Carbon Compass

E S S A Y

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INTRO

Carbon Compass an app created by seven students as a semester assignment, during this project we have had guidance from our app-development professor at HVL. In this segment, you as a user are going to get a basic idea of why and how you use this app.

In recent years, the importance of climate change and specifically reducing carbon emissions has become increasingly important, this is one of the reasons Carbon Compass came to life. Carbon Compass is an app made not only to help save the environment, but help people see how they themselves are affecting carbon emissions. As topics like carbon emissions and environmental changes are growing in media attention, more people will likely want to see what they can do to help. This is where Carbon Compass comes in, and why it was created.

Our app is designed for people who want to partake in a more sustainable world. If everyone changes small parts of their lives, we believe it combined can greatly impact the environment. Therefore, the carbon app was made, to help people make these small changes. Our methodology is providing customers with easy and intuitive charts and numbers about their traveling habits. By providing our customers with the necessary information, and letting them see their carbon footprint, we hope they will feel motivated to make informed decisions that can help them travel in a more sustainable way.

To achieve this, the app is based on the methodology, or a set of steps and calculations, to estimate how much CO2 is emitted through different types of transportation. For the app to be able to calculate the carbon emission, the user must provide some data. To demonstrate, if you want to calculate the carbon emission for a specific car ride, you need to provide the distance, type of car (electric, diesel, or gasoline), and the number of passengers. Once the app collects the user-provided data, it uses formulas to estimate carbon emissions. The formulas will be presented in the app under “methodology” and down below.

Our buisness model is based reaching out to a specific target audience, our audience will mainly be the private market, starting with students (ages 18-25) as beta testers. As the app grows and we manage to get funding or incorporate subscription payments, we will be able to create other features for our users to get more accurate data and reach out to other customer groups.

METHODOLOGY

Methodology could be defined as the specific procedures used to identify, select, process, and analyze information on a topic (University of Witwatersrand, 2023). The idea behind our methodology is to provide an application to help users track their carbon emissions on a daily, weekly or longer basis. Throughout this

segment, the focus is on the structural and theoretical analysis-based calculations behind the methodology. Firstly, the "data sources" exhibit where the numeric values derive from. From there, we have developed different formulas to calculate the total carbon emission.

DATA SOURCES

To develop the formulas needed, numeric values are required. Following thorough research found that the sources most suited for this paper were SSB and Future in our hands. SSB is the official provider of development, preparation, and dissemination of the statistics of Norway (SSB, u.å). While the future in our hands is one of Norway's biggest environmental- and solitary organizations (Fremtiden i våre hender, u.å).

However, a significant challenge encountered was the lack of information regarding certain reliable numbers. Specifically, finding reliable sources for Bybanen in Bergen. Bybanen only provides the emission of the whole company. Therefore the app will not provide numbers of traveling with Bybanen.

CALCULATIONS

In order to provide our customers with an accurate amount of carbon emissions, the application will be based on one general formula. The formula is derived from the emission factor, which easily includes fossil fuel based transportation. However, in order to take into account the carbon emission produced by energy production, there is an extra calculation needed. In the general formula there is a variable which bears in mind the amount of passengers. It is included due to the fact that the source used to determine the emission factor for buses takes into account the emission factor per person for public transport modes. And thus since one of the big advantages of taking public transport is the sharing factor, it was a goal to include the benefits of carpooling into our formula as well. Mind that p = 1 for the ferry, airplane, train and bus.

General formula:

$$CO_2 = d \cdot \frac{ef}{p}$$

In which:

CO2 = carbon emissions in grams
d = distance traveled in km
ef = emission factor in gCO2/km
p = amount of passengers

Formula for electrical transportation modes:

$$CO_2 = d * 31 * \frac{ec}{p}$$

In which: CO2 = carbon emissions in grams
d = distance traveled in km
31 = carbon intensity in gCO2/kWh
ec = energy consumption in kWh/km
p = amount of passengers

Some components of the second formula might need some explanation. Starting with the carbon intensity of 31 gCO2/kWh. Although the carbon intensity is a constant for every transportation mode, it varies based on the place you are in. Since our main target group are students between the ages of 18-25 based in Bergen NO, the application uses a carbon intensity of 31 gCO2/kWh; this is based on data from the past year (Electricity Maps, n.d.). But what is carbon intensity? Carbon intensity is used to evaluate the cleaness of the electricity produced and is thus expressed in grams of CO2 per kWh (National Grid Group, n.d.). As mentioned before it varies based on the place you are in. Due to the different ways of producing electricity; think about nuclear, coal, wind, gas, etc. Together with the energy consumption, a variable based on the transportation mode, this is essentially the replacement of the emission factor which is used in the fossil fuel formula. Thus you could inherently say that:

$$ef = 31 * ec$$

In which: ef = emission factor in gCO2/km
31 = carbon intensity in gCO2/kWh
ec = energy consumption in kWh/km

Because it will be easier to use only one formula in the application, the carbon intensity and energy consumption will already be combined to create an 'emission factor' for the electrical transportation mode. In the following subcategories, the emission factor and/or the energy consumption will be defined for each of the transportation modes and fuel types.

