MANCHESTER METROPOLITAN UNIVERSITY DEPARTMENT OF COMPUTING AND MATHEMATICS

6G6Z0018 RESEARCH METHODS FEASIBILITY STUDY

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| **Degree title:** | BSc Computer Science |
| **Project Theme:** | Computational Systems |
| **Project title:** | An application to help people log, visualise, understand, and take steps to reduce their carbon footprint |

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6Z0018 Research Methods NPC Assignment

# Introduction

# In this report, I will be carrying out a feasibility study to check the practicality of the proposed project: a carbon calculator. The following report will include the aims and objectives of the project. I will also be investigating current applications and the gap within the market for carbon calculators. Ethical risks and solutions will be assessed along with researching tools to help me in completing the project. Overall, the purpose of this study is to investigate and identify if the project is feasible and any requirements needed to create an application that allows users to log, visualise, understand, and take steps to reduce their carbon footprint.

# Aims and Objectives

* 1. **Aims**

The aim of this project is to complete a software solution that can be used to help people reduce their carbon footprint by tracking, visualising, and understanding their carbon usage. The application will offer techniques tailored to the user to assist them in reducing their carbon footprint. Another aim is to compose a report that details the procedure.

* 1. **Objectives**

1) Conduct a literature review to evaluate current carbon tracking applications and assess their effectiveness and user interfaces. Carry out research to find out the requirements needed for a carbon tracker.

2) Investigate and discover the most useful components of other carbon applications.

3) Design the user interface, considering target audience and produce an ERD for database.

3) Implement the user interface, database, and test.

4) Using Visual Studio Code and JavaScript, code the back end of the system and test. Connect database to the application.

5) Conduct alpha and beta testing to check system is meeting requirements and to have end user input.

6) Improve system based on testing results.

7) Evaluate the system by analysing performance and produce a report.

* 1. **Learning Outcomes**

I will exhibit my understanding of computational thinking as well as the fundamentals and workings of programming languages, compilers, and interpreters in my project. I will demonstrate how the software industry operates using the instruments and methods used in the software development process.

I shall demonstrate my capacity for critical thought as well as my ability to explain concepts and solutions to audiences who are experts and non-experts alike both orally and in writing. I will display the use of programming languages for the development of appropriate computational solutions to problems. Using a variety of suitable languages and/or approaches, I will analyse, design, and implement algorithms.

# Literature Survey

**Background information:**

* 1. **Background information and expected activities**

Due to the rapid exponential growth of the internet (Kaminow & Li, 2002), personal devices have become more popular. One of the most widespread electronic technologies is the mobile phone (Herring et al., 2013). The mobile phone is a portable device, so it is often taken everywhere with the user. For the purpose of making a carbon calculator that is accessible to all, a web application would be best suited as anyone with an electronic device and the ability to connect to the internet would be able to access the calculator. The carbon calculator will be calculating a user's carbon footprint, which is the total amount of the greenhouse gas, carbon dioxide, emissions caused by that individual (Hughes, 2013). As a result of the increase in greenhouse gas emissions, the earth’s climate is warming (Montzka et al., 2011). This is due to the greenhouse gases trapping more of the sun’s infrared radiation, which increases the earth’s temperature. One of the biggest contributing factors to the volume of greenhouse gases is the burning of fossil fuels, which is a non-renewable energy source, this means it will eventually run out. There are multiple ways for individuals to reduce their own carbon footprint. One of the potential ways is by switching to renewable energy like solar power (Albrecht et al., 2008).

The middle class in developed countries cause 40 times more carbon emissions than the poorer (Carrington, 2023). This is due to them being able to afford products that are exported from different countries and having the funds for travel and transport. Transport is the third largest source of carbon dioxide emissions (Hensher et al., 2009). The working class are more likely to want to know their carbon footprint, due to the cost of carbon increasing which affects their finances, for example the UK government have started ULEZ charge to reduce the amount of carbon emission from vehicles. There are numerous ways to calculate an individual’s carbon footprint. These range from basic calculations to sophisticated analysis (Pertsova, 2007). The basic calculations can be done by simply adding numbers together to find out the overall carbon footprint, however, this does not explain how the user has gotten to the final total neither is it accurate as it is just a broad calculation. The sophisticated analysis can be too complicated as it requires information that not everyone knows, but it gives a more accurate carbon footprint. After examining both ends of the carbon calculation, it is important that my calculations meet in the middle of both. The carbon footprint should not be broad but not everyone will know enough information to give an exact carbon footprint.

