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Impacts of COVID-19 on Travel Behaviors: The Case of Izmir

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Abstract

With the emergence of the COVID-19 pandemic, passenger preferences for transportation modes and transportation management strategies have rapidly changed in the last few years. In this study, field research was conducted to reveal the behaviors and perceptions of passengers before and during the COVID-19 pandemic in Izmir city of Turkey. A total of 1437 participants were asked to evaluate the pre and during pandemic periods with their frequency of use for different types of transportation modes in Izmir. When the results of the study were evaluated holistically, it was revealed that the participants used environmentally friendly transportation modes such as bicycles and e-bikes more than before the pandemic and that they wanted to use them after the pandemic. Despite this, it is seen that the use of taxis and private vehicles has increased during the pandemic, especially for long-distance trips, and the use of public transport and light rail systems (LRS) in general has decreased. Nearly half of respondents (49.7%) said bus drivers did not use adequate protective equipment during the pandemic. In addition, 41.1% of the participants stated that the HES code application was not applied adequately in public transportation. In the study, it was also revealed that the practice of reducing the number of operational public transport vehicles during the pandemic was found to be negative by the participants.

Keywords: COVID-19, Mode Preferences, Public Transportation, Travel Behaviors, Travel Habits

1. INTRODUCTION

The COVID-19 outbreak was first reported in mid-December, 2019 in Wuhan, China. Compared with other outbreaks, the spreading rate of COVID-19 infection was found to be higher than the others (Benita, 2021; Elbany and Elhenawy, 2021; Zhang et al., 2021a). Although previous pandemics have negatively affected societies in many ways, the impact of COVID-19 on health, social life, and the economy has been felt more deeply. Many small and large businesses and industries, including the transportation industry, have suffered from this pandemic (Areallana et al., 2020; Mogaji, 2020; Lacka and Supron, 2021). Therefore, it is believed by many researchers that this pandemic will continue to change the way people live, behave and interact (Benita, 2021; Naveen and Gurtoo, 2022).

On March 11, 2020, COVID-19 was announced as a global pandemic by the World Health Organization (WHO). During the pandemic process, many countries took various measures such as restriction of travel, prohibition of mass events, making face masks mandatory, maintaining

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social distancing, and closing restaurants, cafes, schools, and gyms to prevent the spread of infection (Anwari et al., 2021; Tiikkaja and Viri, 2021). Especially travel restrictions affected the traffic and mobility characteristics. The number of home-to-work and home-to-school oriented travels decreased dramatically. People started to work from their own homes and students started online learning. With the "Stay at Home" enforcement implemented by the governments and quarantines, in many countries, the number of trips and the road traffic volumes also decreased (Muley et al., 2021; Zhang et al., 2021a). For this reason, it can be said that the COVID-19 pandemic leads to a decrease in traffic accidents, emission rates, and noise pollution, especially on the days of curfew (Katrakazas et al., 2020; Das et al., 2021; Shang et al., 2021).

The COVID-19 pandemic has directly affected many areas, from energy and tourism to planning and decision-making. Besides, it has also caused changes in some of the preferences of people. One of the most sudden and great changes in this process is the changes related to travel mode preferences and travel habits (Erkek and Cabuk, 2021). In fact, factors such as travel-related parameters, income, education, age, and gender are effective in travel mode preferences (Das et al., 2021; Parker et al., 2021; Eisenmann et al., 2021; Luan et al., 2021). But, these factors were ignored with the extraordinary pandemic conditions. As the virus spreads more easily and quickly in public transport, people preferred their private cars for long-distance travel on the days when there was no curfew. For short-distance trips, motorcycles, e-scooters, bicycles, and electric bicycles were also preferred (Tirachini and Cats, 2020; Lock, 2020; Abdullah et al., 2021a; Hasselwander et al., 2021). Even, some people made a habit of walking considering the healthy lifestyle factor for their short-distance trips (Bhaduri et al., 2020; Abdullah et al., 2021b; Anwari et al., 2021). Therefore, the demand for public transport has decreased in almost all countries. In this process, public transport capacities were reduced by decision-makers in most cities to decrease the spread of the pandemic.

The COVID-19 outbreak, which has taken the whole world under its influence, has also negatively affected Turkey in many ways. According to the data of the Turkish Ministry of Health, the total number of COVID-19 cases has exceeded seventeen million. In addition, the number of deaths has also reached one hundred thousand (Turkish Ministry of Health, 2023). The time-dependent variation of the total number of deaths and cases in Turkey is shown in Figure 1 (URL 1).

As seen in Figure 1, although there has been a significant decrease in the number of deaths and cases in Turkey for about four months, the pandemic has not yet ended. The social, economic, and environmental impacts of the COVID-19 pandemic continue.

This study aimed to analyze the changes in travel behaviors and mobility during the COVID-19 pandemic in Izmir, Turkey. For this purpose, a questionnaire was applied to 1437 people in five different districts (Buca, Bornova, Karabaglar, Menderes, and Gaziemir) of Izmir with different development levels. Thus, the impact of COVID-19 on travel behaviors and mobility in Izmir was examined in detail. Then, solution suggestions were offered to the decision/policy makers after revealing the current problems.

The rest of the paper is organized as follows: Section 2 includes an extensive literature review related to the effects of COVID-19 on the mobility patterns and travel behaviors of travelers around the world. Section 3 introduces the study area (Izmir). Section 4 describes the demographic data and the randomized selection approach for the survey participants. In Section 5, the results are analyzed and discussed. In Section 6, outcomes are summarized and several conclusions are made in the light of the aforementioned results and some solution suggestions for decision/policy makers upon the emergence of a pandemic.

