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Sustainability of On-Demand Public Transportation from the Customer Perspective

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The goal of this article is to examine the sustainability aspects of on-demand public transportation systems. Demand-based transport systems have many benefits, including reducing traffic congestion, thereby reducing air pollution, and offering more sustainable transport alternatives in urban areas. In addition, they can provide complementary systems to existing transit networks and increase overall mobility, as these services can efficiently meet high-level transportation needs. In this adaptive service context, sustainability aspects are also of great importance, both in terms of reducing harmful emissions and energy consumption. There is a great need for process-based approaches in terms of service development and operation. The present research examines the preferences of potential travelers with the help of a questionnaire, aiming to examine what attributes customers would prefer in case of such a service, including time, flexibility, and sustainability, showing what type of service would be the most popular based on the respondents' opinion. 229 answers were collected, showing that respondents value flexibility and the shortening of waiting time and traveling time, but they would also like services that offer more environmentally friendly vehicles, such as electric vans or buses.

1. Introduction

People's behaviour and demand for using public transportation have changed over the past decades. These changes happened due to the fast development of technology and growing concern over climate change. Additionally, public transportation has become an essential instrument for lowering carbon emissions. (Potts, 2010). By providing an alternative to individual car use, public transportation plays an important role in sustainable transportation. However, in order to encourage more people to use public transportation, it is necessary to first understand their travel habits as well as their preferences for flexible and sustainable options (Dzikuć et al., 2021).

Transportation is an essential part of modern society, providing mobility and access to goods and services (Hidalgo and Carrigan, 2010). However, it also has significant environmental and social impacts, particularly related to sustainability challenges. The transportation sector is responsible for a significant proportion of global greenhouse gas emissions, air pollution, noise pollution, and habitat destruction. Road transportation is the dominant mode of transportation, accounting for most of the global transportation-related emissions (Ganti, 2022). The increasing number of personal cars and road congestion is a significant contributor to air pollution, particularly in urban areas. (O' Brien, 2020). The sustainability challenges facing the transportation sector are complex and require a multi-faceted approach to address. Key strategies to reduce transportation-related emissions include increasing the use of low-emission vehicles, improving public transportation, and implementing sustainable land-use policies that reduce reliance on personal cars. By implementing sustainable transportation policies and reducing reliance on personal cars, we can create a more sustainable transportation system that benefits both people and the planet (World Economic Forum, 2021; Heong, 2022). According to Ku et al., (2021), this is an important factor in eco-friendly city transportation as Bencekri (2021) also highlighted.

Sustainable transportation policies and initiatives have grown in importance in recent years as the world has become increasingly concerned about climate change, air pollution, and traffic congestion. These policies and initiatives aim to promote environmentally friendly and energy-efficient modes of transportation while reducing the negative environmental and public health impacts of transportation (Potts, 2010). The amount of private car

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traffic is rapidly increasing, which is causing greater traffic congestion, longer travel times, and worse air quality (Feng, 2022).

Singapore is one of the top-ranked countries that has the most sustainable transportation system. With the high amount of tax received, the government then also heavily invests in improving the public transportation system and infrastructure to meet the high demands of commuters (Harini et al., 2020).

According to (Phillips et al., 2023), the application of electric vehicles in public transportation fleets can be also a rational solution as electric vehicles may be used more effectively by increasing passenger loads, enhancing service options, and reducing traffic congestion. This procedure would lessen greenhouse gas emissions in addition to making public travel more attractive and cheaper. These adjustments are projected to result in large annual savings for the governments' treasuries and lessen the effects of transportation's unfavourable externalities, including poor air quality and noise pollution. However, this might also come with obstacles; given that there will probably be employment losses in the traditional combustion-based automobile sector throughout the switch to electric vehicles. Because of this governments should support the training or retraining of affected employees, supporting the traditional automobile and related sub-sectors that would lose.

The main goal of on-demand transportation is to create operating vehicles within a designated zone to dynamically pick up and drop off passengers in a flexible manner. This type of transportation has been around for decades. The first form of it was taxi services, followed by phone services that allow the user to book a car in advance and the newest installation of this form is app-based services that connect the users to a number of privately owned vehicles. The emergence of smartphones and mobile apps enables a seamless and fast connection to the desired way of transportation. Generally, in most cases this allows the user to have the ability to commute by car, taxi, scooter, or single occupancy vehicles. In many countries, it is even possible to connect to a nearby bus and get picked up by it at a convenient location (Phillips et al., 2012).

