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Marek BUGDOL¹, Józef OBER², Charli SITINJAK³

MODEL OF ATTITUDES TOWARDS FREE PUBLIC TRANSPORT

Summary. The aim of the study was to find passengers' opinions on the changes that took place after the introduction of free public transport, both in terms of daily transport choices and the assessment of service quality, transport accessibility, and changes in the urban environment. A diagnostic survey method was used employing a proprietary questionnaire. A total of 1,109 adults participated in the study. Passenger opinions formed the basis for developing a novel and original model of attitudes towards free public transport using PROFIT analysis. The developed model clearly shows that preferences regarding the form of public transport financing are closely related to how residents perceive the objectives and effects of its implementation. The most comprehensive and positively motivated are supporters of completely free transport for residents, who recognize the broad social benefits and environmental, economic, and functional effects. Respondents in favor of payment or limited availability are more critical, emphasizing political motives and negative consequences such as system overload. Practical recommendations for transport policy in Poland add to the originality of the research.

¹ Quality Management Department, Faculty of Management and Social Communication, Jagiellonian University, Łojasiewicza 4 Street, 30-348 Cracow, Poland. Email: marek.bugdol@uj.edu.pl. ORCID: <https://orcid.org/0000-0001-9993-7765>

² Department of Applied Social Sciences, Faculty of Organization and Management, The Silesian University of Technology, Roosevelt 26-28 Street, 41-800 Zabrze, Poland. Email (corresponding author): jozef.ober@polsl.pl. ORCID: <https://orcid.org/0000-0001-6290-381X>

³ Faculty Psychology, Universitas Esa Unggul, West Jakarta City, Special Capital Region of Jakarta 11510, Indonesia. Email: charli.sitinjak@esaunggul.ac.id. ORCID: <https://orcid.org/0000-0002-2247-6777>

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1. INTRODUCTION

Free bus transport is not a new solution [1]. It operates in Brazil, Poland, France, the United States, and Estonia [2-3]. However, most such solutions are found in Poland and France [4]. Several hundred cities implement free public transport programs. An analysis of the literature showed that research in this area is concerned with economic aspects [5-14], environmental [4, 11, 15-19] and social [9, 11, 20-25].

This article analyzes the case for the introduction of free transport in the city of Racibórz and its surroundings. The following research questions were formulated:

1. How do residents perceive the motives behind the introduction of free transport – do they consider them to be pro-environmental, social, economic, or political measures – and how do they influence support for different variants of this solution (e.g., universal or limited free transport)?
2. What are the effects, according to the respondents, of introducing free public transport?

The motives and effects/consequences of introducing free public transport have already been the subject of research. However, in this article, they serve as an introduction to the development of an innovative model of attitudes towards free public transport using PROFIT analysis and the presentation of practical recommendations for public transport in Poland.

The research objective was adopted because, although previous studies have examined the motivations and effects of free public transport, there is still a lack of research that integrates residents' perceptions of these factors with their preferences regarding different transportation financing. This gap justifies the need to develop a more comprehensive explanatory model of attitudes toward free public transport.

The remainder of the article is structured as follows: Section 2 discusses the motivations for implementing free public transport, Section 3 outlines its perceived effects, Section 4 presents the materials and methods, Section 5 reports the results, Section 6 provides the discussion and future research directions, Section 7 addresses the study limitations, and Section 8 concludes with practical recommendations.

2. MOTIVES FOR IMPLEMENTING FREE PUBLIC TRANSPORT

Many European municipalities recognize that the main motive behind the changes is to reduce car use and the pollution and noise associated with cars, thus improving quality of life and urban environment [4, 26-27]. The health benefits are associated with the emission of the exhaust gases and the environmental benefits. By reducing the concentration of fine particulate matter, free transport programs are expected to contribute to improving air quality and thus reducing mortality and healthcare costs [15, 18]. Free transport is being implemented for environmental reasons, to relieve car traffic after various epidemics and breakdowns [28].

In addition to environmental considerations, economic considerations are not less important. Free public transport is intended to stimulate economic activity [13]. By abolishing travel charges, cities are trying to encourage people, especially car drivers, to use public transport instead of cars. When authors refer to environmental effects, they usually provide data on passenger numbers [19]. Of course, to achieve an environmental effect, it is necessary to

encourage as many drivers as possible to leave their cars at home and switch to more economical and environmentally friendly means of public transport [29]. However, this is not an easy task.

