

SUSTAINABLE RESOURCE MANAGEMENT

Technische Universität München

Title of project: Carbon Reduction Challenge (CRC)

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Submitted on:

30.03.2018

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1. INTRODUCTION

The Carbon Reduction Challenge at the Technical University of Munich (CRC TUM) is a response to a growing threat that has the potential to completely reshape and restructure society as we know it – and likely not in a good way. Greenhouse gas emissions from anthropogenic activity have sent earth's climate system into a catastrophic freefall that may end with parts of the world under water, sweltering under an unforgiving, unbiased sun, or worse, engaged in military conflict. Neither of the aforementioned scenarios ends well for humanity, but be that as it may, there is still plenty that can be done to ensure humanity has a bright and prosperous future.

CRC TUM recognizes not all change is incumbent upon elected officials. There are myriad initiatives that everyday people can carry out to make a difference; CRC TUM has identified behavioral change through a carbon calculator as its niche.

A 2013 study by the European Environmental Agency (EEA) concluded there are many factors that determine consumer behavior, not the least of which are social, cultural and economic. Further, the EEA found that consumer behavior is constantly changing to fit the standardized paradigm of society. Thus, if more sustainable practices permeated into the threads that bind society, these practices would become the norm (or status quo) (2013). CRC TUM aims to change the status quo, beginning first at the TUM Weihenstephan Campus in Freising.

CRC TUM's carbon calculator is a not-for-profit application that will allow students and faculty to track their daily CO₂ emissions. The calculator will inspire people to be more mindful of their daily choices and show the causality of those choices. The calculator, in a way, will be a companion; its purpose won't be to shame users into better habits but rather to show them the effects of their habits and then recommend alternative, environmentally-friendly solutions. Ultimately, the calculator will encourage sustainable behavior one person and one decision at a time.

The calculator's focus areas are mobility (i.e. the forms of transportation used daily), nutrition (i.e. daily eating habits) and home (i.e. energy consumption at home). The calculator will be implemented as a web-app on a website and will have a simple-to-use interface that will allow the user to be in and out of the app very quickly. It's important to us that the calculator is a companion that does not burden or inconvenience, yet it should still have the ability to extract important information from users, parse it and give back relevant feedback. All user data will be stored on a server being managed by a third party; we hope to leverage our feedback and the calculator with the stored data.

There are other calculators and apps that already perform many of the functions that we intend for our calculator, but we have also noticed that they are barely being used – as evidenced by their low total downloads or sparse web visits. We intend to remedy this consumer apathy in our market analysis, by taking note of where consumers believe other apps have failed.

2. INITIATION

In the Initiation there will be a overview of the Project Definition Statement and Project Overview Statement.

2.1 Project Overview Statement (POS) (Refer to: Appendix A 'Project Overview Statement')

2.2 Project Definition Statement (PDS)

2.2.1 Purpose

- This PDS provides a brief overview of CRC TUM to promote a shared understanding of it before a more detailed plan, schedule, and budget are prepared.

2.2.2 Problem/Opportunity

- We observed that there is problem with CO2 emissions. This is based on available information stating the constant rate of carbon increasing in the atmosphere, currently about 409 ppm (CO2 Daily, 2018). Additionally, there are complex social and environmental issues that arise from the continued creation of CO2. Currently, there are many tools (e.g. applications, data centers, research laboratories, etc.) to measure CO2; however, these are not being utilized on a large scale by individuals.

2.2.3 Project Goal

- The goal of the project is to implement a carbon calculator called (Carbon Compass or Eco2mpass). The idea being, that if we can create a carbon measuring tool for consumers, we may be able to incite some effective change and reduce user's carbon footprint. Ideally the project (calculator + PR-campaign) will lower the carbon footprint of all the users combined by 500t/year.

2.2.4 Project Objectives

Objective 1: Creation, launch and implementation of carbon calculator.

- In the project, we are looking to create a fully functional carbon calculator from scratch. This means creating the initial syntax, stress testing the calculator, building multiple stages of a calculator, launching the calculator and implementing the calculator for our target market. This is going to be a formidable challenge, as we want to build a functional calculator that is both desirable to use and not overly scientific. A calculator that can measure both static and non-static carbon-emissions from users. Additionally, the calculator has to adequately measure the users carbon footprint, otherwise it will lose interest due to ineffective data. This entire process has to be completed in a timely manner.

Objective 2: Implement public relations campaign for users to inform them about their carbon footprint.

- We will create a public relations campaign (PR-Test) to implement in the early phases of the project. It will focus on getting our message out to potential users and also inform them of when the calculator will be available for use.
- This will be followed up by a full public relations campaign at the end of our project. We will expand our target audience from our Sustainable Resource Management (SRM)

students and teachers to TUM MA students in studies related to Natural Science, Economics, Business, Environment and Technology.

Objective 3: Reduce the carbon emissions of calculator users.

- This objective is focused on decreasing the carbon footprint of our user base. This will be done through a computer application (i.e carbon calculator). With this calculator, users will be able to track both their static and non-static carbon emissions, thereby allowing them to observe how much carbon they are using on a daily, weekly, monthly and yearly basis.

Objective 4: Track carbon footprint transformations of users.

- Focus on tracking users during their use of the calculator. By tracking the change of their carbon footprint, we can support users in a personalized manner. The aforementioned will result in a large amount of data that will be stored on a separate server. With this server, we can collect and analyze the carbon data. By analyzing and tracking carbon consumption with the calculator, our users can make choices about how to reduce their respective footprints.

Objective 5: Analyze user data to determine why carbon footprint was reduced.

- This objective will be focused on analyzing and interpreting the data received from the calculator users. By creating an active feedback system, our user base can help us to improve the calculator. On the other hand, it allows us to determine or deduce what causal links can be found between the working of our calculator and the (possible) reduction of people's carbon footprint. In other words, we want to find out what components of our calculator and PR-campaign have shown to be effective, and what parts could be improved.

2.2.5 Project Organization Structure

- Maarten Klap was appointed as project manager as he was the individual who created and organized the team. The rest of the team decided individual project roles via a group discussion (Refer to: Appendix B 'CRC TUM Team Structure').

2.2.6 Project Scope

- Major Deliverables (Refer to: Appendix C 'Work Breakdown Structure' and Appendix D 'Milestones').
- Project Budget (Refer to: Appendix E 'Financial Plan').
- Implementation of Carbon Reduction Calculator will follow a phase approach as shown in table 1:

| Phase | Major Deliverable |
|-------|-------------------|
|-------|-------------------|

| | |
|----------------------------|---|
| Phase 1 – Initiation | Realize Basic Concept for Project. |
| Phase 2 – Pre-Planning | Concrete Plan for the Carbon Reduction Calculator Implementation. |
| Phase 3 – Rough Concept | Develop Early Stage of Carbon Calculator. |
| Phase 4 – Detailed Concept | Develop 3rd Stage of Carbon Calculator. |
| Phase 5 – Realization | Implement Calculator with Users and Data Analysis. |
| Phase 6 – Closeout | Wrap Up Project. |
| Phase 7 – PR Upscaling | Expand the PR to entire TUM. |

Table 1: A representation of the seven phases and their major deliverables.

2.2.7 Project Outcomes/Success Criteria

1. We want to reduce the carbon footprint of our calculator user base by 500t/C/y. This will be determined by comparing the initial carbon footprint of every user with the carbon footprint of the user at the end of each week. This way we can measure trends over the course of the year and reflect on how much less carbon has been emitted in comparison to a business as usual model without our carbon calculator.
2. We want to see the regular and effective use of the carbon calculator. This will be measured in the amount of data we are obtaining from the users and if there is improvement in their actions.
3. Our team will consider the PR-campaign a success if it succeeds in both increasing people's interest/awareness in their carbon footprint, and secondly, will result in an increased and sustainable use of the carbon calculator.

2.2.8 Assumptions and Constraints

2.2.8.1 Assumptions

1. Full support of students, faculty (SRM) and the university.
 - There is an assumption in the project that there will be support from the faculty of the SRM program, and support from our fellow students. This is a significant assumption as our project relies on their willingness to cooperate.
2. Truthful information input by user base.
 - There is an assumption that the users of our carbon calculator will do so with full and complete honesty. This is an important assumption as the significance of our data and eventual carbon reduction tracking are based on it. The calculator would lose its relevance if the information recorded and analysed is false.
3. The calculator works smoothly and effectively.

- There is an assumption that this project will be successful despite some of the constraints that will be discussed below. Another important assumption is that the calculations will be reasonable and will be able to determine the carbon footprint of our users.

2.2.8.2 Constraints

The project has constraints of time, scope and budget:

1. Time

- The project has a severe constraint of time as it has to be completed within approximately 18 weeks. Additionally, there is a constraint imposed by the use of the calculator. The calculator has to track users' actions overtime. The time constraint on the calculator can be a function of how long users' continue to use the calculator.

2. Scope

- The scope of the project has a narrow focus on the Technical University Munich Weihenstephan campus. The focus is on a small group of SRM Master's students to use the carbon calculator and begin to track and change their behaviour. The project has many small tasks that are extremely important to the possible success. Additionally, after project closeout, there will be an expansion of scope to a broader user base across of the TUM campus (Refer to: Public Relations Plan).

3. Budget

- The budget of the project is relatively small at only €21,000 Euros. This is money is obtained from funding provided to us by the State of Bavaria and the TUM university.

2.2.9 RISK Management and Potential Risks:

The CRC TUM will run a risk management strategy as follows:

- Step 1: Identify the risk event.
- Step 2: Analyze the risk event and how it will affect the project.
- Step 3: Evaluate the risk according to a Low, Medium or High assessment. .
- Step 4: Treat the risk by outsourcing or re-arranging resources.
- Step 5: Monitor and review the risk event.

Potential risks include, but are not limited to:

1. Apathy towards the carbon calculator.

- There is a significant risk in regard to the apathy of the target market and user base. This risk could completely derail the project as it needs the user base in order to obtain data, which can then be scanned for trends.

2. Risk of cost increase during the creation of the calculator.

- There is a risk that there will be a cost incurred during the creation of the carbon calculator. Given that the calculator needs to be developed rapidly to meet the implementation time of the schedule, there could be a scenario where work will be outsourced, in order to meet the timeline of the project.

3. Accuracy of the calculator.

- There is a risk that the accuracy of the calculations will not be 100 percent. This is an obvious risk when trying to calculate something as difficult as a carbon footprint, which can be calculated varying ways. Therefore, the calculations have to have some legitimate basis. Otherwise, the calculations could be considered false and irrelevant.

4. False Information from users.

- There is a risk that users will give false information. This is a risk that is very hard to combat. It could give us false outcomes, which would affect the legitimacy of the calculator.

5. Technology (i.e. carbon calculator) fails to impress users.

- There is a risk that the carbon calculator will fail to impress the user base. This is due to the ever increasing complexity of technology. This could lead to the user base becoming bored and halting their use of the calculator.

6. Limited experience of team (i.e. SRM-students).

- There is a risk that the limited experience of the team will affect the project. This is a project that is pushing the team to think differently and approach the problem of carbon reduction from a different angle. Additionally, we are trying to include the broader SRM population. This can lead to significant challenges amongst the team. Including, but not limited to, infighting, quitting, wrong assumptions, lack of teamwork, failure to meet timelines, inappropriate target market, inadequate technological know-how, etc.

7. Insufficient return on the team's investment (i.e. time and grant money).

- There is a risk that the project will not meet the ideal of the team and financiers by project end.

2.2.10 Budget & Estimated Cost Breakdown

The budget for this project will be €21,000,-. This money will be obtained from different funding within the Technical University of Munich and Bavaria state government. These initiatives provide funding for both sustainable projects and businesses.

- TUM ForTe: the proposal would grant us €10,000,-.
- EU Research Funds: the proposal would grant us €11,000,- for the completion of the project that brought the carbon calculator to the larger TUM campus.

We are expecting to incur costs of €15/h of work on the calculator (Refer to: Appendix E 'Financial Plan' and Appendix F 'Resource Plan'). This is based off a simple assumption of labour cost in line with student work (i.e. what a student would be paid doing a similar function for a company).

3. PLANNING MEASURES/PREPARING MEASURES

3.1 SWOT Analysis

The SWOT analysis (Refer to: Appendix G ‘SWOT Analysis’) focuses on some of the major strengths, weaknesses, opportunities and threats of our project. The identified project strengths include:

- The simplicity and appeal of the concept (carbon calculator and PR-campaign). Many people are interested in environmental issues, and the carbon calculator + the PR-campaign offer them a simple way to help them to reduce their carbon footprints.
- Existing theoretical and practical foundation of carbon calculators. Effective ways to calculate carbon footprints, may it be in (online) calculator and app format, have proven to work. The format is where we can make a difference.
- The calculator will be free of charge to users and the team is able to create the project on a small budget with funding received from the Technical University of Munich and the Bavarian Government.
- It serves an educational goal which, in turn, sparks interest from both potential users and (monetary) supporters. Additionally, a feedback system has been put in place to personalize the way the calculator supports people to achieve their carbon reduction goals.

The major weaknesses identified include:

- Simple application (i.e. computer calculator) relative to other the advanced smartphone and computer applications in the market today.
- Success will be based on small scale implementation with a possibility for growth.
- Limited experience of the team in building carbon calculator applications.

The major opportunities identified include:

- The project has an appeal to environmentally conscious individuals looking for a calculator/application that can support them in tracking their carbon footprint.
- The calculator can track behaviour by tracking data inputted from users.
- This calculator has the potential to reduce carbon consumption through awareness.
- There is support from external advisors in the project, these primarily include professors from the TUM and Georgia Technical University.

The major threats identified include:

- There have been other smartphone/computer applications that tried to create a similar calculator. However, many of these applications stopped mid-development (for unknown reasons) or are not (widely) used.
- There is a threat associated with the information we receive from potential users, including concerns with data protection, accuracy and calculations.
- User apathy could completely derail the objectives of the project.

3.2 Stakeholder Analysis

The stakeholder analysis (Refer to: Appendix H 'Stakeholder Analysis') was completed with a comprehensive review of all potential parties that could be affected by the creation and implementation of the project. A stakeholder analysis is a process of gathering and analyzing qualitative information about the interests individuals and groups who should be taken into account when developing project (What is Stakeholder Analysis?, 2017). The CRC TUM's review started with a focus on all potential stakeholders that should be included. After this, the team moved on to deciding on two metrics:

1. What was the power of the stakeholder.
2. What was the major interest(s) of each individual stakeholder.

This is displayed in the stakeholder analysis graph by the y - and x-axis respectively. Next, the team focused on which stakeholders were of the utmost importance with a number ranking. Finally, the team decided where the stakeholders would be positioned on the graph corresponding to sectors with names such as key players and least important.

3.3 Work Breakdown Structure (WBS)

| Project | Phase Level | WBS Code/ID | | Component Name | Brief Description |
|---------|-------------|-------------|---------|-------------------------|--|
| 1 | | | | Project | Implementation of Carbon Reduction Calculator. - Maarten |
| | 1.1 | | | Phase | Initiation. (1 week) - Team |
| | | 1.1.1 | | | Major Deliverable |
| | | | 1.1.1.1 | Work Package | |
| | | | | Brainstorming | Realize Basic Concept for Project. |
| | | | | Business Case Creation. | (1 day) - Team |
| | | | | Work Package | Business Case Creation. (1 day) - Team |
| | | | | 1.1.1.1.1 | Brainstorming and business case creation for the carbon reduction calculator. (1 day) - Team |
| | | | | 1.1.1.1.2 | Assignment Project Manager and other project roles. (1 day) - Team |
| | | | | 1.1.1.1.3 | Develop Project POS, PDS and Charter. (3 days) - Team |
| | 1.2 | | | Phase | Pre-Planning. (3 weeks) - Daniel and Jainy |
| | | 1.2.1 | | | Major Deliverable |
| | | | 1.2.1.1 | Work Package | |
| | | | | 1.2.1.1.1 | Perform Preliminary Planning. (2 weeks) - Daniel |
| | | | | 1.2.1.1.2 | Develop WBS |
| | | | | | Develop Work-Breakdown Structure and Risk Management Plan. (1 week) - Daniel |
| | | | | 1.2.1.1.3 | Plan Schedule |
| | | | | | Develop Gantt Chart, Network Plan. (2 days) - Daniel, Sudipta |

Table 2: WBS - first two phases.

An example of the WBS can be seen above (Refer to: Appendix C 'Work Breakdown Structure'). The CRC TUM WBS is based on a task oriented structure discussed in class. Through this task oriented WBS, we determined the optimal path for distributing tasks, responsibility, duration. The breakdown is as follows:

- The top line of the WBS is just the project and the person in control of the project (e.g. 1 - Implementation of Carbon Reduction Calculator - Maarten)
- The step down is the phase level (e.g. 1.1 and 1.2 - highlighted in red) depicts what phase of the project is being detailed. Additionally, there is the name of the phase (e.g. Initiation and Pre-planning), the length of the phase (e.g. 1 week and 3 weeks) and the individual(s) responsible for the outcome of the phase (e.g. Team, Daniel and Jainy).
- The following step down is into the WBS Code/ID. This breakdown has three parts:
 - First, the major deliverable of each phase is detailed (e.g. 1.1.1 - Realize Basic Concept for the Project and Concrete Plan for the Carbon Reduction Calculator Implementation).
 - Second, the name of the work package, the title associated with it and who is responsible for the work package (e.g. 1.1.1.1 - Business Case Creation - Team).
 - Third, the actual tasks that need to be completed in order for the work package to

be completed (e.g. 1.1.1.1.1 Brainstorming and business case creation.). Additionally, the timeline for the completion of the task and individual who is responsible for that completion (e.g. Team). The cost is measured per task.

The use of the task oriented WBS seemed most appropriate for the CRC TUM because of the sheer amount of tasks needed to be completed. This structure gave us the ability to separate tasks, responsibility and durations.

3.4 Risk Analysis

| Risk Event | Damage/ Impact | Probability (Low, Medium, High) | Preventative Measure | Corrective Measure | Monitor and Control |
|--|-------------------|--|---|--|--|
| Delayed development of planning phase. | Time Delay | Low (0-29%) | Create atmosphere of support within the CRC TUM project team. | Rearrange team members to speed up the planning phase. | Project Manager monitor and determine if the planning phase is moving according to schedule. |

Table 3: Risk Analysis.

