PERSUASIVE DESIGN FOR SUSTAINABLE MOBILITY

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Abstract: *With the rise in need of sustainable mobility, persuasive design interventions hold an important place and have become an active research field in recent years. This paper aims to identify the problems faced by the people in using sustainable modes for daily travel and provide a solution to persuade people to choose sustainable transport options over private transport by using persuasive strategies on a personalized level. Data collection was carried out through a questionnaire filled by 90 participants and was tested using SPSS. Seven persuasive strategies have been used in designing a conceptual application prototype which has been further evaluated using Heuristic Analysis and Retrospective Think Aloud Protocol. The prototype classifies the persuasive strategies used for changing the behaviour in the domain of sustainable mobility while keeping in mind tailor-made features for the COVID-19 pandemic situation.*

Keywords: *Transport, Mobility, Sustainable Mobility, Persuasion, Persuasive Strategies.*

INTRODUCTION

Transport, the sector which accounts for nearly one-third of the world's CO_2 emissions, is a major reason for the massive increase in greenhouse gas emissions in the recent decades [5]. Studies show that the greenhouse gas emissions due to this sector are increasing at a rate faster than any other energy-using sector, especially in urban areas [6][19]. While measures such as energy efficiency, increased production of renewable energy and higher incorporation of renewables in the fuel mix have led to a slower rate of growth of electricity and heat generation emissions, measures to reduce emissions from the transport

sector have not been as effective [12]. With the rapid increase of population in urban areas, meeting the rising demands for efficient mobility within the constraints of existing infrastructure and available land becomes more and more difficult, making mobility a critical and universal challenge faced by cities all over the world [16].

Heavy reliance on cars and limited utilization of local public transport has made transport a major contributor to global climate change [9]. The ever increasing use of private vehicles in urban areas has resulted in several intractable problems, including congestion, accidents, noise pollution, air pollution, smog, air pollutants, greenhouse gas emissions, over utilisation of land resources, depletion of natural resources, global warming and in general poor quality of life with adverse effects on public health as well as the environment [4][16][18]. Apart from having a significant impact on the environment, the transport sector consumes 20 to 25% of the world's energy [5][6][19].

Given these various problems, and their associated economic, social and environmental impacts, the current transport system may be considered in many respects unsustainable with an emergent need for sustainable mobility [18]. The World Business Council for Sustainable Development defines ‘Sustainable Mobility’ as “the ability to meet the needs of society to move freely, gain access, communicate, trade, and establish relationships without sacrificing other essential human or ecological values today or in the future” [18]. Although the notion of ‘Sustainability’ is contested, broadly speaking sustainable mobility is understood to contribute to social and economic welfare, without damaging the environment or depleting environmental resources [18]. Sustainable transport systems make positive contributions to the economic, social and environmental sustainability of the communities they serve [5].

Transport is a crucial sector for promoting sustainability, but changing the habits of the mass population is a hard challenge even though local governments and companies have developed various interventions to support sustainable mobility [20]. The results are sparse, and the majority of them do not reach the critical mass necessary to have sufficient impact, thus making it difficult for the local governments and companies to systematically and actively engage work organizations and commuters in such efforts [20].

According to studies, there is often a gap between individuals' concerns of climate change and their actual travel behaviour. But this gap is not due to inadequate knowledge of climate change, but rather how this knowledge is translated into practice when choosing modes of transport [12]. Though technological innovations and environmental concerns are slowly changing people’s expectations and preferences, these factors alone are not sufficient

to achieve the climate and environmental objectives set out for the transport sector, especially with the rise in processes such as car dependency and decentralisation of cities that are very difficult to reverse [12][13][16].

The intensity of negative environmental impacts due to transport can be reduced, if not eliminated, by changing a major root of environmental problems - human behaviour [3]. Human behaviour remains the most important factor for achieving environmental sustainability as new eco-friendly technologies alone cannot guarantee a successful implementation of sustainable practices [3]. It requires changes in our behaviour and development in which car travel decreases [12]. Moreover, increasing a person's awareness of the environmental impact of travel mode choices and changing their behaviour towards adopting habits that rely more on the use of public transport, bicycles and walking and less on private cars, can provide the means to reduce emissions in the short term, with other positive effects such as less air pollution and smog, as well as more healthy lifestyles with increased exercise and less obesity [19]. On an individual level, people in urban areas have various modes of transport at their disposal, particularly shared ones, such as cars, bicycles or e-scooters, but it is still up to that individual to decide which sustainable option to use, a decision that is influenced not only by pragmatic questions of availability and travel time but also by the salient beliefs one holds [11].

Nowadays, several mass media messages bombard people and try to persuade them to buy or do something and people respond to such an onslaught of media by choosing messages based on their content or other features [10]. This is called persuasive technology which is broadly defined as the technology that is designed to change attitudes or behaviours of the users through persuasion and social influence, but not through coercion [6][19]. In the last few decades, campaigns based on persuasive communication have been conducted often to promote pro-environmental actions [10]. Persuasive systems addressing behaviour change in the context of sustainable mobility is an area that aims to motivate users towards making more eco-friendly choices [19]. Persuasive technologies, tailored for and integrated into applications that support sustainable mobility can affect a person's decisions and guide them towards selecting environment-friendly modes of transport [19].

The diagram shown below showcases the areas that are included in this study and combine to form the focus of this research.