Firstly, the increasing demand for bus services can also have a negative impact on traffic flow due to stopping and starting at bus stops [30].

Secondly, with the increase in private car use, the popularity of online car booking, and the popularity of city bikes, public enthusiasm for bus travel is low [31].

Third, there are grounds for believing that the implementation of a zero fare will not significantly reduce car traffic but will also cause a decline in bicycle and pedestrian traffic [11].

Social motivations are also important. The main motivation is to increase mobility and improve quality of life [20]. As N. Fearnley states, the aim of such programs is to create a more inclusive society and to provide disadvantaged groups with better mobility and prosperity [9]. The free transport system is designed to improve quality of life, especially for people with disabilities who are excluded from the inaccessible bus system [25].

3. EFFECTS

The main benefit is a reduction in CO₂ emissions [17]. Health benefits are associated with exhaust emissions and environmental benefits [15, 18]. The next benefit is a reduction in the number of people using cars [19]. The increase in passenger numbers can be huge – up to 13 times [9] – or negligible. For example, studies conducted in Tallinn showed that free transport represented only 1.2% increase in passenger demand [10]. Some cities have reported lower than expected increases in passenger numbers [32]. Regardless of how many passengers arrive, some researchers express an interesting view [33]. They argue that free public transport will always improve cost efficiency, measured by operating costs per passenger. The rationale is an increase in seat utilization rates [9]. Making public transport free during off-peak hours means that some cities are trying to promote free transport to increase the overall efficiency of their services [8, 20]. The intention is to increase the number of people commuting to certain areas of the city that offer certain services.

Other benefits include eliminating the costs associated with setting and collecting fares (eliminating fares can eliminate these costs and free up staff to focus on service quality and efficiency, which is important for retaining and attracting high-quality passengers) and the absence of inconveniences associated with having to search for change and remember confusing details of the public transport system [27].

4. MATERIALS AND METHODS

The purpose of the study was to find out passengers' opinions on the changes that have taken place since the implementation of this solution, both in terms of daily transport choices and the assessment of service quality, transport accessibility, and changes in the urban environment.

The survey research was conducted in accordance with the ethical principles of conducting research with human participants based on the guidelines of the Helsinki Declaration. Written informed consent was obtained from all participants involved in the study.

The study was conducted using a standardized questionnaire designed to gather residents' opinions on the introduction of free public transport. The questionnaires were collected

electronically between 16 January and 10 February 2025 using the Google Forms platform. Adults who used public transport in Racibórz and the surrounding area were eligible to participate, both those who were users before the abolition of fares and those who only started using them after the introduction of free travel.

A total of 1,109 adult users of free public transport participated in the survey. Cases with data gaps greater than 30% were removed from the analysis, while the remaining incomplete responses were supplemented using non-parametric hot-deck imputation, which involves assigning missing values based on the responses of individuals with similar characteristics.

To estimate the minimum sample size, the formula for sample size for qualitative characteristics (for a finite sample) was used [34]:

$$n = \frac{p(p-1)}{\frac{E^2}{t_\alpha^2} + \frac{p(p-1)}{N}} \quad (1)$$

where:

p – the proportion of the population with the characteristic of interest,

E – the maximum permissible error in estimating the proportion p ,

N – the size of the general population,

t_α – the number of standard deviations, to be read from the normal distribution table for a confidence level of $1 - \alpha$.

When calculating the minimum sample size, data from the website ‘Polska w liczbach’ (Eng. ‘Poland in numbers’) regarding the population of the Racibórz municipality, 49,360 people, was taken into account [35]. A 50% proportion was assumed, and a 95% probability was adopted that the result obtained in the study would not deviate from the actual value in the population by more than 5%. According to these estimates, the minimum sample size is 381 people, which means that in this study the minimum sample size was significantly exceeded.

