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Cleanest Way to Get There

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ABSTRACT: Considering the global crisis that has been unfolding, at least two points have become clear: the value of clean air, and life is not always about the fastest or cheapest way to travel between two points. Navigation tools drive people to choose their desired method based on the fastest or cheapest way rather than the cleanest way to get from point A to point B. To solve this problem, the distinction between carbon emission fuels and greenhouse gas emissions, between electric and gasoline vehicles was researched. Based on the large range of emissions between these two types of vehicles, a web service was envisioned that would connect a variety of applications that would promote the use of clean mode of transport based on factors such as time, location, and efficiency. A reward system was also developed to serve as an incentive for usage of the service. After creating a few mockups and surveying people on their likelihood to use cleaner mode, responses were positive, suggesting that the web service could be used as an effective tool to change individual's behavior in utilizing clean mode of transport.

KEYWORDS: Environmental Science; Sustainability; Transportation; Application; Clean Air.

Introduction

Amid the COVID-19 pandemic, the value of clean air is becoming more apparent. As a matter of fact, during the COVID-19 pandemic, India has been on a country-wide lockdown. Since people are not going outside or interacting with others, pollution levels have come down to a level that even the Himalayas can be seen from 200 miles away.[1] One major source of air pollution is choice of transportation. This can manifest in several different ways. For example, European car habits are completely different from those of Americans. In 2010, a report illustrated that Americans drove for approximately 85% of their daily trips, while European car trip shares ranged from 50% to 65%. Although a fraction of this disparity can indeed be explained by a difference in trip distances, this is not the leading cause. The percentage of daily trips that are shorter than a mile is around 30% in both Europe and America. Of those short trips, Americans drove an amazing 70% of the time, while Europeans made 70% of those trips by foot, public transportation, or bicycle.[2] All of this results in the United States being much more polluted than it should be. This is primarily due to the decision to go from Point A to Point B using the fastest or the cheapest way because that information is easily accessible. While some of this can be accounted to Europe's more efficient public transportation system, it is likely that transportation could be further streamlined within the United States. This problem stretches worldwide, and every nation could benefit from a solution. Data suggests that transportation causes an overwhelming 29% of all greenhouse gas emissions, making it the largest contributor.[3]

The average carbon footprint of an American household is 48 tons.[4] In urban cities, such as Chicago, New York City, and San Francisco, this number is approaching a daunting 100 tons, much of which comes from transportation. This demonstrates that people are not using the cleanest way to get from one place to another. The surprising part of this is that Americans do not even know what the cleanest method is to get to a destination or do not have the knowledge to use the method when applicable. Below is a table detailing the tailpipe carbon emissions that popular vehicles have today:

Table 1: Carbon Emission Statistics.

Vehicle Type	Tailpipe Carbon Emissions (~ grams/mile)
SUV/Van	550
Sedans	320
Plug-in Hybrid	200
Hybrid	290
Electric Car/Bike	0

Credit: www.fueleconomy.gov/feg/findacar.shtml[5]

In addition, it is estimated that a typical passenger vehicle emits 4.6 metric tons of carbon dioxide per year.[6] Although the solution begins with the arrival of clean cars, like electric cars, the problem continues despite this innovation.

Methods

Solution Description:

Multivariable linear regression is widely used to account for the strength of the relationship between a dependent variable and multiple independent variables simultaneously, and thus

The solution will primarily focus on rechanneling these environmentally harmful habits worldwide by changing the way information is shared on the apps that provide information regarding travel routes.

A web service would be designed that guides the user to the cleanest way to go from their location to destination after considering a series of factors, including convenience. The solution would be embedded in popular programs that are available today, such as map services (Google Maps, Apple Maps, Waze, etc.), which are now found worldwide,[7] ride-sharing vehicle services like Uber and Lyft (which data has shown to have a large effect on car ownership and transportation in urban cities),[8] Amazon Alexa, or even an app on the app store. Furthermore, these separate modes would be connected, depending

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on the user's preferences, so personal information updates or activity in one of the modes would be recorded in the databases of all programs. Inputs to the web service would include point A and point B coordinates, as well as user preferences. A high-level overview of the service would include several service considerations. Some of these considerations include local transportation modes, user preferences, and practicality (e.g., walking may be the cleanest way but not the most convenient to go from NH to NJ). The output of this web service would include the cleanest mode options, carbon footprint costs, and recommended clean points.

Prototypes:

Here are a few prototypes of how envision the idea may be implemented:

1. Google Maps Prototype
2. Lyft Prototype
3. Amazon Alexa Prototype

The web service can be utilized by Google Maps in the following way. As seen in Figure 1 and Figure 2 (traditional car), Figure 3 (electric car), Figure 4 (electric bus), Figure 5 (electric bicycle), and Figure 6 (electric bike), the display will show the carbon footprint cost and the number of clean points the user can receive by choosing one of the vehicle options:

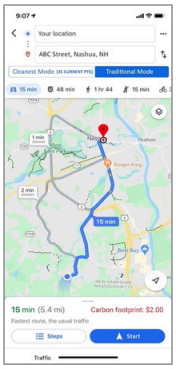

Figure 1: This shows the map when a user takes the traditional mode of transportation.

