Would You Change Your Travel Mode if You Know its Carbon Footprint?

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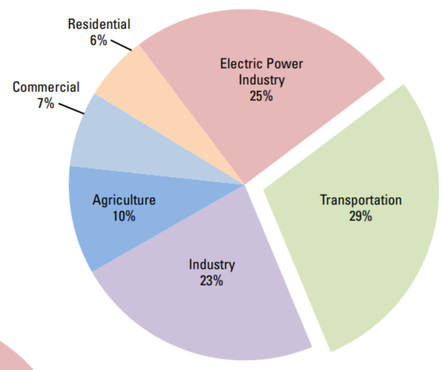
Background

The search for alternative modes of transportation has seen a spike in interest with the growing concern about various environmental impacts of the transportation system. It is estimated that 29% of the greenhouse gas emissions (GHG) in the United States (U.S.) comes from the transportation sector (U..S. EPA, 2021). This significant contribution from transport emissions presents an urgent need to reduce overall GHG emissions in the U.S. by adopting environmentally-friendly modes of transportation. Over the past decade travelers have witnessed a growing number of such transportation modes, with electric options surging the market (electric vehicles, hybrid vehicles, e-scooters, E-bike, etc.) With the presence of different modes of transportation, comes an intricate web of choices that can alter transportation demand and in turn have potential environmental implications. A critical, yet overlooked, factor in people adopting different modes of transportation is their awareness of their carbon footprint. This work focuses on that problem specifically.

Research Goals

i. **Build** an emission calculator as function of trip distance and mode of transportation
ii. **Understand** how traveler's respond to being exposed to carbon-footprint information for their travel trips
iii. **Analyze** socio-economic and travel behavior characteristic of user's willing to change their travel modes
iv. **Induce** a transportation modal shift away from carbon-intensive modes

Figure 1. Share of U.S. GHG emissions by sector, 2019



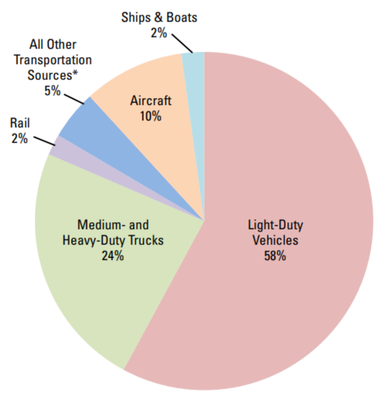


Figure 2. Share of U.S transportation sectors GHG emissions by source, 2019

Methods and Modeling

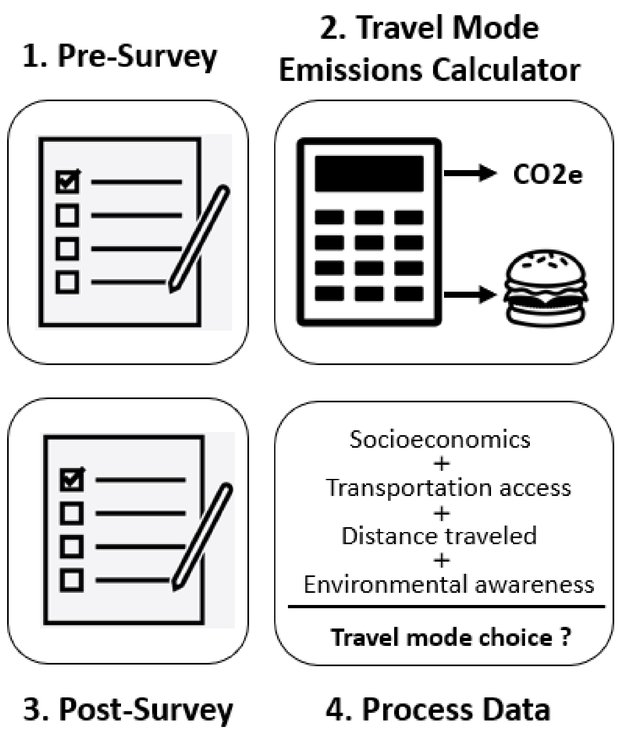


Figure 3. Travel mode behavior study design.

