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FREE FARE PUBLIC TRANSPORT AS A DETERMINATE ON PUPILS TRAVEL BEHAVIOR AND PREFERENCES IN THEIR DAILY TRAVELS TOWARDS SUSTAINABLE MOBILITY – THE CASE OF GDYNIA (POLAND)

Summary. The concept of influencing changes in transport behavior towards sustainable mobility, which is gaining popularity in the 21st century, is free public transport (FFPT). It is estimated that the number of cities in which attempts were made to introduce FFPT exceeds 100. Most of them are located in Europe, especially in France and Poland. FFPT has mostly been restricted to specific city areas or market segments in the hope of increasing demand for public transport services. Because of this, a number of publications on free fare results refer to specific cases in cities. The main aim of this article is to examine the impact of free

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fares on the behavior and transport preferences of pupils in Gdynia, Poland. On the basis of the study of preferences and transport behavior of the inhabitants of Gdynia, carried out earlier by the team in 2010, 2012, 2015, and 2018, a preliminary description of the behavior and transport preferences of students was prepared. The research of the pupils was conducted twice: before and after the introduction of free travel entitlements. The results of the research carried out, and the data analysis, confirmed that FFPT had no impact on demand for public transport services or the travel behavior of pupils. According to the authors, the lack of positive effects of FFPT on travel behavior in the segment of students, or even more broadly, for achieving the purposes of sustainable mobility, results from the interaction of the following factors: specificity of students' travel behavior determined by the schedule of school activities, pupils' positive attitude to cars as urban transport means, not covering all means of public transport services of FFPT in Gdynia (the city rail is not covered by FFPT), short period of time since FFPT has been introduced. The results of the presented studies could not be verified due to the COVID-19 pandemic. The authors emphasize that before introducing FFPT, politicians should rely on the analysis of anticipated changes in the behavior of residents and the impact of FFPT on the economy of public transport, sustainable mobility goals and political and social results. This article complements the current knowledge on the results related to the introduction of FFPT for a selected group of residents.

Keywords: public transport, travel behavior, travel preferences, sustainable mobility, free fare public transport

1. INTRODUCTION

The main goal of long-term activities in the field of balancing mobility is to reduce transport needs and change transport behavior to those that will minimize the negative impact of transport on the environment. Therefore, it is necessary to identify current transport behavior, e.g. by researching and analyzing modal split and transport preferences that determine these behaviors.

The economic situation of households has an impact on the transport behavior of residents. The increase in revenues in passenger transport leads to modal shifts - the share of journeys made by cars is increasing. The results of research in Greek cities show that the effects of the economic crisis have a strong impact on the reduction of car use, compared to sustainable means of transport [40].

Another one of the goals of the sustainable mobility policy is to counteract the increase in the share of private passenger cars in travel. Some researchers assume, however, that the structure of demand for travel in cities will not change radically in the future. Other researchers are looking for determinants underpinning potential changes in transport behavior towards more sustainable ones. The authors of this article represent this line of research.

A dozen years ago, it was claimed that transport behavior is most often determined by the will to drive a car, shaping identity and own image, and social recognition. The respondents were aware of climate change, but the understanding of the relationship between transport and climate was relatively weak [25]. Research on attitudes towards travel and various modes of transport consistently found that about 30% of people were willing to reduce car use when good-quality alternatives existed [3].

Travel behavior in urban areas tends to be repeated. Repetitive travel is a type of behavior with relatively stable causes [21]. Since the quality of a transport service can only be assessed after it has been delivered, a change in transport behavior always carries a specific risk for the passenger. In this context, referring to rationality in their implementation may prove ineffective [22]. People may maintain suboptimal travel patterns based on misconceptions about travel characteristics, such as travel time [32]. This sometimes leads to a tendency to depreciate the quality of travel by other, alternative means of transport [52].

In recent years, research on susceptibility to changes in transport behavior has emerged in a new trend focusing on important events in the life of residents that determine changes in their behavior [34]. They can be: a neighborhood [1], a change of the workplace [50] or a change in the phase of the family lifecycle, e.g. related to the birth of a child [5]. Changes in the specific habits of residents create an opportunity to effectively influence the change in transport behavior.

