“It shows how little room there is for flying” - Designing a Flight Emission Converter

Abstract

Even though it is commonly known that air travel emits a high amount of CO_2, many individuals still fly regularly. This is referred to as the knowledge-action gap. To overcome this gap, studies indicate that communication that combines rational knowledge with an emotional response is most successful. One tool that provides individuals with rational knowledge is a flight emission calculator, but many existing calculators do not evoke an emotional response or fail with presenting the knowledge in an engaging way. Therefore, this study aims to investigate how to design a flight emission converter that combines rational knowledge and emotional responses through emissions comparisons. A prototype with 14 comparisons was created and evaluated through nine semi-structured interviews. The results show that the comparisons the participant could easily relate to were most successful. Therefore, the end-design of the converter includes emission comparisons to a sustainable personal budget, household electricity, and boiling water. These comparisons are easy to understand and evoke the strongest emotional reactions.

Author Keywords

Flight emission converter; Air travel; CO_2 emissions; Knowledge-action gap; Emotional response

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Introduction

In Sweden, carbon dioxide (CO_2) emissions from flying add up to 10% of all consumption-based emissions [1], meaning air travel is the largest source of CO_2 emissions for many individuals [2]. Each employee at the Swedish university KTH Royal Institute of Technology, for instance, is accountable for 1,3 tonnes of CO_2 emissions per year from air travel only [3]. These numbers harshly contradict the Paris Agreement, which regards a personal carbon budget of 2 tonnes of CO_2 emissions per year as sustainable to limit global warming below 2°C [1, 4]. Furthermore, the carbon law developed by Rockström et al. [5] shows that emissions need to be halved every decade until the year 2050 to achieve the goals stated by the Paris agreement. This also includes emissions caused by flying.

Although being aware of the negative environmental consequences many people still fly. This is known as the knowledge-action gap [6]. Studies have shown that it is possible to overcome this gap by understanding the scope of the environmental impact of flying (rational) and having feelings about it (emotional) [1, 7]. Therefore, several different digital tools have been developed to inform, show, and convince individuals about the negative effects of flying. A flight emission calculator is such a tool. By calculating the emissions caused by a flight and comparing them to other variables, they become more tangible and easier to grasp [7].

However, many of the existing emission calculators only work towards presenting the emissions as rational knowledge but do not include emotional factors. Therefore, this project aims to investigate *how to design a flight emission converter that combines rational knowledge and emotional responses.* Rational knowledge includes how well the user understands and can relate to the result of the converter. The emotional response involves feelings and emotions the converter evokes. A prototype was created based on an analysis of existing flight emission calculators. This prototype was then evaluated by a test audience during nine semi-structured interviews. Since behavior change takes time (M. Wolrath Söderberg, personal communication, 10 Nov. 2020), the main target group of the converter are people who already have knowledge about the impact of flying and have potentially thought about reducing or stopping to fly.

Related Work

Despite the widespread knowledge that flying has negative consequences on the climate, many people continue to fly. Not acting according to your best knowledge seems irrational, but it is a common behavior that can be observed in other areas as well, for example with regards to smoking [8]. Kollmuss and Agyeman [6] call this the knowledge-action gap. While behavior change takes time, excuses are often used to justify a behavior that is not in line with knowledge [7]. By accumulating knowledge, however, it is possible to overcome the gap (M. Wolrath Söderberg, personal communication, 10 Nov. 2020). In a study about the reasons why people reduce or stop flying, Wolrath Söderberg and Wormbs [7] found four different drivers for behavior change: Knowledge and experience were identified as most important, followed by moral concerns, social contexts, and the availability of alternative means of transport. However, as Stoknes [8] notes, it is not the pure amount of knowledge about climate change that leads to changed behavior. Since climate messages often consist of raw data that is intangible and hard to understand, increasing the amount could even harm the willingness of individuals to change their behavior [8]. Instead, as Kollmuss and Agyeman [6, p.253] note, "information about environmental damage has to be translated into understandable, perceivable information."