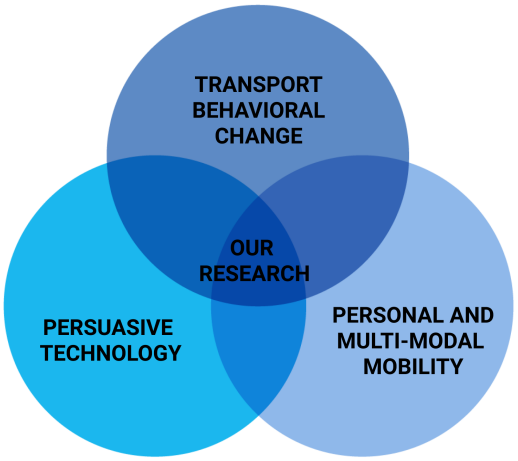

Fig. 1: Research Areas

LITERATURE REVIEW

Sustainability is still relatively peripheral to transport regime interests but is beginning to receive attention slowly but steadily [18]. Many countries and cities like France, Belgium, Bellevue and San Francisco have introduced new sets of policies and incentives like travel plans and discounts for travel passes to increase the usage of public transport to reduce the usage of Single Occupancy Vehicles (SOV) and encourage their citizens to use sustainable transport options [20]. But, this transition towards sustainable mobility needs to be gradual and should aim to contribute to social and economic welfare, without damaging or depleting the environmental resources [18]. People need to be nudged towards using public transport more as these travel modes are less costly, have high accessibility, are less complex and have an almost negligible harmful impact on the environment [18].

Nowadays, researchers are coming up with interventions involving interactive systems which involve the users and try to induce behaviour change in them. This is called Sustainable HCI (Human Computer Interaction) and is being widely used for persuasive sustainability [20]. Such interactive systems are generally based on Fogg's Behaviour Model and their main aim is to convince their users to opt for more sustainable transport options [1][20]. There are many applications present in the market which are trying to promote sustainable mobility like TRIPZOOM, PerCues, UbiGReen, EcoIsland, I-Tour, Green Daily Guide, SUPERHUB, MOTIVATE, OPTIMUM, SMART, BikeTogether, EcoTrip, etc [19]. These web-based or mobile-based applications aim to optimize mobility by supporting the users in gaining insights on their mobility behaviour through travel details like costs,

emissions, and impact on health [19]. They try to persuade their users to use public transportation instead of their private vehicles to reduce emissions [19].

Though there are a lot many initiatives in a variety of different forms out there to promote sustainable mobility, there are some major problems because of which these various initiatives taken related to sustainable development don't reach global levels thus reducing their intended impact [20]. One of those problems arises due to the lack of support, communication and coordination between the different stakeholders, policymakers and firms [20]. Interactions among them must be continuous, tailored and traceable [20]. Another of those problems is that these initiatives' benefits, costs, and impact are difficult to estimate in advance, thus preventing allocation of resources [20]. Lastly, understanding the infrastructure and geographical context is also very important, and many times lack of this knowledge becomes a barrier during implementing those initiatives [20]. Following are some points that need to be considered and understood while developing initiatives for sustainable mobility: (i) Understanding the context of roads; (ii) Understanding the public transportation; (iii) Understanding the evolution of private services; and (iv) Understanding the commuters [20].

Many times designers ignore the target users' motivations, the existing institutional, social and cultural influences and the constraints while designing which creates acceptability problems and lack of adoption by the users [20]. Changing human behaviour is not a simple matter of just persuading, the users behaviour and its determinants need to be deeply understood, and then to finally design any appropriate intervention addressing a certain behaviour, that particular intervention's practicability, acceptability, and affordability need to be considered [20].

The results of an examined study show that people differ in their susceptibility to different persuasive strategies [6]. This also leads to the assumption that personalized approaches can be more successful than "one size fits all" approaches [6]. By considering the personality of users, applications can be tailored according to the users' needs and can therefore be more successful [6]. Also, timely and proactive delivery of information can enhance the persuasive potential of an approach [6]. It was also noted that for a successful behavioural change, availability and accessibility of sustainable transport alternatives is also of much importance [5]. In one of the studies, it was found that visual elements were more successful in creating stimulated awareness about the users' transport activities [8]. The users enjoyed unfolding the narrative of image sequences, which provoked curiosity and anticipation leading to more sustainable choices [8]. Another way of encouraging users

according to studies can be through reward structure, where users earn some points on taking a sustainable trip [8].

Communicating the benefits of having more positive attitudes towards public transport like buses and railways, and less favourable attitudes towards private transport like cars and bikes, might be an effective approach for changing mobility behaviour [9]. According to a study, factors of motivation, ability and trigger from Fogg's Behaviour Model with an added factor of emotional relationship have a positive effect on the overall success of an application as compared to other applications [1]. Another study supports the idea of anticipated emotions playing a key role in the elaboration of a persuasive message [10]. Their studies provide evidence towards the importance of emotions and arguments, thus confirming the interplay between cognition and emotion in the explanation of human behaviour [10].

Given the positive effects of exercise and physical activity on individuals' health and quality of life, it was suggested in one of the studies that examining whether the promotion of non-motorized sustainable mobility can be compatible with suggested exercise regimens would be a great area to explore [16]. Non-motorized transport modes can be classified as physical activity and thus a non-motorized transport can be considered as a health-related physical activity that can have a significant impact on health and quality of life [16]. Urban regeneration schemes can incorporate urban transport restructuring towards non-motorised mobility to promote fitness as a persuasion for sustainable mobility [16].

The objectives of this study are as follows: (i) To identify and explore new ways of changing the behaviour of people towards sustainable mobility by using persuasive technology. (ii) To nudge people on a personalized level by exploring various persuasive strategies in order to influence them to make more sustainable transport choices.

METHODOLOGY

Based on the initial desk research on Persuasive Designing, the focus area of research was narrowed down to Persuasive Design for Sustainable Mobility. Then further desk research was carried out which was followed by data collection through a Questionnaire. Hypotheses were formed and analysed using various methods to understand the underlying structure of the data and as a result, a prototype was proposed for a mobile application which was evaluated using Heuristic Analysis and Retrospective Think Aloud Protocol. The diagram below shows the process followed for this study.