The following factors influencing the choice of travel modes are indicated:

- access to cars, including company cars [46] and public transport;
- land use [7], although other studies found this factor statistically insignificant [8],
- areas with a well-developed sidewalk or pavement infrastructure encouraging commuters to take the bus or, surprisingly, join a car-pooling initiative [15],
- stronger urban planning and design control that in European countries has led to a more compact and higher density of urban form and hence an increased use of public transport [24],
- socio-demographic variables such as: age, gender, household composition, income [38], [20], [45], [24], [6],
- psycho-social variables – theoretical relationships between attitude and behavior [2], determined by: safety, independence, prestige [29] and perception of the quality of public transport [18],
- travel costs, determined by ticket prices [51] and tariff integration [48] fuel prices [19] and other related costs (e.g., parking fees) [28], [42].

Searching for regularities in transport behavior and preferences, the inhabitants are segmented according to specific criteria. The a'priori segmentation criteria are commonly accepted by including questions about the characteristics of the inhabitants in the data sheet of the research instrument. The criteria for distinguishing the segments are then such parameters of the inhabitants as gender, age, social and professional status, place of residence, automotive status, income, number of people in the household, and marital status. In order to better understand the reasons why residents choose different modes on their daily travels, an approach is also used that analyzes the complex attitudes that determine the choice of travel modes [47]. These analytical approaches employ factor and cluster analysis to shed light on travel preferences and other characteristics [33]. Segmentation proves that the choice of transport modes is influenced by several factors, such as individual characteristics and lifestyle, the type of journey, the perceived service performance of each transport mode, and situational variables [4].

Due to the specificity of behavior and transport preferences, it is advisable to study the behavior of pupils and students as a separate market segment. This is confirmed by the results of the research conducted by the authors in Gdynia in 2018. The share of public transport and cars in all travels of the residents without the ones on foot was almost the same. In trips of working residents' cars dominated with a share of 57,4%. In contrast to trips of those persons,

in trips of pupils, students, pensioners, annuitants and non-working persons, public transport dominated with a share of 56,7 (nonworking) - 87,1% (students) [57].

Research on the transport behavior of adolescents carried out in Greece allowed for the distinction of seventeen (17) different travel patterns for morning activities and forty-three (43) for extracurricular activities [30]. The same authors show that gender, family status, place of residence and extracurricular activity influence the behavior related to the choice of modes of travel in this group. The share of a passenger car in trips related to extracurricular activities. On the other hand, McDonald's argues that gender and race do not appear to have a large influence on the modes of travel of children during their trip to school [36]. Several researchers have discovered important differences between teenage girls and boys. In urban areas, teenage girls travel in cars for a higher share of their trips than do boys; correspondingly, they are less likely to take transit [17] or to walk. When parents chauffeur their teenagers, mothers are roughly twice as likely as fathers to do the chauffeuring [56]. Some authors [35], [49] found that young adult women are more likely to perceive difficulties in their daily travel, most notably safety.

Local conditions also have an impact on pupils' transport behaviour. Based on the results of surveys carried out in 12 secondary schools in New Zealand, it was shown that the dominant mode of travel for students was using a car as a passenger and traveling on foot. It was found that two-thirds of students had some form of driving license, and the behavior was influenced by the type of activity and gender [54]. The evidence indicates that the causes of the changes in young people's travel behavior lie largely outside of transportation. Changes in travel behavior have been driven by changes in young people's socioeconomic situations (increased higher education participation, rise or lower-paid, less secure jobs and decline in disposable income) and living situations (decline in homeownership and re-urbanization) [16]. Walking was once a very important way to travel to school, but its share of travel has dropped dramatically in the last few decades - from 40% in 1970 to 15% in 2000 [37]. A study in Vermont found that those variables with a family income component, such as high family education, access to a car, and smartphone ownership, have a positive effect on teenagers driving more to and from school. Similarly, those teens who travel longer distances depend more on rides and choose active modes of travel than teens living in more populated neighborhoods [43]. An important factor in modal selection is the perception of individual modes of transport. This factor is especially important in countries with high accessibility to passenger cars. Research in the USA shows that young people see buses as "dirty, bumpy and slow" and also dangerous. In addition, many teenagers see driving or owning a car as a symbol of independence and prestige. Most US public transport providers incentivize fare reduction and use educational activities to encourage the use of public transport [11].

It is also worth noting the results of research on the transport behavior of students in Tirana (Albania), as an example of the patterns of transport behavior of residents of former socialist countries [41]. Investigators found that even students studying there, even with a negative attitude towards cars and car travel, intend to learn to drive and use a car in the future.

