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Research Article

Revealing the Impacts of the Pandemic on Travel Behavior by Examining Pre- and Post-COVID-19 Surveys

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Recently, the topic of travel behavior and social media usage has been widely discussed. The current study specifically focuses on how specific factors, such as the sociodemographic variables, the number of friends, the social media usage, and the ICT usage, influence their travel patterns based on survey results conducted in pre- and post-COVID-19 times. The effect of the COVID-19 pandemic is taken into consideration to better understand the impact of restrictions on travel attitudes. Statistical analysis is carried out to investigate the survey data. The results show that the pandemic has made a huge impact on general travel behavior, especially in terms of transport mode choice shifting towards individual modes, such as car and walking. The location choice of the participants has a significant connection to the available transport mode and the price range of the place, together with the retrieved information from the ICT devices. Based on the results, it can be seen that the pandemic has deepened the number of close friendships, but younger people do not tend to choose trendy places anymore. In addition, the results show that there is no direct connection between the number of friends and the number of meetings, and the daily online meetings have not replaced all personal meetings.

1. Introduction

Nowadays, after many waves of COVID-19, it is important to understand what the impact of the restrictions and the social distancing on our everyday life was [1]. As more and more young people use electric devices to stay connected and to get information on various topics, it seems to be interesting to explore the connections between ICT (information and communication technology) usage and travel behavior among other factors, such as the sociodemographic variables, the number of friends, and social media usage. Moreover, these devices are helpful to get the most recent information about the status and changes of the transport system, and this new type of information source influences the travel behavior of the users.

At the same time, social media platforms have to be considered, where the users have access to various information on recent events (including traffic incidents and disruptions) that may have an impact on travel-related decisions. Therefore, the relationship between social media usage and travel behavior is an interesting topic to investigate.

In this paper, two surveys are created and analyzed to compare travel behavior before and after the COVID-19 pandemic to understand its connections to specific aspects. The aim of the paper is to provide the results of the analysis on travel behavior change due to the measures in response to the COVID-19 pandemic. During the research, two online surveys have been analyzed. The first survey was conducted in 2017, and the second one in 2021. The first survey was

more detailed and focused on the ICT usage, while the second survey was more focused on the questions, which were also included in the first survey including travel behavior. The surveys were mostly filled by students of Budapest University of Technology and Economics in Hungary, but it was also open for teachers and researchers. The participants have been reached by mailing lists using a convenience sampling method. This way we were able to understand the travel behavior-related changes which have been realized in the university community.

The paper consists of six sections. Section 1 is an introduction to the topic. Section 2 is about previous works related to similar analyses. In Section 3, the surveys used in the research are presented. Afterward, Section 4 introduces the applied methodology. Section 5 shows the main achievements based on the survey data analysis. Finally, Section 6 provides a discussion of the results.

2. Related Literature

Recently, numerous papers appeared assessing the effects of the pandemic measures on travel behavior, where most of these studies use survey data [2]. Studies find that the COVID-19 pandemic resulted in significant and disruptive changes on the everyday life of people [3]. Another similarity in these papers is that they rather focus on the younger generation [4]. For example, the research work of Ebrahim Shaik and Ahmed [5] provides a thorough literature review on the topic of travel behavior changes due to the COVID-19 pandemic. As a main research result, it is found that a significant portion of public transport users shifted to the car during the pandemic. Additionally, they identify strong relationships among gender, income, and travel intensity during the pandemic compared to the prepandemic era.

The first studies conducted on the connection between travel behavior and ICT consider the impact of mobile phones, investigating how these devices interfere with the typical behavior of travelers [6]. Obviously, ICT has a significant impact on travel behavior, but there is only limited research on the relationship between ICT usage and travel behavior. Most of the available papers focus on big data issues; for example, how vast amounts of data can be collected from users. Several studies were built upon survey data since this is an efficient way to acquire reliable information [7]. It is crucial to know what kind of data should be collected as the key to a successful survey is to acquire adequate answers [8, 9]. At the same time, other papers point out that there are other ways to collect data than classical surveying methods. The paper of Ahmed et al. [10] suggests that a survey can be supplemented with anonymous data from applications providing information on the routes and the chosen travel modes. Similarly, as suggested by Sierpiński et al., an efficient way to collect data is to use mobile applications [11] as data obtained from applications can better highlight travelers' personal preferences.

While the connection between travel behavior, ICT, and social media usage is to be understood, people should be asked about the frequency of social media usage, the purpose of the usage, the way they keep connected with their friends, and the types of electric devices they possess [12, 13]. With these kinds of data, it is possible to create various models (from linear regressions to sophisticated machine learning methods) about the relationship between travel behavior and social media usage [14]. Several studies assess these aspects, but there is a lack of papers dealing with travel behavior, ICT usage, and social media as well as focusing on youngsters using a recent dataset.

