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Switching costs of citizens' behavior change as a tool of post-pandemic urban transport policy: the case of St. Petersburg

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Abstract

The goal of this study was to discuss possibilities to use Covid-19 as a context situation to change citizens' transportation behavior. The concept of switching costs is applied to construct algorithm for search of suitable post-pandemic urban transportation policy tools based on analysis of citizens' transportation behavior and transportation mode choice factors before and during Covid-19 pandemic. To accomplish the goal this work provides analysis of St.Petersburg citizens' survey results. The study examines what changes in the transport preferences of citizens have occurred. The reasons that contributed to changes in transportation preferences were analyzed. One of the conclusion states that context (objective) changes influence transportation behavior of just some groups of citizens. For others the greater role in post-pandemic transportation behavior is played by subjective factors of transportation mode choice. So, we conclude that those subjective factors should be used to construct switching costs to preserve positive transportation behavior, and switching benefits to avoid negative transportation behavior, which occurred during Covid-19 pandemic.

Keywords: Urban transportation policy; public transport; transportation preferences; citizens' behavior; COVID-19 pandemic.

1. Introduction

In December 2019 outbreak of pneumonia, caused by coronavirus Covid-19, was detected in Wuhan (China). On the 11th of March 2020 the World Health Organization has declared Covid-19 to have a status of a pandemic.

The pandemic led to dramatic changes in everyday activities of people all around the world. Governments of most countries have introduced different measures to prevent rapid spread of the virus. Most of governmental measures were aimed to reduce social contacts, for example, closing shops, city malls, schools, cinemas, restaurants, canceling

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public events and stimulating remote work and studying. Recent research shows the impact of Covid-19 pandemic on household activities, shopping patterns, outdoors activities, ethics, housing market, mental health and others. These changes form new habits – a new repeated behavioral patterns.

After the end of pandemic people can switch back to their pre-pandemic habits, but it is more likely that the initial habits will be modified by new regulations and procedures. Habits that once were formed influence future choices. Therefore, it is necessary to review regulatory approaches in many areas, since the existing policy tools were formed based on pre-pandemic habits, and they will not necessarily be effective towards new habits that appeared after March 2020. Moreover, the new habits may be either desirable or negative for society. Therefore, regulators should either decide whether to try to "fix" these new habits or to get rid of them by switching people to the pre-pandemic behavioral patterns.

One of spheres which must be investigated for changes in people's habits is urban mobility and transportation modes choice. Most of research in field of urban mobility claims that during the Covid-19 pandemic there has been a significant traffic decrease and a statistically proven significant influence on the transport mode choice. Many countries face drops in car traffic (measured by decrease in congestion and air pollution), and in public transport ridership (measured by decrease in average revenue of transportation companies).

Since the aim of urban transport policy in most urban agglomerations is to reduce traffic congestion including trough increase of demand for public transport, these new insights should be considered to fulfill this aim. Therefore, the goal the current research is to design an approach towards possible changes in post-pandemic urban transport policy based on switching cost. The analysis is held for St. Petersburg citizen's transportation behavior before and after pandemic. Findings of this study will be useful for policy makers for improving city transport services.

A considerable amount of literature has been published on transportation preferences since late 1950s to propose sustainable urban transportation planning and public transport services. The goal of those studies was to identify main determinants of citizens' transportation behavior among three groups of factors:

transport attributes (transport waiting time, trip price, travel time, reliability etc.);

socio-demographic characteristics of the users (gender, income, age, vehicle ownership etc.);

external factors (GDP per capita, unemployment rate, city population, number of car sales etc., external shocks – terrorist attacks, construction of new transportation infrastructure, weather conditions.

Overall, recent studies generally conclude that transportation preferences are complex and are influenced by combination of various factors.