Figure 2: This shows the map when a user takes the traditional mode of transportation.

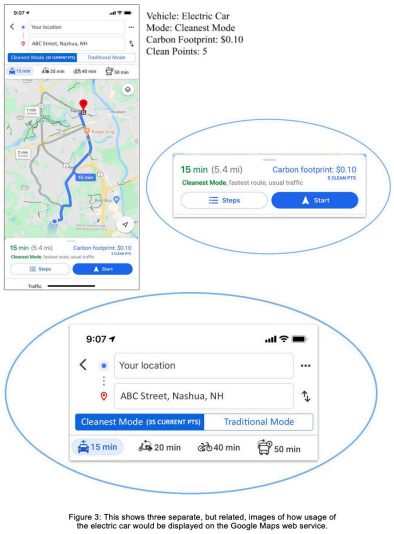

Figure 3: This shows three separate, but related, images of how usage of the electric car would be displayed on the Google Maps web service.

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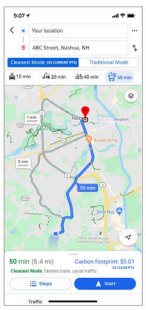
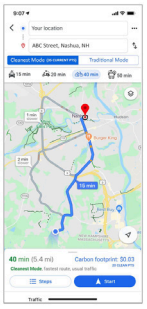


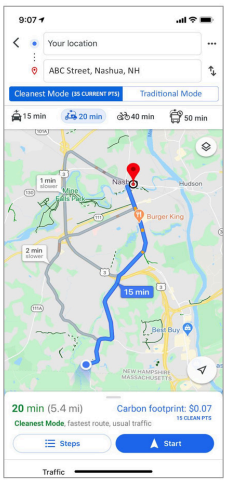


Vehicle: Electric Bus
Carbon Footprint: $0.01
Clean Points: 25

Vehicle: Electric Bicycle
Carbon Footprint: $0.03
Clean Points: 20

Figure 4: This shows how use of the electric bus would be displayed on the Google Maps web service, with the carbon footprint cost and clean points presented.

Figure 5: This shows how use of the electric bus would be displayed on the Google Maps web service, with the carbon footprint cost and clean points presented.



Vehicle: Electric Bike
Carbon Footprint: $0.07
Clean Points: 15

Figure 6: This shows how use of the electric bike would be displayed on the Google Maps web service, with the carbon footprint cost and clean points presented.

As one may imagine, the cleanest way to get from Point A to Point B may not be the cheapest way in the short term, so to approximate the real cost, the service will also return the carbon footprint cost of other modes of transportation. The total cost of the other modes of transportation may seem cheaper now but will be much more expensive to the user and humankind in the long run. The algorithm that will be used to determine cleanliness will consider factors such as transportation mode, the distance of travel, availability of transportation mode, number of people to be transported, carpooling options/preferences, convenience, time, and location.

To encourage people to make the cleanest choice, every individual can collect "Clean Points" according to the choices they make. Each choice can be assigned a value by these different services and have an associated reward system (e.g. free rides in Uber and Lyft). Lyft, a ridesharing service with

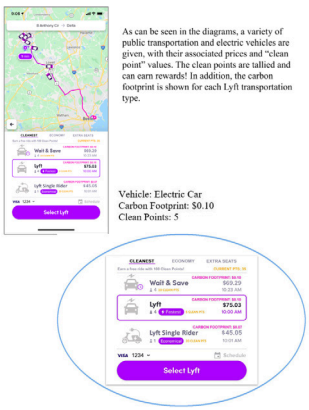


Figure 7: This shows how use of the electric car would be displayed on the Lyft web service, with the carbon footprint cost and clean points presented.

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bicycles, cars and scooters can use the web service in the following way, as shown in Figure 7.

If a user decided to access the web service using an Amazon Alexa device, a sample utterance could be "I need to go to the mall at 3:00 PM; show me the cleanest way to get there." Based on the factors listed above, the time that it would take to get from one place to another using the cleanest method would be outputted. The cheapest and the fastest methods would also be given, along with the carbon footprint, the cost, and the time of each. Amazon Alexa can be utilized as a Voice User Interface to give a response as outlined above. Alexa will prompt the user for the factors above and based on this information, create a balance between clean options, efficiency, and economy to present the best option to the user.

The web service can be utilized by Amazon Alexa in the following way as shown in Figure 8:

Figure 8: This shows how use of the Amazon Alexa service could help users to find the cleanest way to get from one way to another in conjunction with maps services.