The most obvious influence of ICT on travel behavior is the time reduction for trip planning. This is explained in a study [15] focusing on the effects of a travel planning application on metro passengers. It seems that there is a strong connection between the realized get-togethers and the usage of travel planning applications. Furthermore, it is found that due to the shorter travel planning times, travelers organize more meetings. Therefore, in the current study, it is worth making some hypotheses aiming to show such connections. According to another research, short and instant messages do not reduce the number of trips, instead they generate more trips [16]. Accordingly, in this research, the connection between ICT usage and the number of trips is investigated.

Among young adults, the reduction of travel planning time has an effect on the organization of leisure events. The travel time is less relevant if the public transport provider gives Wi-Fi access. The study of Bounie et al. [17] demonstrates that travelers are willing to spend more time on a vehicle if they can use their mobile devices with a reliable network. Nevertheless, not only the travel time but also the types of get-togethers are more important to the younger generation than the chosen transport mode. Accordingly, in this study, these effects on travel behavior are investigated, as well.

When modeling travel behavior, an important step is to choose the age range that should be considered in the sample. A paper shows that the correlation between the usage of ICT devices and the chosen routes is higher when the participants' age is between 15 and 25 [18]. The members of this age group can be called digital natives, who are rather familiar with ICT devices. The paper of Etminani-Ghasrodashti et al. [19] states that the role at a university has an effect on travel behavior, as well. Moreover, most smartphone users are from the young generation; thus, the biggest impact of travel information can be observed within this group.

Furthermore, the research of Jamal and Habib [13] shows that most of the members of this age group have monthly public transport passes, and this has an effect on their travel behavior. Although the smartphone has one of the biggest influences on young adults, Internet availability has its own effects on the millennials, where the age can be significant to analyze the differences in travel behavior [20]. The study of Blumenberg et al. [21] examines the connection between age and the number of leisure events. The results demonstrate that the age group (where travelers have stable workplaces and incomes) makes the most trips to leisure events. However, this changes when travelers reach middle age and enter a different life stage. Based on previous research, it is interesting to further analyze the differences in

travel behavior considering the age and the number of leisure events, which is an aim of the current paper.

In terms of the potential connection between travel behavior and social media usage, a study about shopping habits [7] shows that the increasing number of e-shopping is directly connected to the decreasing number of trips for shopping purposes. An Egyptian study [22] states that there is a strong relationship between the increasing number of Internet-based events and the decreasing number of real-life events. The paper declares that the more the people use the Internet in their free time, the fewer times they leave their homes. Additionally, a Swedish paper [23] presents that people talk via the Internet with those people who they meet regularly in person, as well. Similarly, in current research, the connection between the regularity of talking to online friends and the number of trips to make personal meetings is investigated.

Considering travel behavior, we should take into account that people are more likely to use cars instead of public transport. However, in a recent research paper [24], it is claimed that youngsters can be encouraged to use public transport instead of cars by highlighting the benefits of planability and relative flexibility in the case of public transport. As an interesting tendency, in the last decade, a decrease in the number of car users can be observed among young adults in Germany, and the same is experienced in Japan [25, 26]. The paper of Lopez-Carreiro et al. [27] demonstrates that shared solutions, such as car-sharing, are rather popular among young adults and middle-aged people, who use these services more frequently than their personal cars. The research concludes that the worldwide trend of decreasing car usage is still ongoing, while the number of car users is expected to be decreasing, as well.

According to the reviewed literature, potential research gaps can be explored, and the following hypotheses are presumed to analyze travel behavior based on the surveys conducted in the pre- and post-COVID-19 times:

(1) It is assumed that people who have everyday access to a car and a driving license make fewer trips by public transport.

(2) A person whose friends or acquaintances live in the neighborhood makes fewer trips to far places and makes fewer trips by public transport

(3) A person talking with his acquaintances regularly online makes fewer trips. The effect is more significant if the talking is on a daily basis.

(4) The age has a significant effect on the choice of leisure event place.

(5) The higher the number of acquaintances, the more likely it is that they make more personal meetings.

3. Methodology

In this section, the design of the online surveys, which are the basis of current research, and the applied statistical methods are introduced.

3.1. The Survey Questions. Two surveys with the same questions were carried out in the pre- and post-COVID-19 pandemic times. The data are obtained from an online survey distributed among university students through social media and mailing lists. The first survey was conducted in July 2017 with a focus on investigating the impact of ICT devices on travel behavior and social behavior among the younger generation. The second survey focusing on a similar set of questions enabling the analysis of the differences in travel behavior was conducted in July 2021 after the second wave of the pandemic. At the time of the survey, there was no special restriction (i.e., in-person education was in action); only huge events were not allowed to be organized in general.