It should also be noted that, on the one hand, the travel behavior of the pupils is the result of their parents' influence [26] and on the other hand, adolescents with specific environmental motivations influence their parents' transport behavior [39].

The concept of influencing changes in transport behavior towards sustainable mobility, which is gaining popularity in the 21st century, is free fare public transport (FFPT). It is estimated that the number of cities in which attempts were made to introduce FFPT exceeds 100. Most of them are located in Europe, especially in France and Poland [44]. Kębłowski made a broad review of the free fare, considering economic arguments related to the goals of sustainable mobility and the sociopolitical ones [31]. Cities with FFPT vary in size. For

example, in France, FFPTs have been introduced in around 30 cities, most with a population between 10,000 and 110,000 inhabitants [55] In 2017, the free fare covered 57 cities in Europe, 27 in North America, 11 in South America, 1 in Australia and 3 in Asia [31].

The results of FFPT experiments vary between cities. In some cases, such transportation was carried out solely for research purposes, aimed at assessing the impact of the FFPT on the travel behavior of residents. In other cases, FFPTs have been restricted to specific city areas or market segments in the hope of increasing demand for public transport services.

A number of publications on free fare results refer to specific cases in cities [10], [13], [14] University of California students obtained the right to free fare, which increased the number of passengers commuting to the campus by bus by 56% and reduced car driving by 20% [9], [31]. There were slight modal shifts to public transport from the passenger car segment - 3% and pedestrian and bicycle travel (i.e., within sustainable ways of travel) by 5%. The introduction of free fares in Tallinn contributed to an increase in the number of public transport passengers in individual market segments: youth by 21%, the elderly by 19%, the poor by 26% and the unemployed by 32% [14]. In Hasselt, Belgium, the number of passengers increased tenfold during the free fare period. Most of the newly generated trips (63%) were made by existing bus users. About 37% of the new demand was made up of passengers who switched from another mode of transport to the bus: 16% had previously used a car, 12% a bicycle, and 9% had walked [53]. It should be added that in Hasselt with the launch of free fares, the supply of services increased from 500,000 vehiclekm to 2,250 million vehiclekm. It is worth noting that the public transport in Hasselt was co-financed by the Flemish government under a long-term agreement. The free fare project in Hasselt for political reasons (no support from politicians) was withdrawn in 2014. A similar situation occurred in other cities experimenting with free fare, including Castellón (Spain) and Colomiers (France) [31].

The above literature review indicates that before introducing free fares, politicians should rely on the analysis of anticipated changes in the behavior of residents and the impact of free fares on the economy of public transport, sustainable mobility goals and political and social results. Such a procedure is supported by the different results of the FFTP, both in individual cities and in relation to individual segments of inhabitants and their specific transport behavior.

This article complements the current knowledge on the results related to the introduction of free fare for a selected group of residents. It presents the results of research on changes in transport behavior as a result of the introduction of free travel rights for secondary school pupils in Gdynia, Poland, and an analysis of the actions taken from the point of view of the results obtained.

2. JUSTIFICATION OF THE SELECTION OF THE RESEARCH PROBLEM AND HYPOTHESIS

The authorities of the cities and municipalities of the Tri-City Metropolis, which is the fifth-largest metropolitan area in Poland (1.1 million inhabitants), decided in 2018 to introduce FFPT for pupils. The decision was justified by:

- the possibility of increasing the number of pupils traveling by public transport;
- expected favorable changes in the modal split of this segment;
- striving to encourage parents to give up driving pupils to school by car;
- striving to develop the habit of using public transport in the segment of young people.

The way it was introduced may have influenced the results of the FFPT for pupils. Politicians in individual cities (8 cities) and rural municipalities (6) introduced FFPT for pupils in an uncoordinated manner. As a result, in the individual cities and municipalities of the Tri-City metropolis, the FFPT applies to various age groups (up to 15, up to 20 and up to 24) and generally applies only to trips within a given city or municipality, not the entire metropolis.

This article is a continuation of the research on the results of extending the FFPT, the results of which were based on the study of the number of passengers in the Tri-City Metropolis in Poland, taking into account the segments distinguished on the base of the type of ticket held [27]. The results of the previous research did not give grounds to conclude that the FFPT for pupils contributed to the increase in the number of trips by this segment of the population. However, they showed to what extent the revenues of public transport related to the introduction of FFPT for pupils decreased, which resulted in the necessity of increasing subsidies for public transport.