CAR

Although there are many factors that influence the CO2 emissions a car produces in g/km, we can take the average in the most plausible situation. Based on information provided by the Statistic Central Bureau of Norway (SSB, 2016) and Electric Vehicle Database (EV Database, n.d.), we will use the following data:

- Petrol: 156,47g CO2 /km
- Diesel: 130g CO2 /km
- Energy consumption: 0.199 kWh/km
    - Emission factor 31 gCO2/kWh0.199 kWh/km = 6.17g CO2/km

FERRY

Since we are in Norway, where the ferry is a commonly used public transportation mode, we will include it in our app. We found information on the carbon emissions of fuel oil ferries in which the number of passengers is already taken into account (Helle, 2022). For the E-ferry it took some more effort since the energy consumption needed to be calculated based on the information of E-ferry Ellen (E-ferry project, n.d.). It is stated that Ellen needs +-1600 kWh of energy for the 22 nautical miles covered by the round trip and is able to transport 196 passengers plus 4 crew members. Knowing that 1 nautical mile equals 1852 meters, we can say that the 22 M equals 40.744 km ("The International System of Units," 2006). The following calculation led to the final energy consumption per passenger: 1600 kWh40.744km/200.

- Heavy Fuel Oil: 170g CO_2 /pkm
- E-ferry: 0.196 kWh/pkm
    - Emission factor: 31 gCO_2/kWh0.196 kWh/pkm = 6.08g CO_2/pkm

TRAIN

When looking up the carbon emissions for the train, they differed a bit per country. However, since the application is focussed on use in Bergen, it will use information from the 2022 annual report of Vy ("When Every Journey Counts," 2022). It states that all of the trains Vy uses are electrical so the application will only provide this option.

- Electrical: 10g CO_2/pkm

AIRPLANE

The airplane is probably one of the most 'feared' ways of traveling when looking at the carbon emission per person. However, when taking into account the number of passengers, it is not much worse than driving a non-electrical car by yourself. An article on BBC, based on a report published by the UK Department for Business, Energy and Industrial Strategy, shows that a domestic flight even releases fewer carbon emissions (BBC, 2019). Since the grams of CO_2/km match those provided by Future in our hands for an economy class flight (Helle, 2022) the application will calculate the carbon emissions based on the following:

- Kerosine: 133g CO_2/pkm

BUS

Bus transportation in Bergen is organized by both Skyss and Vy. Since Skyss does not provide any information about the climate footprint of their transportation, the application will use data provided by Vy ("When Every Journey Counts," 2022). Their buses run on 3 different types of fuel; diesel, biodiesel and electrical.

- Diesel: 27g CO_2/pkm

- Biodiesel: 14g CO2/pkm
- Electrical: 13g CO2/pkm

MOTORCYCLE

Most motorcycles run on petrol, however there are some electrical motorcycle alternatives. For the carbon emissions produced by a petrol fueled motorcycle, the data will be based on information gathered by the SSB (SSB, 2016). For the electric motorcycle, calculations will be based on information and data gathered from a comparative study (Koossalapeerom et al., 2016).

- Petrol: 85.2g CO2/km
- Energy consumption: 0.028 kWh/km
    - Emission factor: 31 gCO2/kWh0.028 kWh/km=0.87g CO2/km

WALKING AND CYCLING

Besides the transportation modes mentioned above, the application will also provide the option of registering walking and cycling. Both of these transportation modes do not produce any carbon emissions so no calculations are needed. Nevertheless, the app will consider the kilometers traveled by walking and cycling. This will be shown in the charts and tables.

BUSINESS MODEL - BMC

The business model canvas is used to showcase the processes and resources a company needs to operate and make money. The model consists of nine blocks; key partners, key activities, key resources, key propositions, customer segments, channels, revenue streams, cost structure, and customer relationships (Innovasjon norge, 2023). The next part will be presenting the BMC model, as well as taking a deeper look into each segment.

Key Proposition

Carbon Compass is not the first application which provides the service of tracking your CO2 emissions (Panchwagh, 2021). This is why it is important to differentiate so that your target group will choose your application over others. The main purpose of our application is to make students more aware of the carbon emissions produced by their traveling habits and give them the ability to track and thus improve them. Since we strive to reach both people who are already interested in reducing their footprint as well as motivating people who are not, we want to provide a simple outlook while also being transparent about our methodology and sources for those interested.