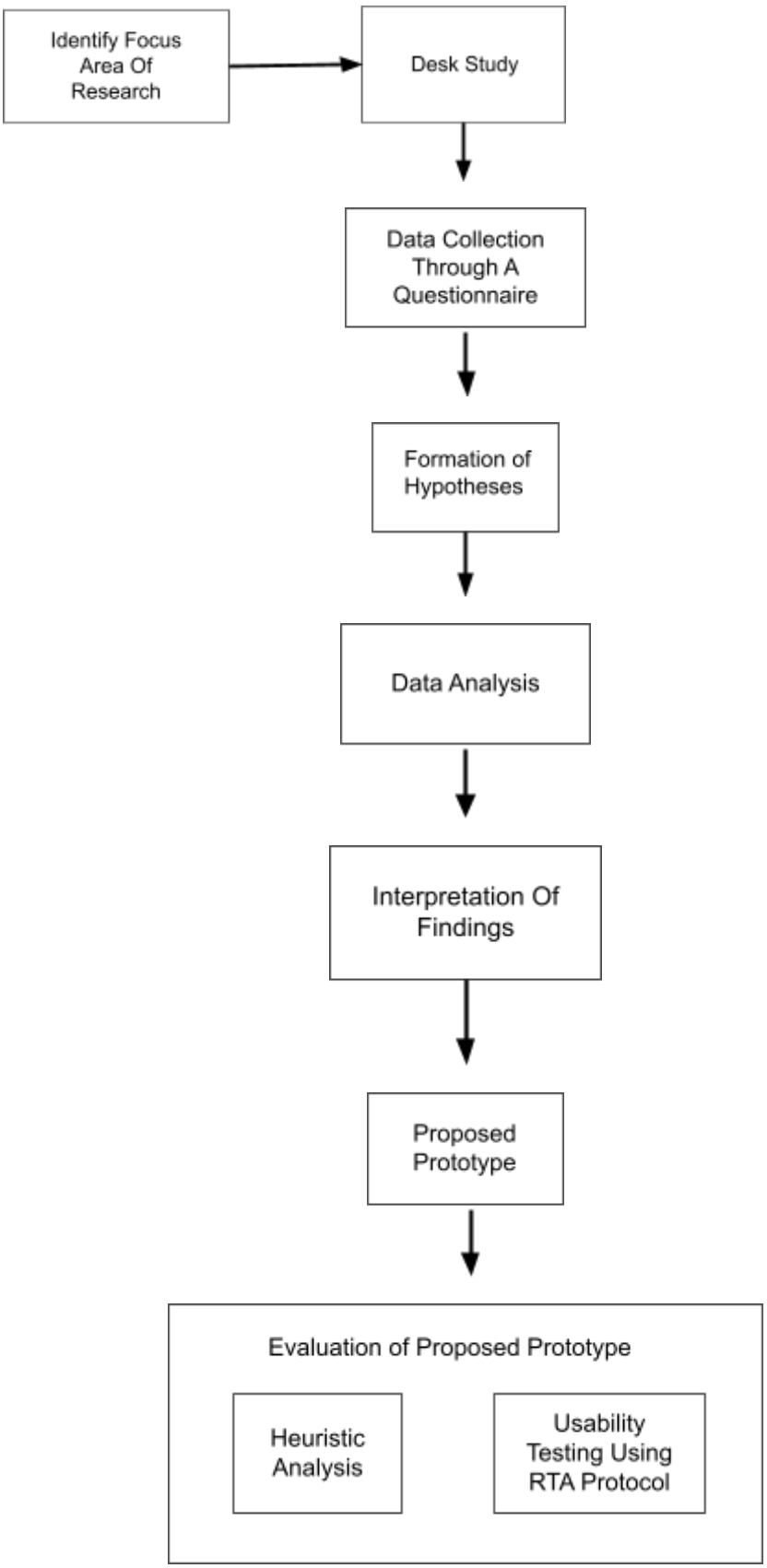

Fig 2: Process Followed for the Study

Questionnaire

A pilot study was carried out with the help of a questionnaire to understand the habits of people regarding their choices in choosing a mode of transport in their daily life. The questionnaire included three parts: (i) the first part was to collect general information about the participants and their daily travel; (ii) the second part was to collect the participants' preferences regarding public transport; (iii) the third and last part was to collect information on the participants' sustainable travelling choices. This research instrument was used mainly to gather information from the participants and identify the major issues. The structured questionnaire with close-ended questions was planned and designed to gather precise information. It mostly consisted of multiple-choice questions (both single-select multiple-choice questions and multi-select multiple choice questions). The questionnaire was an online form that was shared with the participants via mail and other online mediums. A total of 90 valid responses were collected from the survey.

Participants

All 90 participants were permanent residents from various cities of India. Participation in this study was completely voluntary and the participants were free to withdraw at any time. Also, they were assured that their responses would remain anonymous and that the data would be kept confidential. The range of the target group selected for this study was from the age of 18 to 40 (Mean = 26.36; Standard Deviation = 4.851) with 58.4% females and 41.6% males. As far as the professional status is concerned, 38.2% of the participants were college-going students, 49.4% were employed, 7.9% were homemakers, and 4.5% were unemployed. The participants participating in this study owned a minimum of one private vehicle, either a 2-wheeler or a 4-wheeler. Of these 90 participants, 83% of them agreed that they were aware of the massive effects that the transport sector has on our environment.

Hypotheses

The five major hypotheses formed were based on the information gathered from the questionnaire as a basis of reasoning. Major factors such as public transport options, sustainable transport options and purpose of trip were considered while forming the various

hypotheses. These hypotheses were then tested by analyzing the data using Statistical Package for the Social Sciences (SPSS) which is a graphical data science and predictive analytics platform used by researchers for complex statistical data analysis.

The first hypothesis consisted of three sub-hypothesis, in each of which a different purpose of the trip was considered to test the significant difference between choosing private and sustainable mode of transport.

H1a: There is no significant difference between people using private and sustainable mode of transport while going to work/college.

H1b: There is no significant difference between people using private and sustainable mode of transport while going to market/store.