The authors of this article decided to examine the impact of FFPT on the behavior and transport preferences of pupils in one of the largest cities of the Tri-City Metropolis – Gdynia (245 thousand inhabitants). On the basis of the study of preferences and transport behavior of the inhabitants of Gdynia, carried out earlier by the team in 2010, 2012, 2015, 2018, a preliminary description of the behavior and transport preferences of students was prepared. The research of pupils was conducted twice: before and after the introduction of free travel entitlements. On its basis and the justifications of the politicians presented above, the following research hypotheses were adopted:

- pupils transport behavior is determined by travel related to school attendance;
- cost of the trip does not play a primary role in making the decision about the choice of the mode of transport;
- introduction of FFPT did not change pupils' transport behavior;
- introduction of FFPT did not change the importance of particular attributes that should be characterized by public transport in the assessment of pupils.

3. METHODOLOGY

The research units were selected by the method of group randomization. The research was conducted in secondary schools. Due to the specifics of the research subject - transport behavior, which is determined by the location of traffic sources and targets - it was decided to have a large sample size in order to minimize the impact of the school location on the measurement results. The second reason for increasing the sample size was the use of the research results by the Gdynia public transport organizer to plan the transport offer. In the randomly selected schools, research was carried out in the same classes of pupils twice - before and after the introduction of FFPT. As a result, a large quasi-panel was obtained, entitling to quantitative analyzes. The research was carried out using the auditorium survey method. The questionnaire was completed by the pupils under the supervision of moderators, who provided explanations in case of doubt. The method of the auditorium survey also enabled the control of the return of the questionnaires, which was important for the representativeness of the obtained results.

The authors are aware of the impact of the relatively short period of FFPT on the behavior and transport preferences of pupils. Nevertheless, the impact of FFPT in the short term was also analyzed by other authors [12]. Therefore, we treat the presented conclusions with some caution, regardless of the results of statistical analyzes.

4. RESEARCH RESULTS AND ANALIZES

Statistical analyzes were performed with the use of IBM SPSS Statistics 25.0. Using the program, a frequency analysis was performed with Pearson's $\chi 2$ test or Fisher's exact test (when the expected count was less than 5) in order to compare qualitative data collected in 2018 and 2019. For quantitative data, the t-test analysis was performed on independent samples.

First, the sample structure was analyzed in both studies (2018 and 2019) in order to exclude or identify the impact of factors other than price changes on passenger behavior (introduction of free fares). The respondents participating in the research in 2018 and 2019 were compared in terms of gender, place of residence, possession of a passenger car in the household, and possession of a bicycle.

Place of residence. In order to compare the distribution of the place of residence of the respondents in 2018 and 2019, an analysis was carried out using the Fisher exact test. The analysis did not show any significant differences in terms of the place of residence between the analyzed samples in 2018 and 2019, $p = 0.938$; $V = 0.07$.

Sex. In order to compare the percentage of gender distribution among the respondents in 2018 and 2019, an analysis was performed with the Pearson $\chi 2$ test. The analysis showed no significant differences in the sex proportions in the analyzed years, $\chi 2\ (1) = 2.39$; $p = 0.122$; $V = 0.03$.

Having a car in the household and the number of cars. The analysis with the Pearson $\chi 2$ test did not show significant differences in the proportions of pupils with and without a car in the household in 2018 and 2019, $\chi 2\ (1) = 1.45$; $p = 0.229$; $\varphi = 0.02$.

Additionally, the difference in the number of cars in the analyzed years was also checked using the $\chi 2$ Pearson test. The analysis showed significant differences between the compared years, $\chi 2\ (2) = 19.10$; $p < 0.001$; $V = 0.08$. Post hoc analysis with the Z-proportion test with a Bonferroni significance level adjustment showed that in 2019 the percentage of pupils owning 2 cars in their household was lower than in the previous year (40.0% vs. 44.5%), while the percentage of pupils having 3 or more cars in their household was higher (17.4% vs. 12.1%). The percentage of students with 1 car in their household was similar in both years (in 2018 - 43.4% and in 2019 - 42.6%).

Having a bicycle. The analysis with the Pearson $\chi 2$ test showed no significant differences in owning and not owning a bicycle in a household in 2018 and 2019, $\chi 2\ (1) = 0.10$; $p = 0.753$; $\varphi < 0.01$. About 80% of the surveyed students in 2018 and 2019 had at least one bicycle in their household.