An example of the Risk Analysis can be seen above (Refer to: Appendix I 'Risk Analysis'). The risk analysis is based on a five step process for identifying, quantifying and rectifying potential risks that arise during the CRC TUM project. The risk management structure is as follows:

- Step 1: Identify the risk event. This process determines what risk events might occur during the CRC TUM project.
- Step 2: Analyze the risk event and how it will affect the project. When is it likely to happen, what is the damage or impact of the risk event.
- Step 3: Evaluate the risk event according to a Low, Medium or High assessment. What preventative measures can you use to avoid the risk event happening.
- Step 4: Treat the risk event. What actions can correct the risk event and can be completed by outsourcing or re-arranging resources.
- Step 5: Monitor and control the risk event. The risk events need to be monitored on a daily, weekly and monthly time scale. This process involves identifying known risks, anticipating new risks and evaluating overall risk management effectiveness.

3.5 Financial Plan and Resource Plan

This paragraph will summarize the importance of the Resource and Finance Plans and elaborate on their contents (Refer to: Appendix F 'Resource Plan' and Appendix E 'Finance Plan'). First of all, the Resource Plan:

- Sums up all the different resources a project will need over the course of its implementation.
- Distinction between five types of resources is made:
 1. Technical resources - different forms of technology.

- 2. Natural resources - naturally occurring materials and substances.
- 3. Infrastructure - rooms and other spaces we made use of.
- 4. Time - amount of hours expected per work package or other.
- 5. Human resources - significant skills and abilities team members.
- The resource Plan is divided into seven columns:
 1. Resource type - which type of professional can do this specific job.
 2. Source - is the *resource type* internally/externally available.
 3. Necessities - what *resources* (1,2,3,4,5) are required per work package.
 4. Extra cost estimate (€) - the costs of the *necessities*.
 5. Quantity - amount of people working on a certain *work package*.
 6. Hours required - estimation hours required per *work package*.
 7. Controller - who is responsible for the completion of a *work package*.

Now follows an elaboration on which resources we needed, when we needed them, which of them were readily available and, if not, how we could compensate:

- First and foremost, we needed human capital. To be able to successfully implement a project like the CRC, we needed enough people with the necessary skills to work on all the work packages specified in the WBS (Refer to: Appendix C 'Work Breakdown Structure'). Furthermore, we required technical resources such as computers, certain types of software and mobile phones to keep in touch and enable us to perform the necessary data computations. The necessary infrastructure was found in the Freising TUM library, and in different rooms all around campus for our PR-plan. Moreover, we needed time. And a lot of it. As is specified in multiple of our works in the Appendix, we planned to spend a total of 1192h on the whole project. Divided by eight people that gives us +- 9 full work days (8h/d) per person. Lastly, the PR-plan desired flyers, banners and consumptions for the events they care to organize.
- The time points in we needed the aforementioned resources were spread out. Human capital was always in demand, as were the technical resources and the time people could spend on the project. But, the infrastructure, and the resources the PR-plan required were concentrated around certain events. We would meet up almost every week to discuss the developments. The PR-plan requirements were needed during the five events they organized/will organize.
- The time resource was available, and so were/are the infrastructure resources. The technical resources did offer a bit of pickle since we did/do not possess all the necessary software to properly develop a good working carbon calculator. Furthermore, we definitely lacked some of the required human capital. Most of us are relatively inexperienced in setting up a project of this scale.
- But, for all the resources that were not available, we managed to work around them. We have been actively trying to contact external experts to help us with the technical parts of the development of the carbon calculator. Furthermore, the lack in human capital was (partly) solved by working together as a tight unit. Together we could solve most of the problems that we as individuals would not have been able to.

The financial plan gives a more comprehensive overview of how much will be spent on what. It adds up all these costs, and will add another 10% in the end to finalize the contingency plan. The average contingency is between 5-10% (7 Things You Need to Know, 2016) So, secondly, the Financial Plan (Refer to: Appendix E 'Financial Plan'):

- Is split up in six columns:
 1. Project task - the different phases and work packages.

2. Labour hours - per phase or work package.
3. labour cost - 15€/h for all our experts.
4. Material cost - cost of material required for project.
5. Travel cost - cost of public transport tickets.
6. Extra costs - consumptions for PR-meetings.

A description of our budget:

- The majority of our budget is reserved for the wages of our experts. The modest sum of 15€/h was based on the average wage of students who hold 'studentenwerk' positions.
- This project will need €21000,- to ensure its effective implementation. More than 85% of our budget is reserved for wages. The other 15% will be spent on the PR-strategy.
- PR-test: 2 x €25,- for snacks ('Natural Resource (2)' in 'Resource Plan', and 'Other Costs' in 'Financial Plan'). Furthermore, 1 x €100,- for printing flyers and 1 x €100,- for posters during one of the events ('Technical Resources (1)' in 'Resource Plan', and 'Material Cost' in 'Financial Plan').
- PR-target: 2 x €25,- for snacks ('Natural Resource (2)' in 'Resource Plan', and 'Other Costs' in 'Financial Plan'). 1 x €200,- for posters during three events (reuse the ones from PR-test) ('Technical Resources (1)' in 'Resource Plan', and 'Material Cost' in 'Financial Plan'). 1 x €220,- for miscellaneous objects needed during the multiple events ('Technical Resources (1)' in 'Resource Plan', and 'Material Cost' in 'Financial Plan'). 1 x €200,- for travel costs during PR-campaign ('Technical Resources (1)' in 'Resource Plan', and 'Travel Cost' in 'Financial Plan').

3.6 Gantt Chart

Above is a small example of the CRC TUM Gantt chart (Refer to: Appendix J 'Gantt chart'). The CRC TUM used Microsoft Excel as our project management tool for creation of the Gantt chart along with other tools. The Gantt chart is the graphical display of CRC TUM's project timeline. It is a series of tasks that need to be completed in a series of steps for the project to meet its deadline (Gantt Chart, 2018). This is depicted by the horizontal blue lines representing start dates, duration and end dates. The Gantt chart begins with the first tasks of creating a business case and assigning the project manager and team roles. The Gantt chart ends with the wrap up of the CRC TUM project. The final phase (phase 7 PR campaign) was not included because it was considered to be outside of the main focus of the project, which is for carbon calculator implementation in the SRM program at Weihenstephan. Phase 7 brings the project to masters students in all three TUM campuses.

Generally, a Gantt chart includes slack time for many of its tasks (Gantt Chart, 2018). However, given the lack of experience in using project management tools we decided to keep a simple plan without slack time (slack). To account for possible issues with deadlines and slack, we allotted extra time for high risk tasks (e.g. Build 2nd Stage Carbon Calculator, 28 days and Implement Feedback, 9 days). The experience of the CRC TUM team members was something that needed to be accounted for in the Gantt chart planning.

3.7 Network Plan and Critical Path

A Network Plan is a visual representation of a project's schedule and the relation between the different tasks that ought to be performed in a scheduled manner within a project (Natarajan & Hales, 2008). Hence, for the purpose of analytical treatment, to get solutions for scheduling and

controlling the activities of the project we have created the following network diagram from the Work Breakdown Structure (WBS). The methodology used for developing the Network Diagram is Critical Path Method (CPM).

The essential technique for using CPM is to construct a model of the project that includes the following:

1. A list of all activities required to complete the project (categorized within a work breakdown structure),
2. The time (duration) that each activity will take to complete,
3. The dependencies between the activities and
4. End points including milestones and deliverables.

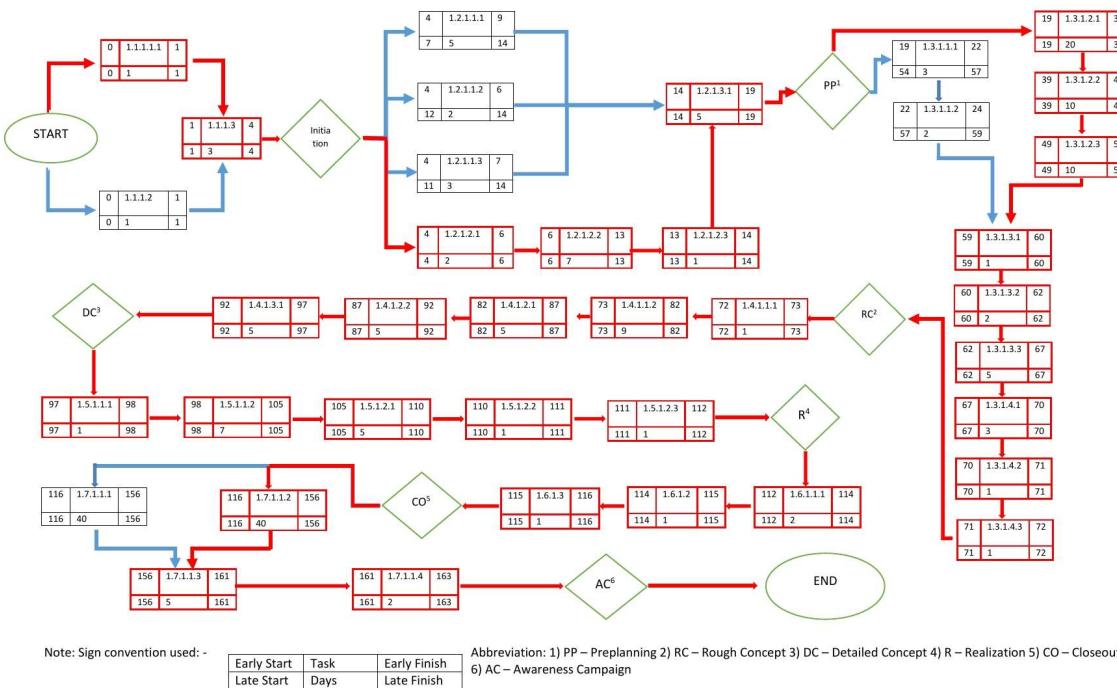


Figure 1: Network diagram along with Critical Path

The above network diagram follows the scheduled task name code (WBS code ID) as represented in WBS (Refer to: Appendix K ‘Network Diagram and Critical Path’). The scheduled task name code contains separate tasks and their estimated duration. Every task package represented follows a tabular representation as shown in Table 3.

| Early Start | Tasks | Early Finish |
|-------------|-------|--------------|
| Late Start | Days | Late Finish |

Table 4: Task representation Network Diagram along with Critical Path.

Components of represented table (Figure 2):

- **Early Start:** Represents the earliest time schedule at which the task can be initiated.
- **Late Start:** Represents the latest time in the timeline of the project to start the task.
- **Early Finish:** Represents the earliest time schedule at which the task can be completed.

- **Late Finish:** Represents the latest time in the timeline of the project to complete the task.
- **Days:** Numbers of days required to complete a task.
- **Tasks:** Includes the particular task that must be performed.

From the WBS we get our entire project is divided into seven phases: Initiation, Preplanning, Rough Concept, Detailed Concept, Realization, Close Out, and Awareness Campaign-PR scaled up to TUM campus (Refer to: Figure 1 and Appendix C 'Work Breakdown Structure'). A detailed description of the phases is given below:

Phase 1: Initiation

At the initiation phase, we simultaneously performed the task of Brainstorming (1.1.1.1) and the task of assigning the Project Manager (1.1.1.2). This was followed by the development of Project POS, PDS and Charter (1.1.1.3).

Phase 2: Preplanning

For the second phase of the project, we began with Preliminary Planning (1.2.1.1), this included items such as the WBS & Risk Management Plan (1.2.1.1.1), the Gantt chart, Network Plan (1.2.1.1.2), Resource Plan (1.2.1.1.3). The market analysis for carbon reduction (1.2.1.2.1) applications occurred simultaneously, even though they are independent to one another. Phase 2 is completed by writing the initial syntax for internet carbon calculator (1.2.1.3.1).

Phase 3: Rough Concept

Phase 3 starts with the creation of feedback system (task 1.3.1.1.1 & 1.3.1.1.2) along with building the second stage of the carbon calculator (1.3.1.2.1) simultaneously. Both of the aforementioned work packages are joined at the stage of SRM survey (1.3.1.3.1). The phase ends with a group presentation of the rough concept of the project (1.3.1.4). This is an important work package as it allows for the team to elaborate on the project and development of 2nd stage of the carbon calculator.

Phase 4: Detailed Concept

In this stage, firstly, we develop the structure of a feedback system (1.4.1.1.1) and implement the feedback system (1.4.1.1.2) into the project. Then we will create a complete final master plan (1.4.1.2.2), which is the final point for changing anything in the project. At the end of the phase, we will start the final stage of stress testing and updating the calculator (1.4.1.3.1).

Phase 5: Realization

The phase starts with the implementation of the carbon calculator with the user base (1.5.1.1). We will teach the participants how to use the calculator correctly (1.5.1.1.1) and allow them to experience it for a week (1.5.1.1.2). Then we will begin collecting data (1.5.1.2.1), evaluating the PR in SRM sample (1.5.1.2.2) and provide a survey for users' reactions and reviews after using the calculator (1.5.1.3.1).

Phase 6: Closeout

At this stage, we will continue to monitor the users' data and provide feedback for improvement (1.6.1.1.1). We will close out project specific team functions (1.6.1.2) and wrap up the project at the end of this phase (1.6.1.3).

Phase 7: Awareness Campaign- PR Scaled Up To TUM Campus

This stage will start with two simultaneous tasks: broaden the knowledge of TUM students on carbon footprints, environmental impacts etc. (1.7.1.1) and introducing the TUM students to the calculator and provide instructions to use it (1.7.1.2). On completion of the above two tasks, an evaluation of the Public Relations campaign (1.7.1.3 and 1.7.1.4) will be carried out which will conclude the PR awareness campaign.

Critical Path

The critical path in a sequence of networked work packages is the path with the least amount of slack. This path is the longest and any delay in following the sequential arrangement of events will delay the entire project (Esposito, 2015). The path marked with red arrows in Figure 1 (Refer to: 'Appendix K Network Plan and Critical Path') represents the Critical Path for our project. Any subsequent delay in any of these tasks will delay the entire project. The sequential arrangement of critical path representing the work packages is as follows:

(1.1.1.1.1) \Rightarrow (1.1.1.3) \Rightarrow (1.2.1.2.1) \Rightarrow (1.2.1.2.2) \Rightarrow (1.2.1.2.3) \Rightarrow (1.2.1.3.1) \Rightarrow (1.3.1.2.1) \Rightarrow (1.3.1.2.2) \Rightarrow (1.1.1.2.3) \Rightarrow (1.3.1.3.1) \Rightarrow (1.3.1.3.2) \Rightarrow (1.3.1.3.3) \Rightarrow (1.3.1.4.1) \Rightarrow (1.3.1.4.2) \Rightarrow (1.3.1.4.3) \Rightarrow (1.4.1.1.1) \Rightarrow (1.4.1.1.2) \Rightarrow (1.4.1.2.1) \Rightarrow (1.4.1.2.2) \Rightarrow (1.4.1.3.1) \Rightarrow (1.5.1.1.1) \Rightarrow (1.5.1.1.2) \Rightarrow (1.5.1.2.1) \Rightarrow (1.5.1.2.2) \Rightarrow (1.5.1.2.3) \Rightarrow (1.6.1.1.1) \Rightarrow (1.6.1.2) \Rightarrow (1.6.1.3) \Rightarrow (1.7.1.2) \Rightarrow (1.7.1.3) \Rightarrow (1.7.1.4)

4. PROJECT TESTING

4.1 Market Analysis

A market analysis is a quantitative and qualitative assessment of a market which can provide a detailed estimate of the opportunities (entry requirement, barriers, regulations, the presence of competition) present within that market (What is Market Analysis?, 2016).

The objective of our project is to analyze and reduce the carbon footprint of individuals (to the tune of 500 tons/year) by providing them with a tool that measures their individual carbon consumption, thereby helping individuals to become more sustainable. There already are several tools available in the market like apps, websites, etc. that calculate these (carbon consumption) values; however, these are not engaging enough for users to continue regular or routine use. Hence, to assess market potential for our project and provide a tool that is more engaging and frequently used by the users, we conducted market analysis.

The objective of CRC TUM market analysis was to provide information on the following:

1. Examine and determine the need for a CO2 calculator.
2. What competitors are present in the market.
3. Analyze possible trends in consumer behaviour.
4. Possible reasons for failure/success of competitors.

5. What entry barriers and regulations exist.

In order to achieve these objectives, we conducted a review of applications (platform-Android and iOS) and websites present in the market relating to carbon footprint management (Refer to: Appendix L 'Market Analysis'). The details of the market study are as follows:

- A total of 30 apps and websites (combined) were examined. Generally, the applications had more than a thousand downloads with a sufficient amount of comprehensive reviews from users. We analyzed these reviews to determine reasons for success or failure of the applications. Additionally, we gathered information on trends in consumer behaviour.
- The trend suggests that there is a demand for a better measurement tool. From the comments we discovered, users require the tool to be more suitable to their needs. If provided with such a tool, they would be willing to use it on a daily basis. This shows that there are conscious consumers who are aware of their consumption behaviour, but are in need of better tools to make improved consumption choices.
- This provides us with an opportunity to introduce a carbon calculator that is in line with our overall objectives of the project. To further understand the current trend of the market, we used the products available in the market as an end user. This helped us in understanding the dynamics of our own consumer behaviour. The general trend for the applications was that either they were too cumbersome or too blunt to bring about any behavioural change to the user. This gave us a qualitative assessment for the project.
- The idea being that our carbon calculator should have a simple data input process. At the same time, be enticing enough for the consumer to be daily users.
- There were no real barriers to entry identified. This is a benefit of using computer applications that can be the low cost associated with use of the internet.

4.2 Milestones

In project management, a milestone is a specific point in time within a project lifecycle used to measure the progress of a project toward its ultimate goal (Harned, 2017). Milestones are an indicator of progression of a project that signals project's start or end date, a need for external review or input, submission of a major deliverable over the entire lifecycle of a project.

Our project consists of seven deliverable milestones at the end of each phase of the project as shown in the Network Plan diagram (Refer to: Appendix D 'Milestones'). The segmentation of project schedule into milestones helps in early identification of schedule problem and act as a system of checks and balances that will help in timely completion of the project. The milestones with a brief mention of deliverables are as under:

Milestone 1: Completion of Initiation phase:

With the accomplishment of this milestone, the project will complete the first phase. The milestones achieved will be Business case creation, team assignments with designated roles for members and completion of basic planning. The initiation phase will take a period of one week to reach this milestone.

Milestone 2: Completion of Pre-Planning:

With the accomplishment of this milestone, the project will complete the second phase. The milestones achieved will be the concrete plan for implementation of the Carbon Reduction Calculator and a detailed overview (Market Analysis) of the Carbon Reduction Applications present in the market. The Pre-Planning phase will take a period of three weeks to reach this milestone.

Milestone 3: Completion of Rough Concept:

With the accomplishment of this milestone, the project will complete the third phase. The milestones achieved will be the completion of second stage of Carbon Calculator and Public Relation Awareness Campaign. The Rough Concept phase will take a period of ten weeks to reach this milestone.