However effective communication with existing and potential passengers is crucial. Passengers need to see the benefit of the On-Demand transport service and how it improves their overall experience. Benefits such as reducing wait times and allowing productive activities during the ride, avoiding poorly lit commutes during the evening, and removing the need to find and pay for parking before changing transport modes can all be valid reasons for a commuter to modify their behavior (Bianchi and Pike, 2015). These factors should be translated into a feature set within a convenient and intuitive app that can have a significant impact on the design of the service (Bamberg et al., 2003).

These benefits need to be communicated with potential passengers to create an accurate sense of understanding. On-demand transport not only promotes ongoing improvements to the passenger experience, but transport operators will also benefit from having a connected fleet with optimized vehicle occupancy and a reduction in unnecessary costs. On-demand transport is emerging as a major technology in the transportation industry, contributing to increased efficiencies within future transportation networks. It shifts the balance of power back in favor of the commuters and provides them with an opportunity to access major transport infrastructure in a more convenient manner. Allowing the passengers to choose the service they want to use and creating an experience that is compelling and conforms to their behavior is a significant attraction (Chu et al., 2012; Castiglione et al., 2015)

This paper examines the traveling habits and demands of individuals regarding flexible and sustainable transportation and perceives solutions on how transportation could be improved in various aspects. Whether we are speaking about individual demand-based transportation services or services that complement regular public transportation systems, it is important to understand potential passenger habits and preferences of the specific area in order to operate successfully, because factors might vary based on social and environmental characteristics. This study analyses the results of an online survey questionnaire with a total of 229 participants. The questionnaire was designed to collect both qualitative and quantitative data, as well as questions about the participants' demographics, travel habits, and attitudes toward sustainable public transportation. The research aims to answer the following research question: What are the travel habits and demands of individuals in regard to flexible and sustainable public transportation options?

This study first discusses the background and current trends in public transportation. Moreover, an overview of the transportation sector and sustainability challenges will be presented, as well as theories and models related to travel behaviour. The research will additionally examine sustainable transportation policies and initiatives that could influence future public transportation developments. Finally, the study will investigate flexible and on-demand transportation systems, as well as the effect of digitalization on transportation options. The study will also provide a comprehensive understanding of the current landscape of public transportation as well as the potential for sustainable and flexible options in the future.

2. Methods

The scientific question of this paper is what are the individuals' travel habits and demands regarding flexible and sustainable public transportation options? A questionnaire approach is used to address this question. Specifically, an online survey questionnaire was designed to collect information on the participants' demographic characteristics, travel habits, and behaviors towards sustainable public transportation. The following sections provide a detailed description of the research design, data collection methods, data analysis techniques, and the sample size and selection criteria for the participants.

The research design gathered both qualitative and quantitative data. A variety of questions, both open-ended and closed-ended questions was included in the survey to collect comprehensive information about participants' travel habits and demands for flexible and sustainable public transit. Overall, the research design and approach enabled the investigation of the complex nature of individuals' travel habits and demands for flexible and sustainable public transportation options, as well as providing valuable insights and recommendations for improving the transportation system. The data collection process involved a self-administered online survey questionnaire. The survey was distributed through various online platforms, including social media and the snowball sampling method was utilized to recruit participants, in which existing participants were asked to invite their acquaintances who met the inclusion criteria to participate in the study. To ensure a diverse sample, the survey was advertised to people of various ages, genders, and socioeconomic backgrounds. The participants' anonymity was maintained throughout the survey process, and informed consent was obtained before they began the survey.

The survey came back with 229 different answers. Table 1 describes the characteristics of the participants in terms of sex, age, and employment.

Table 1: Characteristics of the participants

	Responses	Percentage
Men	81	35 %
Women	148	65 %
Under 18	6	3 %
Between 18-25	86	38 %
Between 26-65	133	58 %
Over 65	4	2 %
Employee	147	64 %
Student	99	43 %
Retired	5	2 %
Other	30	13 %

It is important to note that in the case of employment, the participants could choose more than one answer. Therefore, a person can be a student and employed at the same time. In the distribution of the respondents according to their place of residence, Hungary accounts for the largest share, with about 80 % of the share in the Győr region in western Hungary.