Use of the bicycle in warm and cold months of the year. The Pearson $\chi 2$ test compared the frequency of recreational and non-recreational bicycle use in the warm (April-September) and cold (October-March) seasons in 2018 and 2019. The analysis showed no significant differences in the frequency of use of the bicycle between 2018 and 2019 in the warm season for recreational travels, $\chi 2\ (5) = 7.52$; $p = 0.184$; $V = 0.05$, for non-recreational travels, $\chi 2\ (5) = 2.83$; $p = 0.726$; $V = 0.03$. The differences for the cold season data for recreational travels also turned out to be insignificant, $\chi 2\ (5) = 6.26$; $p = 0.282$; $V = 0.05$ and for non-recreational travels, $\chi 2\ (5) = 9.77$; $p = 0.082$; $V = 0.06$.

Declared way of travel. Analysis with Pearson's $\chi 2$ test showed significant differences between the declared ways of traveling in both examined years, $\chi 2\ (6) = 27.99$; $p < 0.001$; $V = 0.09$. A detailed analysis showed that the percentage of pupils who always use public transport in 2019 was significantly lower than in the previous year (17.5% vs. 21.1%). In 2019, the percentage of pupils always using a passenger car was significantly higher than in 2018 (1.2% vs. 0.3%), as was the percentage of pupils traveling mostly by car (3.6% vs. 2.1%). There were

no differences between the years in terms of the frequency of travelling mainly by bicycle, always by public transport and a passenger car, and mainly by public transport. Certain, but difficult to quantify, impact on the decrease of the share of public transport and the increase of the share of private car in travels was probably caused by changes in the automotive status of pupils households. The results are presented in Table 1.

Tab. 1

Analysis of the frequency of declared travel patterns of students before and after FFPT

Declared way of travel	2018		2019	
	n	%	n	%
Always by public transport	393a	21.12	302b	17.47
Mostly by public transport	1,042a	55.99	950a	54.95
Equally by public transport and by car	373a	20.04	378a	21.86
Mostly by car	39a	2.10	63b	3.64
Always by a passenger car	6a	0.32	21b	1.21
Mostly by bike	8a	0.43	14a	0.81
Other (on foot, motorbike etc.)	0a	0.00	1a	0.06
	1,861	100.00	1,729	100.00

The columns that do not divide the letter index differ from each other at the level of $p < 0.05$ (Bonferroni correction).

The results of the analysis confirm the hypothesis that free-of-charge public transport does not affect travel behavior . This hypothesis will also be analyzed later in the article.

The frequency of commuting to school. Under the influence of FFTP, the number of trips to school could also increase in the group of pupils participating in extracurricular activities. Taking this into account, the number of trips to school was determined using the t-test analysis for independent samples. The analysis did not show any significant differences in the number of trips in 2018 and 2019, $t(3{,}588) = -0.65$; $p = 0.514$; $d = 0.02$; 95% CI [-0.13; 0.07]. In 2018, the average number of trips to school per week was $M = 4.94$ ($SD = 1.54$), while in 2019, $M = 4.98$ ($SD = 1.55$). Also, using the t-test for independent samples, the average number of trips to school per week between the two groups was compared. The analysis did not show any significant differences in the number of trips between 2018 and 2019 among students attending the same school. The results of the analyzes are presented in Table 2.

Tab. 2

Comparison of the number of trips to school before and after FFPT in the cross-section of pupil groups

Schools	before FFTP		after FFPP				95% CI		
	M	SD	M	SD	t	p	LL	UL	d Cohen
CKZIU 1	5,20	0,79	5,14	0,79	0,50	0,619	-0,17	0,29	0,07
CKZIU 2	4,86	1,05	4,74	1,36	0,65	0,518	-0,25	0,50	0,10
I ALO	4,91	1,92	4,85	1,07	0,31	0,759	-0,32	0,44	0,04
II LO	5,01	0,68	5,10	1,03	-0,96	0,336	-0,28	0,09	0,10
III LO	3,90	2,84	3,54	3,03	0,97	0,332	-0,37	1,09	0,12
IX LO	5,18	0,70	5,35	1,44	-1,37	0,171	-0,41	0,07	0,15