Milestone 4: Completion of Detailed Concept:

With the accomplishment of this milestone, the project will complete the fourth phase. The milestones achieved will be completion of third stage of development of Carbon Calculator along with inclusion of feedback from phase three stress analysis to the calculator. The most important aspect of this milestone will be the availability of Calculator for trial run. The Detailed Concept phase will take a period of five weeks to reach this milestone.

Milestone 5: Realization of Project:

With the accomplishment of this milestone, the project will complete the fifth phase. The milestones achieved will be a user base that has been using the calculator regularly and an on going analysis of those user's data. The Realization of Project phase will take a period of two and half weeks to reach this milestone.

Milestone 6: Closeout of Project:

With the accomplishment of this milestone, the project will complete the sixth phase. The milestones achieved will be a complete computational analysis of users data and completion of project. The Closeout phase will take a period of five weeks to reach this milestone.

Milestone 7: Awareness Campaign - PR scaled up to TUM Campus:

With the accomplishment of this milestone, the project will complete the seventh phase. The milestones achieved will be completion of PR Awareness Campaign at TUM campuses. The Awareness Campaign phase will take a period of eight weeks to reach this milestone. Delivery of this milestones indicates the end of the project.

4.3 Public Relations Test and Survey

Before running the official PR Target which takes place when the project ends, we will also run a "PR Test" during the project. This will measure how much the target population knows about CO₂ and its consequences, gauge their willingness to use the calculator, the potential effects of the awareness gain on shifting personal CO₂ footprint behaviors, and analyze the participants' feedback on the calculator and the PR activities. The "PR Test" will use a sample of 40 students of the TUM SRM Master program. Based on the outcomes of the "PR Test", adjustments will be made to improve the "PR Target" plan.

Firstly, to see how the target population know about CO₂ and its consequences, also to gauge their willingness to use the calculator, we will conduct a first survey among a sample group of 40 SRM students (Refer to: Appendix N 'Public Relations Survey Questions' and Appendix O 'Public Relations Survey Results'). There will be also an aware campaign with various activities to awake students' perception about the importance of CO₂ reduction, and therefore understand the calculator's meaning. We also organize an information booth session to introduce, provide Q&A and give trials for the calculator. Social media will be constantly updated (Refer to: Appendix P for photos of our Facebook, Twitter, Instagram and Website). Lastly, to end the PR Test phase, a second survey will be conducted to gather participants' feedback on the calculator and the PR activities, so as to make improvement for the PR Target phase.

Further details about the PR Test (target audience, media lists, tactics, timeline, evaluation options) will be described in section 5.1 Public Relations Plan.

4.4 Internal Testing Phases + Feedback implementation/Pilot Testing

The internal testing phase of the project helped us ferret out mistakes and errors in our code. Additionally, it gave us an opportunity to use the web-app (carbon calculator) ourselves and gauge how our users may experience the app. Each of us used the app for several days and followed all the rules that our users would heed. We also logged how long it took us to enter our personal data every time we used the app. Our goal was to keep each interaction with the app, regarding data submission, under 90 seconds. We also logged the times of the day we accessed the app.

We strived to design questions that were short but succinct, detailed and specific but intuitive, and factual while also not being too scientific. However, even with all of our best intents to create a streamlined user experience, we couldn't know for sure how the web-app performed until we at least tried it ourselves in the same context as our users.

All of us used the app at different times of the day and with different frequency. Some of us logged personal data, in real-time, as we made decisions that impacted our carbon footprint, and others logged data in retrospect. This difference of use reinforced our fear that personal data may not be so accurate if people forget to enter things into the calculator or enter them with discrepancies, especially the people who enter most of their data in retrospect rather than in real-time. Being that a web-app has no way of sending notifications to users' phones, scheduled notifications were not an option, so it became clear to us that we would have to urge our users to be consistent with their daily entries.

5. IMPLEMENTATION + EVALUATION

5.1 Public Relations Plan

Key message: "Preserving our planet for future generations, one gram of CO2 at a time".

- This message implies two meanings. First, it emphasizes that one of the main challenges in this generation is the preservation of the planet for future generations. Second, it suggests a solution to measure our CO2 footprint, and reduce one gram at time based on positive decisions and behaviors that are not just beneficial for the environment but also for our health and economies.

5.1.1 Overview

a) The Project:

The Carbon Reduction Challenge (CRC) is an effort tackling the growing threat of climate change by reducing Greenhouse Gas emission by altering individual behaviour. We believe that the solutions for this global issue do not necessarily need to start at a macro level, but in conjunction with efforts at the micro level. In order to empower individuals to reduce their carbon footprint we developed a personal carbon calculator which allows users to track their daily carbon emissions based on the following categories: 'mobility', 'nutrition' and 'home'. This project focuses on the population of TUM Master students.

b) The PR-Plan:

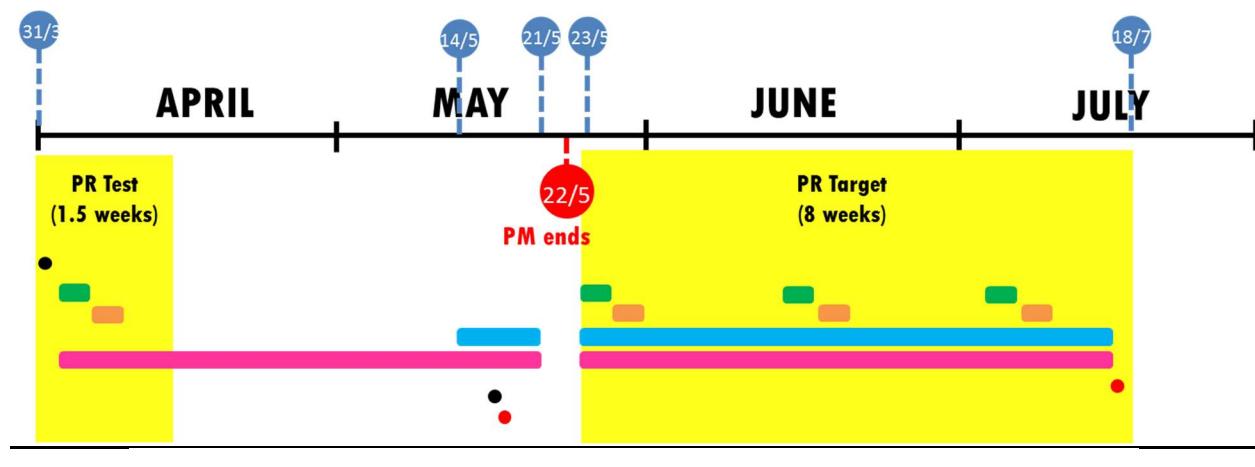
To successfully achieve the project's goal, a PR-plan is needed to introduce the calculator to TUM Master students. Our PR's goal is to raise awareness in this community about the impacts of carbon emissions on the climate. We want to make people understand that a reduction in their carbon footprint not only services to solve several environmental issues, but could also lead to short-term personal benefits.

c) Structure of the PR Plan:

The first phase of our PR Plan is called the PR Test. During the PR-test we will measure how much the target population knows about their carbon footprint and gauge their willingness to use a calculator that could help them to reduce it. Furthermore, we want to figure out what our possible user-base is looking for in a hypothetical carbon calculator. The 'PR Test' will use a sample of 40 students of the TUM Master program SRM. Based on the outcomes of the 'PR Test', adjustments will be made to improve the 'PR Target'.

The main phase of our PR-plan is called the 'PR Target'. During the project, the team will develop and test a carbon calculator, after which the 'PR Target' will help to promote the calculator to a population of 10.000 TUM Master students, as well as increase the population's awareness of their carbon footprint and its consequences.

The timeline for both the 'PR Test' and the 'PR Target' is illustrated in the figure 2.



NOTE:

- Survey
- Awareness campaign (CO2 talks, CO2-weight illustration, photo challenge)
- Information booths to implement the Calculator
- Users use the Calculator
- Communicate via Social media (tips, articles,..), User's story, Expert interview
- Evaluation

Figure 2: PR-timeline.

5.1.2. Objectives & Strategies:

Objective: Promote the calculator through awareness campaigns about the importance of carbon emissions reduction. The campaigns will be focused on the carbon footprints of TUM Master students.

Strategy 1: Introduce the calculator and prove that it can help to reducing carbon footprints. Firstly, we will set up information-booths that will help students to measure their own carbon footprint. Following the strategy “trial and trigger”, such information-booths will allow the students to try the calculator on devices supplied by us, with immediate technical assistance and advice from our team. The calculator provides a function that allows competition between calculator-users, which can be intriguing for students to try and introduce the calculator in their respective networks. Secondly, to gain potential users’ trust, we should share reviews and testimonials from previous users and some field experts on, amongst others, our social media accounts. The aforementioned will stress how user friendly the calculator’s design is, how the calculator has affected their individual behaviour and what its benefits are. This will create a so-called ‘peer effect’ and employ the word-of-mouth marketing strategy. Lastly, certain calculator statistics will be shared on our social media channels and blogs to illustrate the calculators benefits.

Strategy 2: Stimulate the demand for the calculator by showing why reducing carbon footprints is important via an awareness-raising campaign. Even though climate change is a global issue, not every person has understood its mechanism, or is interested enough to change their behaviour. Academic papers can easily discourage people from learning more about climate change. Therefore, our strategy is to communicate interesting and straightforward information through interactive and functional awareness campaigns. We try to gain people’s attention for our project through events during which people can listen to keynote speakers, but also participate in activities (e.g. Carbon Talks), work together with other people (e.g. Photo challenges) and increase their knowledge about their carbon footprints (e.g. Carbon-carrying demonstration). Moreover, since a majority of TUM students use social media networks such as Facebook, Instagram and Twitter, we will utilize these to spread the message. Besides posting photos, videos and relevant links, we will also write blogs on our facebook page, and post interviews with experts in the field of carbon reduction schemes. The strategy is to provide information through multiple channels which can attract different types of Master students.

5.1.3. Target audience:

It is important to note that, because we have both the ‘PR Test’ and the ‘PR Target’, it is necessary to define two primary audience groups. However, the audience group for the PR Test is a sub-group of the PR Target: namely a sample of SRM-students. Therefore, later, when we describe the profile of the primary audience, we mean to describe the whole population (which is of the PR Target). Our target audience populations are the following:

Primary audience

- PR Test: 40 SRM students, TUM campus Weihenstephan.
- PR Target: 10,000 TUM Master students at 3 campuses: Munich, Garching, Weihenstephan.

Secondary audience

- TUM staff.
- Friends/ family members of the TUM students.
- Any other audience interested in environmental issues.

Primary audience’s profile

- TUM Master students in studies related to Natural Sciences, Economics, Business (Administration) and Environmental Engineering. According to WS17/18 statistics, TUM has 40.000 students in total, 16.000 of whom are Master candidates. We have filtered the related programs and ended up with the population of roughly 10.000 Master students.
- Characteristics: open-minded, social, critical thinkers and curious.
- Interested in: environmental issues and opportunities.
- Daily habits: Interested in global issues and active on social media networks, at least weekly use of a mobile app, which has a personal tracking function (distance walked, calories burned, daily finance, etc), active on campus.
- Time availability: regular use of the calculator on mobile for at least 3 minutes per day.

5.1.4. Media List:

If we want to make the CRC a success, we require many people to use our calculator. As such it is of incredible importance to be able to spread the message through a multiplicity of channels. We created this media list (Refer to: Appendix M 'Media List') to showcase what media sources we would like to use and why:

1. First of all, since our primary audience are all TUM Master students, spreading our project via the TUM's channels is essential. We will use the TUM's many screens to announce our plans. Furthermore, online newsletters allow readers to quickly click on links to our webpage as well as upcoming events on our facebook page. Additionally, asking coordinators of related study programs (SRM, Environmental, Economics and Business, etc.) to introduce the project to students via internal mail list will be a efficient way to reach out. Last but not least, we can have a calculator download link embedded into TUM's mobile app which is currently used by many TUM students.
2. Secondly, we would like to use the official channels of Green Cities, Climate-KIC and Greenpeace. Green Cities and Climate-KIC are two associations renowned for supporting result-oriented entrepreneurial projects. All of them have their online blogs and facebook pages with high numbers of followers (2600 for Green City e.V., 100.000 for Climate-KIC, and 297.737 for Greenpeace Deutschland).
3. Thirdly, we care to work with certain national and local magazines. We can introduce our calculator to the public, and increase the scope of our PR-campaign.

5.1.5. Tactics

This is the general list of the tactics we will employ in our "PR Test" and "PR Target":

- Surveys (Refer to: Appendix N 'Public Relations Survey Questions' and Appendix O 'Public Relations Survey Results')
- Social media platforms: Facebook, Instagram, Twitter (Refer to: Appendix P 'Public Relations Social Media Outreach').
- Other online media channels: The project's Website, Blogs (Refer to: Appendix P 'Public Relations Social Media Outreach').
- Carbon Talks at TUM campuses.
- Interactive Carbon-carrying demonstration at TUM campuses.
- Photography challenge at TUM campuses.
- Information-booths for the calculator (at TUM-cafes).
- Users' testimonials and personal accounts/experiences.
- Interviews with experts and users.

A) PR Test:

- Firstly, to test our target audience's knowledge about carbon footprints, and gauge their willingness to use the calculator, we will conduct a survey with a sample group of 40 SRM students.
- Secondly, an awareness campaign will be implemented to make students understand why carbon footprints matter and how the calculator can help them to decrease these. We will organize so-called Carbon Talks, in which keynote speakers will present and discuss the current environmental developments. During the Carbon Talks, two other activities will be organized:
 - Activity one: 'Carbon-weight carrier'. The participants calculate their daily carbon footprint with our app (+-25kg). We will prepare material with such a weight and the participants have to carry this weight to a specific point, so that they can see how "heavy" their carbon footprint is. With this activity, we want to visualize the carbon that is normally invisible and therefore neglected by many people.
 - Activity two: 'PICyourChange!' We want to invite participants to post photos on Instagram with the hashtag #meandcrc, where they can share how their behavior has changed (i.e. less use of cars, eat more vegetables, led lights, etc.) after participating in our activities, reading our news and using the calculator.
- Before the project team finishes the development of the calculator, we will have an information booth session to announce the launch of the calculator in the nearby future. When the calculator is launched, updated statistics about, among others, how much carbon emissions have been reduced by our user community will be posted on our social media channels and blogs.
- Our social media pages, website and blogs (Refer to: Appendix P 'Public Relations Social Media Outreach') will be regularly updated with useful information/articles, innovative entrepreneurial ideas and tips how to reduce carbon footprints. The dates of our events and calculator launch can also be found here.
- At the end of the PR test, a second survey will be conducted to gather participants feedback on the calculator and the PR activities. We will be able to use this feedback to improve our PR-tactics.

B) PR Target

- 'Information booth': we will organize three information booth sessions on each of the TUM campuses to promote the calculator and reach out to more users. At each session there will be a stand where people can receive information, ask questions and try the calculator.
- Secondly, an awareness campaign will be implemented just like during the PR Test. However instead of only one Carbon Talk, we will organize three Carbon Talks, one at each of the TUM campuses. During each of the Carbon Talks, two other activities will be organized:
 - Activity one: 'Carbon-weight carrier'. Same idea as during the PR Test.
 - Activity two: PICyourChange! Same idea as during the PR Test.
- A publicity campaign will include: Interviews with experts and TUM professors about the importance of reducing carbon emissions; stories, reviews and testimonials about the calculator from previous users and field experts; updated statistics about how much carbon has been reduced by our user community. All of the aforementioned results will be posted on our social media accounts.
- Our social media accounts, website and blogs (Refer to: Appendix P 'Public Relations Social Media Outreach') will be regularly updated with useful information/articles, innovative entrepreneurial ideas and tips how to reduce carbon footprints. Furthermore, additional information about the calculator and our events can be found here.

5.1.6. Evaluation Plan

| Tactics | PR Test | PR Target |
|-----------------------|---|---|
| Social Media Tracking | Evaluation criteria: - Reach number of facebook page likes/follows of at least 40 at the beginning, and 100 at the end of test phase | Evaluation criteria: - Reach number of facebook page likes/follows of at least 1000 after 2 months - Maintain total number of Post Reach (in facebook) at 200 per week in the first month, and 500 in the 2nd month - Increase number of individual post reach by 10%-20% throughout each week |

Table 5: Representation of Evaluation Plan.

Above is an example of the Evaluation Plan (Refer to: Appendix Q 'Public Relations Evaluation Plan'). The left column explains the individual tactic used. These tactics include social media tracking, surveys, photography challenge, etc. and serve the purpose of focusing the evaluation into defined sections. The next two columns serve to differentiate evaluation criteria between the PR Test and the PR Target. In each column there is an analysis about what criteria need to be met in order consider the PR Test and PR Target successful or unsuccessful.

5.2 Calculator

The carbon calculator collects user data from three area of interest. These are Food (Nutrition), Mobility and Home. This area of interest is chosen as these are the primary source of CO₂ emission and have well defined CO₂ emission measurement techniques. Significant changes in these fields can be numerically measured. A user enters the data regarding these field on a web-based application to be provided in multiple options to choose from. The concerned field is further subdivided into multiple sub-parts. The sub-division is as under:

1. Food – i) Meat ii) Fish iii) Dairy iv) Vegetables
2. Mobility - i) Distance ii) Mode of transportation
3. Home - i) Size ii) People iii) Heating iv) Water v) Electricity

Once the user gives the input for these sub-parts, the calculator calculates the emission for each part. The total emission is shown as an addition of result obtained in the three fields. The calculation is based on a computational formula which carefully takes into account the carbon emission factor for each sub-part. The result obtained is in grams of CO₂ which is converted to tons of CO₂ for annual computation.

5.3 Monitoring feedback

The objective of the project is to implement a carbon reduction calculator that provides feedback to the user based on their consumption choices and help them reduce their carbon footprint. A strong monitoring and feedback system is pivotal to obtain this goal of the project. Hence, we have formulated a data team of three members dedicated to monitoring the progress of users. Once we obtain the data regarding carbon emissions of the user, we suggest a list of improvements to the user depending on the area where unsustainable behavior or consumption choices are observed. This feedback system functions continuously and ensures a real-time two-way communication between users and monitors. The progress of an individual is computed by observing the change in consumption choices. To observe a significant change in consumer behavior we provide feedback to the users for a period of one month. The overall progress is measured by obtaining the difference between the CO₂ emitted at the initial stage of calculator usage and after one-month usage of the calculator. As there is a bulk of user data obtained, we use a third party server to manage the data and recall the information if needed.