H1c: There is no significant difference between people using private and sustainable mode of transport while going for leisure.

The second hypothesis was formed to check if there was any significant difference in the number of people choosing walking or cycling over any public transport.

H2: There is no significant difference between people choosing walking/cycling and people choosing public transport.

The third and fourth hypotheses were to understand if factors like time constraint, cost-effectiveness, accessibility, frequency, price of fuel, comfort, special offers, weather and health issues affect people in choosing a particular mode of transport and also if factors like travel time, waiting time, frequency, reliability, distance to the stand/stop/station, route, overcrowding, safety, discomfort and hygiene annoy and discourage people from using public transport.

H3: There is no significant difference between the factors like time constraint, cost-effectiveness, accessibility, etc. while choosing a mode of transport.

H4: There is no significant difference between the factors like overcrowding, hygiene,.safety etc. that annoy people while using public transport.

The fifth and the last hypothesis was to check whether incentives like cheaper fares, free rides, bonus coupons/tickets and availability of proper cycle lanes, walkways and footpaths attract people towards choosing sustainable modes of transport.

H5: There is no significant difference in the number of people opting for sustainable transport before and after the inclusion of incentives like free rides, discounts, availability of proper cycle lanes and footpaths.

Heuristic Analysis

Heuristic analysis is an analysis that determines the susceptibility of a system by using various decision rules or weighing methods. It is conducted based on the rules of heuristics, popularly used in user experience and user interface design to evaluate a website, portal or an app for their confirmation to heuristic principles. In this study, Heuristic Analysis was carried out to evaluate the prototype proposed for promoting sustainable mobility using persuasive design. Jakob Nielsen's 10 general principles for interaction design which are called the "heuristics" were used for evaluating the prototype. The evaluation involved 2 evaluators who examined the interface of the prototype and judged its compliance with recognized usability principles (the "heuristics"). During the evaluation session, the evaluators went through the interface of the prototype several times, inspected the various elements and compared them with a list of recognized usability principles (the "heuristics"). Heuristic Analysis Report was used by the evaluators for scoring purposes which shows the score in comparison to how many rules were followed for each heuristic. 3 usability rules were checked for each of the 10 heuristics. The evaluators tried to be as specific as possible and listed down each usability problem.

Retrospective Think Aloud Protocol

Retrospective Think Aloud Protocol is a technique used in usability testing to gather qualitative information. This involves participants thinking aloud as they are performing a set of specified tasks. They are asked to say whatever comes into their mind as they complete the task. The participants describe and explain their approach and thoughts while completing the tasks. When using this protocol, participants are less distracted as there are no additional influences. 5 participants were chosen for evaluating the prototype through the Retrospective Think Aloud Protocol. An online session was conducted to carry out this evaluation with each of the participants where the participants went through the prototype and thought aloud to explain what they were doing at each stage, and why. Researchers of this study who acted as the observers took notes of what participants said and did, without attempting to interpret their actions and words, especially noting places where they encountered difficulty. These sessions were recorded so that the researchers could go back and refer to what participants did and how they reacted.

PROTOTYPE

Based on our findings from the research carried out in this study, a prototype has been designed that uses the above seven persuasive strategies to nudge and motivate people on a personal level to change their behaviour towards sustainable mobility and choose more sustainable transport options for their daily travel.

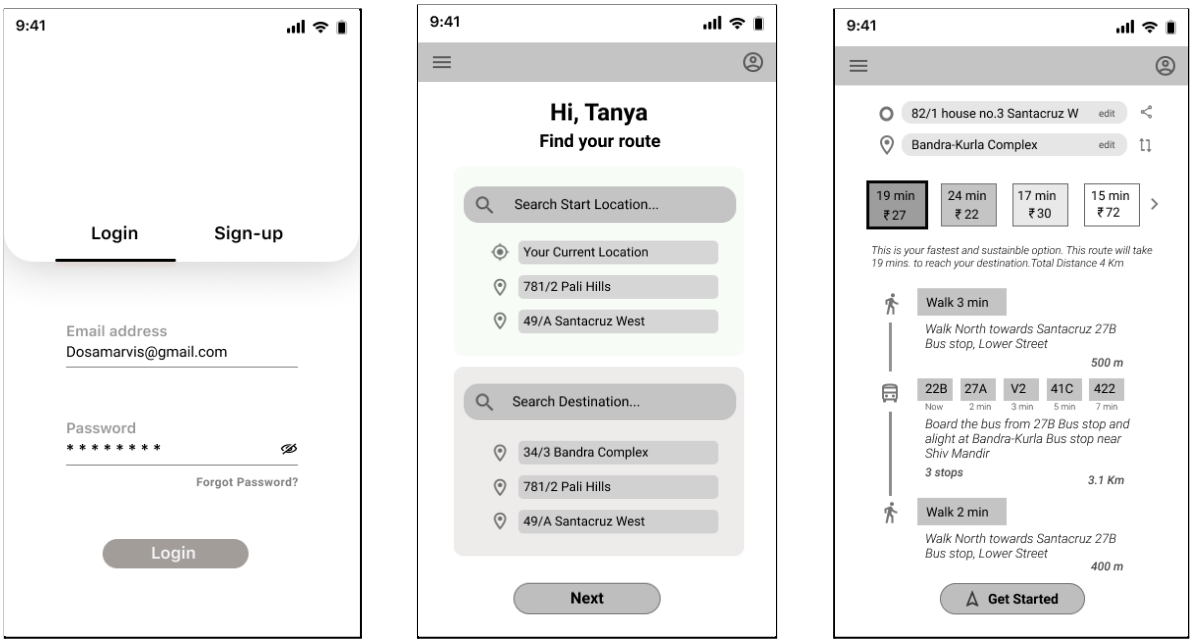

Fig 3: Login/Sign-Up Page, Source & Destination Page, Route Options Page

The prototype of the mobile application designed has an easy to use interface which can be used by anyone without any prior knowledge. The user needs to sign up first to use the application after downloading it. If one has already signed up before he/she can easily log in to the application using an email id and password. Once the user logs in to the application, the user will be able to search and choose their source and destination locations of travel. It will also have the feature of GPS tracking with the help of which it can locate your current location and automatically fill in the source of travel. The user shall also be provided with options like pre-saved routes or they can add any particular route of their choice. After selecting the source and destination the user is now ready to move on to the next step. As they click on Next, they will be shown the various route options in a color coded format calculated based on three factors; sustainability, travel time and travel cost. The best option based on all three factors will be displayed in green, and as we go further the shade will become lighter and finally, the last option will be shown in red which would indicate that it is