The choice of statistical methods was justified by the structure of the empirical data collected, which included qualitative and quantitative variables derived from survey data based mainly on ordinal scales (Likert scales). For this reason, descriptive statistics were used to characterize the sample and the response distributions, the Shapiro–Wilk test to verify assumptions regarding the normality of the distribution, the nonparametric Kruskal–Wallis test with post hoc analysis for comparisons between multiple independent groups, Spearman’s rank correlation to assess relationships between ordinal variables, and Pearson’s χ^2 test to analyze associations between categorical variables. In turn, the PROFIT analysis was used as a multidimensional method, allowing the simultaneous capture of the structure of similarities between groups of respondents and the graphical interpretation of the relationships between preferences and the motives and effects of implementing free public transport. The first stage of the PROFIT analysis for the set of objects $A = \{A_1, \dots, A_n\}$ and dissimilarities δ_{ij} between A_i and A_j ($i, j = 1, \dots, n$) consisted in creating, using multidimensional scaling methods, a perception map of objects in r -dimensional space (r is usually equal to 2 or 3) in order to:

$$d_{ij} = \hat{d}_{ij} = f(\delta_{ij}) \quad (2)$$

where:

d_{ij} – the reconstructed distance between points i and j ;

δ_{ij} – the distance between points i and j for the input data (observed distances);

$\hat{d}_{ij}$ – regression function between i and j .

The values were determined so as to minimize the value of the STRESS (Standardized Residual Sum of Squares) fit function. This was due to the fact that the quality of the fit of the reconstructed data to the input data is measured using the above-mentioned STRESS function, whereby the lower its value, the better the fit of the reconstructed distance matrix to the observed distance matrix. The STRESS function took the form:

$$\phi = \sqrt{\frac{\sum \sum (d_{ij} - f(\delta_{ij}))^2}{\sum \sum d_{ij}^2}} \quad (3)$$

where:

d_{ij} – reconstructed distance between points i and j ;

δ_{ij} – distance between points i and j for input data (observed distances);

$f(\delta_{ij})$ – function on input data.

As a result of multidimensional scaling, in the case of a two-dimensional perception map, each object was described by two coordinates.

The second stage of the PROFIT analysis consisted of using information about the preferences of the analyzed objects from the point of view of the features adopted in the study. After creating a table of average ratings for individual objects and features, regression models (multiple regression models) were developed, in which the dependent variables were the ratings of objects in terms of individual features and the explanatory variables were the coordinates of objects on the perception map. Linear regression analysis made it possible to estimate how the studied objects are distributed in terms of the intensity of each of the characteristics describing them. The number of such estimates carried out in the second stage was equal to the number of characteristics of the studied objects.

For the multidimensional scaling matrix of point coordinates $X = [x_{ia}]$ in r -dimensional space, normalized so that $X^T X = D$ (D – diagonal matrix), and preference ratings $p_k = (p_{k1}, \dots, p_{kn})^T$ of objects with respect to the k -th feature, the standardized regression coefficients (beta) for individual dimensions:

$$tk = (X^T X)^{-1} X^T p_k \quad (4)$$

determined the coordinates of the vector of a given feature on the perceptual map.

PROFIT analysis functions allow for a non-linear relationship between the explained variable and the explanatory variables. In this case, the variable vector was the vector corresponding to the smallest non-zero eigenvalue of the matrix $X^T A_k X$, where:

$$A_k = \begin{cases} -w_{kij} & \text{dla } i \neq j \\ \sum_{j \neq i} w_{kij} & \text{dla } i = j \end{cases}, \quad w_{kij} = \frac{1}{(p_{ki} - p_{kj})^2} \quad (a = \text{const.}) - \text{a monotonically decreasing function of the absolute differences between the preference ratings of objects } A_i \text{ and } A_j.$$

The projection of points representing individual objects onto feature vectors:

$$Hk = Xtk = X(X^T X)^{-1} X^T p_k \quad (5)$$

allowed the position of objects to be determined based on the intensity of these features in the given objects and thus to establish a preference order.

Statistical analysis of the collected data was performed using the Statistica v.13.3 PL statistical package from Tibco Software Inc. A 5% risk of inference error was assumed, and $p < 0.05$ was considered statistically significant.

5. RESULTS

5.1. Motives for the introduction of free public transport

The most frequently cited motive was to increase the attractiveness of the city – 43.02% of respondents strongly agreed with this justification, and another 22.21% chose the answer "I rather agree". Similarly strong support was given to responses concerning the promotion of innovation (38.58% "strongly agree") and the improvement of public transport flow (39.34%). A high percentage of positive responses also concerned environmental motives – 35.53% of respondents strongly agreed with concern for the environment, and another 24.37% chose the answer "somewhat agree".