Furthermore, information about the impact of flying on the climate should not only aim at rational (knowledge-based) aspects but at an emotional involvement as well [1, 6]. Jacobson et al. [1] define the integration of knowledge-based and emotional aspects as internalized knowledge. Since our actions are not always rational, as described above, an emotional reaction to a message can have more influence on our beliefs, values, and behavior than a purely rational one [6]. On the other hand, since climate change is highly complex, a basic rational understanding of the topic is necessary to be able to develop an emotional connection [6]. Jacobson et al. [1] also note that the degree of rational awareness of climate change influences how people react to different emotions. While negative feelings, such as fear, shame, or guilt, can have positive effects on climate-aware people, climate skeptics might react with denial and rejection [7].

Besides the content of the message, the visual presentation plays an important role for the emotional involvement. As mentioned above, just presenting raw data about CO_2 emissions has little effect, since the numbers are perceived as abstract, distant, and hard to understand [8]. However, in addition to translating the information into relatable categories, visual elements such as images or graphs can make the message more tangible and easier to perceive [6].

Flight emission converters are, therefore, a useful and powerful tool to provide knowledge about the environmental impacts of flying in an engaging way. Many individuals who have reduced or quit flying state that putting the emissions into context helps to make otherwise intangible numbers easier to understand and relate to. This is one important driver for behavior change [7].

Method

To investigate our research question, three different steps were performed. We began by evaluating already existing calculators, to get an impression of how they compare emissions. Secondly, based on the evaluation study, we designed a prototype. As our final step, we conducted semi-structured interviews with nine participants. Each step will be discussed in detail below.

Evaluation study

We analyzed the six calculators Klimatsmart Semester, Flight Emission Map, atmosfair, the Guardian's Carbon Calculator, Omni Flight Carbon Footprint Calculator, and ICAO Carbon Emission Calculator (see Table 2). The main focus was on how the calculators present the emissions and what kind of comparisons they use.

Design

With the evaluation and inspiration from the calculator analysis, we sketched a hand-drawn prototype of our flight emission converter. The prototype included a simple frame with input boxes for origin and destination of a flight trip. Based on the conducted research, 14 different emission comparisons were created (see Comparison 1 to 14). A return trip from **Stockholm-New York**, amounting to **1717kg of CO_2 emissions**, was used as an example. The flight emissions for this trip were calculated using the FlightEmissionMap (FEM) factor [9]. The factor is valid for economy class and includes direct CO_2e emission from burning fuel as well as non-CO_2 effects, but it does not account for other effects such as flight altitude, aircraft type, or weather conditions. By multiplying the factor with the distance of the flight, the total emissions of the flight were calculated.

Interviews

Nine semi-structured interviews were conducted to assess the prototype on a test audience. The interviews aimed to collect feedback both on the comparisons of the emissions and on the overall design. Since we wanted to investigate not only what type of comparisons the participants preferred but also how they made them feel, we considered interviews to be suitable since emotions can be hard to investigate through quantitative methods. Furthermore, semi-structured interviews were selected since it gave us the possibility to further explore the interviewees' answers and ask follow-up questions [10].

	Gender	Age	Occupation
A	Female	58	Manager
B	Female	56	Manager
C	Male	52	Researcher
D	Male	52	Researcher
E	Female	49	Associate Professor
F	Male	28	Phd Student
G	Female	27	Manager
H	Male	26	Student
I	Female	23	Student

Table 1: A summary of the interviewees.

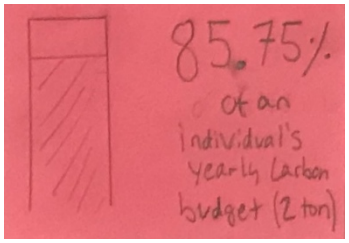
The interviews were conducted through Zoom and lasted for approximately 30 minutes. The test audience consisted of five female and four male participants between the age of 23 and 58 (see Table 1). All participants have traveled by flight before and are aware that flying is bad for the environment. Eight of the participants have even considered flying less due to sustainability reasons and environmental awareness. The participants were selected through convenience sampling, meaning we selected individuals who were easy to reach [10].

During the interviews, each comparison was shown one at a time and discussed how it impacted the interviewees. In the end, the interviewees got to choose the comparisons that had the largest as well as the lowest impact on them. Furthermore, the interviewees had the opportunity to give feedback regarding the graphical interface, illustration of the variables, and the desired number of comparisons.