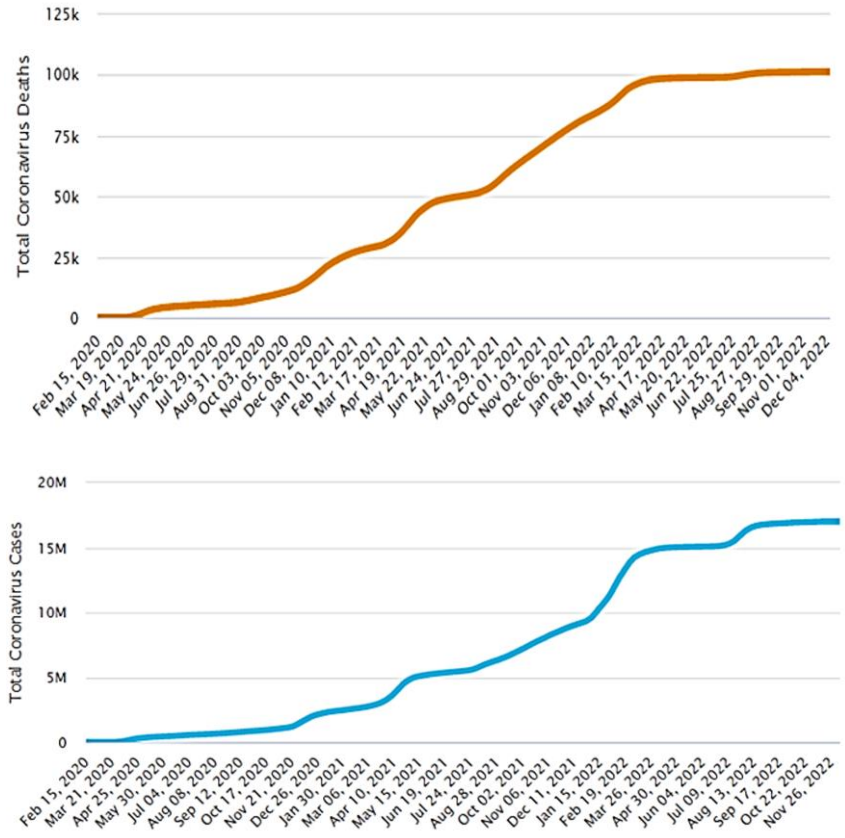

Figure 1. Number of cases and deaths caused by COVID-19 in Turkey

2. LITERATURE REVIEW

The COVID-19 pandemic overturned the traditional patterns related to travel behaviors, daily activities, lifestyles, and risk perceptions (Tirachini and Cats, 2020; Jiao and Azimian, 2021; Kopsidas et al., 2021; Shortall et al., 2021; Zhang et al., 2021a). Since understanding and predicting travel behaviors is an essential issue for transportation planning, decision-making, and policy-making, many researchers have studied the impact of COVID-19 on travel behaviors and mobility. Aloi et al. (2020) studied changing traffic and mobility issues with the COVID-19 process in Santander, Spain. As a result of the study, they stated that mobility with private auto and public transportation decreased by 76% and 93%, respectively. Nikiforiadis et al. (2020), in their study, focused on bike-sharing systems. They conducted a survey of 223 people in Thessaloniki, Greece. As a result of the analysis, they concluded that the COVID-19 process did not increase the use of bike-sharing systems. Jenelius and Cebecauer (2020) declared that the use of public transport decreased between 40% and 60% in Sweeden during the pandemic. Zafri et al. (2021) declared that travel by walking and cycling increased by approximately 50% in Bangladesh during the COVID-19 pandemic. Ku et al. (2021) examined the changes in the travel behaviors of passengers due to the COVID-19 pandemic in Seoul, South Korea. They pointed out that the tendency to use private cars and bicycles increased with the COVID-19 pandemic. In another study, Politis et al. (2021) announced that during the pandemic the number of daily trips decreased by more than 50% in Thessaloniki, Greece. They also stated that the demand for private modes (bicycle, walking, private car) for the trips increased. Abdullah et al. (2021a) developed a logistic-based mathematical model to model the choice of transportation modes during COVID-19 in Lahore, Pakistan. They stated that factors such as safety precautions, education, car ownership, etc., were