Social motives, such as concern for the health of residents (33.12% "strongly agree") and reducing social inequalities (31.09%), received less, but still noticeable, support. In the case of financial arguments, such as concern for residents' household budgets, 32.87% of respondents expressed a positive opinion ("strongly agree").

The political motive was the most controversial. Although 32.74% of respondents strongly agreed with the statement that the decision was political in nature, nearly one in four expressed the opposite view – 23.73% strongly disagreed. A significant percentage of "difficult to say" responses (19.04%) may indicate an ambiguous perception of the intentions of decision-makers. A detailed breakdown of the data is provided in Tab. 1.

Tab. 1

Reasons for introducing free public transport in the opinion of respondents

	Strongly agree		Somewhat agree		Difficult to say		Somewhat disagree		Strongly disagree	
	n	%	n	%	n	%	n	%	n	%
Political (decision influenced by political/electoral considerations)	258	32.74	100	12.69	150	19.04	93	11.80	187	23.73
Care for the environment (e.g., reduction of harmful emissions)	280	35.53	192	24.37	108	13.71	95	12.06	113	14.34
Concern for residents' financial resources	259	32.87	131	16.62	126	15.99%	137	17.39	135	17.13
Concern for residents' health	261	33.12	130	16.50	137	17.39	137	17.39	123	15.61
Reduced Noise in the city	245	31.09%	131	16.62	156	19.80	119	15.10	137	17.39
Reducing social inequalities	245	31.09	115	14.59	155	19.67	138	17.51	135	17.13

Reduction of costs related to road infrastructure maintenance	149	18.91%	108	13.71	270	34.26	128	16.24	133	16.88
Increasing the attractiveness of the city	339	43.02	175	22.21	82	10.41	80	10.15	112	14.21
Promoting innovation	304	38.58%	171	21.70%	121	15.36%	83	10.53%	109	13.83
Improvement of public transport flow	310	39.34	147	18.65	113	14.34	85	10.79%	133	16.88

5.2. Effects of introducing free public transport

Among the positive effects, the highest level of agreement was recorded in the statement that free transport contributed to improving the quality of the services provided; up to 58.76% of respondents strongly agreed with this opinion, and another 16.62% somewhat agreed. A similarly high level of agreement was recorded regarding the increase in the number of passengers (53.05% of respondents “strongly agreed”) and savings for residents (54.06%). Equally often, increasing the attractiveness of the city (51.52%) and greater use of public transport for everyday purposes – both for work (45.43%) and shopping (42.89%) – were indicated as positive effects.

A significant percentage of the respondents also pointed to positive changes in accessibility to transport services – 43.53% strongly agreed with the statement that transport had become more accessible. In addition, 37.18% of respondents believed that the introduction of free transport contributed to a reduction in exhaust emissions, and 36.93% agreed that it helped to reduce social inequalities.

Regarding some of the effects, the opinions of the respondents were more scattered. This applies, among other things, to the reduction in traffic from other vehicles – only 21.83% of respondents strongly agreed with this, while as many as 29.95% answered “difficult to say”. There was also a high degree of uncertainty regarding the assessment of urban noise reduction (23.60% answered “difficult to say”) and significant costs for the city budget (31.85%).

In the case of effects such as overloading of the transport system, irresponsible use of transport, or a decline in the popularity of alternative forms of transport, most responses denied these phenomena or expressed uncertainty.

The highest level of disagreement was expressed on the potentially negative effect of a decline in the popularity of alternative forms of transport – 44.29% of respondents disagreed with this statement, and only 17.89% expressed any level of agreement. However, there was a high level of uncertainty on this issue – as many as 37.82% of respondents answered, “difficult to say”. Similarly, irresponsible use of transport was rather rejected because of free public transport – 35.28% of respondents strongly disagreed with this, and 28.43% had no opinion. A detailed breakdown of the data is provided in Tab. 2.

5.3. Model of attitudes towards free public transport

According to the assumptions and objectives of the study, the PROFIT model was developed to identify the characteristics most important for the general attitude of the respondents towards free transport, and thus to determine which factors (perceived motives for implementing free transport, assessments of its positive and negative effects) have the greatest impact on the general attitude towards free public transport.