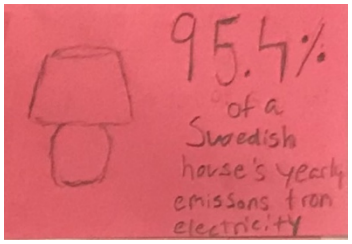
Results

Evaluation study

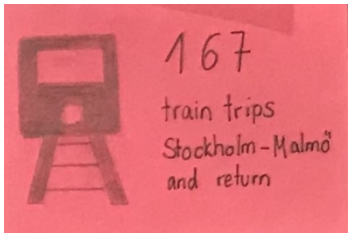
Most of the analyzed flight emission calculators (see Table 2) have a plain and simple design (a, b, c, e, f). Only two use graphical and color-coded representations of the emissions, such as bar charts or traffic-light colors (a, d). A majority of calculators put the emissions into context by using either one or three comparisons. Some calculators compare the emissions with variables related to our everyday life, for instance, other means of transportation (a) or household electricity (d). Three calculators included comparisons to a sustainable carbon budget of an individual (a, d, e,) while comparisons to the carbon footprint of people in other countries were slightly less prominent (a, f). Two calculators present the emissions without any context as a number (b, c).



Comparison 1: "Carbon Budget". The required personal carbon budget per year to reach the goals of the Paris Agreement [1].



Comparison 2: "Household Electricity". Yearly average household emissions for electricity [11,12].



Comparison 3: "Train Trips". Emissions from return train between Stockholm and Malmö [13].

	Name	URL
a	Atmosfair	https://www.atmosfair.de/en/offset/flight/
b	Flight Emission Map	https://flightemissionmap.org
c	ICAO Carbon Emission Calculator	https://www.icao.int/environmental-protection/Carbonoffset/Pages/default.aspx
d	Klimatsmart semester	https://travelandclimate.org
e	OMNI Flight Carbon Footprint Calculator	https://www.omnicalculator.com/ecology/flight-emissions
f	The Guardian's Carbon Calculator	https://www.theguardian.com/travel/2019/jul/31/carbon-calculator-find-out-how-much-co2-your-flight-will-emit

Table 2: A summary of the analyzed flight emission calculators.

Interviews

In this section, the participants' comments and opinions about the comparisons will be presented. Also, the design aspects of the converter will be reviewed.

Emission comparisons

First, the five comparisons which received the most positive response from participants will be presented. After that, we will briefly present the comparisons which were considered to be less impactful. Figure 1 illustrates how many participants reacted positively and negatively to each comparison.

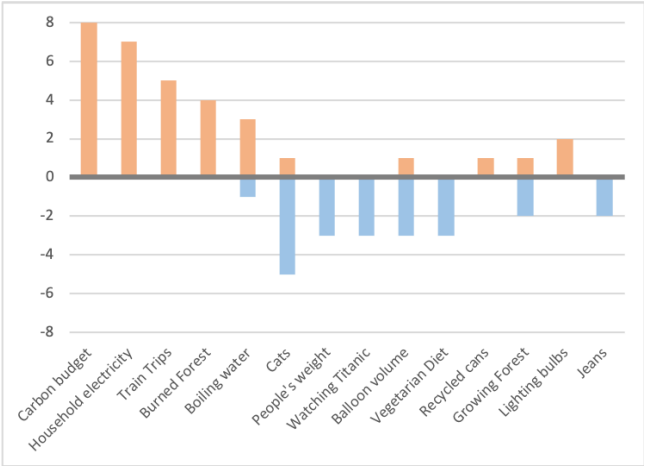


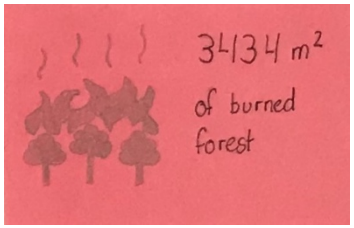
Figure 1: Evaluation of interview results. Red bars above 0 indicate positive reactions while blue bars below 0 indicate negative responses.