3. Results and Discussion

The number of cars per household in the analyzed data shows that 41 respondents have 0 cars/household, which is 17.9 %. 66 have 1 car, which is 28 %, while 88 households have 2, which is 88 %. Only 34 or 34 % of households had 3 or more cars.

In this case, it was also possible to give several answers at the same time. However, the most frequently used means of daily transportation is the car, which accounted for 67 % of the responses, with 155 people who use the car during their daily transportation. In addition, there were 145 people walking, which is 63 % of the responses. The bus came in third place with 116 people, 50 % of whom said that the bus is their typical form of transportation on a daily basis. In addition, 24 people use other forms of transportation as well, which is 10 % of the responses.

As seen in Table 2. the most common forms of public transportation the respondents used are as follows: by car 68 %, on foot 63 %, and by bus 51 %. The least popular ones are other forms of transportation are motorcycles with 5 % and taxi services with 1 % of the total sample. It is not surprising that walking transportation became the second most common way of transportation as it is free and viable. The only downside is time,

distance, and certain weather conditions. This is why almost all of the responders who choose walking also choose the car and the bus as favored forms of transportation.

Table 2: Transportation habits

Transportation	Responses	Percentage
car	155	68 %
walk	145	63 %
bus	116	51 %
train	59	26 %
bicycle/scooter	56	24 %
Other form of public transport	24	10 %
motorcycle	11	5 %
taxi	2	1 %

Regarding the frequency of these transportation modes in Table 3. we can also see that the most common one is walking, which is used daily by the majority. However, looking into the weekly usage, buses are also more popular. Cars are used mostly on a monthly basis. Surprisingly, trains are rarely used compared to the first three most picked ones. The least favorable modes of transportation usage are motorcycles and also carsharing.

Table 3: Transportation usage frequency

Frequency	Walk	Bicycle/ Scooter	Motorcycle	Car	Train	Bus	Other	Carsharing
Never	1 %	28 %	86 %	10 %	15 %	13 %	56 %	87 %
One or two times per year	3 %	33 %	8 %	8 %	46 %	29 %	28 %	9 %
Monthly	10 %	17 %	1 %	13 %	22 %	12 %	2 %	3 %
Weekly	17 %	14 %	3 %	28 %	11 %	16 %	4 %	0 %
Daily	69 %	8 %	1 %	41 %	7 %	31 %	9 %	0 %

In order to reach a destination, people obviously often use more than one means of transport, so here too, several answer options could be marked at the same time. 82 people use public transportation to get to school, which is the most popular and most frequently encountered form of transportation. Then comes bus transport with 64 people. In addition, car transport is also typical with 62 people. These are the three most common modes of transport that occur for the purpose of going to school. Unsurprisingly, with 103 completions, car transport is the most common choice for going to work. In addition, 72 respondents chose buses, and 62 respondents chose walking as the most common form of transportation to work. 6 people stated that they do not use a vehicle during their daily commute. In addition, most of the 157 applicants satisfy their mobility needs with only 1 vehicle. However, a significant 40 people use two vehicles for the same purpose. The most frequently traveled distance among those filling in is between 5 and 25 kilometers (102 people, 45 %). After that, the second largest, with 47 people (21 %), is the distance between 1-5 km, which is also not a long distance. In addition, between 25-50 km and 50-100 km, there are 34 (15 %) and 26 (11 %) people, respectively.