Tab. 2

Respondents' assessment of the effects of free public transport

	Strongly agree		Somewhat agree		Difficult to say		Somewhat disagree		Strongly disagree	
	n	%	n	%	n	%	n	%	n	%
Improvement in the quality of services provided (e.g. drivers do not waste time selling tickets)	463	58.76	131	16.62	51	6.47	46	5.84	97	12.31
Reduced traffic from other vehicles (e.g. cars, motorcycles)	172	21.83	140	17.77	236	29.95%	119	15.10	121	15.36
More people use public transport to get to work	358	45.43	168	21.32	122	15.48	59	7.49	81	10.28
More people use public transport to go shopping	338	42.89	196	24.87	102	12.94%	61	7.74	91	11.55%
Reduction in exhaust emissions	293	37.18%	176	22.34%	160	20.30	59	7.49	100	12.69
Reduction of urban noise	261	33.12%	146	18.53	186	23.60	95	12.06	100	12.69
Greater accessibility to transport	343	43.53	153	19.42	114	14.47	65	8.25%	113	14.34
Reducing social inequalities	291	36.93%	127	16.12	178	22.59	93	11.80	99	12.56
Savings for residents	426	54.06%	148	18.78	74	9.39	48	6.09	92	11.68
Increasing the attractiveness of the city	406	51.52	156	19.80	90	11.42	52	6.60	84	10.66
Increase in passenger numbers	418	53.05	167	21.19	79	10.03	50	6.35	74	9.39
Significant costs for the city budget	154	19.54	145	18.40	251	31.85%	113	14.34	125	15.86
Overload of the transport system	81	10.28	83	10.53	261	33.12%	168	21.32%	195	24.75
Irresponsible use of transport	81	10.28	56	7.11	224	28.43	149	18.91	278	35.28
Decline in popularity of alternative forms of transport	77	9.77	64	8.12%	298	37.82%	140	17.77	209	26.52

The analysis distinguished four groups of respondents (objects), depending on their preferred form of free transport: free transport for all city residents (K1), for all interested parties (K2), for selected groups (K3) and paid transport (K4). The variables (features) in the model under study were the perceived motives for implementing free transport, such as: political (M1), concern for the environment (M2), concern for residents' financial resources (M3), concern for residents' health (M4), reduction of noise in the city (M5), reduction of social inequalities (M6), reduction of road infrastructure maintenance costs (M7), increasing the attractiveness of the city (M8), promoting innovation (M9) and improving the fluidity of public transport (M10) – as well as the positive and negative effects of this transport, such as: improving the quality of services provided (P1), reducing traffic from other vehicles (P2), more people travelling to work by public transport (P3), more people using public transport to go shopping (P4), reduction of

exhaust emissions (P5), reduction of urban noise (P6), significant costs for the city budget (N1), overloading of the transport system (N2), irresponsible use of transport (N3) and a decline in the popularity of alternative forms of transport (N4).

The model was developed based on the average degree of perception of individual motives by respondents and the evaluation of the effects mentioned above, expressed on a scale of 1–5. Detailed results of these data in groups distinguished by their preferred form of free transport are presented in Tab. 3.

Tab. 3

Average ratings of individual motives and positive and negative effects of implementing free transport in groups distinguished by support for the form of free public transport

	Free for all city residents (K1)	Free for all interested parties (K2)	Free for selected groups (K3)	Communica- tion should be paid for (K4)
Political (M1)	3.17	3.36	3.08	3.66
Concern for the environment (M2)	3.50	2.94	3.94	2.61
Care for residents' financial resources (M3)	3.25	2.78	3.70	2.34
Care for residents' health (M4)	3.35	2.74	3.70	2.29
Reduction of noise in the city (M5)	3.32	2.59	3.63	2.30
Reducing social inequalities (M6)	3.21	2.59	3.66	2.32
Reducing road infrastructure maintenance costs (M7)	2.98	2.53	3.34	2.21
Increasing the attractiveness of the city (M8)	3.63	3.21	4.09	2.68
Promoting innovation (M9)	3.53	3.00	4.03	2.70
Improving the flow of public transport (M10)	3.44	2.94	3.97	2.52
Improving the quality of services provided (P1)	4.09	3.30	4.39	2.91
Reduced traffic from other vehicles (P2)	3.17	2.51	3.52	2.04
More people travel to work by public transport (P3)	3.91	3.19	4.18	2.55
More people using public transport to go shopping (P4)	3.89	3.09	4.13	2.54
Reduction in exhaust emissions (P5)	3.73	2.99	3.97	2.27
Urban noise reduction (P6)	3.57	2.71	3.83	2.13
Significant costs for the city budget (N1)	3.13	3.42	2.95	3.43
Overload of the transport system (N2)	2.62	2.94	2.47	2.71
Irresponsible use of transport (N3)	2.42	2.90	2.14	2.68
Decline in popularity of alternative forms of transport (N4)	2.60	2.48	2.56	2.61