This study was conducted in four phases (Figure 3). First, a pre-calculator use survey was administered to survey participants. Information collected included socioeconomic data, travel mode accessibility, travel habits, and self-perception of environmental awareness. Second, study participants used a web-based emissions calculator to determine the emissions generated via different travel mode choices for their respective trips. Third, study participants completed a post-calculator use survey. Fourth (and lastly), the data obtained from the first, second, and third study phases were processed and evaluated as a whole.

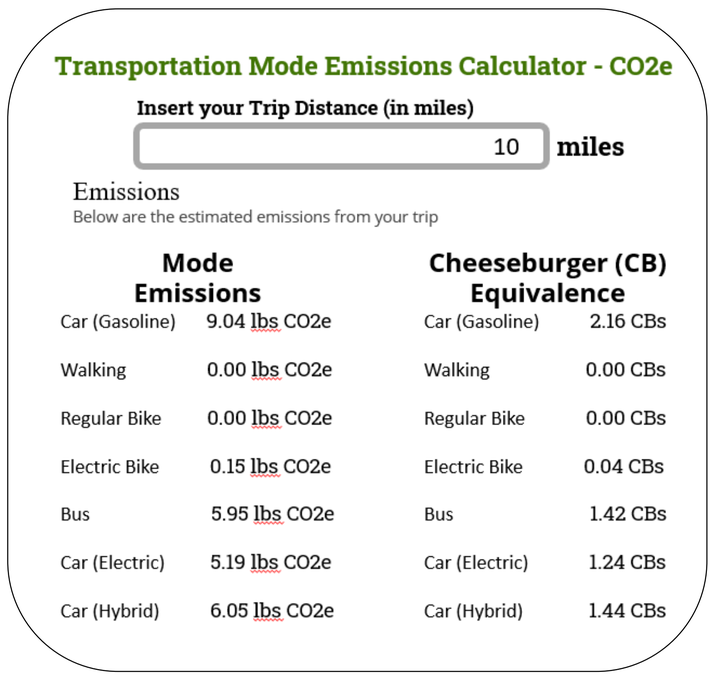
Cheeseburger Carbon Equivalence

Product size 1 cheeseburger

= 1.9 kg of CO_2 equivalent emissions)

Ref: Babakhani et al., (2020)

Transportation Mode Emissions Calculator



Transportation Mode Emissions Calculator - CO2e

Insert your Trip Distance (in miles)

10 **miles**

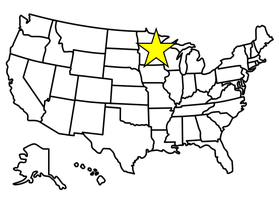
Emissions

Below are the estimated emissions from your trip

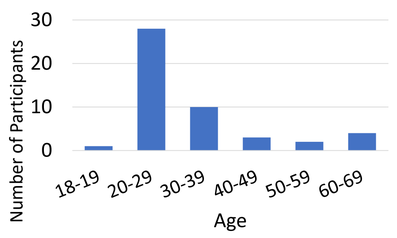
Mode Emissions		Cheeseburger (CB) Equivalence	
Car (Gasoline)	9.04 lbs CO2e	Car (Gasoline)	2.16 CBs
Walking	0.00 lbs CO2e	Walking	0.00 CBs
Regular Bike	0.00 lbs CO2e	Regular Bike	0.00 CBs
Electric Bike	0.15 lbs CO2e	Electric Bike	0.04 CBs
Bus	5.95 lbs CO2e	Bus	1.42 CBs
Car (Electric)	5.19 lbs CO2e	Car (Electric)	1.24 CBs
Car (Hybrid)	6.05 lbs CO2e	Car (Hybrid)	1.44 CBs

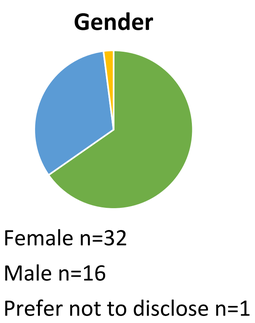
Figure 5. Example of web-based transportation mode carbon emissions calculator used in this study.