The combination of factors, internal to the person, forms his or her habits, which, in turn are influenced by a context – combination of factors, external to the person. The Covid-19 pandemic can be referred as a crisis that destroys the context and may lead to changes in habits. According to Sheth, in case of people's behavior, changes in context matter more than acquired habits. Thus, people's behavior is more contextual rather than habitual. When context changes, people tend to choose solutions to their needs which were not typical for them before. They form new habits which can be perceived for a long period of time. The question occurs on the durability of this effect. Some of scholars claim that once after a shock or a crisis most habits will switch back to normal. However, some unreturnable switches can occur, for example, if person once tries services as Uber, which is more friendly than calling a taxi service, they likely will never come back to their previous habits. However, it is necessary to admit, that the situation of new habit acceptance is possible then costs of switching to it and back are not high for a person. Thus, the policy maker can use the notion of switching costs to fix those behavioral changes which seem to be positive for the society and to avoid those which are negative.

The term "switching cost" means psychological and economic costs that the consumer may deal with when switch supplier or service company. Switching costs are assumed by the user before or at the same time when the substitute can provide its benefits.

Switching costs may become a powerful policy tool to modify citizens' transportation behavior, using Covid-19 crisis as a leverage for adopting new transportation behavior. For example, helping to preserve high demand for bike sharing trials which occurred during the Covid-19 pandemic. Quantification of all possible changes in transportation behavior is needed to derive new transportation habits, formed under new pandemic context. The Covid-19 pandemic should be considered as a driver for authorities to support and encourage sustainable transportation shift.

Several studies have already found out the preliminary impact of Covid-19 on transportation preferences, which should be considered by authorities:

- Public transport lost ground during pandemic while individual modes of transport, especially the private car, became more important in Germany.
- Changes in transport behavior were explained by commitment to slow down the spread of virus in India.
- Empirically proved that social distance measures led to reduce in use of public transport in Belgium.
- Rapid increase of bike sharing behavior in China.
- Decrease in public transport use due to psychological sense of unsafety in China.
- People who had well-paid jobs were more likely to reduce their public transport travel during pandemic, while lower income workers were more likely to continue to travel as they used before in USA.
- Outflow from public transport to private cars and to some extent bikes in Switzerland.
- Tendency of shifting to private cars for job trips in Australia.
- Month ticket sales on public transport decreased rapidly, however 1-day tickets sales grew in Sweden.

For those post-pandemic transportation habits, which should be fixed, the policy maker can create high switching costs associated with resumption of pre-pandemic transportation habits. For those post-pandemic changes, which should be avoided, it is worth to create switching benefits of retrieval of pre-pandemic behavior.

The design of switching costs and switching benefits should be based on difference between the role of factors, forming pre-pandemic and post-pandemic transportation behavior. It is important because transportation preferences are changeable by appropriate police measures.

2. Materials and Methods

To formulate recommendations for transportation policy modifications based on changes in citizens' transportation preferences due to the Covid-19 pandemic, following research logic was performed (see Figure 1). First, we defined pre-pandemic transportation habits of citizens. Second, we defined new transportation habits, which occurred after the beginning of pandemic. Third, based on data on factors of choice of transportation behavior, we formulated recommendations concerning policy tools, which are presented by switching costs or switching benefits for different groups of citizens.
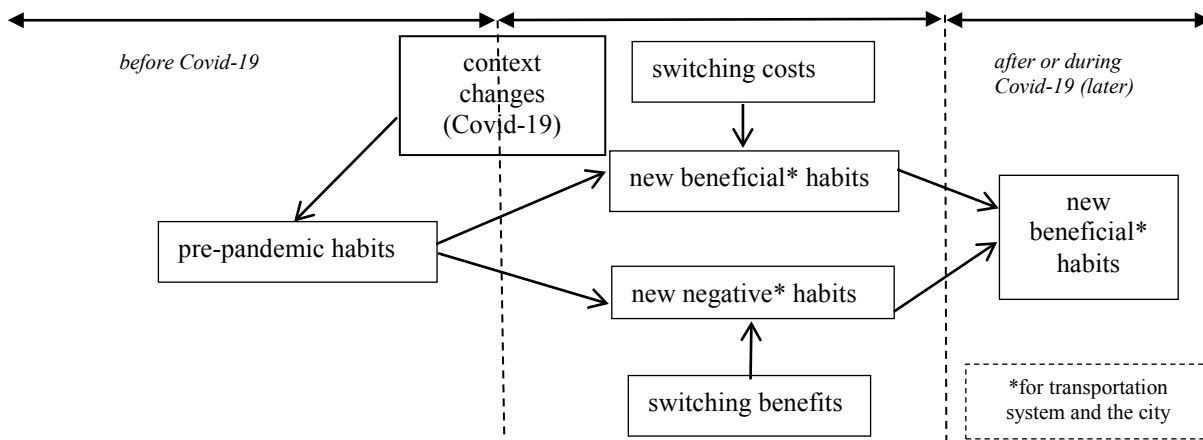

Fig. 1. Research logic: forming new transportation behavior by means of switching costs.