important in the choice of transport mode. König and Drebler (2021) evaluated mobility behavior change during the COVID-19 pandemic using quantitative household surveys in the rural district of Altmarkkreis Salzwedel. According to the result, it was concluded that the mobility behavior of approximately 65% of passengers did not change during COVID-19. Kim and Kwan (2021) examined mobility characteristics during the COVID-19 pandemic in the USA. They pointed out that restricting people's mobility could be a short-term solution to control the pandemic. Eisenmann et al. (2021), in their study, indicated that public transport lost ground, especially during restricted periods. They also stated that many public transport users prefer to travel by private car. In India, Das et al. (2021) determined the factors that affect travel mode choice preferences by using a logistic regression model. Echaniz et al. (2021) conducted a survey to determine the mobility preferences of people in Spain. They evaluated lockdown and post-lockdown periods separately. As a result, it was stated that the number of bicycle and walking trips increased, while public transport trips decreased. Schaefer et al. (2021) analyzed the use of different transportation modes in Hanover, Germany. They conducted a survey study of more than 4000 participants. As a result, they indicated that income affects car use. Barbieri et al. (2021) investigated all transport modes (car, tram, subway, walk, bicycle, etc.) in ten countries. They pointed out that avoidance of public transport was observed in all countries. Kopsidas et al. (2021) worked on the post-pandemic behavior of public transport users in Athens, Greece. They stated that perceptions about health safety in public transportation will play an important role in transportation planning in post-pandemic periods. Zhang et al. (2021b) stated that the number of public transport passengers in Hong Kong during the COVID-19 pandemic decreased by 52% compared to the year 2019. Habib and Anik (2021) analyzed public discourses on Twitter to assess the impact of COVID-19 on travel behavior and transportation mode choice preferences. They noted that instead of public transport, people used private vehicles, bicycles, and scooters for their travels. In another study, Shaer and Haghshenas (2021) investigated the factors affecting the travel mode choice preferences of older people during and after the COVID-19 outbreak in Isfahan, Iran. As a result of the analyses, they stated that the factors (such as trip frequency, quality of walking and cycling routes, public transport accessibility, etc.) positively affected the mode choice of older people. Phandanouvong et al. (2021) studied the travel behavior of passengers during COVID-19 in Cambodia and Laos. They collected a total of 217 data and analyzed these data by using a multinomial logit model. As a result, they pointed out that people preferred private transport instead of public transport to avoid getting infected by the virus. Tiikkaja and Viri (2021) indicated that in Tampere, Finland, public transport passengers decreased by 70% due to the COVID-19 pandemic. Anwari et al. (2021) evaluated the changes in trip frequencies and mode preferences during the COVID-19 pandemic in Bangladesh. They stated that Information and Communication Technologies and healthy transportation modes should be improved. Nguyen and Pojani (2021) discussed the measures (use of hand sanitizer and face masks) taken to prevent the spread of coronavirus on public transport in Hanoi, Vietnam. Harrington and Hadjiconstantinou (2021) found that around 49% of public transport users in the United Kingdom switch their mode of transport due to the COVID-19 pandemic. They also pointed out that cycling and walking may be the most popular modes during COVID-19. Jamal et al. (2022), in their study, focused on transport mode preferences during the post-lockdown period in Dhaka, Bangladesh. They stated that various factors could affect transport mode preferences and mobility patterns during the lockdown period. Abdullah et al. (2022) developed the discrete choice models to model the mode choice behavior during the pandemic in Pakistan. Klos-Ademkiewicz and Gutowski (2022) aimed to determine the relationship between travel behaviors and measures for public transport systems in Warsaw, Poland. They indicated that the use of public transport was significantly reduced. Chen et al. (2022) investigated how COVID-19-related measures affect the behavior and preferences of public transport users in the Netherlands. As a result, they concluded that older people were more likely to comply with enforcement measures.

As seen in previous studies, the impact of the COVID-19 pandemic on mobility and travel behavior has been studied by many researchers around the world for three years. In this process, various

studies related to the impact of the pandemic on transportation were also made by many researchers in Turkey. Erbas (2020) investigated the relationship between urban mobility in Istanbul and the measures taken by the Turkish government during the pandemic period. At the end of the analyses, it was determined that the use of public transport decreased compared to the pre-pandemic period in Istanbul. Dagli et al. (2021), in their study, examined the changes in traffic flows in Antalya during the pandemic process. The results showed that users tend to use private vehicles instead of public transport due to fear of virus infection. Similarly, Atasoy et al. (2021) pointed out that the use of public transport decreased in Ankara and Mersin during the pandemic period. Shahin and Yetiskul (2021) investigated the impact of COVID-19 on public transport systems in Ankara. They stated that the decrease in the use of public transport may threaten sustainable transportation. Bagdatli and Ipek (2022) examined the transport mode preferences of university students during the pandemic in Istanbul, Turkey. As a result, they indicated that a significant change in demand for transport modes could be observed during the pandemic period. Aydin et al. (2022) conducted a survey to assess changes in the perceptions and behavior of public transport users in Istanbul. In the scope of the study, before and during the pandemic situations of COVID-19 were evaluated separately. The results showed a significant shift between transportation modes due to the measures taken under COVID-19. In another study, Melis and Ayalp (2023) compared urban transport dynamics for the cities of Istanbul and London during the COVID-19 process. As a result, they presented various policy suggestions such as micromobility vehicle usage, new public transport policies, congestion pricing for the future, and taking into account transport dynamics in London and Istanbul.

As seen in the aforementioned studies, in Turkey, the studies related to the impacts of COVID-19 on transportation were generally made for Ankara, Mersin, Antalya, and Istanbul. No study has been encountered in the literature conducted for Izmir, considering both the perception of urban transport users before and during the pandemic. To fill this literature gap, in this study, Izmir which is the third biggest metropolitan of Turkey is considered as the study area. In this context, the examination of the impact of the COVID-19 pandemic on the mobility, behavior, and attitudes of travelers in Izmir was conducted using the questionnaire technique, and the perceptions of the users for different transport modes were investigated.

3. STUDY AREA: İZMİR

According to the data of the Turkish Statistical Institute (URL 2), the population of Izmir is approximately 4.5 million, and Izmir is the third largest province in Turkey in terms of population density. Izmir is in the Aegean Region of Turkey and has a coast on the Aegean Sea. Since Izmir is a city with a developed economy and industry, urban transportation (transportation of people and goods) can be provided by different modes. Urban public transportation is under the authority and responsibility of Izmir Metropolitan Municipality. It is aimed that, all modes such as taxis, buses, ferries, and subway work integrated to assure convenient, comfortable, and cheap transportation. Especially in recent years, important studies have been carried out by Izmir Metropolitan Municipality for the development of environmentally friendly transportation infrastructure. It can be said that the construction of new bicycles and walking paths is one of the most important steps that support sustainable transportation. Some preferred transportation modes in urban transportation in Izmir are shown in Figure 2.