the most unsuitable and non-sustainable travel option with the maximum amount of carbon footprints. On selection of the route option as per the user's choice, the information about the selected route would be shown with breakups for the whole route with all travel details like travel time, distance, mode of transport, travel cost, etc. It will also show information about the public transports available on that particular route with the timing mentioned for the arrival of that transport.

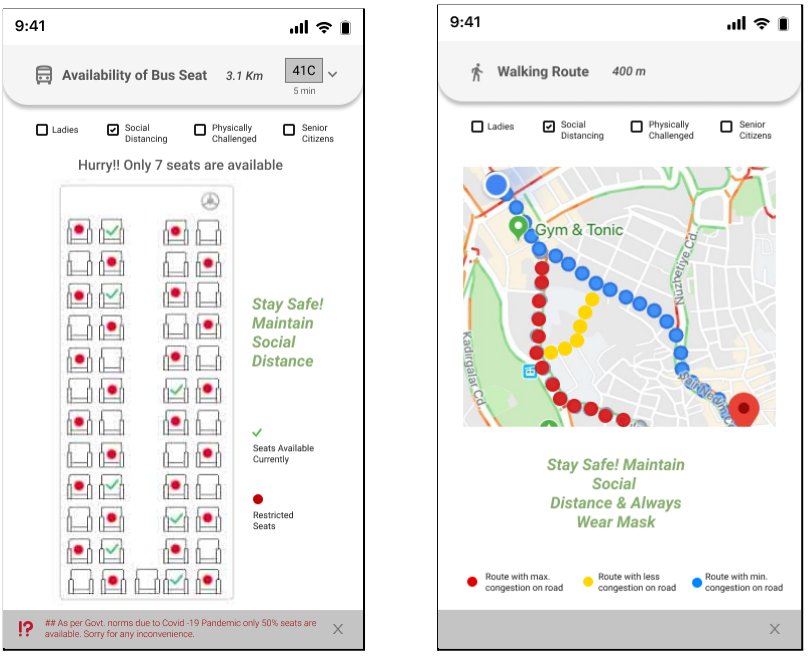

Fig 4: Covid Specific Features

The user can also see the availability of seats on the vehicle and prebook a seat for herself/himself. If the user misses the particular seat it will automatically show vacated for the next stop. Another important feature of the application is for the COVID-19 situation when everyone is presumed to maintain social distance for safety purposes. Seats would be marked keeping in mind the need for social distancing.