The carbon budget (see Comparison 1) was the most popular comparison: eight out of nine interviewees selected it as one of their top choices, and no one expressed negative opinions about it. Based on their comments, the carbon budget is easy to understand and an effective way to put the emissions into context. Furthermore, it evokes strong - mainly negative - feelings, such as shock and shame.

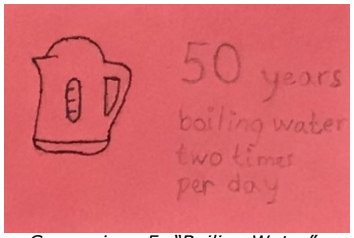
It shows how little room there is for things such as flying.

It feels like you use your two tons in the wrong way. You go to New York to have fun, which is unfair to those who [stay within] their two tonnes.

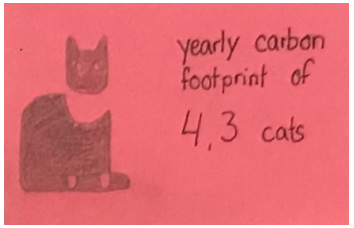
It is a bit frightening. An eye-opener.



Comparison 4: "Burned Forest". The area of burned forest to release the same amount of CO_2 [14].



Comparison 5: "Boiling Water". Emission from boiling water with a kettle two times a day [15].



Comparison 6: "Cats". The yearly carbon footprint of a cat [16].

Household electricity (see Comparison 2) was almost equally popular as the carbon budget and was selected by seven participants as one of their favorite comparisons. Some individuals referred to the comparison as strong, relatable, shocking, and easy to understand. Many participants used the comparison as a starting point to think about what they would need to do to offset the flight's emissions:

12 hours on a plane, the same thing as living in a house for an entire year.

Means you would need to turn everything off and eat cold food [for one year].

One participant found the comparison to be complicated and asked for more information, about what the emissions included and excluded. Still, the participant was able to set the comparison in relation to his own home and family.

The train trips (see Comparison 3) were the third most favorable comparison picked by five participants. Many participants described the option as tangible and found the connection between train and air travel strong. They could build on previous knowledge that train travel is more sustainable than flying. However, for one participant, the amount was a bit hard to understand since he had never traveled between Stockholm and Malmö. Therefore, he did not know if the distance was long or short. Some individuals also expressed a dislike regarding the choice of destination and would have preferred to compare different means of transportation for the same trip as the flight:

The comparison itself is great but [the train] does not help me to get to New York.

The fourth most favorable comparison was **the burned forest** (see Comparison 4)**.** Most participants expressed that they experienced negative feelings regarding the burned forest but also found it hard to grasp and intangible. Some participants wished for some sort of comparison for the area, for example, comparing the square meters to a country, football fields, or similar. Others did not see the need for an additional comparison. For them, it was more important to understand that the number is large, regardless of the exact size:

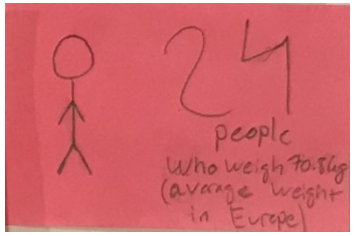
A bit hard to imagine the square meters.

I don't know how much it is, but it feels huge.

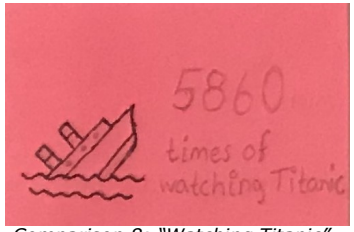
The fifth most favorable comparison, **the boiling water** (see Comparison 5), created a shock value for a majority of the participants. This was mainly due to the time aspect of 50 years, which many individuals found to be surprising and unexpected. One participant said the following:

[It is] really bad to fly if it equals that huge amount of boiling water.

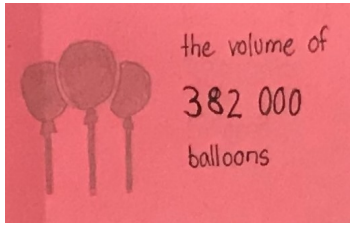
Even though the amount of time is very high, participants did not have trouble relating to the 50 years. They would relate to boiling water from their everyday life, which seemed to make the comparison still easy to grasp. Two participants criticized the comparison as having no emotional effect and being far-fetched. However, only one participant regarded boiling water as one of the least favorable choices.