LK	5,00	0,00	4,83	1,44	0,64	0,525	-0,38	0,72	0,17
V LO	5,00	0,00	5,04	0,79	-0,34	0,735	-0,25	0,18	0,07
VI LO	4,98	2,02	5,07	1,84	-0,37	0,715	-0,58	0,40	0,05
VII LO	4,60	1,96	5,00	1,22	-0,79	0,435	-1,43	0,63	0,25
X LO	5,37	1,36	5,38	1,53	-0,07	0,942	-0,36	0,34	0,01
XIV LO	4,80	1,91	4,92	1,92	-0,45	0,655	-0,60	0,38	0,06
XVII LO	4,59	2,23	5,51	2,79	-1,63	0,106	-2,05	0,20	0,37
ZSAE	5,16	0,75	5,34	1,16	-1,06	0,289	-0,50	0,15	0,18
ZSCHiE	4,95	1,25	4,89	0,77	0,47	0,636	-0,19	0,32	0,06
ZSET	4,83	1,77	4,71	1,39	0,55	0,580	-0,30	0,54	0,07
ZSHG	5,14	0,45	4,97	0,86	1,94	0,054	0,00	0,35	0,26
ZSJ	5,19	0,54	5,79	1,12	-1,82	0,086	-1,29	0,09	0,69
ZSP	5,34	1,19	5,23	0,46	0,70	0,485	-0,20	0,42	0,12

M – average number of travel; SD – standard deviation; t – student's test; p – test's probability; LL – lower limit of the confidence interval (95%); UL – upper limit of the confidence interval (95%); d Cohen – the size of the effect.

Modal split (identified by the use of the method of "photographing" the number of trips in the day before the test). In order to deepen the analysis of the influence of free fare on the modal split, the frequency of indications of a given mode of transport was compared on the basis of the so-called photo of the day before the examination. The analysis was performed with the Pearson $\chi 2$ test. All indications of a given mode of travel were counted throughout the day, including transfers between modes of travel. The analysis showed significant differences between the years for the indicated means of travel, $\chi 2\ (14) = 258.90$; $p < 0.001$; $V = 0.12$.

Detailed analysis of the results showed that the percentage of pupils using buses (37.6% vs. 35.5%) and trolleybuses (13.8% vs. 12.0%) in 2018 was higher than in 2019. In 2019, a higher percentage of pupils than in 2018 used the car in the per minute system as a driver (0% vs. 4%), bike sharing (0% vs. 0.6%), a car as a driver (0.1% vs. 2, 1%) and taxis (0.06% vs. 0.19%). Pupils in both grades used private buses, railways (urban and regional), motorbikes, bicycles, cars as passengers, trams and walking similarly. The results of the analyzes confirm the hypothesis that there is no influence of free public transport on the modal split in the segment of secondary school pupils. The results of the analyzes are presented in Table 3.

Tab. 3

Analysis of the frequency of use of modes of travel before and after launching FFTP

Mode of travel	before FFPT		after FFPT	
	n	%	n	%
Bus (PT network)	3543a	37,62	2938b	35,47
Private bus / bus (ticketed)	3a	0,03	0a	0
Carsharing as a driver	0a	0	4b	0,05
Carsharing as a passenger	3a	0,03	1a	0,01
Rail (urban, regional)	1082a	11,49	958a	11,57
Motorcycle (or moped)	31a	0,33	20a	0,24
Bikesharing	0a	0	47b	0,57
Walking	2662a	28,27	2445a	29,52
Regional bus	48a	0,51	31a	0,37

Bike (private)	108a	1,15	85a	1,03
Private car as a driver	11a	0,12	176b	2,13
Private car as a passenger	599a	6,36	548a	6,62
Trolleybus (PT network)	1296a	13,76	998b	12,05
Tram (PT network)	25a	0,27	15a	0,18
Taxi	6a	0,06	16b	0,19
	9417	100,00	8282	100,00

The columns that do not divide the letter index differ from each other at the level of $p < 0.05$ (Bonferroni correction).

Travel motivations. The possibility of the impact of FFTP on travel purposes unrelated to school and extracurricular activities taking place at school was also analyzed. The frequency of traveling for a given purpose in 2018 and 2019 was compared. The analysis with the Pearson test $\chi 2$ showed statistically significant differences in the frequency of travels for a given purpose, $\chi 2\ (8) = 23.01$; $p = 0.003$; $V = 0.05$. Detailed post hoc analysis showed an increase in travel frequency in 2019 compared to 2018 to work (0.38% vs 0.79%). However, this is a small group, accounting for less than 1%. At the same time, there was a decrease in the frequency of travels related to social matters (6.59% vs. 5.25%) and for shopping purposes (6.28% vs. 5.13%). There were no differences in the frequency in the trips for the remaining purposes. Thus, it can be concluded that free of fare public transport does not intensify optional transport needs of the pupils. The results of the analyzes are presented in Table 4.