This research logic was considered as a basis of our empirical study. We run an online-survey – CAWI (Computer-Assisted Web Interviewing) to collect data about transportation behavior of St. Petersburg citizens before the beginning of Covid-19 pandemic and during it. The survey was conducted from 8 November 2020 to 30 March 2021 via GoogleForms. The questionnaire was offered to St.Petersburg users of Russian social networking service VKontakte (vk.com). As a result, we engaged 340 respondents; however, due to formal errors (incomplete answers or inappropriate cities), the number of received surveys, subject to analysis, equals to 255.

The questionnaire included socio-demographic questions about the respondent (gender, age, marriage status, quantity of family members, occupation, quantity of underage children, education, income, car ownership). Other questions were the same for two blocks. The first block of questions was related to transportation behavior before the beginning of the Covid-19 pandemic (until March 2020). The second block was related to transportation behavior during the Covid-19 pandemic (since March 2020). Some questions were different for car-owners and those citizens, who do not have cars in their family (car non-owners). We investigated not only preferred transportation modes and important factors regarding the transport mode choice, but also frequency of trips, destinations, and changes in lifestyle, caused by pandemic.

The sample is skewed towards young respondents under 34 (57.7%). Average age of respondents is 34,17 years. But for policy reasons this category of citizens is one of the most appropriate because of their vigorous economic activity. Most respondents have full-time occupation (66%) and work as employees (58%). The common family size is 2 (34.9%) or 3 (26.3%) members. The sample is skewed towards respondents without underage kids (69%).

3. Results

As almost half of respondents have declared an availability of cars in their households, we divided the sample into two groups (see Figure 2).
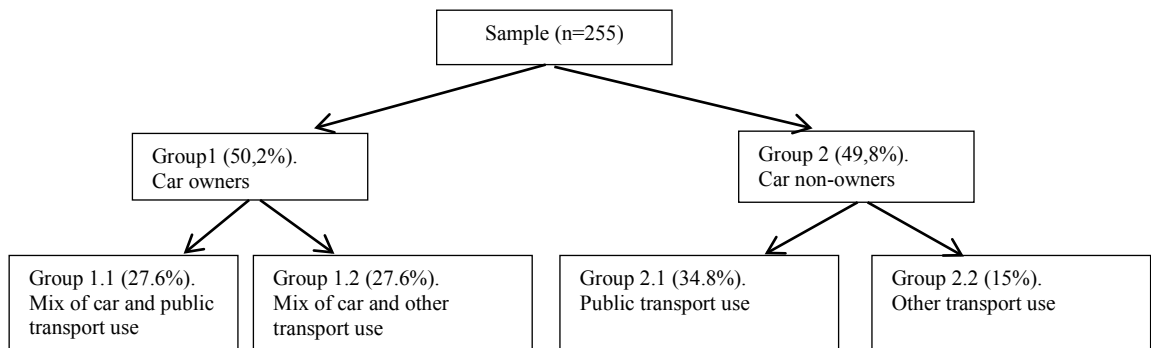
Fig. 2. Respondents' groups by transportation behavior before the Covid-19 pandemic.

Group 1 (50.2% of sample). Car-owners – people, who have one or more cars in their household.
Group 2 (49.8% of sample). Car non-owners – people, who have no cars in their household.
Such division gave us possibility to analyze differences in pandemic-caused transportation behavior changes for those who owns a car, and those who does not.

The next step was to analyze each group's data on their transportation behavior before the Covid-19 pandemic. It turned out that the respondents of each group can be grouped into sub-groups depending on their transportation preferences. So, car owners (Group 1) were divided into two sub-groups:

1) Group 1.1 (27.6% of sample) – those people who combined the use of a personal car and public transport (metro, buses, trolleybuses, tram, mini-bus etc.). It is important to note that the frequency of their use of public transport before the Covid-19 pandemic was high - several times a week and more often.