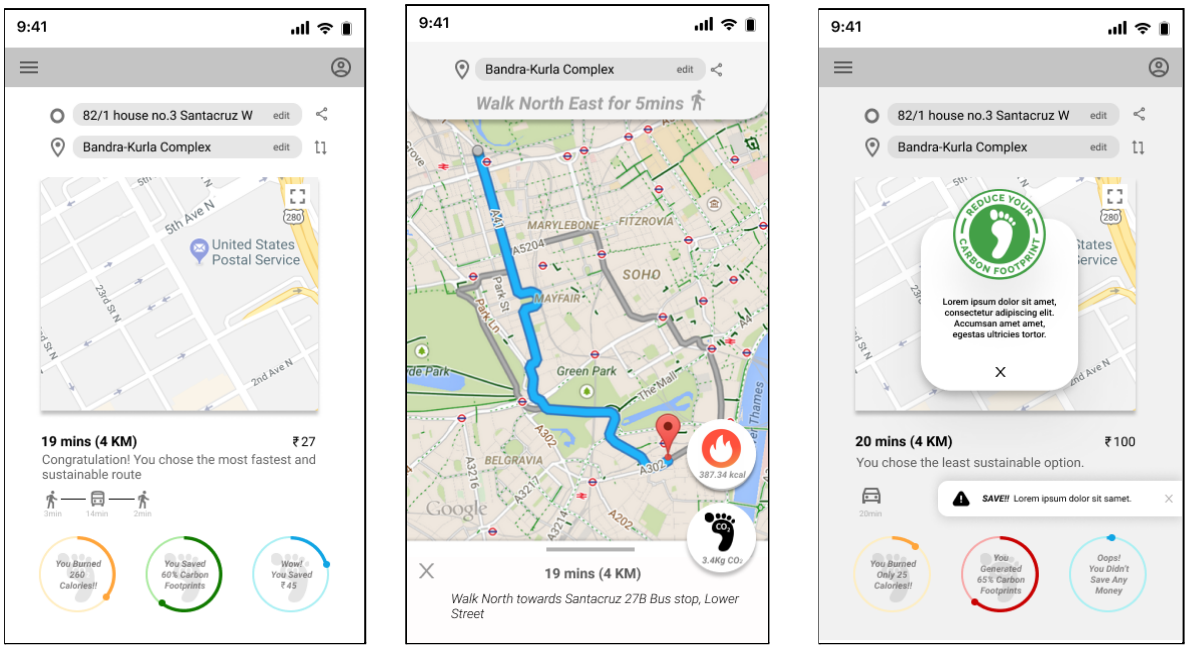

Fig 5: Travel Details, Map of Route, Persuasion Message

After choosing the most suitable travel option and selecting Get Started, a map of the route would be shown along with the congestion on the particular route, so that one can decide on choosing the route with the least congestion. The map could be enlarged as per the user's choice or zoomed in as per the user. All travel details would be flashed in short along with three counter circles that depict calories burned, carbon footprints saved and money saved on that particular route. The calorie counter would count the approximate calories that would be burned if that travel option is chosen and is displayed as a means to persuade the user through fitness goals. Another counter would estimate the carbon footprints that would not be emitted if that particular travel option is chosen, thereby saving a certain amount of carbon emissions. This is another persuasion strategy where the guilt of emitting more carbon will be used to persuade the user. The third counter would showcase the exact amount saved by choosing that travel option against the costliest one as a way of persuading users to opt for that travel option. When the map of the route is enlarged and the trip starts, the calorie counter and the carbon footprint counter will automatically start and track the count respectively throughout the whole journey. If a user still opts for a red color coded option that is not sustainable, a persuasive and personalized message will be displayed in the middle of the page in an attempt to try and persuade the user again to choose a sustainable option.

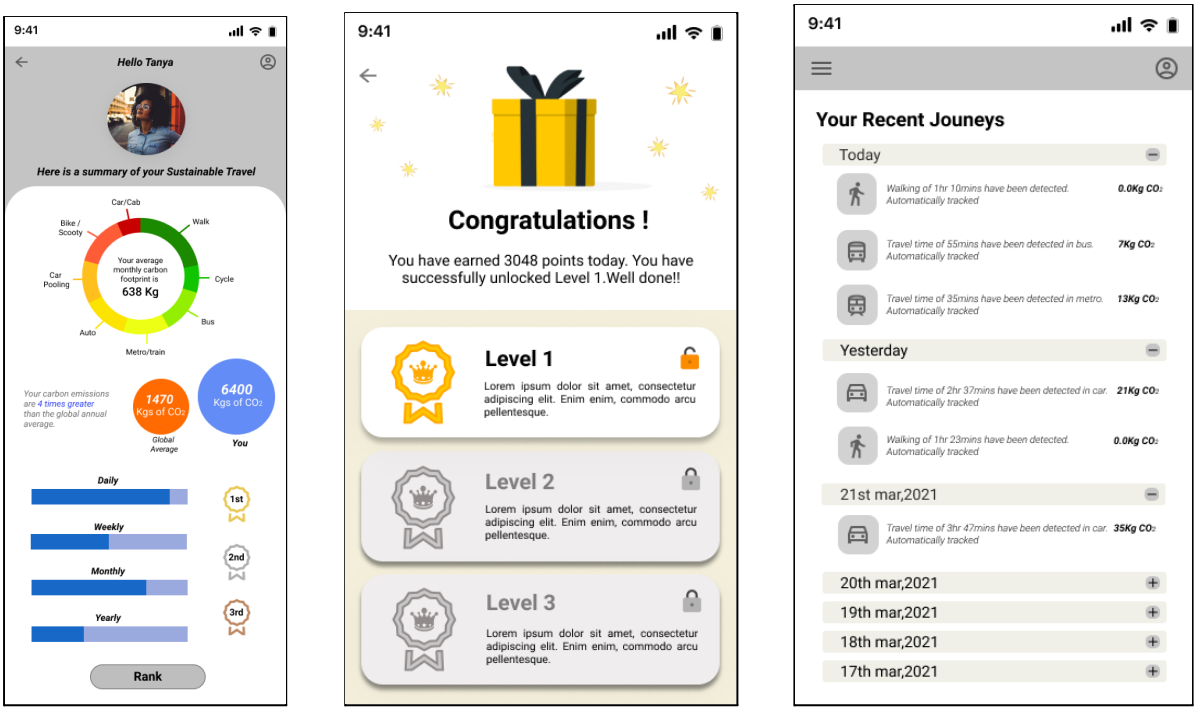

Fig 6: Profile Page, Rewards Page, Community Page

Gamification, social comparison and self-monitoring and feedback persuasion strategies have been used in the rewards, community and profile sections of the applications respectively. In the rewards section, there are 3 levels that can be unlocked one after the other only by earning a certain amount of points. These points can be earned by taking a sustainable transport option for travelling. More the mode of transport is sustainable, the more the points. This way it will be a very powerful persuasion strategy to nudge users towards opting for a sustainable transport option more times. As for the community section, it will connect to the users' social media accounts and can be a place where the user can compare their reward points and levels with their peers or friends. Comparing can be a great way to motivate users to change their mobility behaviour. In the profile section, a summary of all the users' activities with their status and performance towards achieving the goals will be showcased. All the information collected through tracking the users' transport choices every day will be displayed in the form of visually appealing stats. The average of the carbon footprints generated monthly with a colorful distribution specifying carbon footprints generated by each mode of transport opted is shown. Other than that, stats of global versus the users CO2 emissions is shown. Lastly, a daily, weekly, monthly and yearly bar of goals reached towards achieving a gold, silver or bronze batch after crossing a level is displayed along with the users rank.

RESULTS

Data Analysis

The data collected from the questionnaire was tested by carrying out the Normality Test for the purpose of identifying if the data was normal or not. The data was found to be normal. Then for testing the hypotheses, T-Test, ANOVA Test and Paired Sample T-Test were performed using Statistical Package for the Social Sciences (SPSS) which is a graphical data science and predictive analytics platform used by researchers for complex statistical data analysis.

