Project Specification

PORTFOLIO TASK 2

Unit code: COS40005
Unit Name: Computing Technology Project A
Submission date: 30th August at 23:59pm
(Extended to 01/09/2024 23:59pm)

Student Name	Student Id	Statement of contribution to the report
Corey Santarossa	103389809	Problem Statement, Documentation, Functional Requirements, Communication Interface, Critical Reflection, Slide Deck, Flowchart, Prototype, Wireframes.
Marco Giacoppo	104071453	High level description, Scope, Acceptance criteria
Levin Fubex	103534612	Requirement Specification, Non-Functional Requirements, User Interface
Vivek Saini	103828056	Product Feature, User interface
Nick Wijaya	104066763	System Requirements, System In Context, User Experience Description, Software Interface
Rupayan Banerjee	103538229	Scope, User Interface, Application Wireframe Design

ACKNOWLEDGMENT OF COUNTRY

We respectfully acknowledge the Wurundjeri People of the Kulin Nation, who are the Traditional Owners of the land on which Swinburne's Australian campuses are in Melbourne's east and outer-east, and pay our respects to their elders' past, present, and emerging.

Each team member identifies:

the Traditional Owners of the land they lived on while completing this work.

1. PROBLEM STATEMENT

There are three core problems this project aims to solve:

- **Environmental Impact Awareness**: Companies lack tools to accurately estimate transportation emissions, hindering their ability to reduce their carbon footprint and make informed, eco-friendly decisions.
- **Regulatory Compliance**: Businesses struggle to accurately calculate emissions for regulatory reporting, risking non-compliance and penalties without a reliable tool for precise emissions tracking.
- **Cost Efficiency in Logistics**: Logistics companies need accurate distance-based emissions data to optimise routes, reduce fuel costs, and minimise environmental impact, but lack efficient tools to achieve this.

2. SCOPE

In-scope

The project aims to develop a software application that serves as a decision-support tool for comparing Greenhouse Gas (GHG) emissions between rail and road freight options within Australia. The application will be designed as either a mobile app or a web-based platform, providing users with an easy-to-navigate interface to input various parameters and receive emissions estimates for different freight options. The key functionalities and features of the tool will include:

1. **Input Parameters:**

   - Users will be able to input key parameters such as container size, product volume, weight, and specified routes. The application will provide various predefined options for container sizes (e.g., 20-foot, 40-foot containers), along with the ability to specify custom volumes and weights, allowing flexibility for different types of freight.

- The tool will also offer a route selection feature, allowing users to specify starting and ending points for their freight journeys. Only domestic routes within Australia will be supported, with the application providing a list of major cities, ports, and freight hubs to select from.

2. **GHG Emissions Calculation:**

- The application will incorporate algorithms and emissions factor databases that provide accurate estimations of GHG emissions for both rail and road freight options. The calculations will consider factors such as distance, freight weight, and the specific characteristics of the chosen route. Rail emissions will be calculated based on standard emissions factors per tonne-kilometre for rail freight, while road emissions will consider variables like fuel type, vehicle efficiency, and road gradients.
- The results will be displayed in a user-friendly format, showing comparative data between the two modes of transport (rail vs. road). Visual aids such as graphs, charts, or infographics will be employed to help users easily understand the differences in emissions for their selected freight scenario.

3. **User Interface and Experience:**

- The application will be designed with a focus on user experience, providing a clean, intuitive interface that simplifies the process of inputting data and interpreting results. Features like drop-down menus, auto complete for common routes, and tooltips for parameter explanations will be included to enhance usability.
- The tool will also provide an export feature, allowing users to save or print their emissions comparison reports for future reference or for sharing with stakeholders.

4. **Geographical Focus:**

- The application will focus exclusively on domestic freight routes within Australia. This scope ensures that the tool is tailored to the specific regulatory environment, geographical conditions, and logistics networks present in the Australian context. This also allows for more accurate emissions factors and assumptions, contributing to more reliable and relevant outputs for Australian businesses and policymakers.

Out-of-scope

While the application will provide a comprehensive tool for comparing GHG emissions for freight options in Australia, several features and functionalities are outside the scope of this project:

1. **Real-Time Data Integration:**

- The application will not incorporate real-time data such as live traffic conditions, rail schedules, or weather updates that could affect freight emissions. Instead, it will rely on static, historical data and standardized emissions factors to provide estimates.