During the construction of this model, multidimensional scaling was performed to develop a graphical presentation of the similarity (or dissimilarity) structure between the analyzed objects in relation to a selected set of variables (features). The uniform nature of the analyzed features (5-point Likert scale) as variables eliminated the need for their standardization. The classic Euclidean distance was used for multidimensional scaling, and as a result, the 10 features that describe the four objects were reduced to two dimensions. The STRESS coefficient for multidimensional scaling considering all features was 0.00, which indicates the high reliability of the results of the multidimensional scaling procedure.

In the next step, the fits of individual objects were verified – a regression analysis was performed, in which the explained variable was the degree of perception of individual motives for implementing free transport, while the explanatory variables were the values of two dimensions for each unit, obtained because of multidimensional scaling: Dim. 1 and Dim. 2. The criterion for considering a given tool as a key was a fit of $R^2 \geq 0.70$. High values of the determination coefficients (from 0.87 to 1.00) indicate that the adopted set of characteristics well reflects the structure of the attitudes of the respondents. The exception was the effect in the form of a decrease in the popularity of alternative forms of transport (N4) ($R^2 = 0.42$), which was eliminated from the model in development. A detailed breakdown of the data is provided in Tab. 4.

Tab. 4

Results of regression analysis between individual motives and positive and negative effects of implementing free transport, and the dimensions of the surveyed units obtained as a result of regression analysis (applies to groups distinguished on the basis of their support for free public transport)

	Free expression		Dim. 1		Dim. 2		R ²
	b0	p	b	p	b	p	
Political (M1)	3.317	p < 0.05	0.228	p = 0.198	0.142	p = 0.514	0.91
Concern for the environment (M2)	3.248	p < 0.05	– 0.549	p = 0.179	0.010	p = 0.98	0.92
Care for residents' financial resources (M3)	3.017	p < 0.05	– 0.535	p = 0.216	– 0.053	p = 0.912	0.89
Care for residents' health (M4)	3.019	p < 0.05	– 0.584	p = 0.164	– 0.109	p = 0.786	0.94
Reduction of noise in the city (M5)	2.962	p < 0.05	– 0.589	p = 0.11	– 0.014	p = 0.956	0.97
Reducing social inequalities (M6)	2.944	p < 0.05	– 0.562	p = 0.162	0.057	p = 0.878	0.94
Reducing road infrastructure maintenance costs (M7)	2.767	p < 0.05	– 0.456	p = 0.191	– 0.020	p = 0.956	0.91
Increasing the attractiveness of the city (M8)	3.403	p < 0.05	– 0.541	p = 0.235	– 0.111	p = 0.837	0.87
Promoting innovation (M9)	3.314	p < 0.05	– 0.542	p = 0.197	0.060	p = 0.893	0.91
Improving the flow of public transport (M10)	3.219	p < 0.05	– 0.572	p = 0.22	– 0.006	p = 0.991	0.89
Improving the quality of services provided (P1)	3.673	p < 0.05	– 0.650	p = 0.108	– 0.087	p = 0.766	0.97

Reduced traffic from other vehicles (P2)	2.811	$p < 0.05$	– 0.622	$p =$ 0.154	– 0.118	$p =$ 0.768	0.94
More people travel to work by public transport (P3)	3.459	$p < 0.05$	– 0.682	$p =$ 0.143	– 0.254	$p =$ 0.568	0.95
More people using public transport to go shopping (P4)	3.411	$p < 0.05$	– 0.688	$p =$ 0.118	– 0.216	$p =$ 0.562	0.97
Reduction in exhaust emissions (P5)	3.239	$p < 0.05$	– 0.709	$p =$ 0.143	– 0.324	$p =$ 0.504	0.95
Urban noise reduction (P6)	3.058	$p < 0.05$	– 0.738	$p =$ 0.115	– 0.224	$p =$ 0.563	0.97
Significant costs for the city budget (N1)	3.233	$p < 0.01$	0.217	$p =$ 0.103	– 0.085	$p =$ 0.445	0.97
Overload of the transport system (N2)	2.686	$p < 0.01$	0.154	$p < 0.07$	– 0.230	$p <$ 0.096	0.99
Irresponsible use of transport (N3)	2.534	$p < 0.01$	0.281	$p < 0.05$	– 0.282	$p < 0.05$	1.00
Decline in popularity of alternative forms of transport (N4)	2.559	$p < 0.01$	– 0.014	$p =$ 0.807	0.070	$p =$ 0.571	0.42