Both surveys were conducted in Budapest, Hungary, at Budapest University of Technology and Economics involving the same target groups mainly consisting of bachelor, master, and PhD students. Filling in the surveys took 10–15 minutes on average, the participation in both surveys was voluntary, and there was no direct reward offered. In the first survey, 187 observations are collected. After excluding the not fully filled answers, 104 observations remain in the database. During the second survey, 153 valid observations are collected.

The survey questions can be grouped into six categories. The first category is about the participants' sociodemographic data, such as their age and their role at the university. Furthermore, this category contains information on the accessibility to transport modes, such as the opportunity to use a car, whether someone has a public transport pass, and what kind of electronic devices someone owns. The second category deals with the respondents' social networks, namely, how many friends and acquaintances they have. The third group of questions is about the abovementioned friends and acquaintances' types of living places. Questions about travel behavior, chosen transport modes, activity types, and leisure events are grouped into the fourth category. The fifth group of questions is about the participants' size of the social network and the frequency of making connections via social media. Finally, the sixth category is about the social media usage for travel purposes. The full list of the questions is presented in Table 1.

3.2. The Applied Statistical Tools. In the survey assessment work, ANOVA (analysis of variance) is performed, as well. To create ANOVA tests, linear regression is used as a base. To create a working ANOVA analysis, the same assumptions are held as in the linear regression case. The ANOVA can be formulated by equation (1), where the ϵ error term still must have a normal distribution.

$$Y_{gi} = \mu_{gi} + \epsilon_{gi}, \tag{1}$$

where μ is the mean of the group which is being used for the ANOVA analysis

Moreover, the Kolmogorov–Smirnov test is carried out in the survey assessment work. This is a straightforward test in which the following two questions could be answered:

Table 1: The questions of the online surveys.

Number	Question text	Possible answers
Q1.1	What is your age?	
Q1.2	What is your role at the university?	☐ I am a bachelor student (1) ☐ I am a master student (2) ☐ I am a doctoral student (3) ☐ Other
Q1.3	In the last week, did you have opportunity to use car or motorcycle for your own purposes?	☐ Everyday (1) ☐ 3–6 days a week (2) ☐ 1-2 days a week (3) ☐ Never (4)
Q1.4	Do you have a public transport pass currently (monthly, season, or annual ticket)?	☐ Yes ☐ No
Q1.5	With whom do you live together?	☐ Parents (1) ☐ Partner (2) ☐ Dormitory (3) ☐ Lease (4) ☐ Alone (4)
Q1.6	Do you have a driving license?	☐ Yes (1) ☐ No (2)
Q2.1	How many people do you consider as your close friends (beside your family)?	☐ 2 or less (1) ☐ Between 3 and 5 (2) ☐ Between 6 and 10 (3) ☐ Between 11 and 15 (4) ☐ Between 16 and 20 (5) ☐ More than 20 (6)
Q2.2	How many people do you consider as your acquaintances?	☐ 4 or less (1) ☐ Between 5 and 10 (2) ☐ Between 11 and 20 (3) ☐ Between 21 and 30 (4) ☐ Between 31 and 40 (5) ☐ Between 41 and 50 (6) ☐ More than 50 (7)
Q2.3	The statement "my close friends are also part of my social media's small circle network" describes the interrelation between your friends and your social media network correctly	☐ Strongly agree (1) ☐ Agree (2) ☐ Neither agree/nor disagree (3) ☐ Disagree (4) ☐ Strongly disagree (5)
Q3.1	Most of my close friends live	☐ In my neighborhood (1) ☐ In my city, in different neighborhood (2) ☐ In another city region (3) ☐ In another country (4)

Table 1: Continued.

Number	Question text	Possible answers
Q3.2	Most of my acquaintances live	☐ In my neighborhood (1) ☐ In my city, in different neighborhood (2) ☐ In another city region (3) ☐ In another country (4)
Q4.1	What was the main transportation mode you have used to reach the location of the activity?	☐ Car–as driver (1) ☐ Car–as passenger (2) ☐ Motorbike (3) ☐ Public transport (3) ☐ Tram (4) ☐ Bike (5) ☐ Walking (6) ☐ Roller (7)
Q4.2	Why did you choose this specific location?	☐ It was close to my previous location (1) ☐ It was close to my residence (2) ☐ It was convenient to the people I was meeting (3) ☐ It was not expensive (4) ☐ It has a good atmosphere (5) ☐ It is trendy (6) ☐ Easily accessible by public transport (7) ☐ Available parking (8) ☐ It was chosen by the event organizers (9) ☐ Other (10)
Q4.3	Who are the people who joined you in this activity?	☐ Acquaintances (1) ☐ Close friends (2) ☐ Relatives (3) ☐ Partner spouse (4)
Q4.4	During the last year, how often did you go to	☐ Bar pub café restaurant (1)-(1–5 scale according to the frequency) ☐ Sport (e.g. gym, running, yoga) (2) ☐ Cinema theatre (3) ☐ Park outdoor activity (e.g. hiking, picnicking) (4) ☐ Visiting (family⟍acquaintances) (5) ☐ Party at home (6) ☐ Concert sports event party public events (7) ☐ Other (8)
Q5.1	From the abovementioned network, what is the size of your “small circle?”	☐ 2 or less (1) ☐ Between 3 and 4 (2) ☐ Between 5 and 7 (3) ☐ Between 8 and 10 (4) ☐ Between 11 and 20 (5) ☐ Between 21 and 40 (6) ☐ More than 40 (7) ☐ Don’t use web based social media (8)

Table 1: Continued.