Figure 2. Some preferred modes for urban transportation in Izmir

This study investigates the impacts of COVID-19 on the mobility and travel behavior of travelers in Izmir. For this purpose, a face-to-face questionnaire study was conducted on approximately 1437 people in 5 districts (Buca, Bornova, Karabaglar, Menderes, and Gaziemir) of Izmir province as seen in Figure 3.

Figure 3. Study area: İzmir

Bornova, Buca, and Karabaglar are the three largest districts of Izmir province and the total population of these districts is approximately 1.5 million. The total population of the Menderes and Gaziemir districts is also around 250,000. Besides, It should be noted that these districts contain people with different socio-demographics (income, profession, etc.) from each other's characteristics. This study tried to generalize the outcomes by considering districts with different levels of development. The classification of the districts was based on the rankings of their development, calculated and categorized using the official report prepared by the Turkish Ministry of Industry and Technology, incorporating post-pandemic data. The report utilized 56 variables representing socio-economic development. Principal Component Analysis was employed to categorize districts into different levels of development (TMI, 2022). The classification of the districts in this study is depicted in Table 1.

Table 1. Socioeconomic development classes of the districts in the study (TMI, 2022)

District	Country Ranking	Development score	Category
Bornova	17	3.02	Level 1
Gaziemir	43	2.03	Level 1
Buca	99	1.22	Level 2
Karabağlar	120	1.07	Level 2
Menderes	145	0.90	Level 2

It is shown by Table 1 that Bornova and Gaziemir have a development level of Stage 1, while Buca, Karabağlar, and Menderes districts have a development level of Stage 2, as evaluated within the scope of this study. To conduct the survey, individuals with diverse socio-demographic characteristics were selected, ensuring the inclusion of different perspectives and thoughts.

4. MATERIALS AND METHODS

In this study, data were collected from 1437 participants using the face-to-face questionnaire method. The participants comprise a wide range of individuals belonging to various education levels, professions, and ages and are selected with a random selection approach. The questions extensively focused on examining the factors that were influenced by the mobility patterns and travel behaviors of individuals in Izmir during the COVID-19 pandemic. In addition, the measures taken by decision-makers in public transportation were comprehensively evaluated. The questions were grouped into pre-pandemic and during pandemic categories. In this research, pre-pandemic refers to the period before the onset of the COVID-19 pandemic. The period before the pandemic represents the participants' travel behavior without any changes, while the period during the pandemic refers to the time when the impact of the pandemic is noticeable. During this time, public transport restrictions were being implemented, such as mandatory mask-wearing and HES code application. The questionnaire for the study was conducted between December 2021 and January 2022. The period during which the questionary was conducted, along with the start and end dates of COVID-19 measures in public transportation and the progression of the pandemic, are displayed in Figure 4.

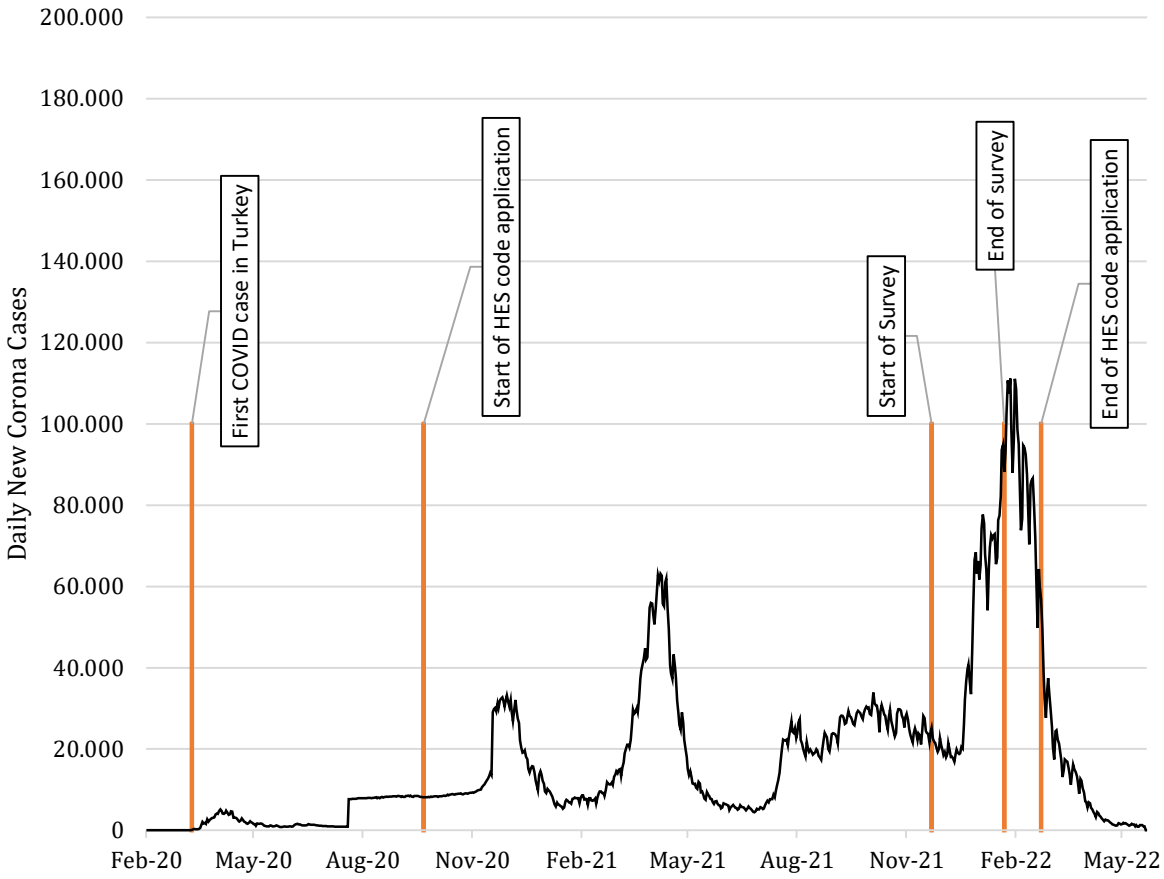

Figure 4. Timeline of the study and progression of the COVID-19 pandemic (Turkish Ministery of Health, 2023)

As seen in Figure 4, the study was conducted during a period when COVID-19 measures were in place in public transportation and the pandemic was at its peak. It is believed that the impact of the pandemic was significant on the preferences and perceptions of the participants in the study. The demographics of the randomly assigned participants are depicted in Table 2.