Comparison 7: "People's Weight". The weight of the CO2 converter to average European's weight [17].



Comparison 8: "Watching Titanic". Emission from watching Titanic on a Primary TV LCD (34-37 inch) [15, 18].



Comparison 9: "Balloon Volume". The volume of CO_2 expressed in inflated balloons [19].

The comparison most individuals (five out of nine) did not like was the **cat comparison** (see Comparison 6)**.** Most participants mentioned that they found the comparison to be abstract and irrelevant. They also stated that the comparison did not have a connection to flying and did not evoke any feelings. Some were also surprised by the low numbers, and they expected a higher number due to a cat's small size. One participant felt, however, positive about the comparison and could relate to it because he owns a cat.

Other less favorite comparisons in this study were **people's weight** (see Comparison 7), **watching Titanic** (see Comparison 8), **balloon volume** (see Comparison 9), and **the vegetarian diet** (see Comparison 10). These comparisons received three negative votes each. The participants had a hard time seeing the connection between the comparisons and flying or could not relate to them. Other given criticism was that the comparisons were hard to understand or had no emotional impact:

Not enthusiastic about that, it doesn't sting.

The other comparisons, **recycled cans** (see Comparison 11)**, growing forest** (see Comparison 12)**, lighting bulbs** (see Comparison 13)**,** and **jeans** (see Comparison 14)**,** received both positive and negative remarks from the interviewees, but not as strong remarks as the other comparisons.

The design of the converter

Overall, the interviewees shared similar opinions about the design of the converter. A strong majority requested visual elements, such as illustrations and icons, but with a simple and clear design. Most participants also asked for only little text, but at the same time wished for additional information about the converter and the different comparisons. However, opinions about how that information should be presented differed. A few participants mentioned that the additional information should not be displayed immediately and instead appear for users that actively search for it. For example, by pressing a button or through some interaction feature:

If you could flip [the comparisons] and the backside would give a bit more information about them that would be an option

Regarding the number of comparisons to be featured in the converter, most interviews stated three to five comparisons as the appropriate number. One participant also mentioned that an interesting feature could be to allow users to pick their favorite ones from a large number of comparisons to ensure that each user receives comparisons that speak to them.

The end-design

Based on the results from the interviews and the conducted research, we created a flight emission converter with the design shown in Figure 2.

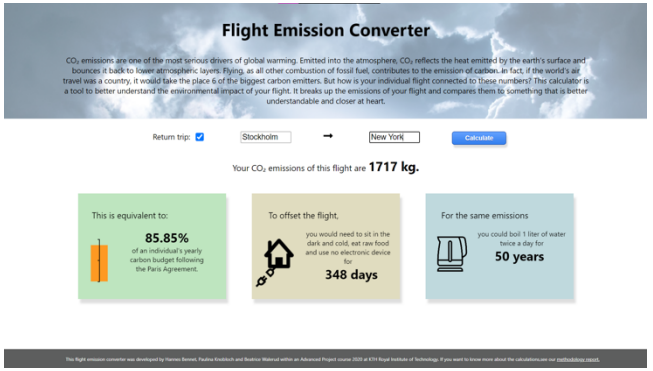
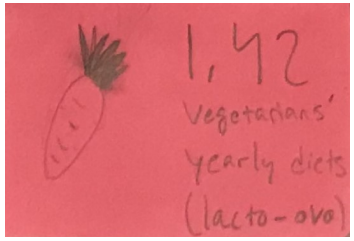
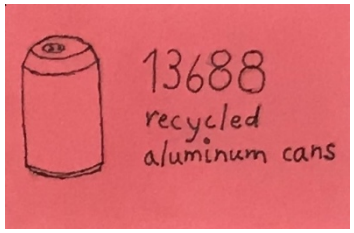


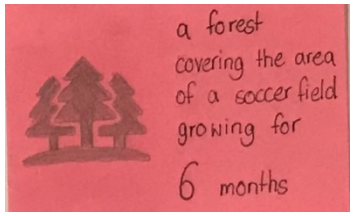
Figure 2: The end-design of the flight emission converter.