Number	Question text	Possible answers
Q5.2	Where does this person live?	☐ In my neighborhood (1) ☐ In the same city but in different neighborhood (2) ☐ In a different city/village (3)
Q5.3	How often do you contact this person via social media?	☐ Every day (1) ☐ A few times in a week (2) ☐ Every week (3) ☐ A few times in a month (4) ☐ A few times in a year (5) ☐ Never (6)
Q6.1	What information did you search in social media or official websites before this activity?	☐ How to reach the destination (1) ☐ Timetable of transport from official websites (rail authorities/bus authorities, etc.) (2) ☐ Timetable of transport from social media apps (Moovit, Waze, etc.) (3) ☐ Street view to check the area (Google street view or else) (4) ☐ Photos and⁄or video of the destination (5) ☐ Information and recommendations (6) ☐ Didn't look for information on social media or official websites (7)

(i) Are the two sample distributions the same or significantly different from each other?

(ii) Does a particular sample distribution arise from a hypothesized distribution?

It is natural that two samples are statistically different from each other if their means are not the same. But the question is whether they are different from each other if the mean values are similar. To respond to this question, the variances can be investigated. The test applies the cumulative distribution function providing the probabilities of a randomly selected X value according to Crawley [28]:

$$f(x) = P[X \leq x], \tag{2}$$

where f is the function and x is the randomly selected variable.

Finally, the Wilcoxon rank sum test is applied on the collected data, which is a nonparametric alternative to the Student t-test. This test can be used when the error terms are not normally distributed [28].

To create the models, we have used the same variables for the pre- and the post-COVID-19 surveys to understand the changes in travel behavior.

4. Results

In this section, the figures are depicted by using the same scale from 50% to −50% enabling the comparison of the results with each other. The values represent the percentage changes of observations between the pre- and post-COVID-19 datasets. Figure 1 shows the changes in the participants' age and level of the study program. In the second survey, there are older participants than in the first survey. In the first survey, the representation of the bachelor students is relatively high, while in the second survey, there is a more equal distribution of all target groups. The Kolmogorov–Smirnov test and rank sum test results show this difference because both of the tests provide significant divergence.

In Figure 2, the first diagram presents the change in the number of monthly ticket subscriptions. A decreasing trend is observable in the case of the monthly tickets. According to the two statistical tests, this decreasing trend is confirmed because the p values show that there are no statistical differences between the two datasets. The second diagram depicts the changing trend in daily car usage. It can be observed that there is a significant increase in everyday car usage. The third diagram demonstrates the trends of the different transport modes. The results clearly present an increase in car usage (i.e., both as passenger and driver), while there is a decrease in public transport. The fourth diagram presents the number of people who are in the participants' inner circle. As it is observable, most of the changes are in the case of the participants who have three or four close friends. According to the p values of the two tests, it can be assumed that these trends are related to the effect of COVID-19 because the tests show statistical differences between the two datasets.

Figure 3 demonstrates the frequency of social connections, where the number of everyday meetings severely decreases. After the overview of the changes, the structure of the data should be discovered.

Tables 2 and 3 provide the statistical description of the data collected in the pre- and post-COVID-19 surveys. As it can be seen from Tables 2 and 3, some of the variables are transformed into factor type from continuous integer type. This way the model takes into account the variable as it would be used by hand.

When comparing Tables 2 and 3, the participants' age increases in the second survey. However, the median value is the same for both datasets (Q1.1). Furthermore, it is interesting that the average number of close friends increases in the second dataset, as well. It could mean that the restrictions have a good impact on close friendships (Q2.1).

According to the tables, the number of friends who live in the same city but not in the same neighborhood (Q5.2) increases despite the restrictions. As expected, the everyday contacts via social media (Q5.3) rise in the second dataset than the first dataset.

According to Figure 2, it can be stated that the pandemic has a significant effect on travel behavior; i.e., the number of monthly tickets drastically decreases. There are various explanations for that. First, it can be explained by the restrictions and the home office and online teaching periods. Because of these activities, most people did not need to use the public transport system for their daily commute. This remark can be strengthened by Figure 3, where it can be seen that the frequency of the social meeting decreased in the case of the daily meetings and the number of monthly get-togethers increased. It means that an individual did not need to have a monthly ticket during this period because no trips were made regularly.