Table 1: Results of Data Analysis

Hypotheses	Test Performed	P-value	Result
H1a	T-test	0.068 > 0.05	Accepted
H1b	T-test	0.07 > 0.05	Accepted
H1c	T-test	0.001 < 0.05	Rejected
H2	T-test	0.006 < 0.05	Rejected
H3	ANOVA Test	0.08 > 0.05	Accepted
H4	ANOVA Test	0.003 < 0.05	Rejected
H5	Paired Sample T-test	0.001 < 0.05	Rejected

H1(a,b,c) and H2 were tested using T-Test, the test which determines if there is a significant difference between the means of two groups, which may be related in certain features. According to the results, H1a with a p-value (0.068 > 0.05) was accepted, meaning that there was no significant difference between people using private and sustainable mode of transport while going to work/college. Similarly, H1b with a p-value (0.07 > 0.05) was also accepted, resulting in no significant difference between people using private and sustainable mode of transport while going to market/store. But, H1c with a p-value (0.001 < 0.05) was rejected, meaning that there was a significant difference between people using private and sustainable mode of transport while going for leisure. It could be thus derived from H1c that

people preferred using the private mode of transport over the sustainable mode of transport while travelling for leisure. And H2 with a p-value (0.006 < 0.05) was also rejected, resulting in a significant difference between people choosing walking/cycling and people choosing public transport. From H2, it could be concluded that people preferred travelling by public transport rather than walking or cycling.

For testing H3 and H4, the ANOVA Test which stands for Analysis of Variance was carried out to gain information about the relationship between the different variables/factors. In the case of H3, it was accepted with a p-value (0.08 > 0.05) resulting in there being no significant difference between the factors like time constraint, cost-effectiveness, accessibility, frequency, price of fuel, comfort, special offers, weather and health issues while choosing a mode of transport. On the other hand, H4 was rejected with a p-value (0.003 < 0.05) meaning that there was a significant difference between the factors like travel time, waiting time, frequency, reliability, distance to the stand/stop/station, route, overcrowding, safety, discomfort and hygiene that annoy people while using public transport. According to H4, it could be said that people considered factors like travel time, waiting time, frequency, reliability, distance to the stand/stop/station, route, overcrowding, safety, discomfort and hygiene annoying when using public transport.

Lastly, H5 was tested using the Paired Sample T-Test which is used to determine the difference between two variables for the same subject where the two variables are often separated by time. The result was that H5 with a p-value (0.001 < 0.05) was rejected, meaning that there was a significant difference in the number of people opting for sustainable transport before and after the inclusion of incentives like cheaper fares, free rides, bonus coupons/tickets and availability of proper cycle lanes, walkways and footpaths. From H5, it was found that people were more willing to opt for sustainable transport after the inclusion of incentives like cheaper fares, free rides, bonus coupons/tickets and availability of proper cycle lanes, walkways and footpaths than before.

Heuristic Analysis

Heuristic Analysis of the proposed prototype was carried out by using Jakob Nielsen's 10 general principles for interaction design which are called "heuristics". They have been listed and explained in detail below:

1. Visibility of system status

The design should always keep the users informed about what’s happening, through

appropriate feedback within a reasonable amount of time. When users know the current system status, they learn the result of their prior interactions and determine the next steps.

2. Match between system and the real world

The design should speak the users' language. Words, phrases, and concepts used should be familiar to the user, instead of internal jargon. Real-world conventions should be followed, making information appear in an exceedingly natural and logical order. When a design's controls follow real-world conventions and correspond to desired outcomes, it's easier for users to learn and remember how the interface works.

3. User control and freedom

Users often perform actions by mistake. They need a clearly marked "emergency exit" to leave the unwanted action without having to go through an extended process. When it's easy for users to back out of a process or undo an action, it fosters a sense of freedom and confidence. Exits allow users to stay in control of the system and avoid getting stuck and feeling frustrated.

4. Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Failing to maintain consistency may increase the users' cognitive load by forcing them to learn something new.

5. Error prevention

Good error messages are important, but the most effective designs carefully prevent problems from occurring in the first place. Either error-prone conditions should be eliminated, or users should be presented with a confirmation option before they commit to any action.

6. Recognition rather than recall

Users' memory load should be minimized by making elements, actions, and options visible. The user should not have to remember information from one part of the interface to another. Information required to use the design should be visible or easily retrievable when needed. Interfaces that promote recognition reduce the amount of cognitive effort required.

7. Flexibility and efficiency of use

Shortcuts, hidden from novice users, may speed up the interaction for the expert user such that the design can cater to both inexperienced and experienced users. Users should be allowed to tailor frequent actions. Flexible processes can be carried out in numerous ways so that people can pick whichever method works for them.

8. Aesthetic and minimalist design

Interfaces should not contain information that is irrelevant or rarely needed. Every extra unit of data in an interface competes with the relevant units of data and diminishes their relative visibility. This heuristic doesn't mean a flat design should be used, it's about ensuring that the content and visual design is focused on the essentials. Visual elements of the interface should support the user's primary goals.

9. Help users recognise, diagnose and recover from errors.

Error messages should be expressed in plain language, precisely indicating the matter, and constructively suggesting a solution. These error messages should also be presented with visual treatments that may help users notice and recognize them.

10. Help and documentation

It’s best if the system doesn’t need any additional explanation. However, it may be necessary to provide documentation to help users understand a to complete their tasks. Help and documentation content should be easy to search for and focused on the user's task.

Table 2: Results of the Heuristic Analysis

Evaluation Criteria (3 Usability Rules for Each Heuristic)	**Score**	**Values**
1. Visibility of system status	3/3	75%-100%
2. Match between system and the real world	2/3	50%-74%
3. User control and freedom	3/3	75%-100%
4. Consistency and standards	2/3	50%-74%
5. Error prevention	2/3	50%-74%
6. Recognition rather than recall	2/3	50%-74%
7. Flexibility and efficiency of use	2/3	50%-74%
8. Aesthetic and minimalist design	3/3	75%-100%
9. Help users recognise, diagnose and recover from errors.	1/3	25%-49%
10. Help and documentation	0/3	0%-24%

After successfully carrying out the Heuristic Analysis the results show that the prototype has the scope of improvement in certain areas like saving the most common routes for daily travel or any particular favourite route option chosen by the user. There can be an option for saving certain routes prior to departure for easier usage. The prototype can also have a few shortcuts and accelerators for a faster and improved interface. Some animations can be added for a better understanding of certain features along with a 24/7 help and support team feature for the users.