2) Group 1.2 (22.6% of sample) – those people who mostly used a private car before the Covid-19 pandemic, sometimes switching to other types of mobility (taxi, car sharing, bicycle, etc.).

Car non-owners (Group 2) were also divided into two groups based on dominant type of pre-pandemic transportation behavior:

1) Group 2.1 (34.8% of sample) – those people who mostly used public transport (metro, buses, trolleybuses, tram, mini-bus etc.) for urban mobility;

2) Group 2.2 (15% of sample) – those people who mostly used other types of mobility (taxi, car sharing, bicycle, etc.).

Next step of the analysis was to understand how each group has changed its transportation behavior due to the Covid-19 pandemic. We analyzed each group separately to derive changes in transportation preferences which have occurred (see Figure 3).
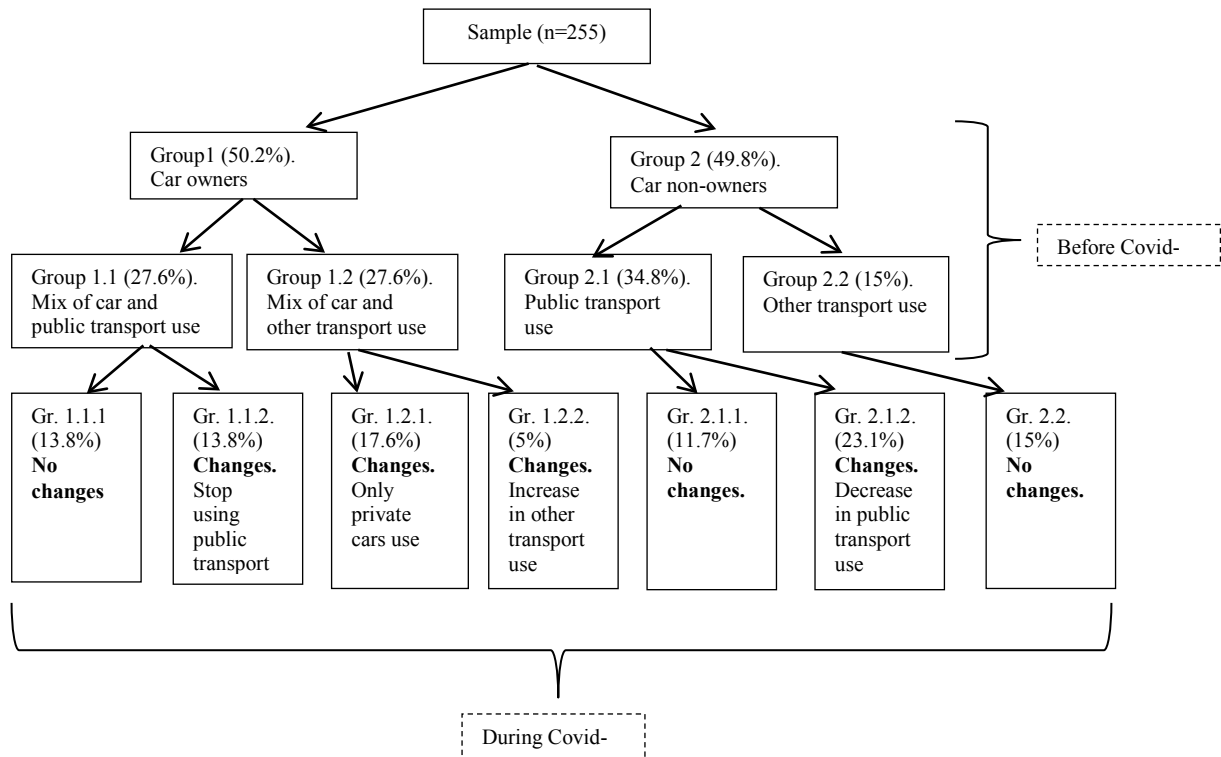

Fig. 3. Changes in transportation behavior due to Covid-19 pandemic.

This group consists of whose people who have combined use of private car and public transport before Covid-19 for everyday trips. According to their answers they used public transport several times a week or more often. However, they also used their own cars quite often.