Table 2. Demographics of the randomly assigned participants

Education Level	Primary school 157 (10.9%)	Secondary School 291 (20.3%)		High school 392 (27.3%)	University 597 (41.5%)	
Gender	Man 947 (65.9%)			Woman 490 (34.1%)		
Profession	Educator 53 (3.7%)	Private Sector 410 (28.5%)	Health Sector 75 (5.2%)	Public Sector 78 (5.4%)	Finance 31 (2.2%)	Retired 138 (9.6%)
	Unemployed 122 (8.5%)	Worker 109 (7.6%)	Student 421 (29.3%)			
Age	18-25 457 (31.8%)	26-35 287 (20.0%)	36-45 273 (19.0%)	46-55 213 (14.8%)	56-65 104 (7.2%)	66 > 103 (7.2%)

The questions asked to participants are also summarized in Table 3.

Table 3. Questions asked to participants in the survey

Question 1	How frequently did you use public transportation before the pandemic?
Question 2	How frequently did you use public transportation during the pandemic?
Question 3	Which mode of transportation did you prefer for short-distance trips in pre-pandemic?
Question 4	Which mode of transportation did you prefer for short-distance trips during the pandemic?
Question 5	Which mode of transportation did you prefer for long-distance trips in pre-pandemic?
Question 6	Which mode of transportation did you prefer for long-distance trips during the pandemic?
Question 7	Was the frequency of public vehicles sufficient during the Covid-19 period?
Question 8	Did you use a taxi during the pandemic, and if so, were the personal precautions taken by the drivers in the vehicles sufficient?
Question 9	Do you think that the HES code application in public transport vehicles during the Covid-19 process has been done at an adequate level?
Question 10	Do you think that the traffic density in Izmir has changed after the bans in the Covid-19 process?
Question 11	Do you think that the station areas are sufficient to maintain sterilization and physical distancing to protect against the pandemic while waiting at the stops during the use of public transport?
Question 12	Would you consider using bicycles, e-scooters, etc. for transportation in the future?
Question 13	How did your transportation budget change before and after the pandemic?
Question 14	Were the personal precautions taken by bus vehicle drivers sufficient during the pandemic?
Question 15	For what purpose do you think individuals traveling on public transportation have had more influence on the transmission of the disease?
Question 16	Having a specific chronic, genetic, etc. disease what would be your public transportation use frequency during the pandemic?

5. RESULTS AND DISCUSSION

In this study, a total of 16 questions were asked to the participants to assess the travel choice behavior shifts, frequencies of using public transport modes, and the effects of the pandemic on the perception of public transportation. The usage frequency of public transportation by the participants before and during the pandemic has been shown in Figure 5.

Corresponding to Figure 5, the general frequency of public transport usage among participants decreased during the COVID-19 pandemic. This implies a less frequent usage of public transport since numbers belonging to less-frequent-usage groups increased. Before the pandemic, 497 (34.5%) of the 1437 participants reported the use of public transport every day which has dropped to 312 (21.1%) during the pandemic. During the pandemic, the number of participants using public transport 2 to 3 times in a month and 1 time in a month increased by 43% (from 218 to 311) and 107% (from 184 to 380) compared to the pre-pandemic. The highest increase considering the pre-pandemic and during pandemic levels among the frequency groups belongs to the “1 time/month” group. The participants who never used public transport during the pandemic were accumulated in this group. The results indicated that participants avoided the use of public transport during the pandemic or decreased the frequency of usage if necessary.