5.4 Obstacles and Achievements

The carbon calculator hasn't been fully launched just yet, but we can still see our progress as an achievement. We have successfully found many people on campus that would like to partake in our project once the calculator is ready to be used. Furthermore, we have had 40 people filling a survey that made them specify why they would (not) use a hypothetical carbon calculator. We did this to get a better grasp on why the other carbon calculators out there have yet to become successful. Finding a market for your product might be as important as the development of the product itself. But, there's still a lot of work to do.

The carbon calculator's number one challenge is the accumulation and storage of data. Managing a server can be quite the tedious and expensive process, especially when the data starts piling up. For the purpose of our project, we want to outsource this task to a third party. This would help us with some back-end issues regarding cloud maintenance, but it would not resolve some of the other complications we will face. For instance, we need additional human capital to help us successfully compute the necessary data for our carbon calculator.

Another challenge we face is that we want to give our users a personalized experience, so we need to create a way to manage and add memberships. This requires additional work in discipline and computer programming, in which no single member of our team is experienced. So, while data management remains a major obstacle for us, so does inexperience. In the future we might want to educate ourselves in the areas where we miss the indispensable knowhow.

5.5 Close out

Although we faced some difficulties, we still launched (a Beta-version of) the calculator. The next step is to wrap up the CRC. Now, we are continuously monitoring the data from the users and computing the change of users' consumption. The behavioral change is being determined by the change in consumption of each of the users. We will have two days to monitor data and provide feedback for improvement. Then we will start to close the separate teams that complete different tasks. Next, we will wrap up the entire project on 22nd May, 2018.

Due to the limitation of time and number of users, it will be hard for us to meet the CO₂-reduction goal of 500 tons from the atmosphere right now. To achieve this goal, we need a bigger audience. So, after closing the project we will start a second-round public relation campaign (see Public Relation section for more details) in all three campuses of the TUM. Approximately, 10,000 masters students (10% of the total students) will participate in the next step. We have already

created our social media pages (Facebook page, Twitter account, etc.) and created our website. Social media responses are constantly checked.

We have a goal to reach 200 Facebook likes in the first month of the campaign and 500 in the second month of the campaign. Through social media outreach, we are trying to enrich the knowledge of TUM students about their carbon footprints, its environmental impacts, etc. When the calculator is finally created on the 22nd of March, we will try to connect with our users via our calculator. We will also provide them specific instructions pertaining to the use of the calculator. Their responses will be monitored closely.

We will arrange at least three talks and we expect at least 100 people in each talk, and we will also arrange different awareness activities. If everything goes well, we expect about 300 users will regularly use this calculator. After the eight-week campaign, the whole project will come to an end. Then our PR team will evaluate the campaign and then move it forward to be evaluated by the whole team. Thus, this would be the end of our work as members of the project; success in this project will encourage us to move further with this project.

6. DISCUSSION

In conclusion, the Carbon Reduction Challenge - and its calculator - have made big steps over the last few months. We created a detailed plan to efficiently manage the development of the calculator and all the other tasks around it. We evolved from having to appoint everyone their role in the team to a smooth running entity that will, hopefully, manage to develop this carbon calculator in the future. We cannot say that this paper is the end of our Project Management course. It is merely the beginning. In the next few months we will carefully discuss how we want to move forward, and the creation of this extensive Project Management report will be of vital importance during this time.

But, with more knowledge come more questions. Over the next couple of months we will face and have to deal with a variety of challenges. One of these is that there is a lot of competition. Upon carrying out the intensive market survey, our expert team realized there were many such calculators available, none of which seemed to dazzle. So, we focused on designing a calculator that stood out from all others in the market. Arguably, we are not the only ones with this idea. The sustainable development of our society is increasingly becoming a socio-economic issue of vital importance. As such the attention for applications like carbon calculators will rise. We will have to find out in the future if we are able to compete in this market.

Secondly, our team represents an apparent lack of the required human capital. We have adequate knowhow to create a simple carbon calculator, but we are not experts in the field. We have created an extensive PR-campaign, but we have never organized anything from this scale. Furthermore, we will need to find a suitable way to store and compute all the data we will be receiving when people start using the carbon calculator. This is an issue we do not know how to solve at the moment.

But, regardless of our shortcomings, we will keep on developing this carbon calculator. As mentioned before, we have made big steps over the past couple of months. We have been able to identify our weaknesses and focus on our strengths. As such, the discussion amongst ourselves is not if we want to keep on developing this project, but how we are going to do it.

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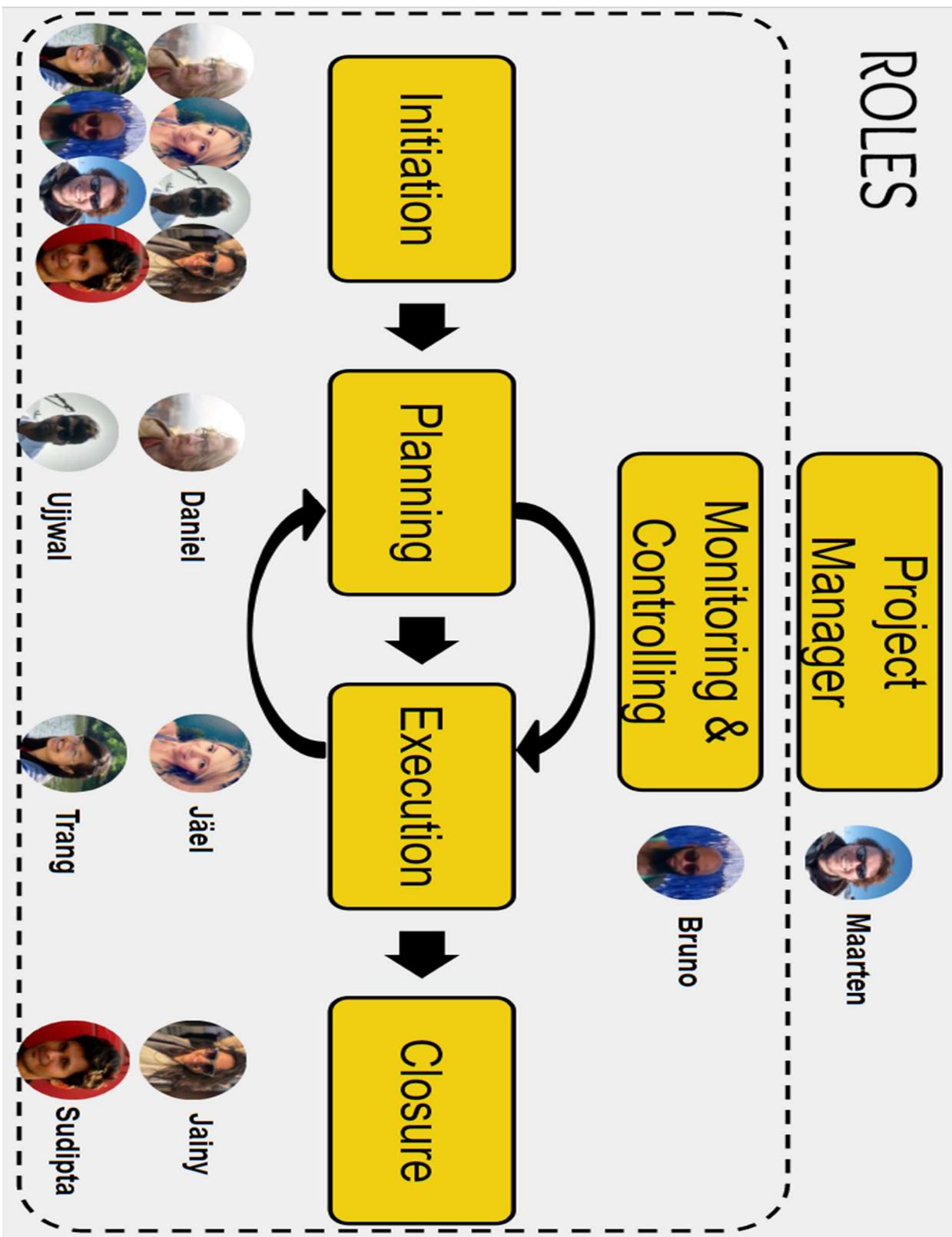
8. APPENDIX

Appendix A: Project Overview Statement

| | | | |
|-----------------------------------|---|-------------------------------|----------------------------|
| PROJECT OVERVIEW STATEMENT | Project Name: TUM Carbon Reduction Calculator | Project Number: 001 | Date: 28.01.2018 |
|-----------------------------------|---|-------------------------------|----------------------------|

| | | | | | | |
|--|--|--------------------|-------------|--|--|--|
| Project manager: | Maarten Klap | | | | | |
| Team members: | Daniel Hall, Trang Le, Jael Perz, Bruno Gaston, Sudipta Roy, Jainy Shah, Ujjwal Verma | | | | | |
| Clients/stakeholders: | TUM Weihenstephan Students and Faculty, Community of Freising, Government of Bavaria, Business in Freising | | | | | |
| Project Sponsor | Technische Universität München | | | | | |
| Problem/Opportunity | | | | | | |
| <ol style="list-style-type: none"> 1. CO2 emissions are a growing threat, along with the social and environmental factors involved in the creation of CO2. 2. There are many tools to measure CO2 emissions. However, these are not being used on a large scale. 3. People are failing to reduce their carbon footprint. 4. Our target market, TUM faculty and staff, these people try to be more CO2 conscious. 5. Current socio-political conditions call for a reduction of CO2. | | | | | | |
| Goal | | | | | | |
| <ol style="list-style-type: none"> 1. To implement a CO2 calculator to reduce 500 tons/year of CO2 from our target market. The carbon reduction calculator project will last for 18 weeks. | | | | | | |
| Objectives | | | | | | |
| <ol style="list-style-type: none"> 1. Creation, launch and implementation of CO2 calculator within 18 weeks. 2. Implement Test Public Relations Campaign for users over 1-2 weeks to reduce their carbon footprint. 3. Reduce the CO2 of calculator users. 4. Track change of carbon footprint of users. 5. Analyze user data to determine if CO2 was reduced. | | | | | | |
| Success Criteria | | | | | | |
| <ol style="list-style-type: none"> 1. Reduction of 500 tons/year by the users of the carbon calculator. 2. Regular use of the carbon calculator. 3. Response to awareness campaign. | | | | | | |
| Assumptions | | | | | | |
| <ul style="list-style-type: none"> - There will be full support by the faculty, and students in the TUM Weihenstephan campus. - Individuals will be completely honest with the information they input into the calculator. - That the project is feasible and the carbon calculator will give accurate calculations regarding user's carbon use. | | | | | | |
| Risks, Obstacles | | | | | | |
| <ul style="list-style-type: none"> - Apathy for the carbon calculator. - Risk of costs increasing during the creation of the calculator. - Accuracy of the calculator. - False Information from Users. - Technology (i.e. carbon calculator) fails to impress users. - Limited experience of team (i.e. SRM Students). - Insufficient return on the team's investment (i.e. time). | | | | | | |
| Prepared by: Daniel Hall | Date: February 1 st , 2018 | Approved by | Date | | | |

Appendix B: CRC TUM Team Structure



Appendix C: Work Breakdown Structure

| | | | |
|-----------------|-----------------------------|----------------------|---------------------------------|
| Project Name | Carbon Reduction Calculator | Date | January 31 st , 2018 |
| Project Number | 001 | Project Owner/Client | Martina Wayward |
| Project Manager | Maarten Klap | | |

| Project | Phase Level | WBS Code/ID | | Component Name | Brief Description |
|---------|-------------|-------------|--|-------------------------------------|--|
| 1 | | | | Project | Implementation of Carbon Reduction Calculator. - Maarten |
| | 1.1 | | | Phase | Initiation. (1 week) - Team |
| | | 1.1.1 | | Major Deliverable | Realize Basic Concept for Project. |
| | | 1.1.1.1 | | Work Package | Business Case Creation. (1 day) - Team |
| | | 1.1.1.1.1 | | Brainstorming | Brainstorming and business case creation for the carbon reduction calculator. (1 day) - Team |
| | | 1.1.1.2 | | Work Package | Assignment Project Manager and other project roles. (1 day) - Team |
| | | 1.1.1.3 | | Work Package | Develop Project POS, PDS and Charter. (3 days) - Team |
| | 1.2 | | | Phase | Pre-Planning. (3 weeks) - Daniel and Jainy |
| | | 1.2.1 | | Major Deliverable | Concrete Plan for the Carbon Reduction Calculator Implementation. |
| | | 1.2.1.1 | | Work Package | Perform Preliminary Planning. (2 weeks) - Daniel |
| | | 1.2.1.1.1 | | Develop WBS | Develop Work-Breakdown Structure and Risk Management Plan. (1 week) - Daniel |
| | | 1.2.1.1.2 | | Plan Schedule | Develop Gantt Chart, Network Plan. (2 days) - Daniel, Sudipta |
| | | 1.2.1.1.3 | | Resource Plan | Develop Resource Plan and Milestones (3 days) - Maarten and Jainy |
| | | 1.2.1.2 | | Work Package | Market Analysis of Carbon Reduction Applications. (2 weeks) - Jael |
| | | 1.2.1.2.1 | | Develop Market Analysis Tool | Create a Calculator/App Comparable Table to analyze other applications on the market.(2 days) - Ujjwal |
| | | 1.2.1.2.2 | | Complete Market Analysis | Analyze and determine what is important and missing in other applications (7 days). - Bruno and Jael |
| | | 1.2.1.2.3 | | Market Analysis Recommendation | Determine where the need in the carbon calculation market is and pick the niche.(1 day) - Bruno and Jael |
| | | 1.2.1.3 | | Work Package | Develop 1 st Stage Carbon Calculator. (1 week) - Bruno |
| | | 1.2.1.3.1 | | Develop 1st Stage Carbon Calculator | Write initial syntax for internet Carbon Calculator.(5 days) - Bruno |
| | 1.3 | | | Phase | Rough Concept. (10 weeks) - Sudipta and Jael |

| | | | | | | |
|--|------------|---------|-----------|--|-------------------|---|
| | | 1.3.1. | | | Major Deliverable | Develop Second Stage of Carbon Calculator and PR Test. |
| | | 1.3.1.1 | | | Work Package | Develop Calculator Feedback System (1 week) - Trang |
| | | | 1.3.1.1.1 | Create Feedback System | | Create a feedback system for users of the carbon calculator. (i.e. customer support system) (3 days) - Trang and Jael |
| | | | 1.3.1.1.2 | Begin Feedback Response System | | Allow for input on perceived problems of the calculator from team. (2 days) - Bruno |
| | | 1.3.1.2 | | Work Package | | Create 2 nd Stage of Carbon Calculator. (8 weeks) - Bruno |
| | | | 1.3.1.2.1 | Build on first stage on Carbon Calculator | | Continue to build on syntax of 1 st Stage. (4 weeks) - Bruno |
| | | | 1.3.1.2.2 | Conduct 1st Calculator Stress Test | | Conduct testing within CRC Team on Calculator. Look for bugs, broken links, issues with syntax, issues with server storage, etc.(2 weeks) - Sudipta and Bruno |
| | | | 1.3.1.2.3 | Complete Second Stage Carbon Calculator. | | Finish stress testing and fix problems any problems discovered. (2 weeks) - Sudipta and Bruno |
| | | 1.3.1.3 | | Work Package | | Awareness Campaign - PR Test. (1,5 weeks) - Jael and Trang |
| | | | 1.3.1.3.1 | Public Relations Survey (H0) | | Survey SRM (1 day) - Jael |
| | | | 1.3.1.3.2 | Public Education | | Broaden SRM's knowledge about CO2 footprints, environmental impacts, tips,etc. (2 days) - Trang |
| | | | 1.3.1.3.3 | Announcement of Carbon Calculator | | Announce to SRM that the Calculator will be launched in phase 5. Encourage people to use. (1 week) - Jael |
| | | 1.3.1.4 | | Work Package | | Team Presentation of Rough Concept.(1 week) - Maarten |
| | | | 1.3.1.4.1 | Prepare Presentation | | Preparation of presentation. (3 days) - Maarten, Bruno and Jainy |
| | | | 1.3.1.4.2 | Team Feedback Session | | Elaborate on the development of the project. Allow for feedback in round table discussion. Discern where problems have arisen. (1 day) - Team |
| | | | 1.3.1.4.3 | Presentation of 2 nd Stage of Carbon Calculator | | Thorough presentation of the carbon calculator, focus on use, how to use, data collection, etc. (1 day) - Bruno |
| | 1.4 | | | Phase | | Detailed Concept. (5 weeks) - Ujjwal and Maarten |
| | 1.4.1 | | | Major Deliverable | | Develop 3 rd stage of Carbon Calculator. |
| | | 1.4.1.1 | | Work Package | | Implement feedback from phase three stress testing. (2 weeks) - Bruno |
| | | | 1.4.1.1.1 | Inform and Review | | Team discussion on feedback and how it will be implemented into the project.(1 |

| | | | | | |
|------------|------------|---------|-----------|---|---|
| | | | | | day) - Team |
| | | | 1.4.1.1.2 | Implement Feedback | Implement feedback into project. (9 days) - Bruno and Jael |
| | | 1.4.1.2 | | Work Package | Complete Detailed Master Plan.(2 weeks) - Maarten |
| | | | 1.4.1.2.1 | Project Run Through | Complete run through of project, final addition moment for project. (5 days). - Team |
| | | | 1.4.1.2.2 | Final Implementation Plan | Create final version of the implementation plan with users (5 days). - Maarten |
| | | 1.4.1.3 | | Work Package | Develop 3rd Stage Carbon Calculator.(1 week) - Bruno |
| | | | 1.4.1.3.1 | 3rd Stage Carbon Calculator and Stress Test | Include implementations from final feedback and 3 round of calculator update/design. Stress test calculator before moving onto next phase. This is final phase of testing and updating the calculator. (5 days) - Bruno |
| 1.5 | | | | Phase | Realization. (2,5 weeks) - Bruno |
| | | 1.5.1 | | Major Deliverable | Implement Calculator with Users and Data Analysis |
| | | | 1.5.1.1 | Work Package | Implement Calculator with User Base. (1,5 weeks) - Daniel and Jainy |
| | | | 1.5.1.1.1 | Calculator Implementation /User Training | Implement calculator with users and teach participants how to use correctly.(1 day) - Bruno and Jael |
| | | | 1.5.1.1.2 | User Experience | Allow users to use full calculator application to track Co2 emissions. (7 days) |
| | | | 1.5.1.2 | Work Package | Begin Data Analysis on Users. (1 week) - Ujjwal and Sudipta |
| | | | | 1.5.1.2.1 | Collect Data |
| | | | | | Begin analyzing data that is obtained from users and start tracking CO2 emissions. (5 days) - Ujjwal,Daniel, Sudipta and Jainy |
| | | | | 1.5.1.2.2 | PR follow up survey (H1) |
| | | | | | Survey H1 measuring user's reactions and reviews after using the Calculator (1 day) - Jael and Trang |
| | | | | 1.5.1.2.3 | Evaluation of PR Sample |
| | 1.6 | | | Phase | Closeout (0.8 week) - Maarten |
| | | 1.6.1 | | Major Deliverable | Wrap Up Project |
| | | | 1.6.1.1 | Work Package | Compute and Monitor Data from Users. - Ujjwal, Sudipta and Jainy |
| | | | | 1.6.1.1.1 | Monitor Data |
| | | | | | Monitor user's data and provide feedback for improvement. (2 days) |
| | | | 1.6.1.2 | Work Package | Close Out Project Specific Team Functions. (1 day) - Team |
| | | | 1.6.1.3 | Work Package | Wrap up Project. (1 day) - Team |
| | 1.7 | | | Phase | Awareness Campaign - PR scaled up to TUM Campus (8 weeks) - Jael and |

| | | | | | Trang |
|--|-------|---------|-----------|-----------------------------|--|
| | 1.7.1 | | | Major Deliverable | Expand the PR to full TUM. |
| | | 1.7.1.1 | | Work Package | PR Awareness Campaign at TUM campuses. (8 weeks) - Jael and Trang |
| | | | 1.7.1.1.1 | Public Education | Broaden TUM students' knowledge about CO2 footprints, environmental impacts, tips,... (8 weeks) - Jael and Trang |
| | | | 1.7.1.1.2 | Implement of the Calculator | Introduce to TUM students about the Calculator, instruct them to use it to track their own CO2 (8 weeks) - Bruno |
| | | | 1.7.1.1.3 | Complete PR Campaign | Evaluation Public Relations TUM Project - Jael and Trang |
| | | | 1.7.1.1.4 | PR Evaluation | Evaluation of Public Relations Campaign TUM Campus - Team |