For the framework of the application, Visual studio code is the best option as it is the most user friendly. It helps users to code by highlighting any syntax errors, matching brackets and it allows users to debug any errors whilst offering helpful solutions (*Why visual studio code?* 2021). Visual Studio Code provides an Integrated Development Environment (IDE) which supports coding in JavaScript, JSON, HTML, CSS etc. (*Language support in visual studio code* 2021). HyperText Markup Language (HTML) will be used to create the user interface along with Cascading Style Sheets (CSS), which will be utilised to format and style the interface. JavaScript will be used to code the backend of the application to make sure the user interface runs smoothly. JSON will be utilised in sending and retrieving data from the database. Visual Studio code makes creating the web application easier as it supports all the languages I will be using, which will make combining the web application and the database easier. The database will be created using MariaDB which supports Structured Query Language (SQL). MariaDB is an open-source software (*MariaDB foundation* 2019), which is readily available and free to use. It is essential to keep track of the tasks and their deadlines, a helpful tool to do this is Trello. Trello has boards that hold task cards (*Trello brings all your tasks, teammates, and tools together*), which can be organised to show the progress of each task. Visually seeing each task move from one stage to another helps to feel a sense of accomplishment as the task moves closer towards being completed. Trello also offers colouring task cards, which can be used to colour coordinate tasks based on their importance, so the high priority tasks can be red to create a feeling of urgency.

To increase the web applications' useability, there will be a user's help guide to aid users. This will help users with any common queries they may have about the application and help them navigate. There will also be a brief explanation on each page, so the user understands what the page does. Overall, a simple layout should be implemented so users are not overwhelmed and confused by the application. The carbon footprint chart should be coloured in contrast colours so that users know where they need to improve the most. The colours of the web application should consider the colourblind users. Colourblind users cannot see the colour red so additional text can be added for the users to know their percentage in each section of the carbon footprint.

The waterfall methodology treats a project as a linear process (Aroral, 2021). Waterfall moves through each step at a time. This makes sure the project is on time for each deadline and only the set amount of time is spent on each stage. The biggest drawback of the waterfall method is that there is no room for change, but requirements can change during the process of creating the application and the waterfall method will not be able to accommodate this. The agile methodology utilises iterative development (Kumar & Bhatia, 2012). This methodology allows for changes to be made throughout as there are no set steps to complete the project. Due to this, it is easier to find and fix faults in the program at an earlier stage. Agile allows the requirements to be changed throughout the project, but if they become too overwhelming, the project might not be completed in time. In conclusion, the agile methodology is better suited towards my project as steps may need to be skipped and revisited later due to my lack of knowledge.

An ethical and security concern is the collection of personal data from users. To add a form of security to the application, I will be adding a login page that prompts the user to create an account and password. Setting passwords will help to prevent unauthorised access to personal data. To further secure the users' information, I will be implementing encryption and protection against SQL injections as I am using a database to store data. This combined helps to make the web application more secure.

There are calculations that one can do to find an individual's carbon footprint. (Just Energy, 2022) is an example of this. This requires the user to multiply and add up based on their home usage. Despite its simplicity, this does not help users to understand how their carbon footprint is calculated as it does not explain where the numbers came from and does not show how to lessen their footprint. (EarthHero.org) is an app that allows users to enter, track and monitor their carbon footprint. Some good features are that it shows the individual’s carbon emissions compared to an average person in their country and in the world. It provides challenges to reduce your carbon footprint and labels them on difficulty. One drawback to this is that it is just an app and not everyone has a mobile phone, so it is not readily available. Another carbon calculator is (*Carbon Footprint Calculator - version 3* 2007) This calculator simply asks users questions to fill out based on their household and personal lifestyle. It calculates the users total carbon emissions and compares them to others around the world. The page has helpful notes on the side of each question, so users understand what the question is asking. The bar chart shows the drastic difference in size and colour compared to other areas. The drawbacks of this calculator are there is not enough information from the chart for users to understand where they need to improve and there is no advice on how to improve.

I aim to address the question of how users can reduce their carbon footprint. Although there are multiple carbon calculators already available, not all of them are easy to use and helpful. The user group is increasing over time as carbon emissions are affecting people’s lifestyles. There is a gap between scientific output and resource action (Masanet et al., 2021). The carbon calculator will bridge this gap by using scientific output compared to the user's information to suggest a helpful resource action to reduce the users carbon footprint.

* 1. **Evaluation plan**

The system will undergo evaluation by myself and the end users. I am testing the system to check it has met all its functional and non-functional requirements. To begin, I will test the system using multiple different data: erroneous, on the boundary and acceptable data. I will check the system's response to all of these matches the expected to ensure that it is passing all requirements to do with input. To continue this, I will be inputting all acceptable data and checking how the system is handling and storing the data, this will allow me to evaluate the database and check it against its requirements. Finally, I will check whether the output matches the expected output.