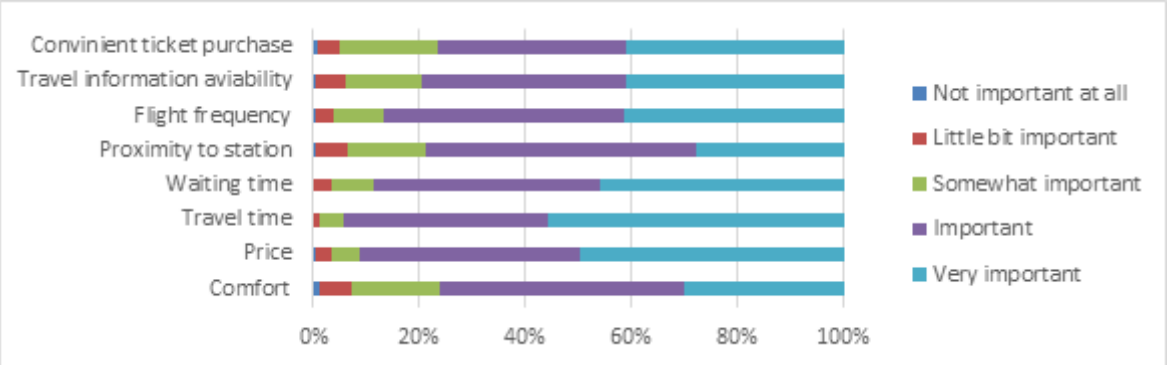

Figure 1: Transportation aspects importance

In Figure 1. it can be seen that being on time has been ranked as the most crucial aspect of public transportation. Most importantly, prices and traveling time are ranked second and third best. Resulting in the easiness of purchasing tickets and accessibility of traveling information being ranked fourth and fifth, respectively.
Table 4. shows whether the participants would use the public transportation system that is more flexible and based on demand that has the following features. The first feature introduced was on-time transportation based on demand, transportation/vehicle ordered by mobile app or internet, minibus sized vehicle, electronic vehicle, carpooling vehicle, travel planning in real-time, accessibility to locations that regular lines don't go to, and lastly, vehicles used with only electronic tickets.

Table 4: On-demand transportation opinions

	Wouldn't use it	Might use it	Would use it
demand-based vehicle	6 %	34 %	60 %
online booking	11 %	34 %	54 %
minivan	24 %	45 %	31 %
electric vehicle	5 %	37 %	59 %
carsharing	27 %	55 %	19 %
real-time travel planning	8 %	46 %	46 %
getting to areas not served by normal lines	11 %	43 %	46 %
vehicle that can only be used with an electronic ticket	16 %	49 %	35 %

The most picked one is the demand-based vehicle (60 %), closely followed by the electric vehicle (59 %), followed by vehicle ordered online (54 %). 55 % of the participants responded that they might use carpooling vehicles, travel planning in real time, and vehicles used with only electronic tickets scored 46 % and 49 %. lastly, accessibility to locations that regular lines don't go to scored 43 %. When asked a more behavioral question, most participants agreed that quicker traveling methods and cheap traveling methods are the most important to them. In the case of current issues related to public transportation that have been raised the most are overcrowding and capacity constraints, limited coverage, poor communications and customer service and accessibility, and high cost. Leaving the lack of punctuality to be the biggest problem for public transportation.

4. Conclusion

In conclusion, this study aimed to gain insight into people's travel preferences and needs for flexible and sustainable public transportation options, as well as to examine how on-demand transportation works in practice. As more people become aware of the negative impacts of traditional transportation on the environment and public health, there is a growing demand for sustainable transportation options that are flexible and convenient. To meet this demand, policymakers and transportation planners must work together to develop and implement public transportation systems that are sustainable, efficient, and accessible to all.
This study analyzed the results of a questionnaire about customer traveling habits and preferences. The results of the 229 collected answers show that passengers are looking for sustainability, flexibility, and accessibility. According to the survey, people also expect the transportation system to reduce traffic congestion, improve air quality, and more accessible and quicker travel options. It is important to note, that in order to operate successfully, demand-based transportation services have to know the needs and preferences of their potential passengers in that specific area. While there are generally important factors such as time and flexibility, other factors might vary based on social and environmental characteristics. By continuing to research and understand the travel habits and demands of individuals in regard to flexible and sustainable public transportation options, we can create a more sustainable and equitable transportation system for the future.
Regarding the questionnaire, we can clearly conclude the main point of interest regarding what to improve with current transportation. The first one is the lack of options and cost issues. Some transportation options can be considered great value, such as bus and train. However, the most ideal form would be to travel alone in a car or car share with a minimal amount of people. Unfortunately, this is considered too expensive and also hard to obtain.
On-demand transportation options like bike-sharing and app-based booking services like Bolt are growing in popularity as they offer flexible and practical ways to get from A to B while lowering the number of cars on the road. At the same time, sustainable transportation options such as electric vehicles, public transportation, and cycling are also gaining popularity as people seek to reduce their carbon footprint and contribute to a more sustainable future. By adopting on-demand and sustainable transportation solutions, we can help reduce traffic congestion, improve air quality, and build more sustainable and livable cities for everyone.