The multidimensional scaling presented in the PROFIT below (Fig. 1) indicates that people in favor of free transport for all city residents (K1) are located close to the group of vectors corresponding to motives such as concern for residents' health (M4), concern for the environment (M2), reducing social inequalities (M6), reducing infrastructure costs (M7), reducing noise (M5), promoting innovation (M9), improving the fluidity of public transport (M10), increasing the attractiveness of the city (M8), and concern for residents' financial resources (M3). This group is also close to the vectors representing the positive effects of implementing free public transport, such as improving service quality (P1), increasing passenger numbers (P2), savings for residents (P3), greater transport accessibility (P4), more people traveling to work (P5) and more people using transport for shopping (P6). The proximity of these vectors indicates that respondents in this group perceive free transport as a comprehensively beneficial measure – pro-social, pro-environmental, and pro-development. Their attitude is more positively aligned with the full spectrum of implementation objectives.

Supporters of free access for selected groups (K3) are also relatively close to the aforementioned motivations and positive effects, suggesting compatibility with many social and environmental aspects. Compared to group (K1), however, their approach may be characterized by greater caution or conditionality – they recognize the benefits but prefer a more selective model of accessibility.

Respondents who are in favor of maintaining fees (K4) are clearly distant from social and environmental motivations. Their position is close to the "M1 – Political" vector, which means that the main motive they perceive is the political interest behind the implementation. This group's proximity to vectors corresponding to negative effects – such as overloading of the transport system (N1), irresponsible use of transport (N2) and a decline in the popularity of alternative means of transport (N3) – demonstrates their critical attitude towards the effects of introducing free transport.

The group that supports free transport for all interested parties (K2) is closer to the political motivation (M1) and indications of negative effects (N1–N3). This may suggest that people in this group see both the benefits and the possible risks associated with full accessibility – they approach the subject more cautiously and realistically, considering various aspects of the system's functioning.