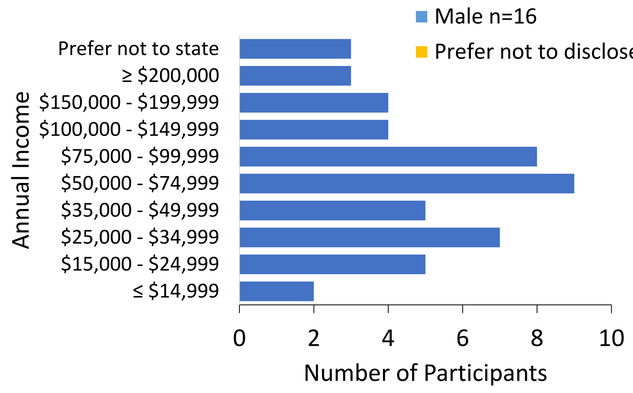
Participant Demographics



Education Level
Less than high school: 1 participant
High school: 3 participants
Some college or associate's degree: 3 participants
Bachelor's degree: 17 participants
Graduate or professional degree: 25 participants







Travel Behavior Results

Net savings (kg CO2e) for trips reported over the duration of the study (3 months) = 248 kg CO2e.

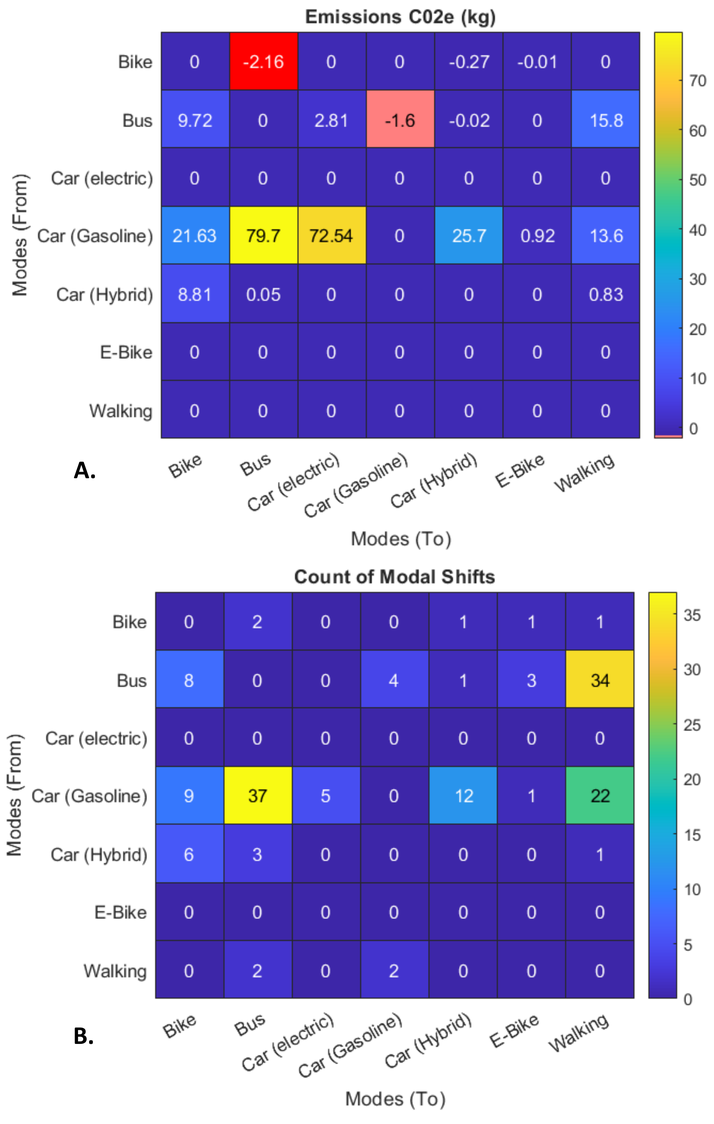


Figure 6. A. Emissions savings from transportation mode shifts.
B. Number of transportation mode shifts over the duration of the study.