As a society, a decision regarding which is the more important commodity (short-term pleasures and profits, or long-term fitness and success) needs to be made.

Following the development of the web service, it became important to test how the idea, if it were to enter the market, would be received. By sending out an online survey made on surveymonkey.com to a group of one hundred people, it became clear whether this idea would really be beneficial and accepted in society or not.

Results and Discussion

The idea and prototype of the app interface was shared with a small group of people. A Transformation Mode Preference survey was made asking them the following questions seen in figures 9 and 10:

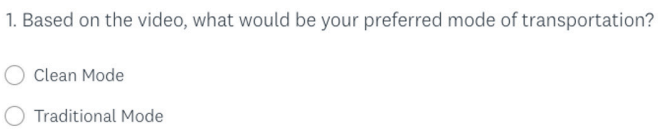

Figure 9: This displays the first question on the survey asked to the group of 100 people.

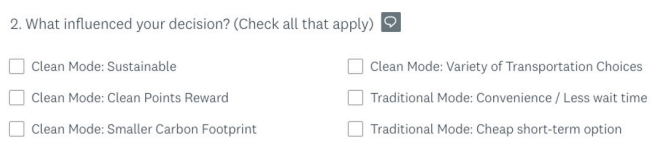

Figure 10: This displays the second question on to the group of 100 people.

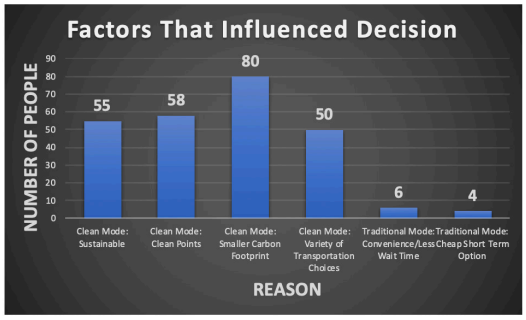

Figure 11: This graph shows the results of the first question of the survey, where participants were asked to choose between the traditional and the clean mode of transportation.

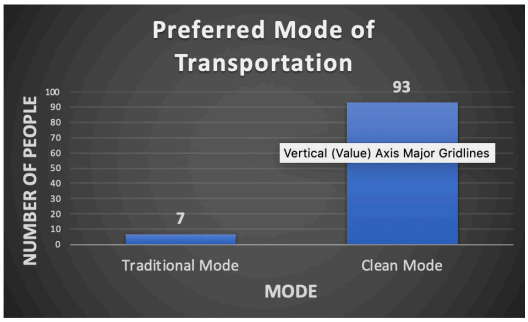

Figure 12: This graph shows the results of the second question of the survey, where participants were asked to choose their reasoning for their decision of the mode of transportation.

Discussion/Conclusions

Behavioral Changes at the Individual Level:

The premise of the entire solution is to drive individual behavior changes by positively reinforcing "clean" actions with rewards like "Clean Points" and creating negative connotations by adding the "carbon footprint" cost for using traditional transportation methods. Over time, these clean points could even be shared on social media platforms, fostering healthy competition, and further urging the growth of clean transportation. When individuals start valuing "clean" mode over "fast" mode or "cheap" mode, the collective results will drive long term benefits to the environment, which will help the entire society and the generation to come.

The other behavioral aspect that this solution considers is an individual's tendency to react affirmatively when they are asked to do more "good" actions versus less of "bad" actions, or habits that they are accustomed to. For this reason, the solution uses the technique of prompting users to use more of a cleaner mode of transportation rather than asking them to use less of a traditional mode of transportation.

Analysis of Results:

Upon performing graphical analysis of the data in Figures 11 and 12, there was a far higher percentage of people (93 people vs. 7 people) who favored the cleaner mode of transportation compared to the traditional mode. It appears that if given the option, people would prefer clean mode, which would be healthier for the environment. As for the reasons, the largest reason that people preferred the cleanest mode was actually due to their awareness of the carbon footprint gasoline vehicles leave, indicating that if this were to be employed, the "carbon footprint" section of the app would work to induce behavioral

change.

Limitations:

The primary biases that could have affected the surveying of the participants in the survey were nonresponse bias and response/wording bias. The questions used in the survey explicitly avoided the wording of "to make the environment cleaner" when assessing how potential users would feel about either mode or what influenced their selection, so response bias's effect is diminished. Another method through which response bias was decreased was by not asking any personal questions regarding the tendencies that respondents have.

Due to the nonresponse bias having the ability to easily skew the data, a variety of techniques were undertaken to limit the effects of this bias as much as possible. For one, the survey was kept short so that people would not need too much time to answer the questions. Secondly, all subjects were aware that the information was anonymous and even their names would not be recorded. These factors resulted in a respectable and unbiased survey to use as data in this research paper. Another possible bias that could have occurred from this is the small sample size.

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