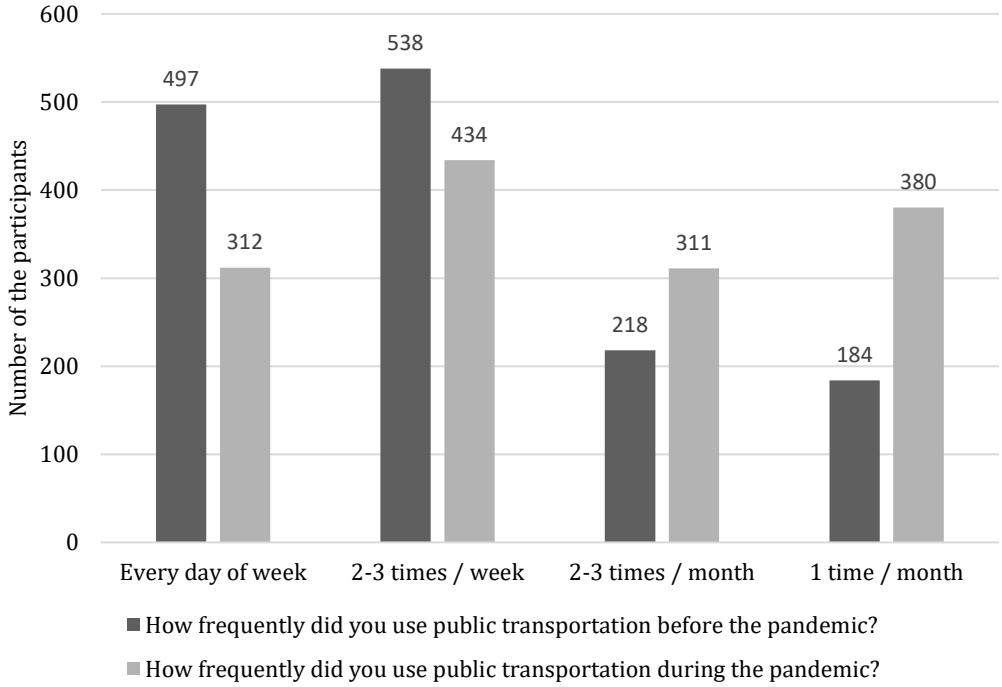

Figure 5. Frequencies of public transport usage before and during the pandemic

The participants were also asked for more detailed travel choice behaviours considering the trip distance and travel modes. The participants were asked which travel mode they use pre-pandemic and during the pandemic for the short-distance (3 to 5 kilometers) and long-distance (5 to >10 kilometers) trips. The numbers of participants choosing travel modes before and after the pandemic are depicted in Figure 6 for short-distance (a) and long-distance (b) trips.

Considering Figure 6, since the participants prefer more than one mode of travel, the total number of answers is higher than the number of participants. The most significant drop during the pandemic was attributed to light rail systems (LRS) and bus services for short-distance trips by 38.9% (from 599 to 366) and 30.4% (from 588 to 409). LRS included both the Izmir metro and commuter train service (IZBAN). The decrease was 15.5% (from 580 to 490) and 24.3% (from 567 to 429) for the same transportation modes and long-distant trip scenarios. Considering the results, the participants avoid crowded public transportation and preferred taxi services and private cars in terms of both short and long-distance trips. For the short-distance trips, the frequency of the taxi rides increased by 32.7% from 278 to 369 participants and for long-distance trips, increased by 19.5% from 277 to 331 participants. The number of participants choosing bike trips for short and long-distant trips increased by 56.3% (from 128 to 200) and 48.1% (from 54 to 80). This result indicated that the influence of the pandemic made the participants to prefer the bicycle more as a means of transportation. Moreover, for short trips, participants tend to walk more frequently. During the pandemic, the proportion of people who chose to walk short distances increased by 17.6%, from 471 to 554. In addition, to compare the pre-pandemic and during-pandemic passenger perceptions of the effects of the COVID-19 pandemic on public transportation, a series of questions were asked to determine the views on public transportation management, traffic characteristics, and transportation economy. The questions and the answers of the participants are depicted in Table 4.

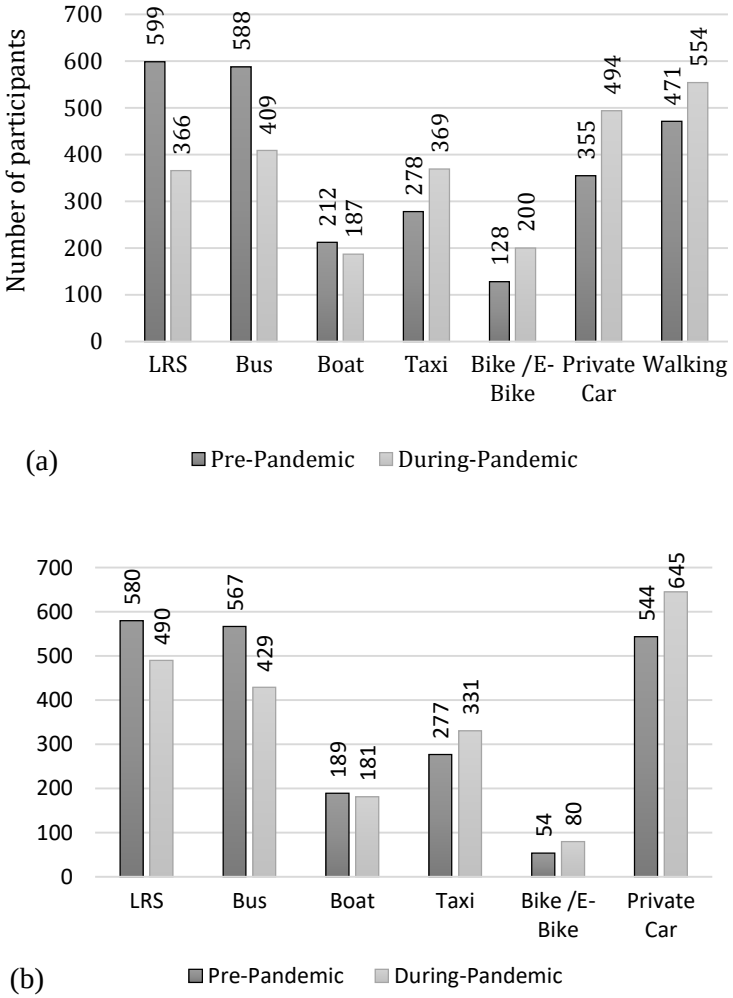

Figure 6. Pre-pandemic and during-pandemic travel mode choices (a) short and (b) long-distant trips

Considering the questionnaire results, 69.4% of participants considered that, the number of vehicles should have been increased during the pandemic and 28.8% of the participants thought that the number of vehicles was adequate.

The effectiveness of the measures taken by the drivers during the pandemic to decrease the spread of the disease was also evaluated through the questions. Participants were asked whether they used taxis during the pandemic and, if so, the adequacy of the precautions taken by the drivers (mask, distance, visor, disinfectant, etc.). A total of 66.1% of the 1437 participants stated that they used taxis during the pandemic, and 49.4% of the participants who used taxis stated that the measures taken by taxi drivers were not sufficient.