*Note: one work day = eight hours (Limited Work Schedule)

*Note: one week = five working days (Mo-Sun)

Appendix D: Milestones

| Phase: | Milestone(s) (chronological order): | Work packages completed: |
|--|--|---|
| <u>Phase 1 – Initiation</u> | <ol style="list-style-type: none"> 1. Business case creation. 2. Team assignments. 3. Basic Planning. | <ol style="list-style-type: none"> 1. <i>Creation Business Case.</i> 2. <i>Assignment Project Manager and other project roles.</i> 3. <i>Develop Project POS, PDS and Charter.</i> |
| <u>Phase 2 – Pre- Planning</u> | <ol style="list-style-type: none"> 1. Concrete Plan for the Carbon Reduction Calculator Implementation. 2. Market Analysis of Carbon Reduction Applications. | <ol style="list-style-type: none"> 1. <i>Perform Preliminary Planning.</i> 2. <i>Market Analysis of Carbon Reduction Applications.</i> 3. <i>Develop 1st Stage Carbon Calculator.</i> |
| <u>Phase 3 - Rough Concept</u> | <ol style="list-style-type: none"> 1. Develop Second Stage of Carbon Calculator. 2. Awareness Campaign - PR Test. | <ol style="list-style-type: none"> 1. <i>Develop Calculator Feedback System.</i> 2. <i>Create 2nd Stage of Carbon Calculator.</i> 3. <i>Awareness Campaign - PR Test.</i> |
| <u>Phase 4 – Detailed Concept*</u> | <ol style="list-style-type: none"> 1. Implement feedback from phase three stress testing. 2. Develop 3rd Stage Carbon Calculator. | <ol style="list-style-type: none"> 1. <i>Implement feedback from phase three stress testing.</i> 2. <i>Complete Detailed Final Implementation Plan.</i> 3. <i>Develop 3rd Stage Carbon Calculator.</i> |
| <u>Phase 5 – Realization</u> | <ol style="list-style-type: none"> 1. Implement Calculator with User Base. 2. Begin Data Analysis on User. | <ol style="list-style-type: none"> 1. <i>Implement Calculator with User Base.</i> 2. <i>Begin Data Analysis on User.</i> |
| <u>Phase 6 – Close Out</u> | <ol style="list-style-type: none"> 1. Compute & Compare data. 2. End presentation. 3. Discharge team-leader. 4. End Project. | <ol style="list-style-type: none"> 1. <i>Computing data.</i> 2. <i>Closing out teams functions.</i> 3. <i>Wrap up.</i> 4. <i>End Presentation.</i> |
| <u>Phase 7 - Awareness Campaign - PR scaled up to TUM Campus</u> | <ol style="list-style-type: none"> 1. PR Awareness Campaign at TUM campuses. | <ol style="list-style-type: none"> 1. <i>PR Awareness Campaign at TUM campuses.</i> |

Appendix E: Financial Plan

| Project Task (workpackages) | Labor Hours (h) | Labor Cost (€/h) | Material Cost (€) | Travel Cost (€) | Other Costs (€) | Total per Task (€) |
|--|-----------------|------------------|-------------------|-----------------|-----------------|--------------------|
| Phase 1: Initiation | | | | | | |
| 1.1 Business Case Creation | 8 | 120,- | x | x | x | 180,- |
| 1.2 Assignment of Project Manager and Other Project Roles | 8 | 120,- | x | x | x | 120,- |
| 1.3 Develop Project POS, PDS and Charter | 24 | 360,- | x | x | x | 360 |
| Subtotal: | 40 | 600,- | x | x | x | 600,- |
| Phase 2: Pre-Planning | | | | | | |
| 2.1 Perform Preliminary Planning | 80 | 1200,- | x | x | x | 600,- |
| 2.2 Market Analysis of Carbon Reduction Applications | 80 | 1200,- | x | x | x | 1200,- |
| 2.3 Develop 1st Stage Carbon Calculator | 40 | 600,- | x | x | x | 600 |
| Subtotal: | 200 | 3000,- | x | x | x | 3000,- |
| Phase 3: Rough Concept | | | | | | |
| 3.1 Develop Calculator Feedback System | 40 | 600,- | x | x | x | 360,- |
| 3.2 Create 2nd Stage Carbon Calculator | 320 | 4800,- | x | x | x | 4440,- |
| 3.3 Create Awareness Campaign - PR Test | 60 | 900,- | 200,- | x | 50,- | 850,- |
| 3.4 Presentation of Rough Concept | 40 | 600,- | x | x | x | 600,- |
| Subtotal: | 460 | 6900,- | 200,- | x | 50,- | 7150,- |
| Phase 4: Detailed Concept | | | | | | |
| 4.1 Implement Feedback from Phase Three Stress Testing | 80 | 1200,- | x | x | x | 1200,- |
| 4.2 Complete Detailed Master Plan | 80 | 1200,- | x | x | x | 1200,- |
| 4.3 Develop 3rd Stage Carbon Calculator | 40 | 600,- | x | x | x | 600,- |
| Subtotal: | 200 | 3000,- | x | x | x | 3000,- |
| Phase 5: Realization | | | | | | |
| 5.1 Implement Calculator with User Base | 60 | 900,- | x | x | x | 300,- |
| 5.2 Begin Data Analysis on Users | 40 | 600,- | x | x | x | 300,- |
| Subtotal: | 100 | 1500,- | x | x | x | 1500,- |
| Phase 6: Implementation/Closeout | | | | | | |
| 6.1 Compute and Monitor Data from Users | 16 | 240,- | x | x | x | 960,- |
| 6.3 Close Out Project Specific Team Functions | 8 | 120,- | x | x | x | 140,- |
| 6.4 Wrap up Project | 8 | 120,- | x | x | x | 140,- |
| Subtotal: | 32 | 480,- | x | x | x | 480,- |
| Phase 7: Awareness Campaign Scaled Up to TUM Campus | | | | | | |
| 7.1 Start Awareness Campaign | 160 | 2400,- | 220,- | 200,- | 150,- | 3070,- |
| Subtotal: | 160 | 2400,- | 220,- | 200,- | 150,- | 3070,- |
| Total: | 1192 | 17880,- | 420,- | 200,- | 200,- | 18800,- |
| Contingency Plan Total (+10%): | | | | | | 21000,- |

Appendix F: Resource Plan

| | Resource Type | Source | Necessities* | 1: Technical resources. 2: Natural resources. 3: Infrastructure. 4: Time (156h). 5: Human resources. | Extra Cost Estimate (€) | Quantity (people) | Hours Required (4) | Controller |
|---|-----------------|-------------------|---|--|-------------------------|-------------------|--------------------|------------------|
| Phase 1: Initiation | | | | | | | | Maarten |
| 1.1 Business Case Creation | Project Manager | Internal | 1: Computers: Google drive, Smartphones: whatsapp. 2: - 3: Meeting room (10p). 4: 8h. 5: Full team. | 1: - 2: - 3: - 4: 120,- 5: - | | 8 | 8 | Maarten |
| 1.2 Assignment of Project Manager and Other Project Roles | Manager(s) | Internal | 1: Computers: Google drive, Smartphones: whatsapp. 2: - 3: Meeting room (10p). 4: 8h. 5: Project Manager(s) - Project Management Experience. | 1: - 2: - 3: - 4: 120,- 5: - | | 1 | 8 | Maarten |
| 1.3 Develop Project POS, PDS and Charter | Manager(s) | Internal | 1: Computers: Google drive, Smartphones: whatsapp. 2: - 3: Meeting room (10p). 4: 24h. 5: Full team. | 1: - 2: - 3: - 4: 120,- 5: - | | 8 | 24 | Maarten |
| Phase 2: Pre-Planning | | | | | | | | Jainy & Daniel |
| 2.1 Perform Preliminary Planning | Manager(s) | Internal | 1: Computers: Google drive, Smartphones: whatsapp. 2: - 3: Meeting room (10p). 4: 80h. 5: Manager(s) - Project Management Experience. | 1: - 2: - 3: - 4: 1200,- 5: - | | 2 | 80 | Daniel |
| 2.2 Market Analysis of Carbon Reduction Applications | Data Expert(s) | Internal/External | 1: Computers: Google drive, Apps: Carbon Calculator. 2: - 3: Meeting room (10p). 4: 80h. 5: Data Expert(s) - Big Data Computation Experience. | 1: - 2: - 3: - 4: 1200,- 5: - | | 3 | 80 | Jäel |
| 2.3 Develop 1st Stage Carbon Calculator | Developer(s) | Internal/External | 1: Computers: Google drive, Developing: Coding Software. 2: - 3: - 4: 40h. 5: Developer(s) - Coding Experience. | 1: - 2: - 3: - 4: 600,- 5: - | | 1 | 40 | Bruno |
| Phase 3: Rough Concept | | | | | | | | Jäel and Sudipta |
| 3.1 Develop Calculator Feedback System | Data Expert(s) | Internal | 1: Computers: Google drive, Apps: Carbon Calculator. 2: - 3: Meeting room (10p). 4: 40h. 5: Data Expert(s) - Big Data Computation Experience. | 1: - 2: - 3: - 4: 600,- 5: - | | 2 | 40 | Trang |
| 3.2 Create 2nd Stage Carbon Calculator | Developer(s) | Internal/External | 1: Computers: Google drive, Developing: Coding Software. 2: - 3: - 4: 320h. 5: Developer(s) - Coding Experience. | 1: - 2: - 3: - 4: 4800,- 5: - | | 3 | 320 | Bruno |
| 3.3 Create Awareness Campaign - PR Test | PR-Expert(s) | Internal | 1: Social Media Marketing, Calculator Release Session SRM, Printing, Interactive Campaign. 2: Food - Snacks. 3: Meeting room (10p). 4: 60h. 5: PR-Expert(s) - Public Relation Experience. | 1: 200,- 2: 50,- 3: - 4: 900,- 5: - | | 5 | 60 | Jäel & Trang |
| 3.4 Presentation of Rough Concept | Manager(s) | Internal | 1: Computers: Prezi. 2: - 3: Meeting room (10p). 4: 80h. 5: Manager(s) - Public Speaking Experience. | 1: - 2: - 3: - 4: 600,- 5: - | | 2 | 40 | Maarten |

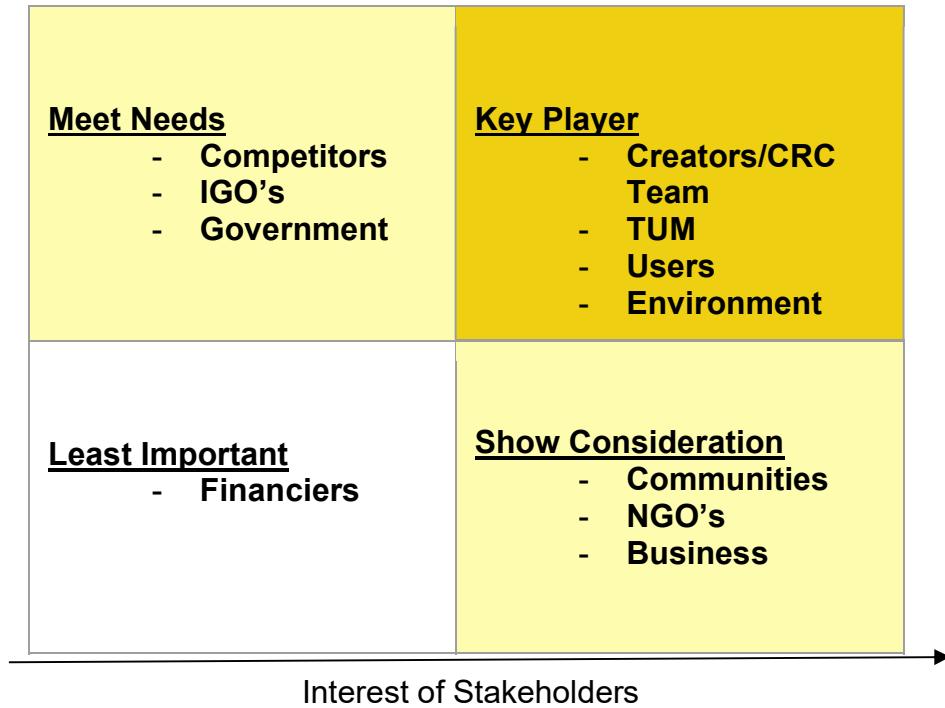
| Phase 4: Detailed Concept | | | | | | | | Ujjwal & Maarten |
|--|-----------------|-------------------|--|---|---|-----|------------------|------------------|
| 4.1 Implement Feedback from Phase Three Stress Testing | Data Expert(s) | Internal | 1: Computers: Google drive, Feedback System: SPSS, Excel. 2: - 3: Meeting room (10p). 4: 80h. 5: Data Expert(s) - Big Data Computation Experience. | 1: - 2: - 3: - 4: 1200,- 5: - | 3 | 80 | Bruno | |
| 4.2 Complete Detailed Master Plan | Manager(s) | Internal | 1: Computers: Google drive, Software: Microsoft Project. 2: - 3: Meeting room (10p). 4: 80h. 5: Manager(s) - Project Management Experience. | 1: - 2: - 3: - 4: 1200,- 5: - | 3 | 80 | Maarten | |
| 4.3 Develop 3rd Stage Carbon Calculator | Developer(s) | Internal/External | 1: Computers: Google drive, Developing: Coding Software. 2: - 3: - 4: 40h. 5: Developer(s) - Coding Experience. | 1: - 2: - 3: - 4: 600,- 5: - | 2 | 40 | Bruno | |
| Phase 5: Realization | | | | | | | | Bruno |
| 5.1 Implement Calculator with User Base | Manager(s) | Internal | 1: Computers: Google drive, Social Media: Facebook, LinkedIn, Instagram. 2: - 3: Meeting room (10p). 4: 60h. 5: Manager(s) - Public Management Experience. | 1: - 2: - 3: - 4: 900,- 5: - | 2 | 60 | Jainy & Daniel | |
| 5.2 Begin Data Analysis on Users | Data Expert(s) | Internal | 1: Computers: Google drive, Feedback System: SPSS, Excel. 2: - 3: Meeting room (10p). 4: 40h. 5: Data Expert(s) - Big Data Computation Experience. | 1: - 2: - 3: - 4: 600,- 5: - | 3 | 40 | Sudipta & Ujjwal | |
| Phase 6: Implementation/Closeout | | | | | | | | |
| 6.1 Compute and Monitor Data from Users | Data Expert(s) | Internal | 1: Computers: Google drive, Feedback System: SPSS, Excel. 2: - 3: Meeting room (10p). 4: 16h. 5: Data Expert(s) - Big Data Computation Experience. | 1: - 2: - 3: - 4: 240,- 5: - | 3 | 16 | Sudipta & Ujjwal | |
| 6.3 Close Out Project Specific Team Functions | Manager(s) | Internal | 1: Computers: Google drive, Smartphones: WhatsApp. 2: - 3: Meeting room (10p). 4: 8h. 5: Project Manager(s) - Project Management Experience. | 1: - 2: - 3: - 4: 120,- 5: - | 1 | 8 | Maarten | |
| 6.4 Wrap up Project | Project Manager | Internal | 1: Computers: Google drive, Smartphones: WhatsApp. 2: - 3: Meeting room (10p). 4: 8h. 5: Project Manager(s) - Project Management Experience. | 1: - 2: - 3: - 4: 120,- 5: - | 1 | 8 | Maarten | |
| Phase 7: PR - Scaled Up to TUM Campus | | | | | | | | |
| 7.1 Start Awareness Campaign | PR-Expert(s) | Internal/External | 1: Interactive Campaign Calculator, CO2 Talks, Social Media Marketing, Calculator Info Booths. 2: Food - Snacks. 3: Meeting room (10p). 4: 160h. 5: PR-Expert(s) - Public Relation Experience. | 1: 200,- 2: 250,- 3: 220,- 4: 2400,- 5: - | 5 | 160 | Jael & Trang | |

Appendix G: SWOT Analysis (Strengths, Weaknesses, Opportunities and Threats)

| Strengths | Weaknesses |
|---|--|
| <ul style="list-style-type: none"> • Easy Concept • Low-Cost • Education | <ul style="list-style-type: none"> • Not Advanced • Experience • Scale |
| Opportunities | Threats |
| <ul style="list-style-type: none"> • Growth in Public Interest • Behaviour Change • Reduction of Carbon • External Advisors | <ul style="list-style-type: none"> • Accuracy • Competitor Applications • Apathy amongst Users and Public |

Appendix H: Stakeholder Analysis





List:

- 1) Creators/CRC Team
- 2) TUM – At this moment the focus will be on the Weihenstephan Campus.
- 3) Users – Generally thought as of SRM students and faculty
- 4) Communities
- 5) NGO's
- 6) Business
- 7) Competitors
- 8) IGO's
- 9) Government
- 10) Environment
- 11) Financiers