Retrospective Think Aloud Protocol

Retrospective Think Aloud Protocol serves as a window on the soul, letting designers discover what users really think about their design. In particular, designers hear the users' misconceptions, which usually turn into actionable redesign recommendations: when users misinterpret design elements, designers need to change them. Even better, designers get to learn why users guess wrong about some parts of the user interface and why they find others easy to use. Being cheap and robust are huge upsides of carrying out qualitative methods for user testing such as thinking aloud. But the flip side is that the method doesn't lend itself to detailed statistics unless one runs a huge, expensive study.

As the 5 users verbalized their thoughts while moving through the user interface, a few misconceptions and misinterpretations were identified. 2 out of 5 users found problems in understanding the section with different route options that consisted of all possible options of travel in a color coded format calculated based on three factors; sustainability, travel time and travel cost. It was noted that 4 from 5 users thought that there was no clarity on how to access the covid specific features. 3 out of 5 users thought that responsive and timely messages on achieving short goals or accomplishing a particular task or reaching the required destination are needed for updating the user and better persuasion. These misconceptions and misinterpretations that were identified can be used as recommendations for redesigning the proposed prototype in the future. The usability of the proposed prototype can be improved by including these points that have been identified.

DISCUSSION

It has been noted from several studies that interactive systems like mobile applications can be designed and developed with the help of persuasive technology to promote desirable

behaviour or motivate change in the existing behaviour of users. In the past, persuasive technologies and behaviour change support systems have been used in several different sectors like health, safety, security, energy conservation, education, etc. These technologies come in various forms including games, wearable devices, mobile or desktop applications, robots and many other dedicated devices. The major problem in most of these existing technologies is that they adopt the so-called “one size fits all” approach in their design and evaluation, which has proved to be far less effective in motivating behaviour change.

According to our findings, persuasive strategies when implemented on a personalized level tend to have more impact on motivating people to change their mobility behaviour and make more sustainable choices. Another of our findings showcase that customization, contextualised information, feedback and appealing design are essential aspects when designing applications based on persuasion strategies. One of our core findings also supports the fact that various details related to travel like travel time, travel cost, CO2 emitted and calories burned are very important for people when considering sustainable options. It was also suggested that including fitness with other persuasive strategies can result in a modern, active and healthy environment. Findings from hypotheses confirm that people are more willing to opt for sustainable transport options after the inclusion of rewards and incentives like free rides, discounts, availability of proper cycle lanes and footpaths.

Seven persuasive strategies have been identified and used for designing the prototype. They are Personalization, Social Comparison, Self-Monitoring and Feedback, Gamification, Fitness, Carbon Footprints, Money-Saving. Our findings showcase significant support for these persuasive strategies as well as the hypotheses and their results obtained from the data analysis show essential implications on it.

Table 3: Persuasive Strategies Used

Strategies	Description
Personalization	For more effective persuasion, solutions should be tailored according to the user. Personalized approaches are more successful than “one size fits all” approaches.
Social Comparison	Comparing different users' performance towards a target behaviour can be a great and powerful way to nudge and motivate them to adopt a certain behaviour.

Self-Monitoring and Feedback	Using technologies like tracking to assess the users' status and performance towards a particular behaviour or routine can help them to achieve predetermined goals or targeted achievements.
Gamification	One of the most effective ways to influence people to achieve predetermined goals and challenges in a self-competitive context is through a comparison of the present and a desirable future situation which can be achieved by offering virtual as well as real rewards.
Fitness	Using fitness as persuasion can have positive effects not only on the environment due to reduced emissions, but also on the users' health and quality of life by pushing them towards their goals.
Carbon Footprints	Making users feel guilty by the number of carbon footprints created can be a great way of persuading them to change their behaviour.
Money-Saving	By creating awareness about saving money users can be persuaded to achieve targeted goals with a more positive effect and outlook.

Based on our findings from the research carried out in this study, a prototype has been designed that uses the above seven persuasive strategies to nudge and motivate people on a personal level to change their behaviour towards sustainable mobility and choose more sustainable transport options for their daily travel. With a broad perspective in mind on the development of sustainable mobility practices for the future, this mobile application can provide a rich opportunity for persuading people towards more sustainable travel options.

CONCLUSION

The transport sector has been a major contributor to the increased amount of emissions as well as in the decrease of the quality of life and environment in general. Also with the current situation of the COVID-19 pandemic that has shaken the world to its core and has made each one of us rethink the way we live and treat our mother nature, the need for

us to change our mobility behaviour and opt for more sustainable options has increased. In this study, this issue of sustainable mobility has been addressed with the help of persuasive design technology.

In this paper, new ways of changing the behaviour of people towards sustainable mobility have been identified and explored by using fitness, carbon footprints and money-saving as persuasive strategies. Based on the findings of this study, a prototype has been designed where in total seven persuasive strategies have been implemented to nudge people on a personalized level to influence them to make more sustainable transport choices. The prototype was then evaluated using Heuristic Analysis and Retrospective Think Aloud Protocol. The aim of this research to persuade people to choose sustainable transport options over private transport for daily travel by using persuasive strategies on a personalized level has been successfully reached through the prototype.

FUTURE SCOPE

Based on the feedback from usability testing and evaluation, the proposed prototype has scope for refinement and improvement in the future. The prototype may have options for various local languages to choose from according to the users' choice to eradicate the barrier of language, thereby promoting sustainable mobility to a much larger audience. Future developments can continue the evaluation of the persuasiveness of the prototype in promoting sustainable mobility behaviours on a larger sample and among a mixed group of users. By doing so, we will be able to better understand the level of effectiveness of the persuasive strategies implemented and how they could be better operationalized to motivate attitudinal and behavioural changes towards sustainable mobility. It can be successfully said that our findings provide a foundation for the future development of research on the use of different persuasive strategies regarding the adoption of sustainable mobility behaviour.

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