The response to the Covid-19 pandemic within the group was different: some of car users (13.8% of sample) did not change their behavior and continued to combine trips by private car and public transport (we denote them as Group 1.1.1); others (13.8% of sample) stopped their trips by public transport at all (Group 1.1.2).

Group 1.1.1. These respondents make up 13.8% of the sample. Before the Covid-19 pandemic most of them used public transport regularly. 80% of their trips were trips to work or school. They used their own car to visit family or friends, as well as for shopping (including grocery stores).

This group is the most resistant to the pandemic. Most respondents noted that the Covid-19 pandemic has very little impact on their lives. During the pandemic, the respondents used public transport with the same regularity as they used before. The purpose of the trips remained unchanged – to get to work or to study. Their use of the car has increased slightly – regular trips outside the city (to explore the nature or to go to country-houses) have been added to habitual daily trips.

It should be considered that each of the respondents from this group noted that a trip on public transport did not cause him any concerns about his health and the possibility of contracting an infection.

Group 1.1.2. These respondents also make up 13.8% of the sample. Before the Covid-19 pandemic most of these people used public transport regularly (several times a week or more often). They performed their public transport trips to cinemas, museums, guest visiting. However, due to the Covid-19 pandemic they stopped commuting by public transport at all.

The reasons that underlie this behavior are fears of being infected in public transport. 74% of this group claim that it is not safe to use public transport during the Covid-19 pandemic. Also, all members or Group 1.1.2. notice that they have concerns about their health and always wear masks out of home.

Nevertheless, fear to be infected is not the only reason to stop public transport trips. The main reason is the decrease of occasions to go outside. 62% of Group 1.1.2. respondents started remote work, so they lost the need to travel for work, although before the pandemic, this was one of the main reasons to choose public transport. Furthermore, 58% of them have decreased their visits to family or friends and 62% increased the amount of online shopping.

As for substitutes of public transport they are not oriented to individual mobility. Most of them have never used bicycle or scooter as a mode for transportation. This is also partly true for taxi and car sharing. Based on this, we can conclude that most of trips during the pandemic, this group made mainly by their personal cars.

3.1. Changes in transportation preferences of the Group 1.2 due to the Covid-19 pandemic

This group consists of car users who did not use public transport at all or used it rarely (several times a year or less) before the Covid-19 pandemic. Before the pandemic in addition to their car, they often took taxi rides, used car sharing less often, and rarely used individual mobility modes.

This group consists mainly of people who used their private cars quite often – every day or several times a week. This habit was fixed before the pandemic and has been intensified during it. They mentioned comfort as the most important factor for mode choice during the pandemic as well as before it. However, their response to the Covid-19 pandemic was different. On one hand it was almost complete rejection of the use of other means of transport in favor of the car usage (Group 1.2.1, 17.6% of sample), but on the other hand, it was increase of other transportation modes usage (Group 1.2.2, 5% of sample).

Group 1.2 mostly consists of employees and entrepreneurs, who access their income as either moderate or good. Average income per family member is more than 40 000 rubles. During the pandemic, these people continued to work on a fixed schedule in the organization's building. They chose a private car for their daily commuting.

Nevertheless, some positive trends have emerged inside Group 1.2 during the pandemic. For example, people who had never used bicycles or scooters before the Covid-19 pandemic started to do so. Also, 20% of respondents noted that during the pandemic, they began to use car sharing and individual mobility modes more often for travel. So, the special transport policy may be required to fix these positive changes.

3.2. Changes in transportation preferences of the Group 2.1 due to the Covid-19 pandemic

People who do not own car and mostly use public transport for their mobility needs is the biggest group in the sample – 34,8% of it. The most important factors for this category, both before and during the pandemic, were the ability to accurately plan routes and travel time. However, during the pandemic, the impact of such factors as the trip price during the pandemic has been significantly decreased, and at the same time the importance of the safety factor has been increased. Based on this, we can conclude that users of public transport were ready to pay more for the trip for not to be infected. This may explain the increased use of car-sharing and taxi services by this group during the pandemic (Group 2.1.2).