2. **Cost Analysis:**

   - The scope does not include the integration of cost analysis for freight options. While emissions data can be a valuable input for cost-benefit analysis, users will need to perform any financial calculations externally, as this tool focuses solely on environmental impact.

3. **International Freight Routes:**

   - The application will not support calculations for international routes or cross-border logistics. Its focus will remain on domestic routes within Australia, ensuring a specialized and detailed approach to emissions calculations in this specific geographic context.

4. **Advanced Route Optimization:**

   - The tool will not feature advanced optimization algorithms for route planning or freight consolidation strategies that consider both cost and emissions. It will provide direct comparisons based on user-selected routes without suggesting alternative routes or logistical arrangements.

5. **Regulatory Compliance and Reporting:**

   - The application will not be designed for generating compliance reports for government regulations or industry standards. It will serve primarily as an informative tool rather than a compliance or auditing solution.

By defining these boundaries, the project can remain focused on delivering a robust and user-friendly tool that provides accurate GHG emissions comparisons for rail versus road freight within Australia.

3. STAKEHOLDER

Stakeholder / Client: Bruce Organ

Additional Personnel

Supervisor: Harsharan Kaur

Project Team: Corey Santarossa, Marco Giacoppo, Vivek Saini, Rupayan Banerjee, Nick Wijaya, Levin Fubex.

4. HIGH-LEVEL DESCRIPTION

The Greenhouse Gas (GHG) Carbon Emissions Calculator for Rail vs. Road is a new tool, designed to operate independently as a full system, created with the ability to calculate the differences in carbon emissions between potential freight transport options available in Australia.

Overall, this software is meant to display a clear difference in the emission of greenhouse gas by road transport and rail transport. In this tool, we can entry some information like product in volume and weight, size of the container and other information about the origin and destination of the freight.

This system is particularly beneficial for logistics companies, environmental consultants, and policymakers who need to assess and reduce the carbon footprint of freight transport. It is also designed to be a prototype that could be expanded into a more comprehensive tool, potentially integrating real-time data or cost analysis in future iterations.

4.1 PRODUCT FEATURE

The GHG Carbon Emissions Calculator is designed to help logistics companies, environmental consultants, and policymakers compare the carbon footprint of rail versus road freight transport. The tool provides detailed, side-by-side emissions data to facilitate better decision-making. Below are the key features of the product:

User-Friendly Input Interface:

- Users can input various freight details, including weight, origin-destination routes, or manually input the total kilometers to travel.
- Easy-to-use form fields and dropdown menus simplify the input process, making the tool accessible to users with varying levels of digital literacy.

Accurate Emission Calculations:

- We have developed a formula to compute the gas emissions for both rail and road transport based on user inputs.
- It factors in distance, weight, and type of transportation to provide precise emission estimates.

Data Visualization:

- Visual representations, such as graphs and charts, provide a clear understanding of the emissions data, helping users to interpret results more effectively.
- Customizable visual outputs enhance user experience and engagement.

Scalability and Performance:

- The system is designed to handle multiple users simultaneously without compromising performance.
- It ensures quick response times, providing emissions results almost instantly, enhancing user satisfaction.

Secure Data Handling:

- User data, including input information and calculation history, is securely stored and managed following best practices.
- All communication between the frontend and backend is encrypted to ensure privacy and security.

4.2 SYSTEM REQUIREMENTS

It is recommended that Google Chrome on the latest version is used as a web browser to open and access all the features of the Calculator application. A good and stable internet connection is also required to effectively use all the components such as saving recent calculations and usage of distance calculation API.

4.3 ACCEPTANCE CRITERIA

Functional Acceptance Criteria:

1. **Accurate Calculations:**
   - The tool must correctly calculate GHG emissions for rail and road transport based on user inputs, using verified data or formula.
   - Emissions are calculated considering the distance and weight.

2. **User Interface:**
   - The interface should be intuitive, allowing users to input data easily and receive clear results.
   - Results must be displayed in a side-by-side format for easy comparison.