Customer Segment

According to an article from business news daily "– customer segments – grants insight into every aspect of your operation. Customer segmentation helps businesses earn greater market share, identify their best customers, and then reach those customers through their most effective channels."(Uzialko, 2023). A company must understand their customer group to successfully sell a product. By knowing the market you are playing in, the company can understand what the needs and preferences of customers are, and adjust the

app to match them. In our case, we are mainly focusing on university students aged between 18 to 25. We choose this target group because this generation is showing an increased concern about the state of the environment. In fact an article from the United Nations Development Programme said that "A global study of 10,000 youth from 10 countries in 2021 found that over 50 percent of young people felt sad, anxious, angry, powerless, helpless, or guilty about climate change, while 45 percent said their feelings negatively affected their daily lives." (*Tapping Into the Power of Young People for Climate Action | United Nations Development Programme*, n.d.). From this statement, we can assume that students have a great interest in reducing their carbon emissions. Additionally, they are using transportation frequently to go from and to university, meaning that they have various opportunities to use our application. In the future we would like to expand to highschool students as well.

Key Activities

The primary actions companies undertake to sell and develop their products is referred to as key activities (Her). Furthermore, we will clarify what actions Carbon Compass is concentrating on to create value for their customers. The team at Carbon Compass has developed an app with great usability. The design gives the user a seamless experience, by using bright colors and intuitive lines of flow through the site. As a result of the target group, we have focused the app design to be more futuristic and modern.

In addition to the design, the programming team has used VS studio and python coding. To deploy and make the app available to everyone, we are using Amazon Web Services. Through «AWS» the app has a domain and database stored in servers in Sweden. In order to provide our users with proper information about their carbon output, one of our key activities will also be gathering data.

Revenue Streams and Cost Structure

Revenue streams are critical for any business to pay any expenses, and to continue the development of the application. Apps like Netflix and Spotify use the method of a subscription to produce revenue streams. This is one of the easiest and simplest ways for an app to produce revenue. With Spotify, you only have to pay around 5 dollars for a monthly subscription as a student according to Spotify's homepage (Spotify, n.d). Through research we found that charging a monthly fee for user statistics is the best way to generate revenue for our app. For the beta launch of the app we are planning on making the app free, after getting feedback from students during the beta launch with the universities. Other forms of revenue streams we want to incorporate in the future are advertisements from partnerships with transportations companies such as Skyss or other businesses that want to promote sustainable products or services. A more distant idea for revenue is data licensing agreements with transportation companies that want to access carbon emissions data, however this will not be focused on in the near future as the app is for now not focused on the B2B market. Apps like Hold have a point system that rewards discounts, we also want to incorporate a similar system (Hold, n.d). The more the user contributes to reduce their carbon emission, the more points they will make. These points

can be used to get discounts for the school cafeteria or from other student related businesses. However, this will take a lot of work and planning, we want this to be a key part of the app, but its not ready for the beta test. (Carmichael, 2022).

Key Partners

Our main key partners will be universities, and public transport companies such as Skyss. For now, we will simply be taking methodology from websites about cars, planes, and ferries. One of our main key partners will be universities like HVL to distribute our product to the students who will be our early adopters. Later when we have developed our app further we will have to make relations with companies like Bybannen and Skyss to get more accurate data.

Customer relationships

For customer relationships, we can set up a way for users of the app to leave reviews on the function and flow of our app. Where we can see how to improve the functionality of our app and fix bugs. Like most apps we expect our app to be ever-improving. To help make feedback easier we have created social media accounts like Instagram, Facebook, Twitter and TikTok.

Channels and Key Resources

Initially we want to "beta test" the website by having HVL distribute it for free to students. Then we can get some easy feedback starting off. By doing this the universities will be our channels towards our customers. Key resources will be AWS to help launch the app and database. The universities will distribute the app by putting on TVs and informational posters to advertise. The universities can also mention our app in presentations, stands and partnering with sustainability days (like the ones at HVL) and lastly through Social media (Tiktok, Instagram, Facebook, Twitter). We have also created our own social media channels to advertise the app and get Feedback from users.

We also need to conduct business activities for universities to promote our app to their students. The ways to promote can be sending notifications by portal website systems like Canvas, displaying posters on campuses and advertising them in events. We also would like to partake in sustainable days at campus, with stands and presentations.

SUMMARY

In the modern world we live in, it is important to be aware of the carbon footprint we leave behind, which is why the application CarbonCompass was developed. By providing a simple to use app which also displays the more complex methodology behind it, we strive to appeal to both those that already have a 'CarbonCompass' as well as those wanting to develop one. In order to reach our target group and succeed, we created a business model based on the Business Model Canvas to set clear intentions and goals. We hope

that our application will help people be more aware and environmentally conscious, creating a butterfly effect.

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