However, while examining car usage, it is shown that the number of daily car trips increased. Thus, according to the data, it can be assumed that the COVID-19 pandemic caused a strong change in travel behavior by steering travelers from sustainable public transport to private car usage.

One more interesting result from the data is that the number of bicycle trips had a reduction, as well. There is more than one factor that can explain this absolutely not straightforward result. On the one hand, during the time period of the second survey, the bike-sharing system in Budapest was reconstructed meaning that during this time, the system was out of order. On the other hand, due to the pandemic, the supply chains of the world suffered great damage. Therefore, the prices of new and second-hand bicycles increased. This provides a potential explanation, too. Moreover, considering the transport modes, walking increased. Thus, it can be stated that people are more likely to cover short distances on foot in the post-COVID-19 era.

After the general overview, the connection between the data is discovered according to the previously-formulated questions. Table 4 contains the ANOVA results, where five models revealing potential connections between the parameters are analyzed for the first survey results.

The numbering is based on the following structure: $x.x.y$, where $x.x$ is the question number and y is the number of the

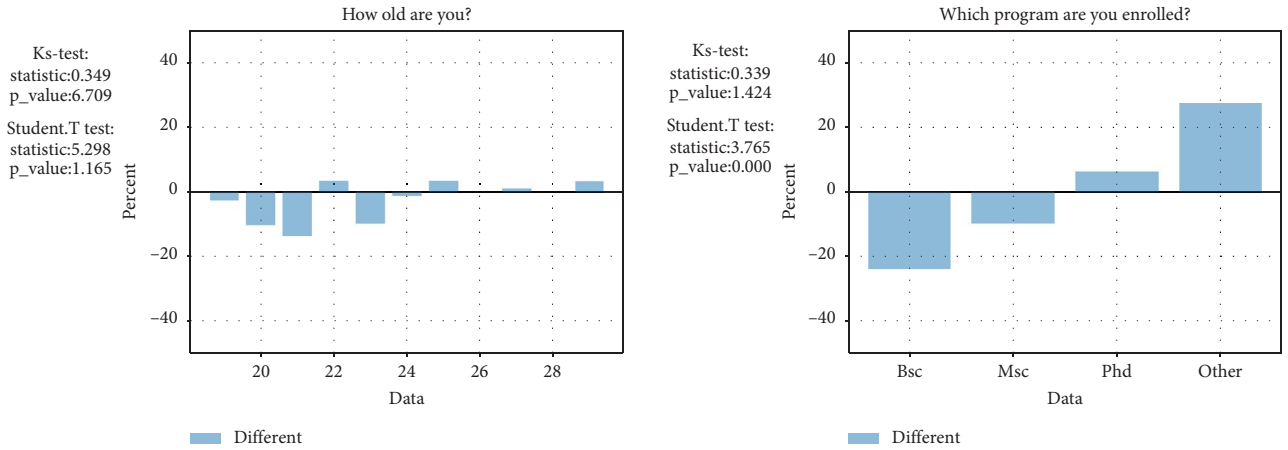

Figure 1: The changes in the distribution of age and university role considering pre-COVID and post-COVID times.