Appendix I: Risk Analysis

| Risk Event | Damage/ Impact | Probability (Low, Medium, High) | Preventative Measure | Corrective Measure | Monitor and Control |
|--|---------------------------|---------------------------------|---|--|---|
| Delayed development of planning phase. | Time Delay | Low (0-29%) | Create atmosphere of support within the CRC TUM project team. | Rearrange team members to speed up the planning phase. | Project Manager monitor and determine if the planning phase is moving according to schedule. |
| Delayed creation of market analysis tool | Time Delay/ Monetary Cost | Low (0-29%) | Set deadline. Create support system. | Hire external support system. Rearrange team members to support the creation of market analysis tool. | Project Manager monitors the creation of the market analysis tool. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Delayed initial calculator syntax | Time Delay/ Monetary Cost | Low (0-29%) | Set fixed deadline. Create support system for syntax writing. | Hire external support system. Rearrange team members to support with syntax creation. | Project Manager monitors the creation of the market analysis tool. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Delayed development of feedback system | Time Delay/ Monetary Cost | Low (0-29%) | Set fixed deadline. Create support team for feedback system development. | Extend deadline for feedback system development. Hire external. Create support system by rearranging resources within the project. | Project Manager monitors the creation of the feedback system. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Failure of feedback in public relations test. | Time Delay/ Monetary Cost | Low (0-29%) | Create contingency plan for PR test. This includes other communication techniques and target markets. | Utilize a second PR campaign. Hire external support. | Project Manager monitors the feedback. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Delayed second stage calculator syntax development | Time Delay/ Monetary Cost | Medium (30-69%) | Set fixed deadline. Create support system for syntax write. | Hire External Create Support System by rearranging resources within the project. | Project Manager monitors the second stage syntax development. Monitors the deadline. Determines what resources will be used in case of risk event. |

| | | | | | |
|--|--|---------------------|--|--|--|
| Delayed stress test on second stage calculator | Time Delay/ Monetary Cost | High (70 - 100%) | Halt all other tasks, focus on stress test completion. | Hire External Create support system by rearranging resources within the project. | Project Manager monitors the second stage stress test. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Delayed implementation of feedback from phase three into project | Time Delay/ Monetary Cost | Low (0-29%) | Set Fixed Deadline. | Hire External Create support system by rearranging resources within the project. | Project Manager monitors the implementation of feedback. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Delayed stress test on third of stage calculator | Time Delay/ Monetary Cost | High (70-100%) | Halt all other tasks, focus on stress test completion. | Hire External Help. - IT - Program Engineers | Project Manager monitors the stress test. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Bad rollout/Implementation of Calculator with User Base | Loss of Trust/ Time Delay/ Money Cost | Medium (30-69%) | Create communication channel with users. Focus all efforts on users. Halt other tasks until implementation is completed. | Hire External Support Teams. - IT - Communications | Project Manager monitors the implementation with user base. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Difficulty with data collection storage | Money Cost | Low (0-29%) | Create a back data collection server. | Hire an external cloud server system. | Project Manager monitors the data collection. Monitors the deadline. Determines what resources will be used in case of risk event. |
| Disrupted TUM campus public relations campaign | Money Cost/ Message Delay | Low (0- 29%) | Contingency plan for alternative forms of communication. | Create a longer awareness campaign. Hire an external public relations firm. | Project Manager monitors the public relations campaign. Monitors the deadline. Determines what resources will be used in case of risk event. |

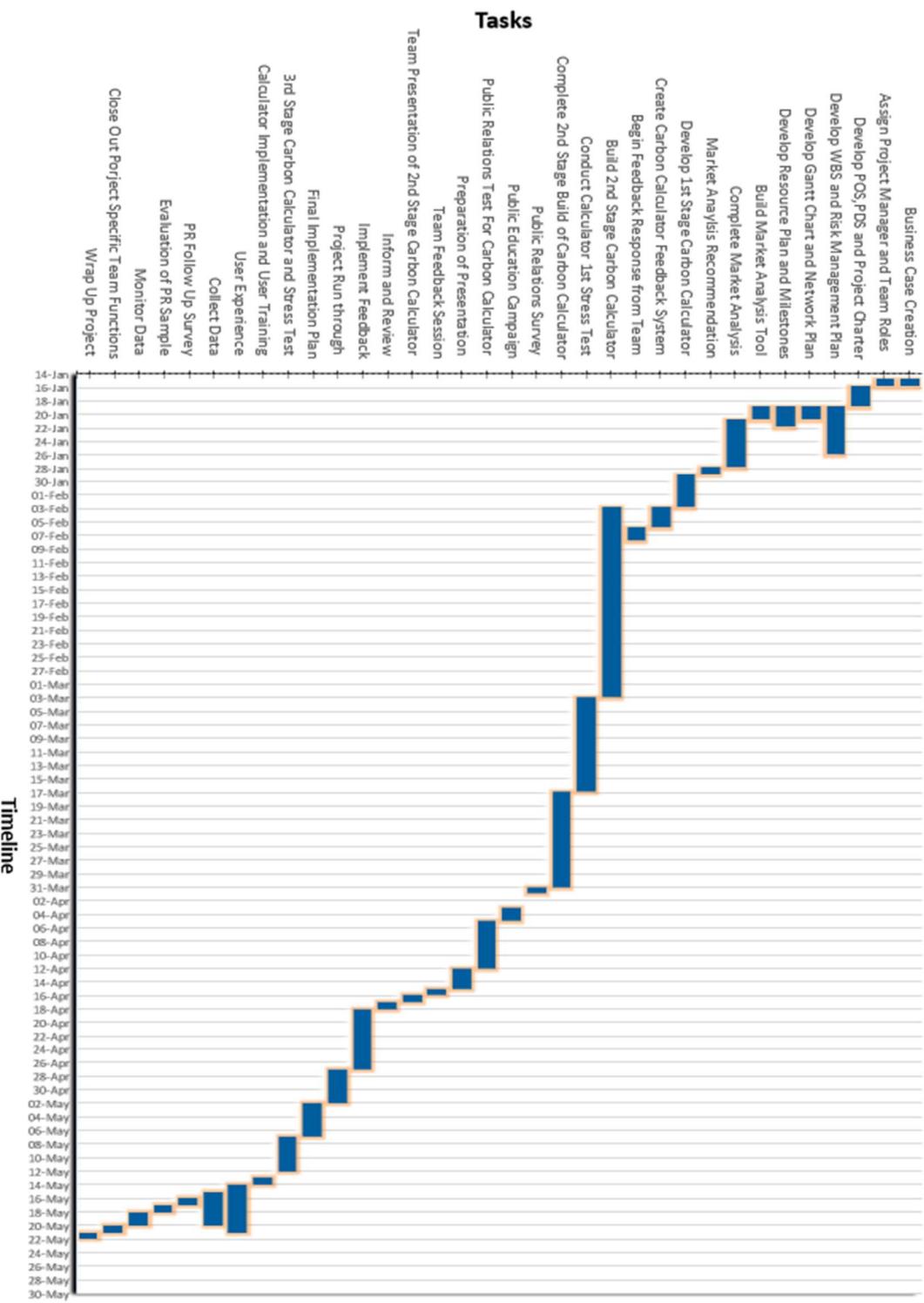
Appendix J: Gantt Chart

| Task | Start Date | Duration | End Date |
|--|------------|----------|----------|
| Business Case Creation | 15-Jan | 1 | 16-Jan |
| Assign Project Manager and Team Roles | 15-Jan | 1 | 16-Jan |
| Develop POS,PDS and Project Charter | 16-Jan | 3 | 19-Jan |
| Develop WBS and Risk Management Plan | 19-Jan | 7 | 26-Jan |
| Develop Gantt Chart and Network Plan | 19-Jan | 2 | 21-Jan |
| Develop Resource Plan and Milestones | 19-Jan | 3 | 22-Jan |
| Build Market Analysis Tool | 19-Jan | 2 | 21-Jan |
| Complete Market Analysis | 21-Jan | 7 | 28-Jan |
| Market Analysis Recommendation | 28-Jan | 1 | 29-Jan |
| Develop 1st Stage Carbon Calculator | 29-Jan | 5 | 03-Feb |
| Create Carbon Calculator Feedback System | 03-Feb | 3 | 06-Feb |
| Begin Feedback Response from Team | 06-Feb | 2 | 08-Feb |
| Build 2nd Stage Carbon Calculator | 03-Feb | 28 | 03-Mar |
| Conduct Calculator 1st Stress Test | 03-Mar | 14 | 17-Mar |
| Complete 2nd Stage Build of Carbon | 17-Mar | 14 | 31-Mar |
| Public Relations Survey | 31-Mar | 1 | 01-Apr |
| Public Education Campaign | 03-Apr | 2 | 05-Apr |
| Public Relations Test For Carbon Calculator | 05-Apr | 7 | 12-Apr |
| Preparation of Presentation | 12-Apr | 3 | 15-Apr |
| Team Feedback Session | 15-Apr | 1 | 16-Apr |
| Team Presentation of 2nd Stage Carbon Calculator | 16-Apr | 1 | 17-Apr |
| Inform and Review | 17-Apr | 1 | 18-Apr |
| Implement Feedback | 18-Apr | 9 | 27-Apr |
| Project Run through | 27-Apr | 5 | 02-May |
| Final Implementation Plan | 02-May | 5 | 07-May |
| 3rd Stage Carbon Calculator and Stress Test | 07-May | 5 | 12-May |
| Calculator Implementation and User Training | 13-May | 1 | 14-May |
| User Experience | 14-May | 7 | 21-May |
| Collect Data | 15-May | 5 | 20-May |
| PR Follow Up Survey | 16-May | 1 | 17-May |
| Evaluation of PR Sample | 17-May | 1 | 18-May |
| Monitor Data | 18-May | 2 | 20-May |
| Close Out Project Specific Team Functions | 20-May | 1 | 21-May |
| Wrap Up Project | 21-May | 1 | 22-May |
| PR Awareness Campaign at TUM Campuses | 22-May | 53 | 14-Jul |
| Implement Calculator | 22-May | 53 | 14-Jul |
| Complete PR Campaign | 14-Jul | 1 | 15-Jul |
| PR Campaign Evaluation | 14-Jul | 1 | 15-Jul |

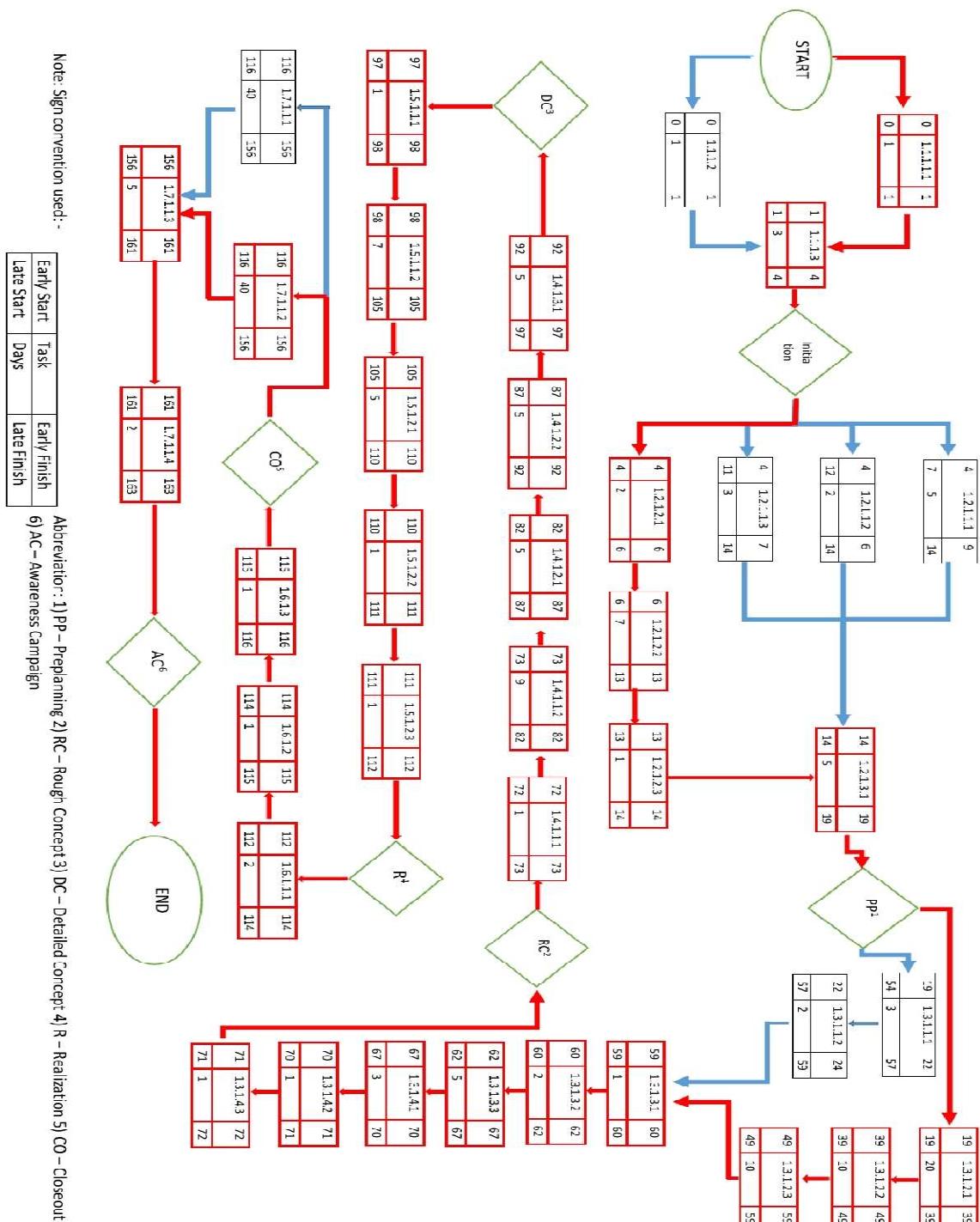
Holiday: April 2nd is a regional Holiday (Easter Monday)

Phase 7 - See PR-Time Line

Carbon Reduction Challenge Time Plan (GANTT Chart)



Appendix K: Network Plan and Critical Path



Abbreviation: 1) PP – Preplanning 2) RC – Rough Concept 3) DC – Detailed Concept 4) R – Realization 5) CO – Closeout

Appendix L: Market Analysis

| | | | Application 1 | Application 2 | Application 3 | Application 4 | Application 5 | Application 6 | Application 7 | Application 8 | Application 9 | Application 10 | Application 11 | Application 12 | Application 13 | Application 14 | Application 15 |
|--------|--|--|-----------------------|-------------------|------------------------------------|--------------------------|----------------|---------------------|--|-------------------------------|--------------------|---------------------------|-----------------------|-----------------------------|----------------------|-----------------------------------|------------------|
| Sl.no. | Category | Name of Application | Green Footprint Calc. | Environment Saver | Carbon Footprint | Changers | Wwf calculator | My Carbon Footprint | Environment Saver | Lotus Green Carbon Calculator | GasCal | Ausanta Offset Calculator | AOE Carbon Calculator | CO2 (UNDP) | Oreco | Count carbon | Carbon Footprint |
| 1 | | Unit of measurement (CO2) | Tons/Year | Tons/Year | Tons per flight | Scope, Off, Goals, coins | | | Tons/Year | Tons/month | CO2 (g/km) | Tons/Year | Kgs of CO2 | Tons/Year | Tons/Year | Tons/Year of CO2 | |
| 2 | Electricity | Electricity | ✓ | ✓ | X | X | X | X | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Formula used / Assessment technique | Monthly Bill | kw per year | | | | | | 100 kWh = 0.032 Tons of CO2 | | | | | | | |
| | | Required data measurement unit | No clear | | | | | | KWH per year | KWH per month | KWH | KWH | KWH | Kwh | Kah | Kah | |
| 3 | Transportation | Car (Specify type of car) | X | ✓ | X | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Formula used / Assessment technique | | | Kilometers per month | | | | | | | | | | | | |
| | | Motorbikes (Specify type of motorbikes) | X | X | X | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | X | ✓ | |
| | | Formula used / Assessment technique | | | | | | | This information is include in car specification | | | | | | | | |
| | | Public transport (Type) | X | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | X | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | | Formula used / Assessment technique | | | Kilometers per year | | | | | | | | | | | | |
| | | Required data measurement unit | | | | | | | KM per year | KMs per month | KMs, Liter of fuel | Kms | KMs | No.of Flights, Lit. of fuel | Trips Miles per Year | Flights | |
| 4 | Food | Dietary habit (vegan/veg./non-veg.) | X | ✓ | X | ✓ | ✓ | ✓ | X | ✓ | X | X | X | ✓ | ✓ | X | |
| | | Formula used / Assessment technique | | | Total meat consumers in your house | | | | | | | | | | | | |
| | | Amount of money spent on food | X | X | X | ✓ | ✓ | ✓ | X | X | X | X | X | X | X | X | |
| | | Formula used / Assessment technique | | | | | | | | | | | | | | | |
| | | Amount of food wasted | X | ✓ | X | ✓ | ✓ | ✓ | X | X | X | X | X | ✓ | X | X | |
| | | Formula used / Assessment technique | | | Total people in your home | | | | | | | | | | | | |
| | | Source of food purchased | X | X | X | ✓ | ✓ | ✓ | X | X | X | X | X | ✓ | X | X | |
| | | Formula used / Assessment technique | | | imported or not | | | | | | | | | | | | |
| | | Required data measurement unit | | | | | | | | | | | | | | organic food and how much you eat | |
| 5 | Home | Type of House | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | X |
| | | Formula used / Assessment technique | | | | | | | | | | | | | | | |
| | | No. of rooms | X | X | X | X | ✓ | ✓ | X | ✓ | ✓ | X | X | ✓ | ✓ | ✓ | X |
| | | Formula used / Assessment technique | | | | | | | | | | | | | | | |
| | | No. of people living | X | X | X | X | ✓ | ✓ | X | ✓ | ✓ | X | X | ✓ | ✓ | ✓ | X |
| | | Formula used / Assessment technique | | | | | | | | | | | | | | | |
| | | Type of heating system installed | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | X |
| | | Formula used / Assessment technique | | | | | | | | | | | | | | | |
| | | Temperature Range for Thermostat | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Formula used / Assessment technique | | | | | | | | | | | | | | | |
| | | Other rises, appliances used | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Formula used / Assessment technique | | | | | | | | | | | | | | | |
| 6 | Other additional information | Refrigerator, Fridge and phone (equipment) | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Computers and IT equipment | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Washing machine, dishwater, tumble dryer oridge freezer | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Clothes, textiles and shoes | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Textiles and other manufactured goods | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Telephone, mobile/landline, cell costs | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Pets and pet food | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Health, beauty and grooming products | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Paper based products (e.g. books, magazines, newspapers) | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Holiday, restaurants, and clubs etc | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Banking and finance (mortgage and loan interest payments) | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Insurance | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Education | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Hobbies, cultural and sporting activities | X | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| | | Recycle | ✓ | X | X | X | ✓ | ✓ | X | X | X | X | X | ✓ | ✓ | ✓ | |
| | | Assessment technique | | | | | | | | | | | | | | | |
| 7 | Additional feature the App provides (X-factor) | Description | | | | | | | | | | | | | | | |
| | | in Transportation calculate with the Bill and monthly. However, the results do not give you a good feedback. It is simple and dynamic. | | | | | | | | | | | | | | | |
| | | Calculation of CO2 for flights around the world | | | | | | | | | | | | | | | |
| | | are one time. It is dynamic, simple and the questions are relevant. It is my favorite. | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| 8 | Reviews (Negative or positive) | How good were the reviews? What were people's grievances? | 2.05.0 | 3.05.0 | 3.55.0 | 4.05 | 4.55.0 | 3.05.0 | 3.75.0 | 3.85.0 | 4.45.0 | 3.95.0 | 4.55.0 | | 45 | | |