Performance Acceptance Criteria:

1. **Speed:**
   - The system must respond and display results as fast as possible.
   - The tool should work consistently across all major web browsers.
2. **Scalability:**
   - The system should handle multiple users simultaneously without significant delays or performance issues.

Non-Functional Acceptance Criteria:

1. **Accessibility:**
   - The tool must be accessible to all users, including those with disabilities, and work well on various devices (desktop, table, mobile).
2. **Security:**
   - User data must be protected with secure handling practices, and all communication between the frontend and backend should be encrypted.
3. **Reliability:**
   - The tool should be reliable with minimal downtime, and the database should be backed up regularly.

4.4 DOCUMENTATION

There will be two primary forms of documentation provided alongside this project, including:

- **User Documentation**: We will create user guides using confluence. These guides will cover the primary use cases of our application, and how the platform can be used to achieve these outcomes. This will also contain an error guide, explaining what the various errors mean and how to resolve each one.

- **Video Tutorials**: Video tutorials will also be made to showcase and demonstrate the platform in a simple 'follow-along' style. This will help introduce new users who are being onboarded to the application for the first time, giving a visual demonstration.

5. REQUIREMENT SPECIFICATION

[User Interface Design]

[UI-01] User Input Interface

Requirement statement: Calculator should be an easy-to-use interface for entering information such as distance, load, and emission factor

Rationale: With an easy-to-use interface, users can easily input data correctly which will result in accurate calculations.

Note: Think about using drop-down menus to reduce user input errors.

[UI-02] Result Display

Requirement statement: Result of calculator should be presented in an easy-to-understand format.

Rationale: Users can quickly interpret details of transport selection with support from clear result presentation.

Note: Graphs and charts are excellent visual tools to support result presentation.

[Functionality]

[FN-01] Consideration of Multi-Factor

Requirement statement: Calculator should consider multiple variables that affect greenhouse gas emissions such as distance, load, and emission factor.

Rationale: To provide a real scenario of the environmental impact, a detailed analysis must consider each variable that can affect GHG emissions.

Note: Ensure calculator is capable of visualizing various situations through a variety of input options.

[FN-02] Comparative Analysis

Requirement statement: Calculator should compare the greenhouse gas emissions of rail vs road, focusing on more environmentally friendly choice.

Rationale: To assist users in making well-informed decisions about their transportation options, a comparative analysis is required.

Note: Provide examples where pros and cons of road vs rail varies depending on circumstance.

[Data Accuracy and Integrity]

[DA-01] Source of Data

Requirement statement: Calculator must use emissions factor from reliable and current databases.

Rationale: Calculating emission(s) with authority promotes accuracy and credibility.

Note: Emission factor can be obtained from Environment Protection Authority. Data source should be updated periodically to consider new findings and legal requirements.

[DA-02] Sensitive to Changes

Requirement statement: Calculator must be sensitive to consider even tiny changes in one of the variables.

Rationale: Users can notice tiny changes which enhance decision-making.

Note: To make sure calculator have consistent sensitivity, test the calculator with different test cases.

[Performance]

[PF-01] Output Time

Requirement statement: Output should be displayed by calculator within two seconds of data input.

Rationale: Quick response from calculator enhances user engagement and satisfaction.

Note: Optimize server response time and algorithms.

[PF-02] Scalability

Requirement statement: Calculator must be able to accommodate many users at once without compromising performance issues.

Rationale: Scalability is crucial for public usage as number of users are increasing.

Note: Consider cloud-based solutions to ensure scalability.

[Accessibility and Compliance]

[AC-01] Multilingual Support

Requirement statement: Calculator must support different languages to appeal to worldwide users.

Rationale: Non-English users can use calculator more easily due to it's multilingual support.

Note: Sort languages according to user's demographics.

[AC-02] Accessibility Compliance

Requirement statement: Calculator must adhere to accessibility guidelines such as WCAG 2.1 to ensure users with disabilities can utilize it.

Rationale: Calculator is inclusive and accessible to wider range of users when it complies with accessibility guidelines.

Note: Integrate functions such as high contrast mode, keyboard navigation, and screen reader compatibility.