As for their reaction on the pandemic, 68% of Group 2.1 (23.1% of the sample – Group 2.1.2) stressed out that due to the pandemic they were less likely use public transport. The main reason was the risk of infection. These respondents (Group 2.1.2) switched to different types of individual mobility (taxi, car sharing, bicycle, etc.).

Particularly noteworthy is the fact that 30% of Group 2.1. said that the pandemic made them think about buying a personal car. These intentions can be realized, since the majority in this group considers their financial situation to

be moderate or even good. It can be noted that this group was less affected by the Covid-19 pandemic from a financial point of view; only 3% of respondents point out a decrease in income or loss of work.

3.3. Changes in transportation preferences of the Group 2.2 due to the Covid-19 pandemic

This group includes respondents who do not own a private car, and do not use public transport for most trips. 75% of this group uses a bicycle or scooter for frequent trips several times a week or more. This trend was established before the Covid-19 pandemic and was intensified during it. The remaining 15% of the group prefer car sharing and taxi services for daily trips.

This group mainly includes people of either middle or low income. Most of this group (about 80%) stresses that they would not like to buy a car soon.

We can see now that positive changes in transportation behavior (those, which connected to smaller use of private cars) have occurred in Groups 1.2.2 and 2.1.2, whereas negative changes occurred in Groups 1.1.2 and 1.2.1 – those, who increased use of private cars. For other groups (1.1.1 and 2.1.1) changes in context (pandemic) had no impact.

So, we can propose to design switching benefits of retrieval of pre-pandemic behavior for Group 1.1.2 and switching costs of retrieval for Groups 1.2.2 and 2.1.2. In order to do this effectively, factors of transportation mode choice should be taken into account for chosen groups.

3.4. Changes in factors of transportation mode choice due to the Covid-19 pandemic

The comparison of factors of transportation mode choice before and after beginning of the pandemic gives us useful insights concerning design of switching costs and switching benefits. Only in Group 1.1.2, there were objective reasons for the decline in the use of public transport. They were the shift to remote work, the increase of online shopping and the reduction in reasons to go outside. Other groups of respondents did not demonstrate existence of objective reasons, saying that they didn't notice any changes in their lifestyle when pandemic started. It means that the changes in transportation behavior were influenced to a greater extent by subjective factors (those, which are not connected to the observable changes in lifestyle). Further analysis can give us information about subjective factors of transportation mode choice before and during the Covid-19 pandemic for different groups of citizens.

To access subjective factors of transportation mode choice, we used the data about factors which affect respondent's mode choices, obtained during the survey. Respondent were offered to choose 1 to 3 factors, which were the most important for their mode choice before Covid-19 and during it. The list of proposed factors included:

- trip price (to assess passenger's perception of money needed for traveling);
- possibility to plan routes and travel time (to assess passenger's perception of transport mode reliability and time accuracy);
- comfort (to assess passenger's perception of comfortable trip);
- transport waiting time (to assess passenger's perception of time needed to a trip start);
- epidemiological safety (to assess passenger's perception of risk of being infected during the trip).

The research question for this step of our research was: "The importance of which factors has been changed due to the Covid-19 pandemic and for which factors the difference turned out to be the most significant?". The answers to these questions allowed us to find out which factors are important for consolidating positive changes in transportation preferences and vice versa. We also used this analysis to understand which switching costs are the most receptive by citizens.

The results of the analysis are presented in table 1. Car-owners (Group 1, including Groups 1.1.1, 1.1.2, 1.2.1 and 1.2.2) showed almost similar choice of factors before and after pandemic, so we integrated their answer for the numerical analysis (see Table 1).

Table 1. The most important factors of transportation mode choice before and during the Covid-19 pandemic.