Appendix M: Media List

| Media List | Description. Reasoning |
|---|--|
| TUM: <ul style="list-style-type: none"> • Newsletters on TUM website. • Newsletter via email. • Info screens at campuses and Mensa. • Info blackboards. • Internal mailing lists at faculties. • TUM App on mobile devices. | First of all, since our primary audience are all students at TUM, spreading our project via TUM's channels is essential. Newspapers (website, email) allow readers to quickly click on links to our webpage as well as upcoming events on Facebook page. Additionally, asking coordinators of related study programs (SRM, Environmental, Economics and Business, etc.) to send the project's introduction via internal mailing list to individual students will be a efficient way to reach out. Last but not least, we can also have a calculator download link embedded into TUM's mobile app, which is currently used by a majority of TUM students. |
| Local (Munich-area) environmental association: <ul style="list-style-type: none"> • Green City e.V. • Climate-KIC. • Greenpeace (Munich branch). | Secondly, we would like to use the official channels of Green Cities, Climate-KIC and Greenpeace. Green Cities and Climate-KIC are two associations famous for supporting result-oriented entrepreneurial projects. All of them have their online blogs and facebook pages with high numbers of followers (2600 for Green City e.V., 100.000 for Climate-KIC, and 297.737 for Greenpeace Deutschland). |
| Newspaper/magazines: <ul style="list-style-type: none"> • Abendzeitung-muenchen.de. • Süddeutsche Zeitung. • Spiegel Online. • BUND (Der Bund für Umwelt und Naturschutz Deutschland). • NABU (Nature And Biodiversity Conservation Union). • Primaklima. • DRK - Wasserwacht (in Bavaria). • Naturfreunde Deutschland. • Peta and Schutzbund Deutscher Wald. | Thirdly, we care to work with certain national and local magazines. We can introduce our calculator to the public, and increase the scope of our PR-campaign. |

Appendix N: PR Plan - Survey Questions

Q1. Are you familiar with what CO2 is?

Yes

No

Q2. Do you know, what is the sustainable amount of CO2 (in ppm - parts per million) allowed in the atmosphere?

- 200-250 ppm
- 300-350 ppm
- 400-450 ppm
- 500-550 ppm
- I don't know

Q3. Do you know the possible consequences of a surplus amount of CO2 in the atmosphere, oceans and soils? Please give examples.

Q4. Do you know how to decrease the production of CO2 in your daily life decisions? Please give examples.

Q5. Are you interested in decreasing your personal CO2 emission?

- Yes
- No

Q6. Are you willing to participate in activities, seminars and talks about CO2 reduction? Additionally would you use technical tools to help reduce your CO2 footprint? Please check the options.

- Activities
- Talks
- Seminars
- Fairs
- Apps
- Other:

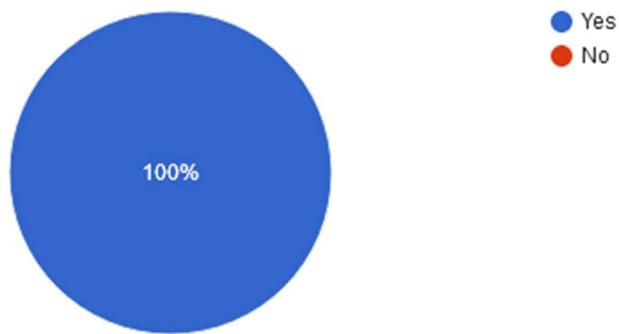
Q7. If there's a personal CO2 tracker on mobile device/web, which can help to reduce your own CO2 footprint, would you use it?

- Yes
- No
- Maybe

Appendix O: PR Survey Results

Q1. Are you familiar with what CO2 is?

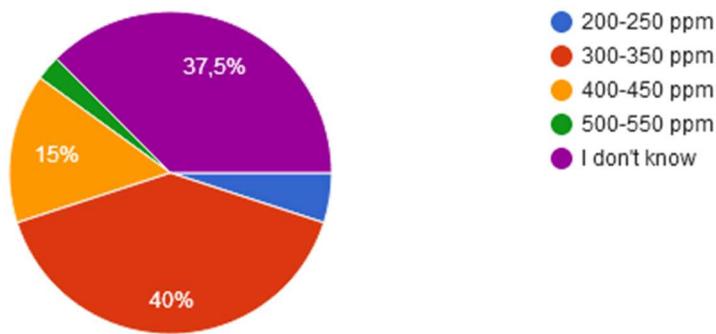
40 Antworten



So happily, 100% of 40 SRM students in our sample know that CO2 is.

Q2. Do you know, what is the sustainable amount of CO2 (in ppm - parts per million) allowed in the atmosphere?

40 Antworten



The right one is 300-350 ppm. 40% of the sample answer correctly.

Q4. Do you know how to decrease the production of CO2 in your daily life decisions? Please give examples.

40 Antworten

Public transport, efficient resource consumption

through sustainable consumption

walking rather than taking transportation

More Public transport or bike. Lesser meat consumption.

using public transportation- saving energy in my daily routines- avoid using plastic stuffs

Eat less meat

using public transport or sharing transportation for travelling, using low carbon vehicle, reduce the consumption meat and dairy products, etc.

I know only these ways but there are other ways also which i am unaware of.

Ride my bike, eat less meat (especially beef) and processed food, buy food locally, save water while taking shower or brushing teeth, recycle, but unpacked items, ...

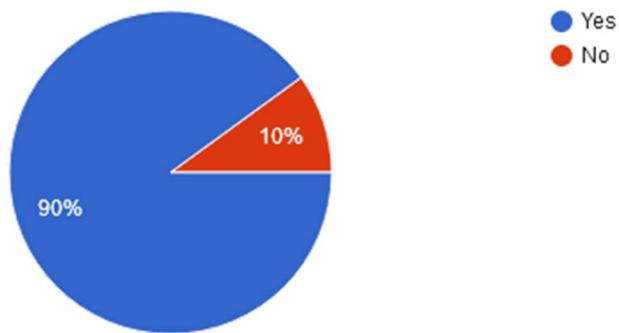
Reducing use of cars, wood, recycling wastes

burn fewer fossil fuels, don't fly, use public transit, buy in-season local foods

About half of the sample can give detailed answers. The other half answered with quite general terms or a short sentence.

Q5. Are you interested in decreasing your personal CO2 emission?

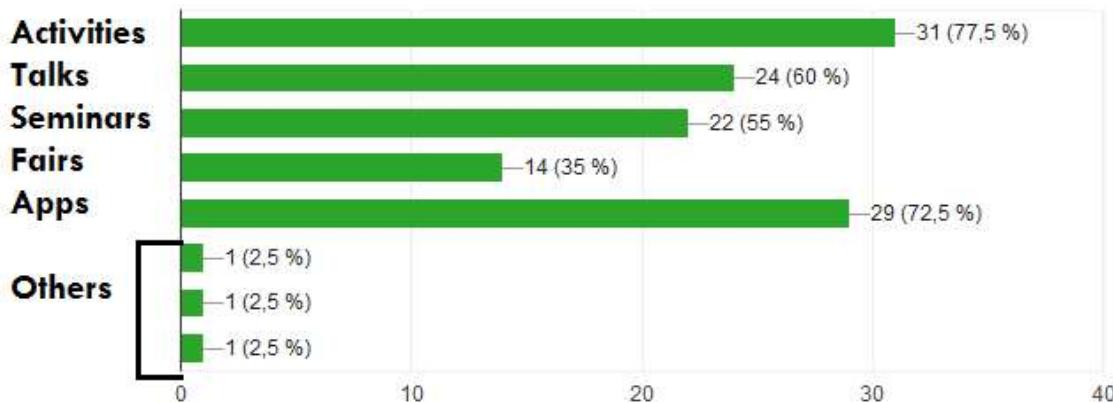
40 Antworten



90% of the sample are interested in decreasing their own CO2 footprints. Meanwhile, 10% show no interest in doing so.

Q6. Are you willing to participate in activities, seminars and talks about CO2 reduction? Additionally would you use technical tools to help reduce your CO2 footprint? Please check the options.

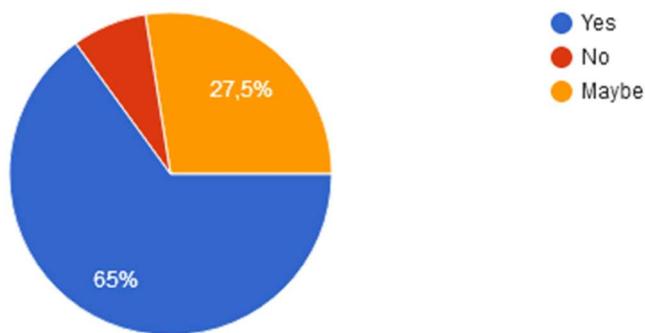
40 Antworten



The result is quite optimistic: Over 90% of the 40 people in the sample are willing to participate in extracurricular things to know more or to reduce the CO2 emission. The most voted options are interactive activities, apps, talks and seminars. Our PR Target has a right direction in making use of these in our tactics.

Q7. If there's a personal CO2 tracker on mobile device/web, which can help to reduce your own CO2 footprint, would you use it?

40 Antworten



The results show that only about 7.5% of the sample showing no interest in using a personal mobile CO2 tracker. 65% say “Yes”. Meanwhile 27.5% say “Maybe”, which may depend on how the calculator is designed (whether it is easy to use, intriguing to use) and its effectiveness in reducing CO2 footprint.

Appendix P: Public Relations Social Media Outreach

CRC Facebook Page

The Carbon Reduction Challenge CRC

Home About Photos Community Reviews Posts Create a Page

Like Send Message Share ... Send Message

Photos

Non-Governmental Organization (NGO)

Community See All

- 3 people like this
- 4 people follow this

About See All

- Contact The Carbon Reduction Challenge CRC on Messenger
- thecroproject.wixsite.com/oromunich
- Non-Governmental Organization (NGO)

People >

PROJECT IDEA
Implementation of the CO2 Calculator, which X number of individuals use to measure their personal CO2 footprint.

OBJECTIVES

1. Measure CO2 footprint of individual app users.
2. Implement successfully the CO2 Calculator.
3. Reduce CO2 footprint of the users.

SCOPE

1. SRM Students
2. TUM Weihenstephan Campus students

CRC Twitter

Tweets 1 Folge ich 98 Follower 2 Listen 0 Moments 0 Profil bearbeiten

The Carbon Reduction Challenge @Thecroproject

If we can create a carbon measuring tool for conscious consumers, we may be able to make some effective change and reduce user's carbon footprint.

Beigetreten März 2018 Fotos und Videos

Tweets **Tweets & Antworten** **Medien**

The Carbon Reduction Challenge @Thecroproject - 18. März CRC Project!

PROJECT IDEA
Implementation of the CO2 Calculator, which X number of individuals use to measure their personal CO2 footprint.

OBJECTIVES

1. Measure CO2 footprint of individual app users.
2. Implement successfully the CO2 Calculator.
3. Reduce CO2 footprint of the users.

SCOPE

1. SRM Students
2. TUM Weihenstephan Campus students

Wem folgen? Aktualisieren - Alle anzeigen

- Dieter Stein @Dieter_Stein
- Guardian Environment @GuardianEnv
- SustainAbility @SustAbility

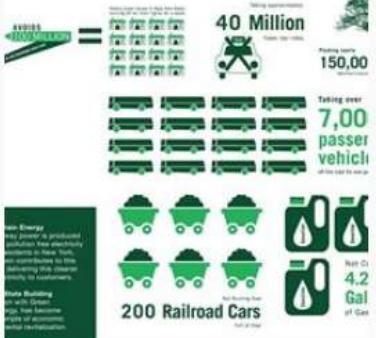
CRC Instagram



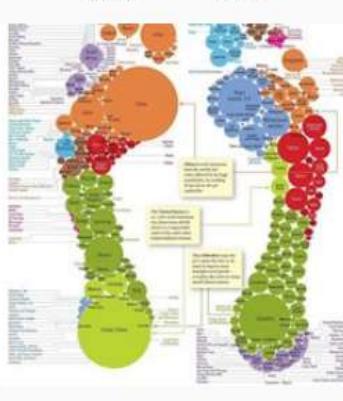
thecrc.project Edit Profile 

3 posts 9 followers 25 following

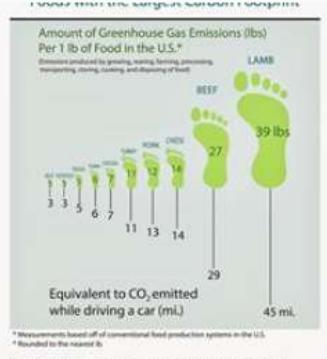
The Carbon Reduction Challenge



40 Million
Passenger Vehicles
Saved
150,000
Passenger Vehicles
Saved
7,000
Passenger Vehicles
Saved
200 Railroad Cars
Saved
4.2 Gal
of Gas
Saved



POSTS SAVED



Amount of Greenhouse Gas Emissions (lbs)
Per 1 lb of Food in the U.S.*
Emissions produced by growing, raising, farming, processing,
transporting, storing, cooking, and disposing of food

| Food Item | Amount (lbs) |
|------------------------|--------------|
| LAMB | 39 |
| BEEF | 27 |
| CHICKEN | 11 |
| EGGS | 13 |
| CHOWMEIN | 14 |
| LEMONADE | 15 |
| SPAGHETTI | 16 |
| WALNUTS | 17 |
| ORANGES | 18 |
| PEANUT BUTTER | 19 |
| AVOCADO | 20 |
| APPLES | 21 |
| PEPPERMINT CANDY | 22 |
| CHOCOLATE CHIP COOKIES | 23 |
| BAKED POTATOES | 24 |
| CHICKEN NUGGETS | 25 |
| CHICKEN FRIED STEAK | 26 |
| CHICKEN WINGS | 27 |
| CHICKEN BREAST | 28 |
| CHICKEN DINNER | 29 |

Equivalent to CO₂ emitted
while driving a car (mi.)
45 mi.

* Measurements based off of conventional food production systems in the U.S.
† Rounded to the nearest lb.

Source: Environmental Working Group's Meat Eater's Guide and the EPA's Guide to...

CRC Website

Link: www.thecrcproject.wixsite.com/crcmunich

[Home /](#)
[The Challenge /](#)
[Application Form /](#)
[Schedule /](#)
[Blog /](#)
[FAQ /](#)
[Quick Sign Up >>](#)
[Create Your WIX Site](#)

THE CARBON REDUCTION CHALLENGE

APPLY NOW!

ARE YOU READY TO
CHANGE THE WORLD?

TAKING PLACE

Opening paragraph

More description

Appendix Q: Evaluation Table

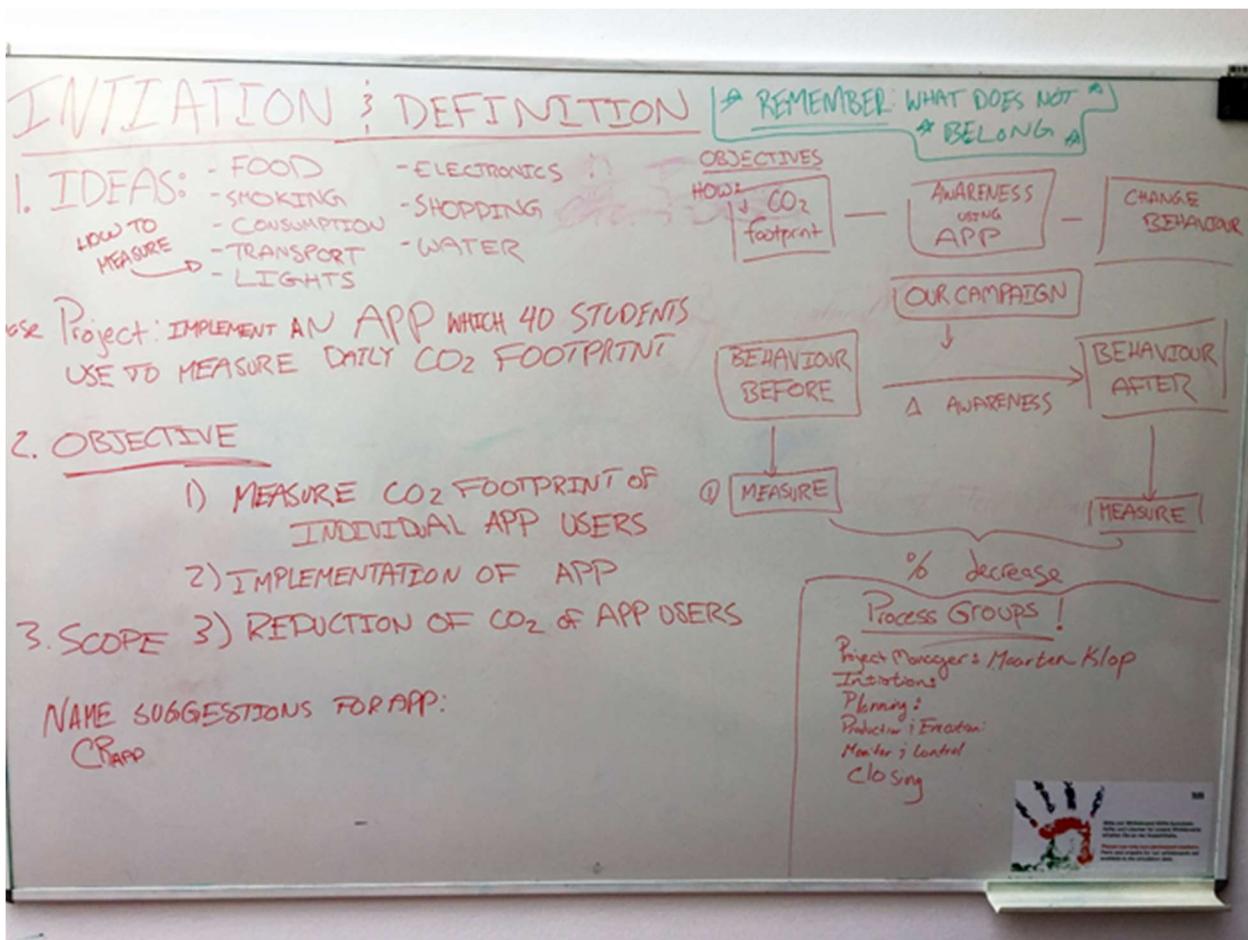
| Tactics | PR Test | PR Target |
|--|--|---|
| Surveys | <p>With 2 surveys conducted at the beginning and the end of the sample phase, we want to see:</p> <ul style="list-style-type: none"> - How people react to the usefulness of the calculator. - If the app and public education tactics have positive impacts on participants' CO2 awareness. <p>Evaluation criteria:</p> <ul style="list-style-type: none"> - Successful participation of controlled 40 students in SRMies: in answering 2 surveys, using the calculator, and joining education activities. - Difference in the 1st and 2nd survey (qualitative): <ul style="list-style-type: none"> + Increase % in correct answer for Q. "The sustainable amount of CO2 (in ppm - parts per million) allowed in the atmosphere". + More detailed and knowledge answers for the Q. "Consequences of a surplus amount of CO2 in the atmosphere, oceans and soils" and "How to decrease the production of CO2 in your daily life" + Increase in the % of "Yes" for the question: "If there's a personal CO2 tracker on mobile device/web, which can help to reduce your own CO2 footprint, would you use it?" | NA |
| CO2 Talks (+ Activity 1: CO2 carrying + Activity 2: Photography challenge) | <p>Evaluation criteria:</p> <ul style="list-style-type: none"> - All 40 participants in the sample attend - Participation of other interested students, TUM teaching staff - Increase in online mentions: facebook & instagram hashtags (#CO2talks, #crc or #meandcrc). | <p>Evaluation criteria:</p> <ul style="list-style-type: none"> - Increasing number of participants throughout each Talk (there are 3 Talks in total) - Minimum number of participants per Talk: 100 - Expected highest participant number in Munich campus: 500 - Increase in online mentions: facebook & instagram hashtags (#CO2talks, #crc |