5.1 FUNCTIONAL REQUIREMENTS

Input Transportation Data

- **Actors:** User
- **Preconditions:** User must either be logged in or using the guest mode.
- **Flow**:
    - User enters the weight of the cargo to be transported.
    - User inputs the start and end location or manually inputs the total kilometres to travel.
    - If the user is logged in, they can save the calculation.

Calculate Emissions

- **Actors:** System
- **Preconditions:** The user has input all information and triggered the calculation.
- **Flow:**

- The system fetches the emission factors stored in the Postgres database.
- The system calculates the CO_2 emissions using the following formula: CO_2 = Emission Factor x Weight x Distance.
- The API endpoint returns the calculation.
- The frontend receives the data and presents it.

View and Compare the Emission Results

- **Actors:** User, System
- **Preconditions:** Emissions were calculated in the backend and returned to the frontend.
- **Flow:**
  - The frontend displays the results for both the road and the rail transport.
  - The frontend also displays the difference in emissions between the two modes.,
  - A graph is presented on the dashboard highlighting the differences visually.
  - If the user is logged in, they can save the calculation.

User Management

- **Actors:** User
- **Preconditions:** User has accessed the platform and is on the login/signup page.
- **Flow:**
  - User registers for an account or logs in.
  - User can set preferences such as custom emission factors or preferred unit measurements.
  - User can access saved calculations.
  - User information is encrypted and stored securely in the database.

Multi-Device Access

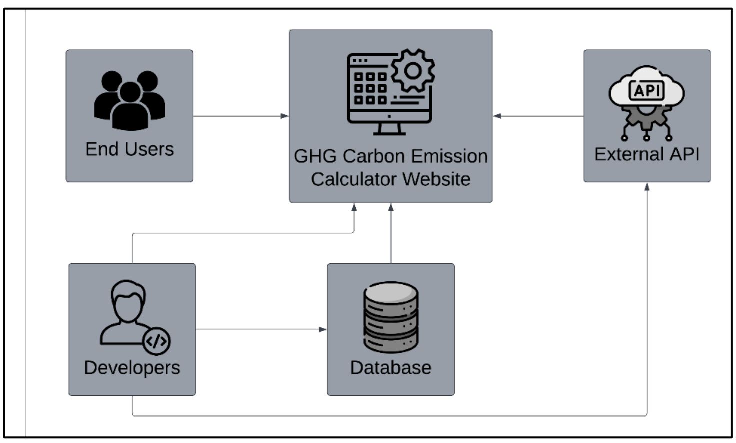
- **Actors**: User
- **Preconditions**: User can access the platform from any mainstream device (mobile, tablet, or desktop).
- **Flow**:
  - The frontend will adjust to the size of the screen depending on the screens dimensions (using media queries and tailwind CSS).

5.2 NON-FUNCTIONAL REQUIREMENTS

- **Accuracy**: There must be a maximum error margin of ±5% in calculating emission.
- **Usability**: Both technical and non-technical users must be considered through a friendly user interface and user experience
- **Performance**: After input is sent, the calculator must process it and produce the results within two seconds.
- **Security**: Utilise security protocols to protect user information such as data encryption.
- **Maintainability**: The software must be modular to enable simple modifications to emission factors and computation techniques.
- **Compatibility**: Calculator must work with common web browsers such as Chrome, Firefox, Safari, Edge.
- **Scalability**: High user traffic must not lead to bad performance.
- **Reliability** and Availability: Calculator must be accessible almost all the time with very little downtime.

