 56                  "type": "text",
 57                  "text": "None"
 58              },
 59              {
 60                  "field": {
 61                      "id": "QJAQMZwUnIqY",
 62                      "ref": "e8679aad-d162-417b-b35c-a21561e8fe04",
 63                      "type": "long_text"
 64                  },
 65                  "type": "text",
```

Online   🔍 Find and Replace   ▣ Console

Figure 4.2 Survey data returned in JSON form

4.4 Technical challenges

Firebase Hosting

During the implementation of Firebase for this project, several challenges were encountered. One of the primary issues was understanding and navigating the documentation to set up and configure Firebase correctly. This required a steep learning curve, as Firebase offers a wide range of services and has its own unique structure and conventions. Additionally, integrating Firebase authentication and database services with the existing web application proved to be more complex than anticipated, resulting in unexpected compatibility issues. Overall, implementing Firebase for the project demanded more time and effort to overcome these challenges than planned for and thus held up progress on other parts of the application.

Parsing GeoJSON

Differentiating between various types of road usage, such as motorways and regional roads, will allow for more precise route planning and optimization was initially a functionality I was looking to implement but parsing GeoJSON itself proved to be quite detail heavy and as result very difficult when attempting to parse out the information. Working with Mapbox's API and handling the intricacies of GeoJSON data necessitated the development of custom functions and logic to ensure accurate and reliable results. Given the time and resource constraints of the project, it was decided to prioritize other core functionalities that were essential for delivering a functional and effective application. This decision allowed for a more focused approach on building the fundamental features of the web application and ensured a more streamlined development process.

mySQL Corrupting

During the course of the project, I encountered difficulties in setting up and working with the mySQL server. It came above the I had to clear program data in order to retrieve the root password for the server. When I tried to reinstall all of the mySQL functionality I found that mySQL had become corrupted and despite hours of searching and many attempts to remedy the situation it was to no avail. These issues posed a potential risk to the progress of the project, and it became necessary to find an alternative solution to avoid falling behind schedule. As a result, I swiftly transitioned to using PostgreSQL and this change allowed me to achieve the same desired results without being hindered by the initial technical obstacles associated with mySQL. The adaptability and quick decision-making involved in this switch were crucial to maintaining the project's momentum and ensuring its successful completion

5.1 Deliverables

The deliverables as set out in the final year project were as follows:

• Project Definition Document 5th November 2022

• Final Project Report - Due on: 1st April 2023

• Project Demonstration and Viva Voce: 6th April 2023

5.2 Context

The final year project was challenging but worthwhile piece of work. The scope of the project can be as broad or as narrow as you allow it to be. Final year of computer science is a time where freedom to work on your project is not easy to find amongst regular studies, assignments and outside commitments and sporting activities. I had envisioned implementing more business specific functionality as the outset of the project definition document related to miles per gallon calculations based upon on a certain vehicle models but again as above the it can then develop further questions like what effect does the load factor have on fuel efficiency and the list goes on. I can say I have implemented the functionality as specified in the project definition document as envisioned and which guided me.

5.3 Future work and Improvements

There is four key areas I would like to develop further if given more time:

1 Vehicle fuel efficiency and cost calculations:
   By incorporating fuel efficiency and cost calculations into the web application database or Metabase dashboard, users will be able to monitor and manage their fleet's fuel consumption more effectively. This feature will enable fleet managers to estimate fuel costs based on distance travelled, fuel prices, and vehicle efficiency, ultimately helping them make more informed decisions about route optimization and vehicle maintenance to minimize operating costs and reduce their environmental footprint.

2 Categorizing road usage:
   Differentiating between various types of road usage, such as motorways and regional roads, will allow for more precise route planning and optimization. By taking into account factors like road conditions, speed limits, amongst other factors business can tailor their fleet to their predominant routes. For example a company operating all around the country will more than likely be travelling on motorways for the majority of the time. The data and business logic would point to a diesel engine vehicle being more cost effective option than a petrol or hybrid which are more suited for urban areas and shorter distance trips

3   Incorporating vehicle load factors:
    The web application will consider vehicle load factors, including cargo weight and volume, when suggesting optimal routes and vehicle assignments. By doing so, the app will help fleet managers balance load distribution among vehicles, ensuring that each vehicle is used to its maximum capacity without overloading. This feature will contribute to better fleet utilization, reduced operating costs, and minimized wear on vehicles.

4   Real-time fleet tracking using GPS technology: Integrating GPS-based fleet tracking into the app will provide fleet managers with real-time location information for their vehicles. This feature will enable more efficient coordination and management of the fleet, as well as improved response times in case of emergencies or unforeseen events. By having access to accurate, up-to-date location data, fleet managers can make more informed decisions on routing and resource allocation, leading to overall improvements in fleet performance and customer satisfaction.

5.4   Lessons learnt

Making software interact is difficult

Throughout the course of this project, it became clear that making various software components interact effectively and seamlessly is a complex task. Dealing with different technologies, APIs, and data formats requires a deep understanding of the systems involved and the ability to adapt to their quirks and limitations. This experience highlighted the importance of thorough research, testing, and documentation to ensure smooth integration and operation of interconnected software components.

Project Management is essential

The project highlighted the importance of effective project management, especially when working individually. Without the support of a team, it becomes even more crucial to plan, set goals, and allocate resources efficiently. Time management and prioritizing tasks are essential skills to ensure that the project progresses smoothly and deadlines are met. When working alone, it is necessary to be proactive in seeking feedback, maintaining a clear vision of the project, and staying organized to avoid potential pitfalls.

Working in multi-disciplinary teams is better in my opinion

This final year project emphasized the difficulties of working individually compared to the efficiency of working in multi-disciplinary teams. When working alone, the lack of diverse skills and expertise can hinder problem-solving and slow down the development process. The absence of a team also means that the responsibility of tackling every aspect of the project falls on a single person, which can be both mentally and physically draining. The experience highlighted the importance of collaboration and the value of diverse perspectives when addressing complex challenges, underscoring the benefits of working in multi-disciplinary teams.

Appendix

Links:

GitHub Repository: https://github.com/Richie1279/FYP

App: https://smarthaul-7c251.web.app

Survey: https://t8dp4hspnaj.typeform.com/to/ircPtaq5

References:

Communications and Information Services Corps CIS Corps - Defence Forces. Available at: https://www.military.ie/en/who-we-are/army/army-corps/cis-corps/ (Accessed: March 4, 2023).

Government announces sectoral emissions ceilings, setting Ireland on a pathway to turn the tide on Climate Change (no date) *Search for services or information*. Department of the Taoiseach . Available at: https://www.gov.ie/en/press-release/dab6d-government-announces-sectoral-emissions-ceilings-setting-ireland-on-a-pathway-to-turn-the-tide-on-climate-change/ (Accessed: March 10, 2023).

Solutions for fleet (no date) *Fleetio*. Available at: https://www.fleetio.com/industries (Accessed: March 7, 2023).

MapBox Documentation (no date) *Mapbox*. Available at: https://docs.mapbox.com/#navigation (Accessed: March 20, 2023).