Tab. 4

Analysis of the frequency of pupils travels in different motivations before and after FFPT

Travel motivation	before FFPT		after FFPT	
	n	%	n	%
Home	2411a	42,06	2088a	42,19
Education	1862a	32,48	1675a	33,85
Giving a lift	8a	0,14	12a	0,24
Work	22a	0,38	39b	0,79
Recreation	324a	5,65	273a	5,52
Personal affairs	330a	5,76	295a	5,96
Social matters	378a	6,59	273b	5,52
Professional and business matters	37a	0,65	40a	0,81
Shopping	360a	6,28	254b	5,13
	5732	100,00	4949	100,00

The columns that do not divide the letter index differ from each other at the level of $p < 0.05$ (Bonferroni correction).

Ranking of the most important public transport attributes. The frequency of considering given characteristics of public transport as the most important was compared. Analysis with the Pearson $\chi 2$ test did not show significant differences in the frequency of selecting individual features in the first place in 2018 and 2019, $\chi 2\ (11) = 19.26$; $p = 0.057$; $V = 0.07$. However, differences in the frequency of selecting features in the top three places turned out to be significant, $\chi 2\ (11) = 20.26$; $p = 0.042$; $V = 0.04$ (Table 5). A detailed analysis showed that in 2019 that most often, the chosen attribute turned out to be the frequency of travel (18.45% vs.

20.03%). Significantly often no answer was given to this question (0.34% vs. 0, 64%). In 2018, on the other hand, attention was paid to the low cost of travel significantly more often than in 2019 (5.43% vs. 4.36%). For the remaining features, the differences in the frequency of indications turned out to be insignificant. The analysis of the attributes ranking showed that the free of fare public transport did not contribute to a change in the order of the attributes in the ranking, and as shown by the above analyzes, it did not change the transport behavior of secondary school pupils.

Tab. 5

Analysis of the frequency of the selection by the pupils of the attributes of public transport services (3 most important features) before and after FFPT

Attribute	before FFPT		after FFPT	
	n	%	n	%
Frequency	1030a	18,45	1039b	20,03
Punctuality	1005a	18,00	903a	17,41
Directness	832a	14,90	789a	15,21
Reliability of access	763a	13,67	715a	13,78
Speed	688a	12,32	591a	11,39
Availability (proximity to the stop)	496a	8,88	468a	9,02
Low cost	303a	5,43	226b	4,36
Convenience	244a	4,37	219a	4,22
Rhythmicity	167a	2,99	177a	3,41
Other	22a	0,39	14a	0,27
No answer	19a	0,34	33b	0,64
Comprehensive information	14a	0,25	13a	0,25
	5583	100,00	5187	100,00

The columns that do not divide the letter index differ from each other at the level of $p < 0.05$ (Bonferroni correction).

At the end of the analysis, the cross-impact of free of FFPT on the evaluation of the services of different means of transport covered by the free travel entitlement (buses and trolleybuses) and not covered by these entitlements (city rail) was analyzed. The overall grades before and after FFPT were compared. The analysis with Pearson's Analiza2 test showed that in 2019 the surveyed pupils more often indicated insufficient assessment of these means of transport than in 2018. At the same time, the assessment of the urban railway deteriorated. After the introduction of free fare in buses and trolleybuses, students more often assessed urban rail with sufficient and insufficient grades compared to 2018, and at the same time gave the railways very good and good grades. The detailed results of the analyzes are presented in Table 6.

Tab. 6

Analysis of the frequency of general evaluation of trolleybuses, buses and urban rail before and after FFTP

Evaluation	before FFPT		after FFPT	
	n	%	n	%
Buses and Troleybuses				

Very good	182a	9,78	197a	11,39
Good	980a	52,66	859a	49,68
Enough	469a	25,2	460a	26,6
Not enough	66a	3,55	84b	4,86
No opinion	164a	8,81	129a	7,46
Urban rail				
Very good	281a	15,10	212b	12,26
Good	886a	47,61	786a	45,46
Enough	337a	18,11	365b	21,11
Not enough	62a	3,33	84b	4,86
No opinion	295a	15,85	282a	16,31
	1 861	100	1 729	100

The columns that do not divide the letter index differ from each other at the level of $p < 0.05$ (Bonferroni correction).