The HES code application aims to prevent individuals who have been in contact with or are positive for COVID-19 from boarding public transportation to reduce the spread of the virus. The system communicates directly with the database of the Turkish Ministry of Health and serves to deactivate the transportation cards through the identity numbers of covid patients or passengers who contacted covid patients. To investigate the passenger perception of the effectiveness of the HES code application they were asked whether the HES code application could be done properly in public transport vehicles. According to Table 3, 58.9% of the participants found that the HES code application was done accurately, while 41.1% of the participants felt that it was not done adequately.

Table 4. Questionnaire results for the assessment of passenger perception of transportation characteristics during the pandemic

Was the frequency of public vehicles sufficient during the Covid-19 period?	Should have been increased 997 (69.4%)	Should have been decreased 26 (1.8%)	Adequate 414 (28.8%)
Did you use a taxi during the pandemic, and if so, were the personal precautions taken by the drivers in the vehicles sufficient?	Adequate 470 (32.7%)	Not Adequate 480 (33.4%)	Didn't use Taxi 487 (33.9%)
Do you think that the HES code application in public transport vehicles during the Covid-19 process has been done at an adequate level?	Yes 847 (58.9%)	No 590 (41.1%)	
Do you think that the traffic density in Izmir has changed after the bans in the Covid-19 process?	Increased 594 (41.4%)	Decreased 400 (27.8%)	Unchanged 443 (30.8%)
Do you think that the station areas are sufficient to maintain sterilization and physical distancing to protect against the pandemic while waiting at the stops during the use of public transport?	Sufficient 322 (22.4%)	Partially sufficient 655 (45.6%)	Insufficient 460 (32.0%)
Would you consider using bicycles, e-scooters, etc. for transportation in the future?	Yes 720 (50.1%)	No 717 (49.9%)	
How did your transportation budget change before and after the pandemic?	Increased 623 (43.3%)	Decreased 435 (30.3%)	Unchanged 379 (26.4%)
Were the personal precautions taken by bus vehicle drivers sufficient during the pandemic?	Sufficient 555 (38.6%)	Insufficient 707 (49.2%)	No idea 175 (12.2%)

The passengers' perception of transportation safety during the pandemic was evaluated by asking if the measures taken at the stations were adequate. Pandemic measures of sterilization and social distancing at stations were considered adequate by 22.4%, partially adequate by 45.6%, and insufficient by 32.0% of the respondents. According to this result, 1 out of 3 participants in the study expressed their concerns by finding the sterilization and social distance application at the stations insufficient. Especially even if sterilization applications were carried out at the stations, the lack of a marker that sterilization is performed for each station or the lack of detailed information about this may have caused the development of this passenger's perception.

To determine the changes in the travel preferences of the participants during the pandemic, the participants were asked whether they would prefer environmentally friendly transportation modes such as bicycles and e-bikes to public transportation more during and after the pandemic process. 50.1% of the participants stated that they would like to use transportation modes such as bicycles and e-bikes more frequently after the pandemic. It is seen that this result has emerged as an effect of the escape from public transportation and the orientation to some modes of transportation, especially during the pandemic.

Participants were also asked if they ever used a transportation mode that they had not experienced or preferred during the pandemic. 38.8% of the participants stated that they didn't

use a different transportation mode. It is seen that 17.8% of the participants experienced bicycles, 15.9% e-bikes, and 27.5% other transportation modes in this process. As a result of the answers given to this question, it was revealed that approximately 61.2% of the users experienced transportation modes that they did not prefer during the pandemic.

During the pandemic, increases in road traffic can be seen due to the more frequent use of personal vehicles. In the study, questions were asked to investigate the perceptions of participants regarding the traffic increase. 41.3% of the respondents stated that road traffic increased during the pandemic compared to pre-pandemic. 27.8% of the participants stated that the traffic decreased and 30.8% stated that the traffic density did not change overall. The study also asked whether passengers had chronic conditions and if they would continue to use their type of transport. The answers to this question are shown in Figure 7(a) and Figure 7(b).

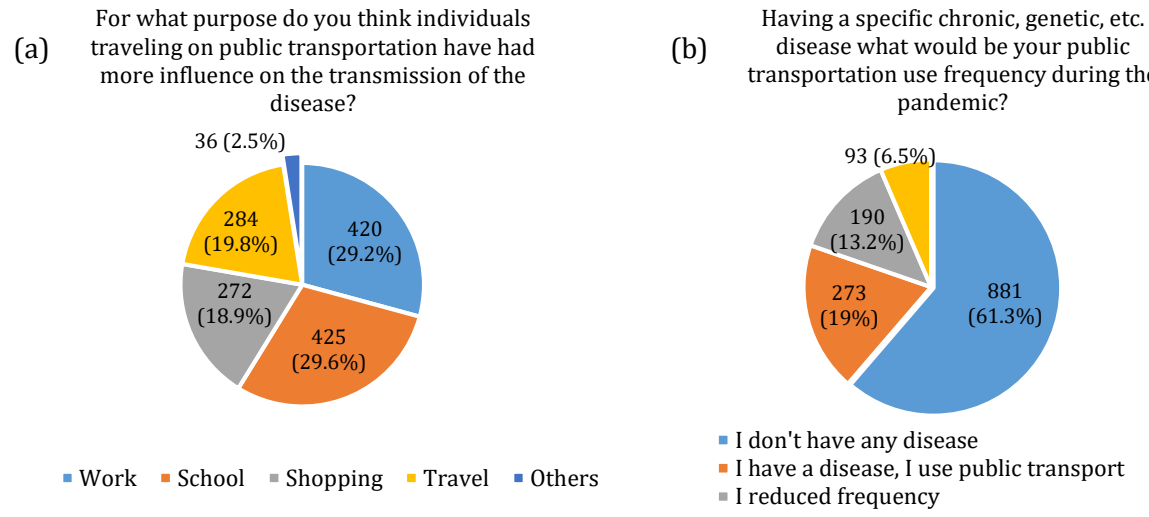

Figure 7. Perception of passengers about the effect of the spread of the disease by public transport