Multiple end users will be asked to evaluate the system. The users will be asked to fill out a form based on their impressions of using the application. On the form, they will be asked about the visual appearance of the application’s layout, the advice given to reduce their carbon emissions and any issues they had with the overall application or if something should be improved/ implemented. There will also be a section on the form that has a system useability scale (Brooke, 2014). This scale is an effective and quick way for the users to share their feedback on the useability.

* 1. **Ethical issues, physical risks, and mitigations of both**

One ethical concern associated with the use of a carbon calculator revolves around the potential for inaccuracies in data research. The accuracy of the carbon calculator relies heavily on the reliability of the underlying data, and any miscalculations could result in users being provided with misleading information about their environmental impact. These inaccuracies diminish the effectiveness of the carbon calculator.

Furthermore, an additional ethical issue arises from the advice provided by the carbon calculator to users on how to reduce their carbon footprint. Inaccurate or misguided recommendations could unintentionally lead users to implement practices that might increase their carbon footprint rather than decrease it. This not only compromises the credibility of the carbon calculator but also poses a risk of counterproductive actions by users aiming to contribute positively to the environment.

For the carbon calculator to function effectively, users must input personal data necessary for the calculations of their carbon emissions. This requires informed consent before use, that must be in adherence to the General Data Protection Regulation (GDPR) guidelines. Users must fully aware and freely agree *(Approval standards and guidelines: Lawful processing (UK GDPR))* to the collection, storage and ultilisation of their personal data for the carbon calculator. Implementing a transparent and comprehensive consent process ensures compliance with legal requirements and upholds the ethical standards of user privacy and data protection.

# Project Plan

* 1. **Activity sequence**

Background research will continue throughout the project.

08/01/24: Feasibility Study deadline.

29/01/24 - 04/02/24: Design the user interface and create an ERD for the database.

05/02/24 - 25/02/24: Code the user interface, continue ERD if needed then create database.

25/02/24 - 26/02/24: Test that the User interface is working.

26/02/24 - 31/03/24: Code the backend of the system and complete creating database.

05/03/24: Construct the final dissertation.

31/03/24 - 01/04/24: Test that the database is working.

01/04/24 - 14/04/24: Connect the database to the system and test it is working correctly.

15/04/24 - 21/04/24: Complete a thorough testing of the entire system.

22/04/24 - 28/04/24: Evaluate the system.

28/04/24 - 03/05/24: End users evaluate the system.

03/05/24: CP deadline.

07/05/24: Showcase.

* 1. **Risks to project completion and back-up plans**

Throughout this project, various challenges and potential obstacles may threaten its completion. Amongst these potential issues, the failure to save work stands out as a critical concern. Forgetting to save work at regular intervals could have cascading effects, which results in missed deadlines and ultimately jeopradises the completion of the entire project. A solution to prevent this issue is to back up at regular intervals onto GitHub so in the chance of work not being saved, a backup could be reverted to when continuing.

Another issue in this project is the database not working as intended, this would be due to my lack of knowledge with databases. To mitigate this risk, it is crucial to conduct thorough testing to identify and address any issues promptly. By implementing continuous testing, any database-related issues can be identified and resolved before proceeding with additional project components, which would have made it harder to identify any issues later. In the event a database issue is difficult to solve, research will be carried out on the software used to ensure that I am able to solve it. There will also be a specialist who can advise me on solutions to the problem.

An additional concern centers around the inadequacy of data collected. The success of this project is intricately tied to the collection of data from research. The insufficiency of data poses a risk to the project's time of completion as it causes delays, which results in the risk of not meeting deadlines. To prevent this, research will be continuously executed throughout the project’s duration. This will ensure that the data collected is reliable and sufficient to create a carbon calculator effective at its job.

* 1. **Resources required**

To execute this project, there are certain resources that will be required. One of the resources is the data collected through research. This is needed to create advice to reduce the users' carbon footprint. I will complete research throughout the project to ensure reliable data is collected for use. For project efficiency, Trello will be utilised for task and deadline management, ensuring seamless coordination.

Microsoft PowerPoint will be employed for crafting a user-friendly interface design and a database ERD. To create the carbon calculator application, Visual Studio Code will be utilised. It offers HTML for web creation, CSS for design and JavaScript for backend coding. Due to this being within a single IDE, it allows for cohesive website application development, keeping code together and enhancing overall project organisation and efficiency. I will be using MariaDB, equipped with SQL, to create the database that will store and handle the data. GitHub will be employed for version control to ensure that there is always a recent backup to refer to in the case of work being unsaved.

# Conclusion

# In conclusion, this report has aided me in finding the requirements needed for the project, through researching background information and current applications. By looking at the potential risks and solutions to avoid them, I feel as though I have become prepared to make the carbon calculator as secure and reliable as possible. Using this report and the research that will be continuous throughout the project timeline, I will be able to create a successful carbon calculator that will help users to log, visualise, understand and take steps to reduce their carbon footprint.

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