Group name	Car owners, who didn't use public transport before Covid-19, Group 1 (50,2% of the sample)			Car non-owners, who used public transport before the Covid-19, Group 2.1 (34,8% of the sample)			Car non-owners, who used other transport before the Covid-19, Group 2.2 (15% of the sample)		
Most important factors of mode choice	Before Covid-19	During Covid-19	Increment	Before Covid-19	During Covid-19	Increment	Before Covid-19	During Covid-19	Increment
Trip price	34%	28%	-6%	58%	44%	-14%	40%	37%	-3%
Possibility to plan routes and travel time	65%	55%	-10%	70%	67%	-3%	72%	70%	-2%
Comfort	48%	40%	-8%	10%	26%	+16%	37%	27%	-10%
Transport waiting time	36%	33%	-3%	60%	48%	-12%	40%	30%	-10%
Epidemiological safety	12%	36%	+24%	1%	45%	+44%	1%	34%	+32%

Most respondents noted that epidemiological safety became one of the main factors of transportation behavior choice. However, this analysis also gives us another important insight. The survey data showed that the perception of subjective factors has changed mostly for those groups which changed their transportation behavior (Groups car-owners and car non-owners, who used public transport).

As for users of other modes of transport (taxis, bicycles, car sharing), their behavior has not changed and as we see their perception of the factors has not changed significantly. The only exception is the importance of the safety factor, but such increase is typical for other groups also and can be explain by general concerns of citizens' about transport's epidemiological safety.

4. Discussion

Based on survey results, we can conclude that the change in subjective factors of transportation mode choice was one of the main reasons for the changes in transportation behavior due to the Covid-19 pandemic.

The next step we will analyze in detail the changes in these factors' perception for each individual groups of respondents, who have changed their behavior. After that we will propose policy measures connected to factors which respondents are receptive to. For each group of respondents, it is possible to propose different policy measures. The proposed recommendations may be a reaction of the authorities to changing preferences in terms of consolidating new positive habits or returning to before Covid-19 transport preferences. However, it should be stated that these possible measures are not exhaustive and are expected further additional studies with possible regulatory impact assessment.

While deciding on possible policy measures, it worth to consider several issues. First, those groups of respondents, which didn't change their behavior in respond to context measures, are either influenced by objective

First, objective (context) factors of transportation mode choice were discovered only in group of citizens, who had possibility to change their transportation behavior costlessly, including monetary costs as well as psychological.

These were those people who used to use different transportation modes (private car and public transport) even before pandemic – Group 1.1.2. Other groups of car owners showed similar to Group 1.1.2 attitude towards subjective factors of transportation mode choice, but for them they were the only reasons to use private car more often during pandemic. Epidemiological safety reasons were important even for those, who complemented private car trips with other transportation modes (Group 1.2.2). Policy measures for car owners should exploit switching benefits connected with trip price (making trips by public transport to be cheaper and trips by private car – more expensive), directed on increase of attractiveness of public transport for them. The main obstacle relates to and may be directed on minimizing risk of being infected.

Second, for car non-users, it is worth to try to introduce switching costs for Group 2.1.2 – those, who decreased public transport use, substituting it by other transport modes. For them the role of comfort has increased, so the development of other transportation modes infrastructure may not only preserve Group 2.2. using alternative modes, but also to fix behavioral changes for Group 2.1.2.

Third, it doesn't worth to try to implement any policy measures to try to change transportation behavior of those groups, who didn't change it when context changes (pandemic has started). These are groups 1.1.1, 2.1.1, and 2.2. For them only subjective habitual factors matter.

While designing urban transport policy tools, the regulator should take into account socio-demographical characteristics of each group to assess the share of the group in general sample – total amount of city population – and to perform more detailed analysis of daily trips of teach group. In this case it will be possible to implement different policy tool for different parts of the city of for different characteristics of urban transport system.

5. Conclusions

Factors of transport mode choice (such as transport waiting time, trip price, travel time etc) and socio-demographic characteristics of the users (gender, income, personal attitudes etc.) are usually affect transportation preferences. But the impact of changes in external context (such as diseases, accidents, weather hazards etc) on transportation preferences was considered more influential and having longer effect. That is why, the Covid-19 pandemic was discussed as an external factor that causes significant changes in behavior patterns of St. Petersburg citizens.

The research showed that there are some groups of citizens, whose transportation behavior is not subject to change under the impact of context changes. Therefore, we showed that the concept of switching costs may become a powerful tool for transportation policy modernizations after the beginning of pandemic, but only in case when the thorough analysis of transportation behavior and transport mode choice factors of different groups of citizens was held. The proposed recommendations may be a timely reaction of the city authorities to changing preferences due to the Covid-19 pandemic.

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