Comparison 10: "Vegetarian Diet". Yearly average vegetarian food emissions in Europe [13].



Comparison 11: "Recycled Cans". Emissions saved by recycling this number of cans [20].



Comparison 12: "Growing Forest". The area of trees needed to bind the emitted CO_2 [14].

For the end-design, we selected three different comparisons: **the carbon budget, the household electricity,** and **the boiling water** (see the Discussion section for more details on the selection process).

Regarding the amount of text in the converter, we decided to include an introducing text about CO_2 emissions and its impact on the environment together with the purpose of the converter. Each comparison comes with a short descriptive text, where the user gets access to more information by clicking on the boxes (see Figure 3). This feature was selected to satisfied interested users without overwhelming other users who are not as interested. The interviews revealed different expectations regarding additional text. By incorporating this feature, it is possible to please both sides.

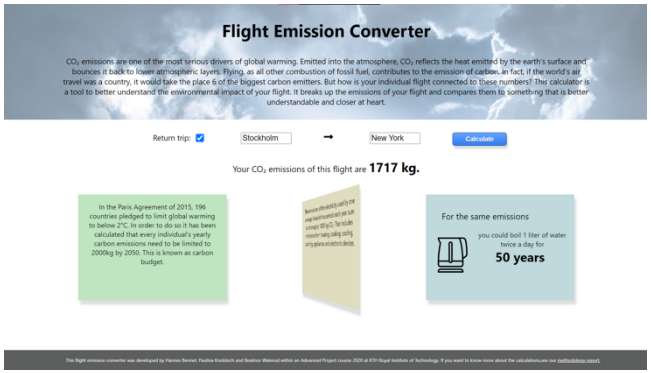


Figure 3: The end-design of the flight emission converter with flipped boxes.

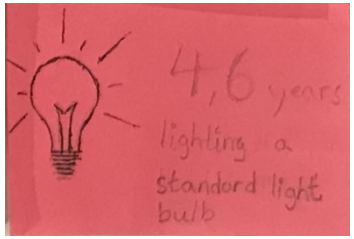
Besides text, we also ensured to illustrate each comparison visually by using icons or a bar chart. Several participants requested the converter to have clear and simple illustrations, which was something we wanted to take into consideration. Besides icons, we also incorporated a background image in the header of the converter, to create interest.

Discussion

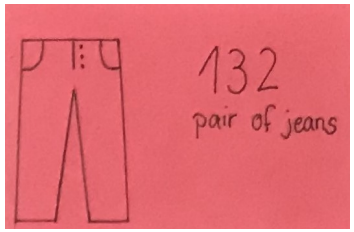
As research has shown, knowledge is one of the most important factors in achieving more sustainable behaviors. This includes to reduce or stop flying [1, 6, 7]. However, as mentioned by Kollmuss and Agyeman [6], just facts about environmental damage are not enough. The message also needs to be easily understandable and achieve an emotional reaction [1, 6]. Therefore, it was important that the flight converter does not simply compare flight emissions, but presents the comparisons in a way that the user can relate to. This also includes a visual presentation that is engaging, for instance, by using graphs or illustrations.

The evaluation study of the flight emissions calculators showed that some existing calculators do not compare emissions at all or use abstract comparisons. The use of illustrations and graphics is limited and the main focus is on numbers and text. However, this does not allow users to properly understand the extent of the emissions and put them into context to allow for an emotional connection [6].

Some existing converters, however, use similar comparisons that were proven successful during our interviews as well. Many of the participants preferred comparisons with a connection to households, such as electricity and boiling water. These were elements the participants had sufficient knowledge of or use on an everyday basis. Other preferred comparisons had a connection to either traveling, for instance, the train trips, or to nature, such as the burned forest. Even though these alternatives were not as closely related to the participants themselves, it seemed as if they



Comparison 13: "Lighting Bulbs". Electricity emissions from one running lighting bulb [15].



Comparison 14: "Jeans". Emissions from producing one pair of jeans [21].

could still connect to them since they could see the connection between them and air travel or sustainability.