5.3 INTERFACE REQUIREMENTS

5.3.1 SYSTEM IN CONTEXT



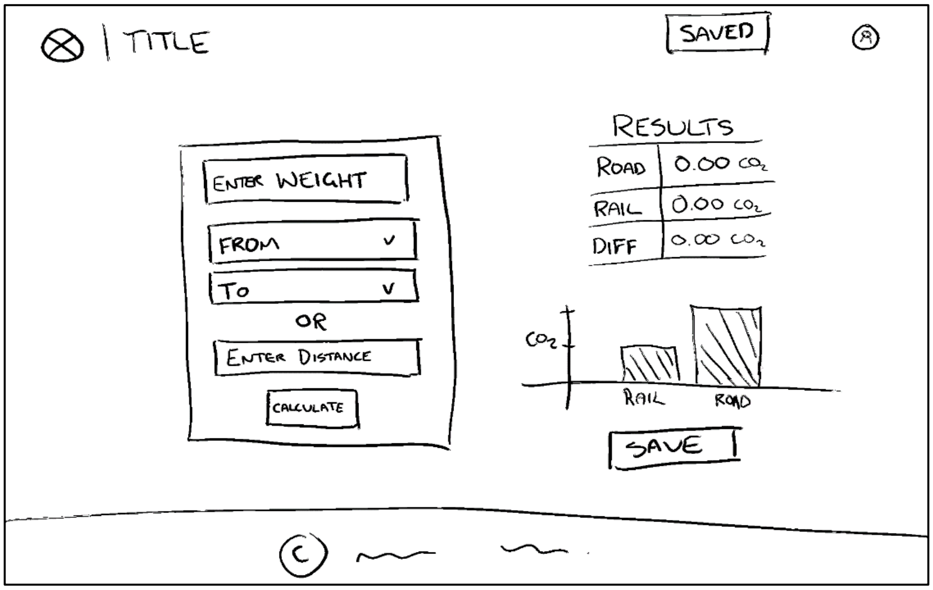
High Level Diagram of Interactions between Components of the Calculator App

Based on the high-level diagram shown, the interactions between one component of the system to another can be seen clearly with the Carbon Emission Calculator Website as the main component of the system. The following are some descriptions for each individual component of the system.

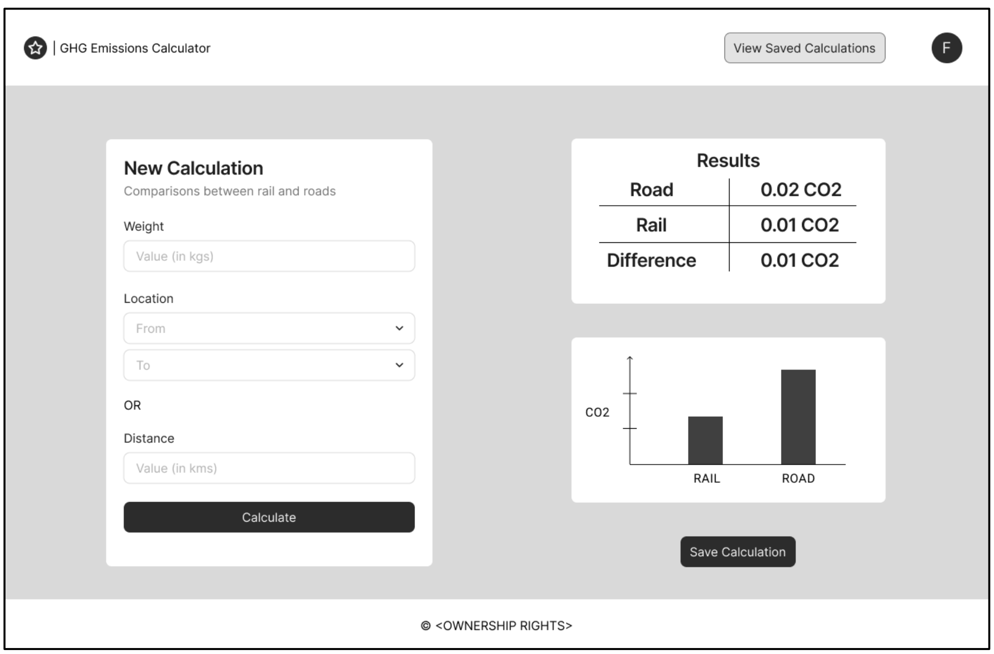
- End Users: Interacts with the web application to do some calculations on GHG Carbon emissions based on the origin and destination city. End users will include everyone who accesses the website and utilises the accessible features provided within the web application.