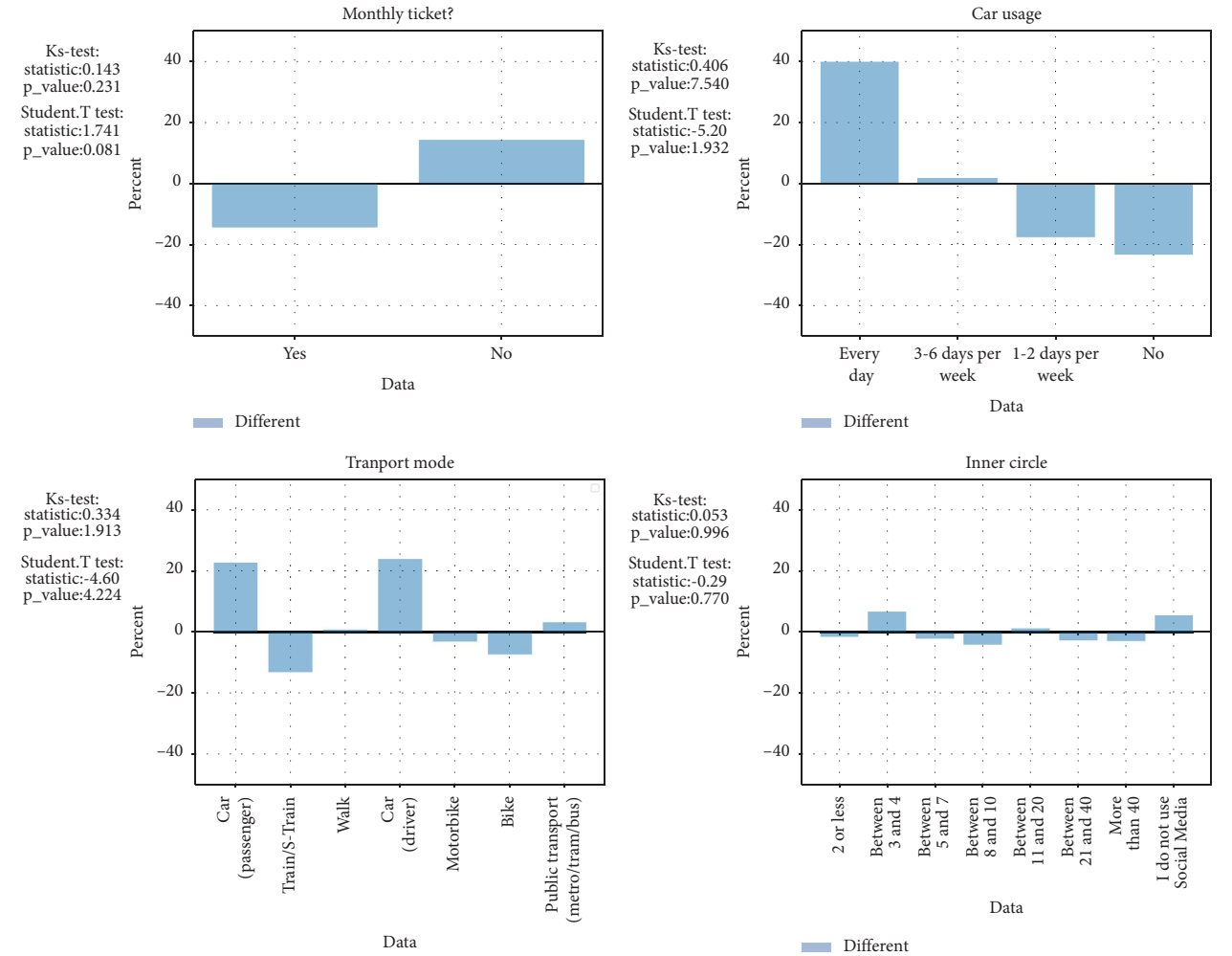

Figure 2: The changes in the distribution of monthly ticket purchase, car usage, transport mode choice, and the number of friends considering pre-COVID and post-COVID times.

alternative answer to the related question. In case there are no alternatives, only the question number is presented. For every variable, the variable with the highest correlation is used thus avoiding the overfitting and cross-correlation in the data.

The first question is to investigate the transport mode (Q4.1) used to reach the location of the activity. According to the results, age (Q1.1) has an influence on the transport mode choice. If the individual decides to go to do outdoor

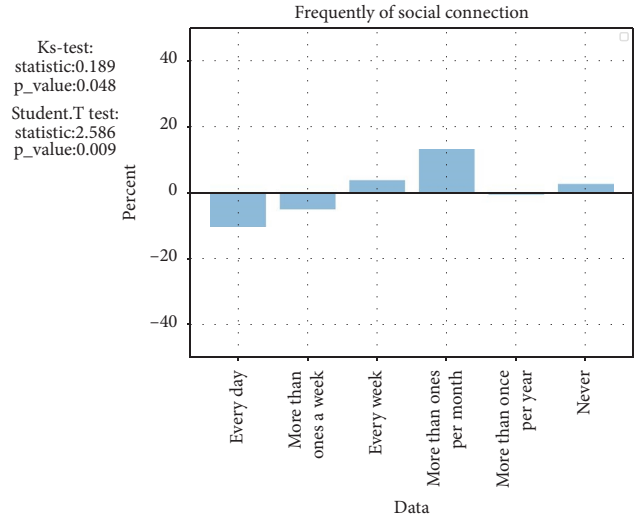

Figure 3: The changes in the frequency of social connections considering pre-COVID and post-COVID times.

Table 2: Statistical description of the collected data considering the pre-COVID survey.

	Q1.1	Q2.1	Q5.1	Q4.1	Q5.2		Q5.3	Q1.2	Q1.4	Q1.3	Q3.1
Min.:	18.0	1.000	1.000	1.000	0.000	The number of variables	1: 41	1: 47	1: 93	1: 12	1: 32
1st Qu.:	21.0	2.000	3.000	4.000	1.000		2: 31	2: 54	2: 8	2: 9	2: 46
Median:	22.0	2.000	4.000	4.000	2.000		3: 8			3: 31	3: 22
Mean:	22.2	2.198	3.634	4.257	1.683		4: 4			4: 49	4: 1
3rd Qu.:	23.0	2.000	4.000	6.000	2.000		5: 7				
Max.:	40.0	6.000	8.000	8.000	3.000		6: 7				

Table 3: Statistical description of the collected data considering the post-COVID survey.