In the final design, we selected the three comparisons: carbon budget, household electricity, and boiling water. These were selected since many participants favored them and described them as comprehensible, impactful, and easy to visualize. They succeeded with both providing rational knowledge and creating an emotional involvement. However, even though train trips and the burned forest were ranked higher than the boiling water comparison, those were not included. The train trip comparison turned out to be only relatable to people who know the specific train journey used for the comparison (in this case, Stockholm to Malmö). Furthermore, it is not possible to go everywhere by train, such as in our example Stockholm to New York. This means that it would be unrealistic to compare air travel to train for all trips and this could potentially provide users with an excuse for why flying sometimes is a necessity. As mentioned by Wolrath Söderberg and Wormbs [7], many individuals use excuses to justify why they fly, and this was something we wanted to avoid. The burned forest comparison was not selected because the numbers turned out to be too abstract, and the participants had trouble relating to the unit of square meters. As discussed by Stoknes [8], intangible information could even achieve the opposite effect and make individuals less willing to change their behavior. Meaning the effect of the comparison could potentially oppose the intended aim of the converter.

Two of the comparisons were directly taken from the prototype, but we decided to slightly change the phrasing of the household electricity comparison. Instead of using percentage, the comparison states how many days the individual could not use any household electricity to offset the emissions created by the flight. This change was made to make the comparison even easier to understand since some interviewees showed tendencies to translate the comparison into days rather than using the given percentages.

The selected comparisons cover three of Wolrath Söderberg's and Wormbs' [7] reasons why we stop flying. All chosen comparisons can in different ways be related to **knowledge and experience**. They help users to understand the flight's impact on a rational basis by comparing them to a well-known item (household electricity) or an activity they do regularly (boiling water). The carbon budget comparison works on an emotional level as well, as it evoked feelings of guilt and shame among the participants, which can be connected to **moral**. As the interviews showed, the carbon budget also made people think about the connection and obligation to others in keeping their 2-tonne budget, which can be regarded as a **social theme**. One participant said that she felt that it was unfair to spend more than the yearly budget to those who keep their allowed budget.

Study limitations and future research

Even though interviews were considered the most suitable method for our study, there are still some limitations. The sample only consisted of nine participants, which means that the results might not apply to a larger group of individuals. For instance, all participants were aware of the climate impact of flying, meaning the study is not applicable for individuals who deny or question climate change. In addition, according to Robson and McCartan [10], the sampling method convenience sampling is considered to be an inadequate method to use. But since we experienced limitations in time and access to available participants due to the covid-19 pandemic, other sampling methods were not feasible.

Since our method did not include a user test of the final product, we lack information regarding the reception of the final design, for instance, how users would experience using the converter, including choosing departure and destination.

Besides performing a study with more participants and a different sampling method, we also suggest that future research should investigate how to design a converter that allows users to compare different means of transportation since the train was considered an impactful comparison by several participants. We also suggest implementing more optional comparisons in the converter so that users can filter the comparisons they are interested in. Lastly, future research could investigate whether the flight emission converter actually has an effect on the user's behavior and leads to reduced flying.

Conclusion

This study aimed to create a flight emission converter that combines both rational knowledge and emotional responses. Our results show that this could be achieved by designing a converter consisting of three different comparisons, the carbon budget, the household electricity, and the boiling water. These were chosen because the participants of our interviews proved to have previous knowledge of the comparisons and, therefore, find them easy to grasp. This study showed that the participants only respond emotionally when they fully understand the knowledge provided, meaning rational knowledge is the most crucial factor when overcoming the knowledge-action gap. This conclusion is supported by the study performed by Wolrath Söderberg and Wormbs [7], who showed that knowledge is the most common reason for individuals to reduce and stop flying.

References

[1] Lisa Jacobson, Jonas Åkerman, Matteo Giusti and Avit K. Bhowmik. 2020. Tipping to Staying on the Ground: Internalized Knowledge of Climate Change Crucial for Transformed Air Travel Behavior. *Sustainability* 12, (March 2020), 1-18. DOI:10.3390/su12051994.

[2] Jonas Allerup. 2020. Hur kan jag minska min klimatpåverkan? (March 2020). Retrieved Nov. 22, 2020 from https://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Klimat/minska-min-klimatpaverkan/.