- Developers: Actively monitors and update the usability of the web application as well as managing database configurations and API set ups that are necessary for the website. Developers will have administrative level permissions which allows them to modify and change features within the different components.
- External APIs: All external services that are implemented to ensure the usability of the application, which may include data APIs for train distance calculations or map APIs used to calculate distance between one city to another based on the least amount of time or the most fuel-efficient routes.
- Database: A database management system is used to store all user data including login credentials that can be used to save calculations and recall them. This can be implemented as a cloud-based database to reduce the need for a physical database server.
- GHG Carbon Emission Calculator Website: The web application which will serve as the main point of contact for users to use and interact with. This application will allow users to input details such as origin and destination city, mode of transport, as well as the weight of freight. On completion of the calculation, it should display the comparison of GHG carbon emission between the chosen mode of transport and a train-based transport system.

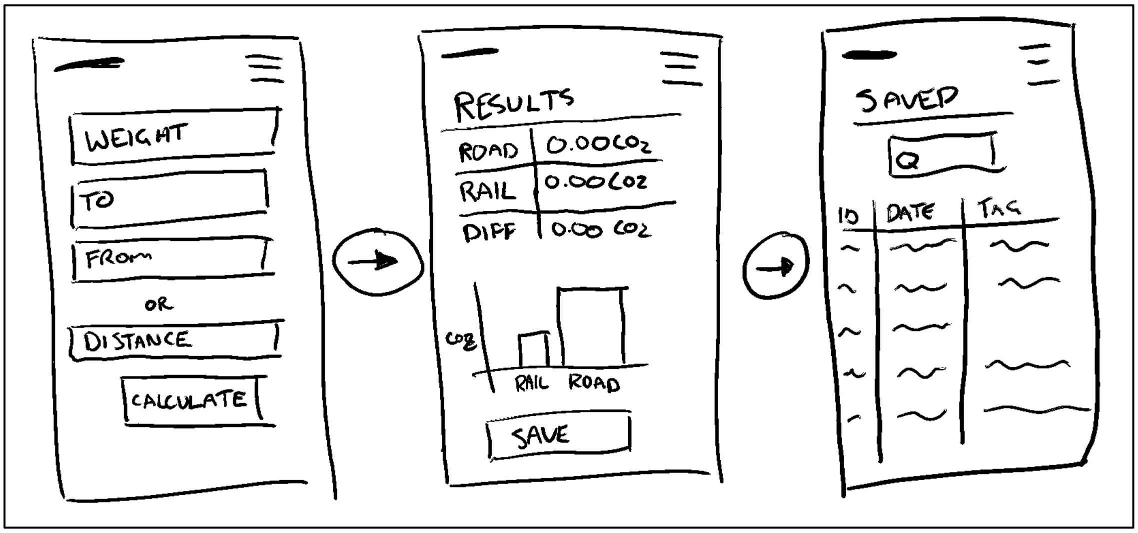
5.3.2 USER INTERFACE



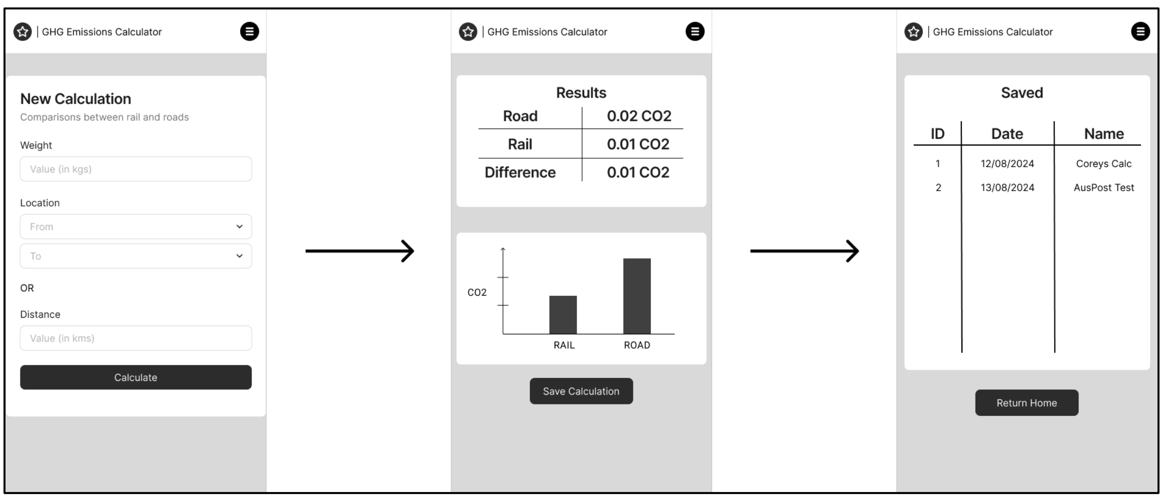
Desktop Wireframe



Desktop Figma Design



Mobile Wireframes



Mobile Figma Designs

The designs presented on the prototype shown above are created in a way that user experience and usability is prioritised. By having a simple yet informative structure, the proposed design should effectively implement all the planned features that will be developed within the application. Some important user-experience principles considered while creating the design include:

- **Layout and Structure**: As mentioned, the design was created with simplicity as the main concept. This simplicity helps users to understand how to use the application much quicker compared to having complicated features. As seen in the calculation forms, users are only required to fill in weight of the freight carried and choose either origin and destination cities or the distance. The calculation process are then completed automatically in the back-end and users are displayed the results.

- **Flexibility**: The option of inputting either the origin and destination city or the distance prevents limitations from the users. As an example, if the user does not have an exact information on distance travelled, they can just opt to input the two cities and data from the database will be used to fill in the distance variable for the calculation. This therefore improves the presence of flexibility within the application.
- **Clarity of Visualisation**: As how it can be seen in each of the calculation results displayed in the UI design, both graphical and numerical visualisation of the data is displayed. With this, users will be able to quickly understand the results based on their inputs and immediately see the difference between the carbon emissions produced by the two modes of transport.
- **Responsiveness**: With the development of a web application, responsiveness is key for the web application to be accessible in all types of devices. Based on what has been discussed so far, both mobile and desktop screen sizes has been designed while preserving all the necessary features. The optimisation of buttons and inputs has also been done in the more compact screen size of a mobile device to further improve user experience.