	Q1.1	Q2.1	Q5.1	Q4.1	Q5.2		Q5.3	Q1.2	Q1.4	Q1.3	Q3.1
Min.:	2.00	1.00	1.000	1.000	1.000	The number of variables	1: 56	1: 117	1: 129	1: 63	1: 11
1st Qu.:	21.00	2.00	2.000	3.000	1.000		2: 43	2: 37	2: 25	2: 16	2: 86
Median:	22.00	2.00	3.000	5.000	2.000		3: 16			3: 26	3: 56
Mean:	25.89	2.24	3.565	4.539	1.929		4: 22			4: 49	4: 1
3rd Qu.:	25.75	3.00	4.000	5.000	2.000		5: 8				
Max.:	68.00	6.00	8.000	8.000	3.000		6: 9				

activites (Q4.4.4) or to go to other activities (Q4.4.8), it has a significant effect on the transport mode. Finally, if a person uses an application (Q6.1.3) to plan the trip, it has a significant impact, too.

The question about the location of the leisure event is in the neighborhood (Q4.2.2) which has several connections. A less significant variable is the transport mode (Q4.1). It was expected because this variable can determine how to reach to the location of the event.

The number of close friends (Q2.1) is significant, because this can be connected with an event nearby, where the meeting with the friends can take place. Moreover, the price of the locations (Q4.2.4) plays a relevant role for choosing the place. The significance of searching on the Internet (Q6.1.1) for the destination is a bit more interesting. Due to the short travel time and short distances, less significance was expected for this variable.

For the question about having a monthly pass for public transport (Q1.4), the most significant variables are the close friends who are in the inner circle of the social media (Q2.3) and the reason why the location for the leisure event is chosen (Q4.2.5). The trendiness (Q4.2.6) and the accessibility (Q4.2.7) of the location are also relevant. In the case of leisure events, this is practically expected. However, it is interesting that the possession of a driver license (Q1.6) has no effect on having a monthly pass.

Also, the connection between the age of the participants (Q1.1) and the location chosen for the leisure event is analyzed (Q4.4), where parking availability seems the most relevant aspect. However, age shows no connection with the variable which describes with whom the person lives together (Q1.5).

In the last model, the connections between the distance to the close friends' occupation (Q3.2) and the location chosen for the leisure event are investigated. According to the results, there is only a weak relationship whether the event is close to the person's residence (Q4.2.2) and whether the event is trendy (Q4.2.6).

Table 4: The results of the ANOVA models for the pre-COVID survey data.

	Q4.1 mode	Q4.2.2 location	Q1.4 PT pass	Q1.1 user age	Q3.2 distance
Q1.1 user age	0.18878				
Q1.2 university role			0.1546866		
Q1.5 household size				0.64605	
Q1.6 driving license			0.2103949		
Q2.1 number of friends		0.008574**			
Q3.2 distance from friends		0.014499*			
Q2.3 inner circle social media			0.0022929**		
Q4.4.4 outdoor activity	0.06821	0.0096844**	0.07926		
Q4.4.8 other activity	0.02471*	0.1828495			
Q4.1 transport mode		6.328e − 07***			
Q4.3.1 with acquaintances				0.08098	
Q4.3.2 with friends			0.0908418	0.03106*	
Q4.2.2 close to residence					0.0527
Q4.2.4 cheap location		0.002255**			
Q4.2.5 good location			0.0030372**		
Q4.2.6 trendy location			0.0169235*		0.1637
Q4.2.7 accessible location		0.491987	0.0297735*		
Q4.2.8 parking location				7.187e − 08***	
Q4.2.9 organized event		0.008453**			
Q4.2.10 other reason		0.276294	0.03957*		
Q6.1.1 destination search		0.005673**			
Q6.1.3 timetable search	0.09495				
Q6.1.6 recommendations				0.05924	

Significance codes: 0.001< "***," 0.01< "**," 0.05< "*."

Table 5 shows the results of the same models with the dataset of the second survey conducted after the pandemic. Compared to the first survey data, we can observe fewer statistically significant connections in each model.

According to the first model, which describes the relationship with the transport mode (Q4.1), the age of the participants (Q1.1) is the only significant variable, while the other variables become irrelevant. The second question to interpret is about the location of the event (Q4.2.2), where only the number of acquaintances preserves some significance (Q2.2). In the last model, the connections between the distance to the close friends' occupation (Q3.2) and the location picking process of the leisure event in terms of sports activities (Q4.4.2) and parties (Q4.2.6) have some very limited significance.

During the research, as mentioned in the description of the questions section, an attempt was made to analyze the data on which kind of electrical devices the participants use. However, it turned out that these data are not significant. Also, comparing car usage to the driving license could be interesting, but the results were not significant and interesting.