Survey Analysis & Results

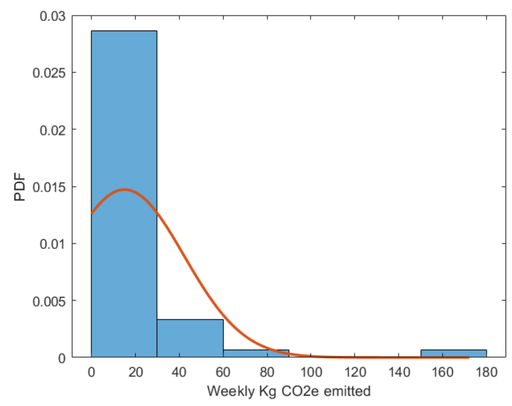


Figure 7. Distribution of emissions by users (per week)

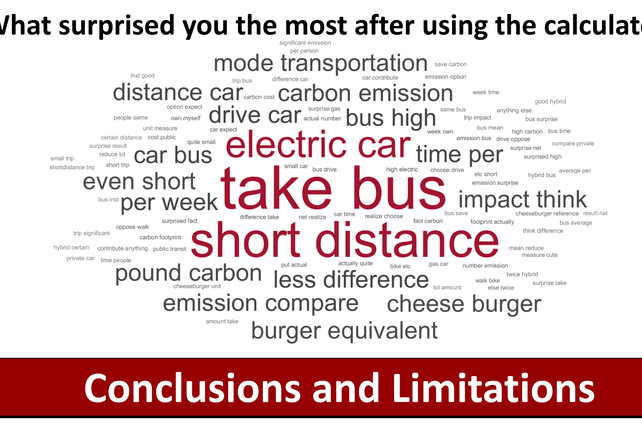
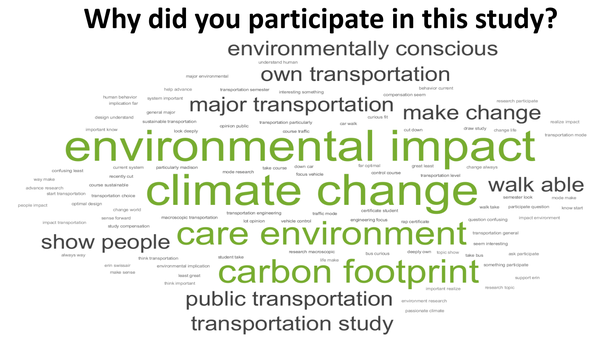


Figure 8. Feature importance in predicting users' shift in mode of transportation as a result of calculator usage

Participants' Sentiment

Why did you participate in this study?



What surprised you the most after using the calculator?

Conclusions and Limitations

Conclusions

i. Some participants changed their travel mode given calculator information, resulting in environmental benefits
ii. Most, but not all, travel mode changes resulted in reduced CO2e emissions..
iii. Environmental awareness, trip distance, and income were most important features in predicting modal shifts

Limitations

i. Data from different geographical regions and cities need to be collected
ii. Larger longitudinal data – longer period of time – is needed
iii. Small sample size

Future Work

I. Map overlay for easier use to determine distance travelled. The web-based calculator used in this study required manual text to be entered for distance. This required an extra step (outside of calculator use) for participants to determine distance travelled.

ii. Develop a stand-alone mobile app and user interface

iii. More context for cheeseburger equivalence designation

iv. Move study quality to high quality based on criteria described by Dreijerink and Paradies (2020).

References

Babakhani, N., Lee, A., & Dolnicar, S. (2020). Carbon labels on restaurant menus: do people pay attention to them?. *Journal of Sustainable Tourism*, *28*(1), 51-68.

Dreijerink, L., Paradies, G. (2020). How to reduce individual environmental impact? A literature review into the effects and behavioral change potential of carbon footprint calculators. TNO Report.

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