- **Consistency**: Within both designs of the desktop and mobile layout, a consistent theme has been implemented for the webpage. This includes maintaining the same font styles, colour palette, and interactive features. By having this, no features are to be sacrificed even though users access the application through different devices.
- **Accessibility**: User interface is usable by users with disabilities such as enabling text alternative for image, using appropriate colours and contrast, and making sure interface can be navigated through keyboard.
- **Error Prevention**: Give user meaningful error messages to assist them fix their mistakes such as when input format is wrong and leads to error.
- **Save Option**: Improve insight and engagement by enabling users to save their calculations in a database.

Considering that this design was made in the early planning stages of the web application development, further changes are bound to be made. These changes might be adding, updating, or even removing unnecessary features within the web application.

5.3.3 HARDWARE INTERFACE

The software has no hardware interface requirements.

5.3.4 SOFTWARE INTERFACE

Database Management System

Name: PostgreSQL

Version: 14

Source: PostgreSQL Global Development Group

Implementation: The PostgreSQL DBMS will act as the back-end foundation for the whole system. It will store nearly all the data required to do the calculations within the application. This database will store user credentials, city coordinates, freight routes, emission factors, as well as saved calculations and more in a structured way. That way data manipulation and processing can be done in an efficient manner.

Map and Route API

Name: Google Maps Distance Matrix API

Version: N/A

Source: Google

Implementation: To calculate the distance variable that is going to be used in the calculation, the Google Maps API can be used to determine the distance between two city coordinates. In addition to that, the most recent version of Google Maps also provides an option to choose routes with the most efficient fuel consumption, which can be used as an additional consideration for the calculation of different modes of transport.

Emission Factor Data Sourcing

Name: National Greenhouse Accounts (NGA) Factors

Version: 2023 – Most Recent

Source: Australian Government - Department of Climate Change, Energy, the Environment and Water

Implementation: The emission factor, which is a part of the calculation formula for the GHG carbon emission, is obtained from the official release of report in the NGA Factors document. By constantly retrieving and implementing data sourcing, the emission factors used in the calculations will be the most accurate and updated.

Front-End Framework

Name: React.js

Version: 18.2

Source: Meta

Implementation: The front-end side of the web application will be built using the React.js library, which allows a simple and efficient communication with multiple RESTful APIs. This will ensure that all functionalities such as connection to the database and distance calculations are usable by all users. The React.js library also provides an interactive and dynamic user interface which will further improve user experience when using the calculator application.