References

Bamberg S., Ajzen I. and Schmidt P., 2003, Choice of Travel Mode in the Theory of Planned Behavior: The Roles of Past Behavior, Habit, and Reasoned Action, Basic and Applied Social Psychology, 25(3), 175–187.

Bencekri M., Ku D., Kwak J., Kim J., Lee S., 2021, Review of Eco-friendly Guidance of Transport Infrastructure: Korea and the World, Chemical Engineering Transactions, 89, 235-240.

Bianchi G. and Pike S., 2015, Exploring the role of social influence in sustainable tourism behavior: A comparative study of international tourist and domestic tourist to an iconic Australian tourist destination, Journal of Sustainable Tourism, 23(4), 576–596.

Castiglione J., Bradley M.A., Gliebe J., 2015, National Research Council (U.S.), Transportation Research Board and Second Strategic Highway Research Program (U.S (2015), Activity-based travel demand models: a primer, Washington, D.C.: Transportation Research Board.

Chu Z., Cheng L., Chen H., 2012, A Review of Activity-Based Travel Demand Modeling, CICTP 2012: Multimodal Transportation Systems—Convenient, Safe, Cost-Effective, Efficient, 48-59.

Dzikuć M., Miśko R. and Szufa S,. 2021, Modernization of the Public Transport Bus Fleet in the Context of Low-Carbon Development in Poland, Energies, 14(11), 3295.

Feng M., 2022, Cost of Getting A Car In Singapore: Why Are COE Prices So #$%&ing High?! [online] blog.seedly.sg. Available at: https://blog.seedly.sg/factors-cost-car-price-singapore/, [Accessed 6 Apr. 2023],

World Economic Forum, 2021, How road pricing is tackling congestion and pollution in cities like London and Singapore, [online] World Economic Forum, Available at: https://www.weforum.org/agenda/2021/12/how-road-pricing-is-tackling-congestion-and-pollution-in-cities/, [Accessed 6 Apr. 2023].

Ganti A., 2022, Rational Choice Theory: What It Is in Economics, With Examples, [online] Investopedia, Available at: https://www.investopedia.com/terms/r/rational-choice-theory.asp#citation-1.

Harini B.K., Parkavi A., Supriya M., Kruthika B.C. and Navya K.M., 2020, Increasing Efficient Usage of Real-Time Public Transportation Using IOT, Cloud and Customized Mobile App, SN Computer Science, 1, 159.

Heong S.K., 2022, Complete Guide To Buying A Car In Singapore. [online] DollarsAndSense.sg. Available at: https://dollarsandsense.sg/complete-guide-buying-car-singapore/ [Accessed 6 Apr. 2023].

Hidalgo D. and Carrigan A., 2010, Modernizing Public Transportation, [online] www.wri.org, Available at: https://www.wri.org/research/modernizing-public-transportation, [Accessed 6 Apr. 2023].

Ku D., Kim J., Yeonseung Y., Dahir A., Kim S., Lee S., Lee S., 2021, Assessment of Eco-Friendly Effects on Green Transportation Demand Management, Chemical Engineering Transactions, 89. 121-126.

O' Brien, J., 2020, Liftango | What is On-Demand Transportation? [online] www.liftango.com, Available at: https://www.liftango.com/resources/what-is-on-demand-transportation [Accessed 8 Apr. 2023].

Phillips W., Nicholson G., Alleyne A. and Alfonso M., 2023, Policy considerations for sustainable transportation in three Caribbean small island developing States: options for improving land transportation efficiency Barbados, the British Virgin Islands and Jamaica 117 STUDIES AND PERSPECTIVES ECLAC SUBREGIONAL HEADQUARTERS FOR THE CARIBBEAN, [online] Available at: https://repositorio.cepal.org/bitstream/handle/11362/48725/3/S2201239_en.pdf [Accessed 6 Apr. 2023].

Potts J.F., 2010, A Guide for Planning and Operating Flexible Public Transportation Services, Transportation Research Board National Research.