5. Discussion

The conducted survey covered several topics, which has many advantages and disadvantages. On one hand, it is possible to create several hypotheses, and there is a decent amount of data to conduct the calculations. On the other hand, several participants did not finish the survey due to its length. The other disadvantage is that the survey was dealing with various topics, and in the end, it might not focus on specific aspects in detail.

The results show that the data can be used to understand people's travel behavior, but it is very important to make adequate hypotheses. The reason why the results include more than one insignificant model value is not that unsuitable hypotheses are created. Instead, the main reason is that the diversity of the data is low. This situation can be explained by the length of the survey, which may cause that some participants decide against finishing the survey resulting in fewer answers.

There are a lot of possible ways to improve and continue this study. The most efficient way is to extend the dataset, on which this study is based. The survey should use data from more countries; thus, more diverse data would be available for analysis. With more data, other parameters could be assessed, as ICT does not only affect the investigated variables, but it can have an impact on the transportation system, the land use, and the temporal components of transportation, as well [29]. Therefore, in further research, it would be important to examine these additional questions.

As another future research direction, according to the literature, the young generation is not interested in possessing a car or using a car frequently anymore, which is especially true in metropolitan areas [26]. Thus, further analyses should focus more on the paradigm shift by using advanced data collection and analysis methods.

6. Limitations and Implications

In case of possible improvements of our methodology, the limitations in the dataset have to be taken into account. Although the same target group was aimed when conducting both surveys, it cannot be considered as classic panel data,

Table 5: The results of the ANOVA models for the post-COVID survey data.

	Q4.1 mode	Q4.2.2 location	Q1.4 PT pass	Q1.1 user age	Q3.2 distance
Q1.1 user age	0.01111*				
Q2.2 number of acquaintances		0.04804*			
Q3.2 distance from friends		0.98246			
Q4.3.2 with friends	0.13503				
Q4.1 transport mode		0.96203			
Q4.4.2 sport activity					0.9038
Q4.2.4 outdoor activity		0.67242			
Q4.2.6 party at home					0.2335
Q4.2.7 accessible location		0.66449			
Q4.2.9 organized event		0.29724			
Q4.2.10 other reason		0.94316			
Q6.1.1 destination search		0.10233			
Q6.1.3 timetable search	0.27089				

Significance codes: 0.001< "***," 0.01< "**," 0.05< "*."

where exactly the same persons are asked in both cases. Of course, the panel data provide higher reliability and more precise answers to explore the changes in travel behavior. In addition, further data sources could be utilized to evaluate the potential connections. As mentioned in the literature review, mobile phone applications could provide additional data, and they may also enable automated data collection. Another limitation of our work was the considered target groups; i.e., due to our possibilities working in university area, we could only conduct detailed surveys efficiently among students by using the internal mailing system to reach out to the students.

In terms of policy implications, the following suggestions could be realized. Initially, policymakers were afraid that the COVID-19 pandemic will make public transport less attractive. As a result, people turned to individual transport modes. During the pandemic, this process was realized, but finally, it seems that this modal shift was temporary. This fact is justified by the responses to the survey, because the people who were using public transport in the pre-COVID era were still willing to use it in the post-COVID time.

Thus, policymakers should keep the public transport ridership, and they should definitely not reduce the capacity of the network. On the contrary, the already initiated improvements should be continued enabling a more sustainable transportation system.

Moreover, as ICT usage is increasing, especially among the younger generation, information provision and soft measures can be extremely efficient in providing a reliable and suitable transportation system for users. Thus, such developments should be prioritized by policymakers not only because of their natural benefits but also because of cost-efficiency.

Based on our study, another general policy implication can be deduced. In case of future pandemic situations, the restrictions must be carefully planned and past experiences about travel behavior impacts are worth to be taken into consideration when planning measures. Not only sustainable transport mode choice should be supported but also the clever usage of ICT tools should be a primary aspect of policymakers.

7. Conclusions

Based on the collected data and analysis of the dataset, the presented hypotheses related to specific factors can be answered as follows for both pre-COVID era and post-COVID times:

(i) There is no significant relationship between the access to cars and the possession of a monthly public transport pass.

(ii) There is a clear connection between friends living in the neighborhood and looking up the way to reach a place online.

(iii) The frequency of talking by using ICT devices and the travel attitude have a clear correlation.

(iv) The age has no significant effect on choosing a place for leisure events.

(v) There is no significant connection between the number of friends and the number of meetings.

As a further conclusion, it can be stated that the COVID-19 pandemic had a huge impact on general travel behavior as expected. According to the results, a significant part of travelers decided to shift from public transport to individual vehicles during this time. This tendency becomes clearer when the communication activity with other people by using ICT devices is considered. It is found that people decided to have face-to-face meetings with fewer people, but it can be stated that the restrictions had a positive impact on the number of close friends. According to the results, the participants have more close friends on average after the pandemic than in the first survey. Moreover, the participants became more familiar with their surrounding area during the restrictions.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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