5.3.5 COMMUNICATION INTERFACE

HTTP (Hyper Text Transfer Protocol)

Purpose: API

Environment: Development

Details: The HTTP protocol will be used for development API endpoints to simplify the development process including the creation of endpoints, and testing.

HTTPS (Hyper Text Transfer Protocol Secure)

Purpose: API

Environment: Production

Details: The HTTPS protocol will be used for production API endpoints, as they provide secure encrypted data transmission, protecting the platform users and meeting common security standards.

6 CRITICAL REFLECTION

Description

During the first semester of our capstone project hosted by Swinburne University of Technology, the team was tasked to create a GHG Emissions Calculator contrasting the CO2 differences between trains and trucks. The team spent a significant amount of time in the first 5 weeks planning and researching the possibilities relating to this project idea. We explored several formulas, analysed competitor products, created wireframes and Figma UI designs, slide decks showcasing the features, flowcharts describing how users will interact with the platform, and created prototypes to test usability. The team was feeling extremely confident and optimistic about this project except for one factor, the client had delayed meeting us for four weeks and we had not conducted our initial meeting yet.

In the fifth week, the team was notified that the client had unexpectedly withdrawn from the project. Their decision to withdraw had a significant impact on the moral of the team as our weeks of planning and research was to be scrapped. The team was now facing the challenge of starting a new project in the middle of the semester.

Risks

This experience shows the risks associated when relying on people during a project, whether it is your team-members, a supervisor, or even the client. For example, losing a team-member who is familiar with a specific component of the project creates a weak-point in the team, where others must scramble to fill the gaps created by the vacant position. Additionally, losing a mentor figure during a project can remove the guidance and strategy your team uses to navigate through the unknowns of project management. Finally, losing the client is frustrating for the team when significant time and effort has gone into tasks that reap no benefit.

Response and Adaptation

Despite this setback, this experience taught the team many valuable lessons in adaptability and risk management. The available members of the team met with the supervisor and unit convenor immediately, where they collectively defined a strategy and plan to onboard the team with minimal disruptions. The team leader contacted the client immediately, and the group began researching the new project requirements.

Conclusion

In conclusion, this challenging experience taught the team lessons in adaptability, risk management, and the benefits of early client engagement. It taught the team that project-work can be unpredictable, and plans for these disruptions should be prioritised from the inception of the project. Moving forward, the team will continue to prioritise immediate communication and quick response-times to clients and supervisors to maintain clear communication between all parties.

7 ADDITIONAL RESOURCES

Project Slide Deck: https://www.figma.com/slides/IyyUy7TNLqcwv38765kGZO/GHG-Emissions-Calculator-Presentation?node-id=1-121&t=dnNydQH3bbka01iI-1

Project Flowchart: https://www.figma.com/board/lR96oU19XXDhvJcNva5lzg/GHG-Emission-Calculator-Flowchart?node-id=0-1&t=SfBXyDQCE3dQ8gER-1

Project Prototype: https://proto-emissions-calculator.onrender.com/

8 REFERENCE

Competitor Product Research

Association of American Railroads (AAR), "Freight Rail Carbon Calculator," Association of American Railroads, 2023, viewed 16 August 2024, https://www.aar.org/carbon-calculator/

Pacific National, "Sustainability Carbon Calculator," Pacific National, 2023, viewed 16 August 2024, https://pacificnational.com.au/about/sustainability/calculator/

Pledge, "Multimodal Freight Emissions Calculator," Pledge, 2023, viewed 19 August 2024, https://www.pledge.io/emissionsmeasurement/multimodal-freight-emissions-calculator/?currency=USD&period=YEARLY

Formula Research

8 Billion Trees, "Truck CO2 Emissions Per Km Calculator," 8 Billion Trees, 2023, viewed 20 August 2024, https://8billiontrees.com/carbon-offsets-credits/carbon-ecological-footprint-calculators/truck-co2-emissions-per-km-calculator/

CLIENT SIGN OFF

Name	Position	Signature	Date
Organisation			

[Client to sign off on the Project Plan to signify they agree with the plan]