As depicted in Figure the participants mostly thought that the principal factors for transmission of the virus are trips for going to work (29.2%) and school (29.6%) followed by travel, shopping, and other purposes. By asking the participants whether they have a chronic disease, the changes in the transportation mode preferences of participants with chronic diseases were examined. When individuals with chronic diseases were isolated and examined from those who were not, it was seen that 49.1% of these individuals did not decrease the use of public transport during the pandemic, 34.2% reduced the frequency of use and 16.7% completely stopped using public transport.

6. CONCLUSIONS

In this study, a questionary was conducted on 1437 participants to examine the behavior of passengers using public transport before and during the covid-19 pandemic. The study showed that the use of LRS and Buses, which were used extensively before the pandemic, decreased by 38.4% and 30.4% and it has been revealed that passengers using these transportation modes shifted to taxis and private vehicles to a large extent. In addition, it is seen that the use of bicycles and e-bicycles, which were limited especially before the pandemic, increased the usage rate for short distances (distances between 3 km and 5 km) to 24.4% at the level of 16.4%. According to these results, it can be said that the COVID pandemic has increased the demand for environmentally friendly transportation modes. Despite this, it is seen that the use of taxis and

private vehicles, which will lead to more congestion and pollution, has increased to a similar extent.

Likewise, it was seen that bus and LRS usage rates for long-distance trips (5 – 10 km) in the city have decreased to a lesser extent than for short distances. It was seen that the use of private vehicles in long-distance trips was 53.1% higher than short-distance trips before the pandemic and taxi and private car usage for long-distance during the pandemic was proportionally less than short-distance trips. The results also indicated that the use of private vehicles for long distances was higher than the short distance before the pandemic, but the participants who did not prefer to use their private vehicles for short distances started to prefer their private vehicles unintentionally during the pandemic. At this point, it was commented that long waiting and transfer times in public transportation over long distances led participants to use their private vehicles even before the pandemic.

Another interesting conclusion reached in the study is that 28.8% of the participants think that the number of vehicles used in public transport during the pandemic was sufficient. This outcome was interesting since several authorities tried to decrease the trip frequencies for keeping operation costs minimum during the COVID-19 lock-ups but the results of the study indicated that a major part of the participants get annoyed by the vehicle crowdedness during the pandemic and demanded less crowded transport environment. These results indicate that the perception of the insufficient number of vehicles can be triggered by either the vehicle crowdedness or the increased time headways between the servicing vehicles.

Participants were asked whether the drivers use personal protective equipment (inspiratory masks, face-visor, etc). The study also found that almost half of the participants (49.2%) did not find the use of protective equipment by bus drivers sufficient. The reason for this result is thought to be the applications regarding the minibusses, which are usually small and congested. Also, these vehicles don't utilize the HES application where money is exchanged manually since the passenger card system is not integrated. Especially in the future, with the full integration of vehicles such as minibusses and publicly operated vehicles with the passenger card system, it will be possible to change the perception toward hygiene and the spread of the pandemic.

Compared with other examples in the literature, it is observed that the use of protective equipment and mask, is relatively higher in developed and developing countries. For instance, in Moscow, the majority of passengers (87.5%) and all transport workers (100%) used face masks and gloves. Although the usage of face masks is high, it is noted that the proportion of drivers and passengers who wear masks correctly is low (only 41.6% of passengers and 74.7% of transport workers wore face masks correctly in Moscow) (Shashina et al., 2022).

Several studies conducted in less developed countries (Ethiopia) have revealed low adherence to mask usage and protective equipment. In particular, findings indicate that a meager proportion (14.32%) of public transport drivers correctly wear masks while performing their duties, and approximately 40.3% of participants only comply with mask usage when prompted by traffic police (Yimenu et al., 2022). Although the utilization of protective equipment in Turkey surpasses these rates, it is advisable to enhance public awareness and implement educational initiatives endorsed by authorities in high-risk areas for potential pandemic outbreaks. These measures are crucial for minimizing the transmission risk in future pandemic scenarios. Similar to the protective equipment usage, the HES code application was not found to be totally successful by the participants. Particularly, passengers were not allowed to a vehicle without a HES code for the state or municipality-operated buses, LRS services, and ferries since the rules are strict in these transport modes. On the contrary, the perception is thought to be induced by the adequate level of HES code application in privately-owned public vehicles including microbuses, where passengers could board without checking the HES code. Considering these issues, the integration

of the passenger card systems for all transport modes is obligatory to ensure the reliability of the HES code application and passenger restriction policies.

As a final note, there are some limitations of the study that need to be discussed. The study noted that almost half of the participants with chronic illnesses remained the same as the frequency of using public transport under pandemic conditions. The reason for this should be examined in subsequent studies whether it is due to economic reasons or reckless behavior in individuals. Although the study generally assessed changes in user preferences for different transportation modes, it did not specifically associate the decrease in public transportation usage during the pandemic with remote work and consequently reduced mobility. Another limitation of the study is that, while shedding light on the choice and perception of passenger transportation modes, it does not compare the usage behaviors of public transportation among participants with different levels of development and socio-cultural backgrounds. Therefore, a study has been planned to explore the preferences and perceptions of public transportation usage between remote work and different districts, encompassing the post-covid pandemic period.

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