[3] Ann Patmalnieks and Jill Klackenberg. 2019. KTH inför klimatpott för flygresor. (Feb. 2019). Retrieved Nov. 22, 2020 from https://www.kth.se/aktuellt/nyheter/kth-infor-klimatpott-for-flygresor-1.883448.

[4] United Nations. 2015. Paris Agreement (Dec. 2015). Retrieved Dec. 18, 2020 from https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

[5] Johan Rockström, Owen Gaffney, Joeri Rogelj, Malte Meinshausen, Nebojsa Nakicenovic and Hans Joachim Schellnhuber. 2017. A roadmap for rapid decarbonization - Emissions inevitably approach zero with a "carbon law". *Science* 355, 6331 (March 2017), 1269-1271. DOI: 10.1126/science.aah3443.

[6] Anja Kollmuss and Julian Agyeman. 2002. Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research* 8, 3 (July 2010), 239-260. DOI: 10.1080/13504620220145401.

[7] Maria Wolrath Söderberg and Nina Wormbs. 2019. *Grounded - Beyond Flygskam.* Fores/Elf, Stockholm/Ixelles.

[8] Per Espen Stoknes. 2015. *What We Think about When We Try Not to Think about Global Warming - Toward a New Psychology of Climate Action.* Chelsea Green Publishing, Vermont.

[9] Björn Von Sydow, Jörgen Larsson and Anneli Kamb. 2020. FlightEmissionMap. Retrieved Nov. 17, 2020 from https://flightemissionmap.org/.

[10] Colin Robson and Kieran McCartan. 2016. *Real World Research* (4th ed.). Wiley, United Kingdom.

[11] Konsumenternas Energimarknadsbyrå. 2020. Normal elförbrukning och elkostnad för villa. Retrieved Nov. 13, 2020 from: https://www.energimarknadsbyran.se/el/dina-avtal-och-kostnader/elkostnader/elforbrukning/normal-elforbrukning-och-elkostnad-for-villa/.

[12] Utsläppsrätt. 2020. Beräkning av utsläpp i hemmet. Retrieved Nov. 13, 2020 from: https://www.utslappsratt.se/berakna-utslapp/berakning-av-utslapp-i-hemmet/.

[13] Jörgen Larsson and Anneli Kamb. 2019. *Travel and climate. Methodology Report*. Chalmers University of Technology, Department of Space, Earth and Environment, Gothenburg.

[14] Sicirec. 2009. Forests and carbon capture. Retrieved Nov. 13, 2020 from http://www.sicirec.org/definitions/carbon-capture.

[15] Carbon Footprint. [no date]. Household Energy Consumption. Helping You To Understand Where Energy is Used. Retrieved Nov. 13, 2020 from https://www.carbonfootprint.com/energyconsumption.html.

[16] Jasmin Annaheim, Niels Jungbluth, Christoph Meili. 2019. *Ökobilanz von Haus- und Heimtieren. Überarbeiteter und ergänzter Bericht.* Internship report. ESU-services GmbH, Schaffhausen, Switzerland. DOI: 10.13140/RG.2.2.35878.98882.

[17] Sarah Catherine Walpole, David Prieto-Merino, Phil Edwards, John Cleland, Gretchen Stevens and Ian Roberts. 2012. The weight of nations: an estimation of adult human biomass. *BMC Public Health*. 12, 439, 6 pages.

[18] IMDb. [no date]. Titanic. Retrieved Nov. 13, 2020 from https://www.imdb.com/title/tt0120338/.

[19] International Carbon Bank & Exchange. 2000. CO_2 Volume Calculation. Retrieved Nov. 13, 2020 from https://www.icbe.com/carbondatabase/CO2volumecalculation.asp.

[20] International Aluminium Institute. [no date]. Carbon Footprint Guidance Document. Position Paper. Retrieved Nov. 13, 2020 from https://www.world-aluminium.org/media/filer_public/2013/01/15/fl0000169.pdf.

[21] Naturskyddsföreningen. 2019. Faktablad: Våra kläder. Retrieved Nov. 13, 2020 from https://www.naturskyddsforeningen.se/skola/energifallet/faktablad-vara-klader.