5. CONCLUSIONS AND DISCUSION

The presented analyzes showed the correctness of the adopted hypotheses. The transport behavior of pupils is mostly (56-58% of trips) determined by compulsory school activities and optional activities carried out by schools. These primary needs (classrooms and extracurricular activities) determine the secondary needs - transport needs. The schedule and organization of these activities affect the needs for the services of public transport. Without a significant change in primary needs, e.g. an increase in the intensification of extracurricular activities, there is no basis to argue that the introduction of FFPT will generate additional demand for its services in the segment of pupils. As other data in Table 3 indicate, the optional destinations did not contribute to increasing the use of FFPT in the segment of pupils. There is no ground to argue that FFPT for pupils generated such needs due to the possibility of shifting household expenses to other purposes, not related to transport. The authors are aware, however, that the period of time since the introduction of FFPT is too short to express an unambiguous view in this regard.

The significance of the cost of travel for pupils as an attribute characterizing public transport services has not changed. It still ranks relatively low (7th position) in the ranking of the ten most important attributes, although its importance has slightly decreased after the introduction of FFPT. This can be explained by the fact that parents, not the pupils themselves, pay for tickets (mainly season tickets) of home budgets rather than pupils pocket money or their own income. At the same time, attention is drawn to the increasing importance for the pupils of frequency of services of public transport.

The analyzes of pupils' transport behavior in terms of choosing the mode of travel before and after the introduction of FFPT hasn't shown any significant changes. Paradoxically, the share of trips made always or mostly by public transport has decreased, while the share of trips made always or mostly by passenger car has increased. This phenomenon could have been influenced by the increase in the share of households with three or more cars (by 5.3%) and the increase in the number of pupils holding a driving license (by 9.9%) in the analyzed period. At the same time, the results make us think about the effectiveness of FFPT for people from households who have access to several cars and are able to use them independently from each other.

Modal split analysis based on the so-called photo of the day before the research confirms the results of the analysis of the declared by the pupils transport behavior. There has been an increase in the share of individual means of transport, first of all cars, including carsharing.

The share of those cars increased by 4%, private cars driven by the pupils - by 2% and bikesharing - by 0.6%. Thus, it can be concluded that three factors has a greater impact on the travel behavior of pupils in the analyzed period than FFPT, namely: access to driving license, the dynamic development of car sharing services and the increasing availability of bike sharing services.

It is worth noting that the assessment of the quality of urban rail services has deteriorated after the introduction of the FFPT for pupils, which was not implemented in that segment of transport. This indicates the need for comprehensive application of such solutions with regard to the entire urban public transport, but not in its selected subsystems.

The results of the research carried out and the data analysis confirmed the theses that FFPT had no impact on demand for public transport services and travel behavior of pupils. According to the authors the lack of positive effects of FFPT for travel behavior in the segment of students, or even more broadly for achieving the purposes of sustainable mobility results from the interaction of the following factors:

- specificity of students' travel behavior determined by the schedule of school activities;
- pupils' positive attitude to cars as urban transport means, evidenced by a high (9.9%) increase in the share of holding by them a driving license and an increase in the share of households equipped with more than 2 private cars, a factor conducive to the increase of the share of cars in modal split is also the dynamic growth of car sharing services after the introduction of the FFPT;
- FFPT not covering all public transport services, in the context of the offered services (the city rail is not covered by FFPT), the age range of validity of the entitlement (individual cities and municipalities introduced FFPT for different age groups) and the spatial scope of the entitlement (apart from a few exceptions, the FFPT is valid only for the area of individual cities and communes);
- short period of time since FFPT has been introduced; the results of the presented studies could not be verified due to the COVID-19 pandemic.

In order to obtain the potential positive results of FFPT implemented for pupils the authors propose the following actions, the results of which may be consistent with the goals of sustainable mobility:

- unifying FFTP privilege for pupils in the terms of age and extending it to the entire metropolitan area;
- promotion among pupils the idea of sustainable mobility;
- showing the pupils, the negative aspects of using a car as an urban transport means, especially in everyday travelling to work and school.

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