| | | |
|---|--|---|
| | | or #meandcrc), TUM news on website, other environmental organizations' news: Climate-KIC Munich, Green City |
| Users' stories, reviews and testimonials | NA | Evaluation criteria: - Agreement of at least 15 over 40 users to share their using experience by writing testimonials or assistance/volunteer in the activities of the PR Target |
| Interviews of experts and professors of TUM | NA | Evaluation criteria: - Agreement of at least 3 experts from environmental organizations such as Climate-KIC Munich, Green City, and at least 3 TUM professors to participate |
| Implementation of the Calculator | Evaluation criteria: - All 40 sample-participants use - Receive enthusiastic feedbacks to improve the Calculator for the Target PR phase | Evaluation criteria: - Increase in number of users within 2 months up to 1000 users - Maintain a number of regular and constant users at least 300 - By tracking data: expect the regular users to reduce their CO2 footprint by 30% of their original threshold after 1 month of using the Calculator. For the total of users, expect to have the total money saved by the reduced CO2 of 5000 euro after 2 months. |
| Social Media Tracking | Evaluation criteria: - Reach number of facebook page likes/follows of at least 40 at the beginning, and 100 at the end of Sample phase | Evaluation criteria: - Reach number of facebook page likes/follows of at least 1000 after 2 months - Maintain total number of Post Reach (in facebook) at 200 per week in the first month, and 500 in the 2nd month - Increase number of individual post reach by 10%-20% throughout each week |

Appendix R: Meeting Minutes

Meeting Minutes January 15th – Brainstorming Session

Meeting Focus: Mind Map and Assignment of Project Manager



Meeting Minutes for January 19th 2018

Meeting Focus:

- Project Overview Statement, SWOT and Stakeholder Analysis. What is our project going to be. Focus on determining project responsibilities/roles.

Role Division (tentative and subject to change depending on project need):

- Project Manager - Maarten Klap
- Initiation (All)

- • Planning (Daniel, Maarten)
- • Production or execution (Bruno, Jael)
- • Monitoring & controlling (Ujjwal, Jainy)
- • Closing (Sudipta, Trang)

Building on the Mind Map planning session from January 18th 2018.

Problem/Opportunity:

- We first discussed the problems: Too much CO2 in the atmosphere, there's a lot of tools out there, but they are hardly used. As such people emit too much CO2.
- Afterwards we discussed the opportunities: use of technology to reduce people's CO2, our target group is invested environmental degradation anyways, the sociopolitical conditions demand for reductions in CO2,

Goal:

- Implement the calculator to reduce CO2, between the 20th of May 2018 and the 30th of January 2045 by 500 ton per year.

Objectives:

- Creation of app
- Launch of app.
- Awareness campaigns for users to reduce their CO2 footprint.
- Track yearly change of CO2 footprint as a result of awareness campaign.
- Make people happy.
- Calculate success gradient.

Success criteria:

- Reduction of users CO2 footprint by 500tons/year.
- Use of the calculator (continued use).
- Success of awareness campaign (awareness has increased (CO2 footprint decrease is proxy of increased awareness)).

Scope:

- TUM attendees (students, or teachers, or Sudipta).

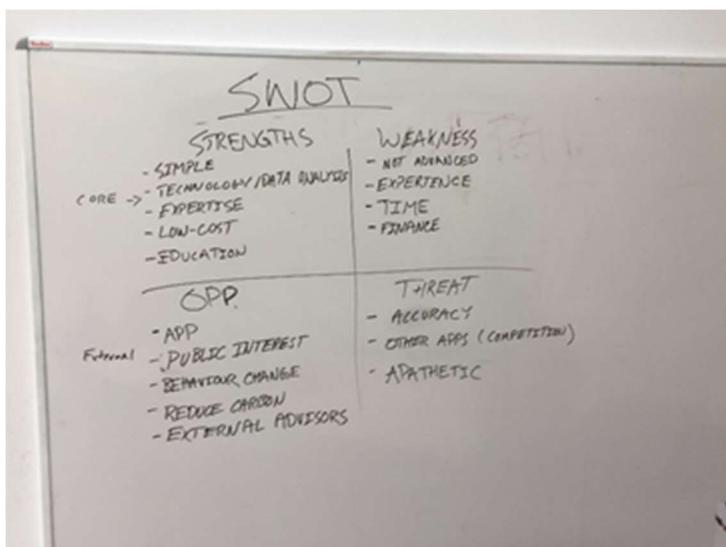
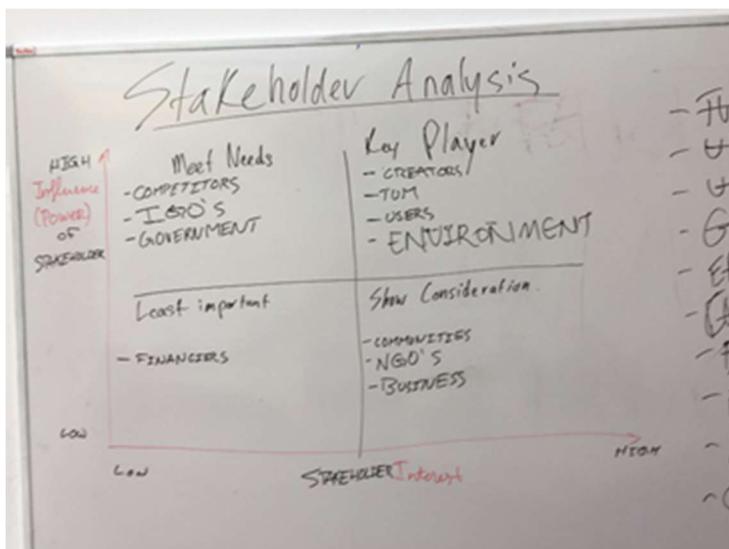
Assumptions:

- People will be interested in using the app.
- People will track their CO2 footprint – honest use of calculator.
- Project feasibility.

Risk/obstacles:

- Lack of interested.
- False information.
- Project is not feasible.
- Other calculators are better.
- No interest from stakeholders.

Stakeholders and SWOT Analysis:



Meeting Minutes January 24th and 25th 2018

Meeting Focus: Work Breakdown Structure

- (Tasks?)(Duration?)(Cost?)(Responsibility?)(Resources needed?)
- Possible WBS – Subject to change
 - o Phase 1 – Initiation
 - § Business Case
 - § Target
 - § Objective, goals, Problems, risks, etc.
 - § What's the problem and what the basic idea is
 - o Phase 2 – Pre Study
 - § Market Analysis
 - § Planning
 - § Beginning of calculator development
 - § Project order
 - § Org structure – creation of teams (monitoring, controlling)
 - § Proposal
 - o Phase 3 - Rough Concept
 - § Elaboration of feasibility
 - § Rough sample of calculator
 - § Calculator testing,
 - § Creation of awareness campaign
 - § Introduce Feedback
 - § Presentation of Master Plan
 - o Phase 4 – Detailed Concept*
 - § Receiving Feedback
 - § Implement Feedback
 - § Detailed Plan of Project
 - § Test runs with calculator
 - o Phase 5 – Realization Phase
 - § Finding respondents to use calculator
 - § Product Knowledge presentation
 - § Obtain data from users
 - o Phase 6 – Implementation/Data Phase
 - § Computing data
 - § Closing out teams functions
 - § Wrap up
 - § End Presentation

Project Manager discusses roles:

Daniel – Complete WBS, Gantt Chart, Risk Table

Maarten – Milestones

Bruno – Updates on Calculator

Trang, Jael and Jainy – Market Analysis

Ujjwal and Sudipta – Network Plan and Critical Path

Meeting Minutes February 6th, 2018

Discussion points for Meeting: Punctuality, Responsibility and Drive Management, Calculator Updates and Public Relations

Punctuality – Maarten discussed the importance of us being on time to group meetings. There has been an issue with almost everyone in our team about arriving on time, it is a bit rude to make us wait an extra 15-20 minutes to start a meeting. So please going forward, be diligent with you time management and arrive to meetings on time.

Drive Management – Maarten and Daniel have spent time re-organizing the google drive (Our Database) so that is all organized. Please use the folders and colour creation we have created.

Responsibility – A couple things we have been messing up. This is not team member specific. Let's try to keep to our promises we have made to the rest of the team, or explain why it cannot be done. This has to do with promises for team meetings, project goals, etc. Also please keep up with you deadlines and communicate it to the team. So let's focus on better communication and meeting your deadlines to the best of your abilities.

Reminder about some important events to apply for, these a good professional development opportunities:

Singapore UNLEASH program – Deadline for application February 15th 2018

Climate KIC Journey (summer school program) – Deadline for application February 18th 2018

Monitoring and Data Updates:

Ujjwal:

- Bundesamt, they have given us some information for our Co2 calculations. They have allowed us to use their data as well!!
- The report we obtained is focused primarily on fossil fuels data and the data team is going to determine how we will put this into the formula.
- Data team will collect invoices and see what type of calculations they are doing for data.
- If anyone has any ideas about invoices then forward the information to data team.
- Regarding formulas – there are some formulas in the drive and there will be further discussion between the OTP and the Data Team.
- Need to work on a plan between the OTP and the Data Team.
- There is a large amount of support for the OTP.
- OTP project needs to finish their market analysis and questions first and once that is done then the Data Team and the OTP will start working together closer. OTP has asked for a focus on food for the data calculations.

One –Time Project/Calculator Updates

Bruno/Jael:

- Looking for some information on how we can calculate food.

- How are we going to structure the questions in how we want to calculate Co2?

Three Main Categories: (where can we make the most change?)

1) Food

- a. Meat, Vegetables, Dairy, possible for more options
 - Meat (Bio, Farming, Don't Know)
 - Veg (Bio, Non-Bio, Don't Know)
 - Dairy (Bio, Non-Bio, Don't Know)
 - Fish (Bio, Non-Bio, Don't Know)

2) Mobility

- a. Km (Distances)
- b. Auto (Small, Medium, Large)
- c. Train
- d. Bike
- e. Bus
- f. Walk

3) Home (Focus on things we can change, some things cannot be altered)

- a. Heat in Winter (15- 20, 20-25)
- b. Water Use (Time in Shower)
- c. Electricity (?) – What type of questions should we ask?
- d. Size Home (Sq meter)
- e. Number of People per house

- There will be a proposal on the Drive to help with the focus and how we want to ask questions.
- Bruno has a whole bunch of data and documents about outreach and flyers and some examples from past projects.
- How can we ask people to do tasks
- Kartik will continue his Character Study next week.

Public Relations – Jael and Trang

- Our Teacher suggested we focus on a PR campaign after the launch of our project.
 - o Jael is asking how we feel about this approach
 - o The PR has to be focused on the University.
 - o Realization Phase of the Project, analyze the media the whole university is using. TUM campuses have different things we can use. Objectives for 40,000 people.

Meeting Minute Notes February 22nd 2018

Intro: Just a quick introduction, Jainy and Maarten were not able to make the meeting, Daniel will run the meeting in Maarten's absence.

Meeting Focus: Updates on Calculator, Long Term Planning, One-Time Project (OTP), Data Team

Long Term Planning:

Three main things to be done by the end of next week March 2nd

- Trang will create a template Infographic that will be used when reaching out to companies.
- Maarten will be finalizing the email template
- Daniel and Maarten will be meeting Saturday to begin building a list of organizations to potentially start working with.

Calculator/OTP:

Bruno: OTP has decided the next steps they will be taking in the project.

- They need to reach out with Data team in the coming weeks and work on coordinating their efforts.
- Home calculations :
 - o Look at size of the home -> carbon saving initiatives -> compile list for these initiatives
 - o Monthly Initiatives
 - o Mobility -> self-explanatory -> transportation types, fuel used, etc.
 - o Consumption -> difference between Bio and non-Bio -> in Germany and abroad
 - § Issue is a lot of information is not in English so hard to discern all the information
 - o Consumption
 - § Bruno and Jael will be working on personally
- Deadline for these are end of next week (March 2nd 2018)

Jael: talked to friend in Japan, stressed the importance of this being an academic calculator and not one focused on the commercial market. -> Academic Approach

Data Team/Monitoring

Ujjwal: Continuing to look at current practices for calculating carbon. Have short listed five companies to analyze in more depth. -> March 2nd Deadline

Bruno: Thinks we should focus our early efforts on Universities around Munich, as they often have more desire to help students. Also, we do not have a lot of credibility with companies at the moment!

- What initiatives are universities doing?
- Look at operations teams -> they have the information we need.
- Gain some clout in the university sphere first
- Help with projects in the universities

Additional Topics Discussed:

- Jael wants to create an education focus in the team where we start learning what everyone else is doing, less division of labour, we can understand what all the different parts are working on.
 - o Additionally, we could start doing online courses together, meeting different experts together, etc.
- Perhaps Maarten and Kartik could head this up.

Ujjwal: everyone add their questions about calculations to the folder in the google drive. Data team can start working on finding some answers and looking at some cases where

companies have been successful at reducing their carbon. However, we need to understand that this is not something that can be applied in all cases, often reduction in carbon is case and company specific. It is useful to see how people have approached these challenges and used “outside the box” thinking to create effective change. Data Team will have these up and running by the end of next week (March 2nd 2018)

Project Management

To keep us on track for our project management assignment, we will be meeting in person either Friday March 2nd 2018, or March 3rd 2018 for a few hours (2-4) to work together on the project. Daniel will find coordinate a time based on the polling for best time and place. At this meeting we will be deciding who will be writing each portion of the assignment, but we will also be checking all of our individual work. This work needs to be matched with everyone else’s work. This is because we have been working independently on our own portions the past few weeks. We need to make sure everyone is on the same page and that everything will be done for our deadline. Hopefully, by the end of this meeting we will all be able to work in small groups to finish each portion of project. We will also need to decide who will be working on the power point presentation (currently Ujjwal and Jainy are presenting the project to our class, this is subject to change if we feel it is needed).

Trang and Jael will have an initial survey completed and ready to be sent out to our class sometime in February or early March. This is in accordance with our scheduling. This is an important part of our P.R campaign so it is necessary to have an initial stock of information on which to build our PR analysis.

Meeting Minutes Project Management March 3, 2018

Introduction: Catch up on the past few weeks of work while everyone was on break.

Meeting Focus: Final updates, Division of responsibility for final report,

Project Manager Maarten: Discuss the writing of the project and who will be doing what. Received feedback from everyone on how they feel about writing the report.

Began by writing the structure, assigning writing based off who completed what work in the project. This is how we will divide up writing the paper.

Paper Structure: 20-30 Pages

1. Introduction + Initiation (**Bruno + Daniel**) – **4/5 Pages**
2. Preparing Measures – **7/8 Pages**

- a. Swot Analysis + Stakeholder Analysis (**Jainy**) - 1/1.5 Pages
 - b. WBS + Risk Analysis (**Daniel**) – 2 Pages
 - c. Financial + Resources Plan (**Maarten**) – 1/1.5 Pages
 - d. GANTT (**Daniel**) – 0.5 Page
 - e. Critical Path + Network Plan (**Ujj + Sudipta**) – 2 Pages
3. Project Testing – **4/5 Pages**
- a. Market Analysis + Milestones (**Ujj**) – 2/3 Pages
 - b. PR-Test and Survey (**Trang and Jael**) – 1 Page
 - c. Internal Testing Phases + Feedback implementation/Pilot Testing (**Bruno**) – 1/2 Pages
4. Implementation + Evaluation -
- a. PR-Plan (**Jael and Trang**) – 5 Pages
 - b. Calculator + Monitoring Feedback (**Ujj**) – 1 Pages
 - c. Milestoens + Obstacles (**Bruno**) – 1 Pages
 - d. Close-Out (**Sudipta and Jainy**) – 1 Page
5. Discussion (**Jainy**) – 1 Page

Deadline for Initial Draft of paper will be March 20th 2018

Discussion about Public Relations: Jael

Jael gave a run through of the first draft of the public relations proposal. There was a discussion about our target market within the broader TUM community. There was still some work that needed to be done on a more specific focus of our target market and what our PR objectives will be. Additionally, the media list and the outreach program need some additional work.

Presentation Structure

Bruno (recorded)

Jael/ Trang (PR)

Maarten (Main Presenter)

The presentation will be built by Maarten, Ujjwal, Jainy, Bruno and Jael/Trang

Deadline for Rough Copy of Project is March 20th, 2018. Presentation will be created March 21st and 22nd 2018.