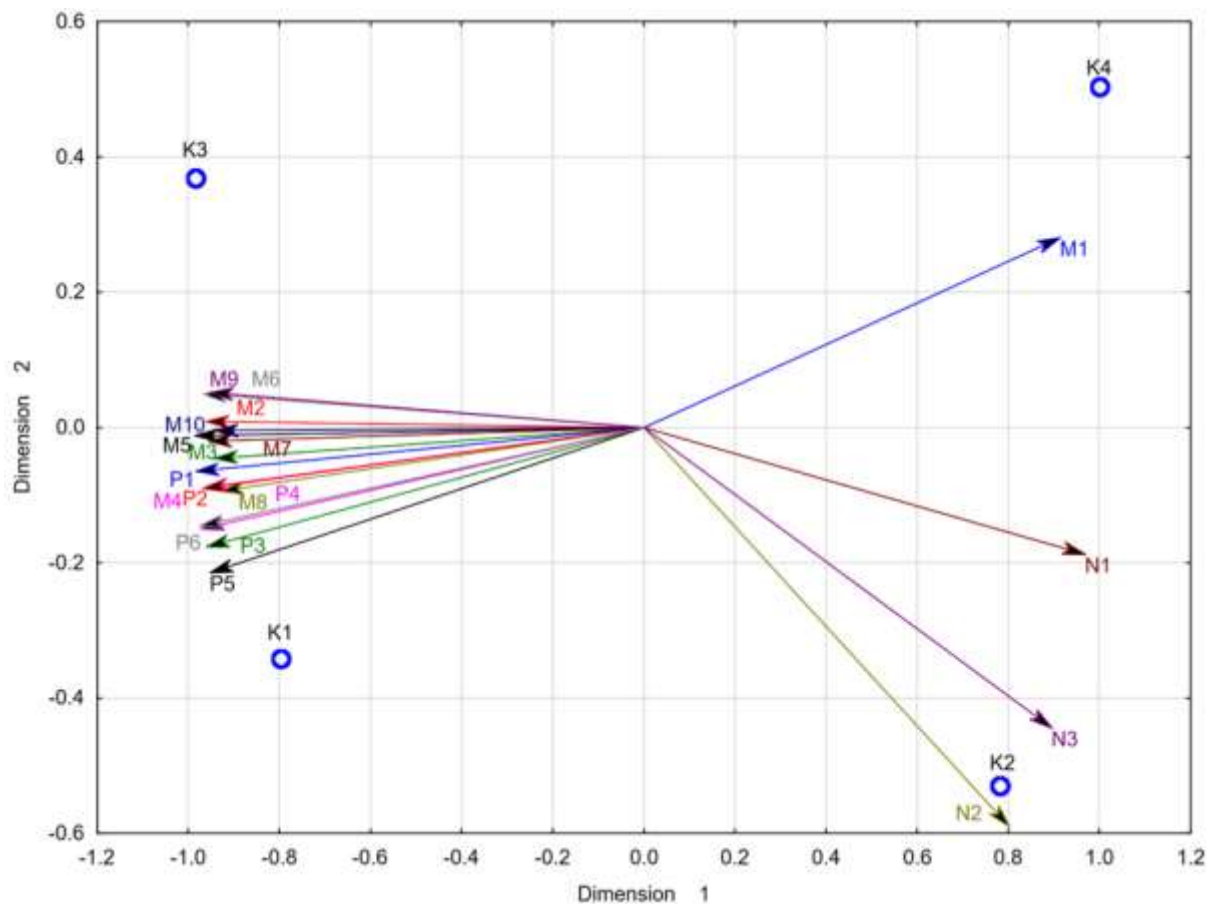


Fig. 1. Biplot considering the results of multidimensional scaling for individual objects (groups distinguished based on their support for free public transport) based on the assessment of individual motives and the positive and negative effects of implementing free transport

Explanation of abbreviations: K1 – Free for all city residents, K2 – Free for all interested parties, K3 – Free for selected groups, K4 – Transport should be paid for, M1 – Political, M2 – Concern for the environment, M3 – Concern for residents' financial resources, M4 – Concern for residents' health, M5 – Reduction of noise in the city, M6 – Reduction of social inequalities, M7 – Reduction of road infrastructure maintenance costs, M8 – Increasing the attractiveness of the city, M9 – Promoting innovation, M10 – Improving the flow of public transport, P1 – Improving the quality of services provided, P2 – Reduced traffic of other vehicles, P3 – More people travelling to work by public transport, P4 – More people using public transport to go shopping, P5 – Reduction of exhaust emissions, P6 – Reduction of urban noise, N1 – Significant costs for the city budget, N2 – Overloading of the transport system, N3 – Irresponsible use of transport

6. DISCUSSION AND NEW DIRECTIONS FOR RESEARCH

The most frequently mentioned motive was to increase the attractiveness of the city. The responses to the promotion of innovation and the improvement of public transport flow received strong support. A high percentage of positive responses also involved environmental motives.

Environmental motivations have already been the subject of research by other authors [15, 26], but several facts should not be overlooked. Firstly, car-restricted or car-free zones can be introduced out of concern for the environment [36-37].

Second, when there is awareness of existing risks, analyses are carried out to improve the quality of bus services [26]. Some cities even attempt to estimate health effects [15].

Fourth, the example of some cities has shown that despite efforts to achieve environmentally sustainable mobility, it remains an unattainable dream [16]. Further research should include the number of passengers who have abandoned private cars, as well as those who have switched to public transport but abandoned bicycle travel. Such detailed data are available in other publications [19, 20].

In the case of the city studied, no economic, environmental, or health analyses were carried out, and free transport was introduced just before the local elections, which proves why the political motive aroused the most controversy. Political motivation is rarely recognized [14, 36, 38] and therefore requires further research, especially on political bribery of the electorate.

The problem is the lack of data on the entire life cycle of the product and the service provided. For example, buses are very often assembled by domestic manufacturers, while many components come from Germany, China, and other countries. This line of research is also supported by the opinions of the respondents themselves, who did not form clear opinions on the reduction of vehicle traffic and noise in the city.

Both our research and the results of the systematic review of the literature indicate the need for further research on health outcomes [39].

Regarding the effects of introducing free transport, it should be noted that the highest level of agreement was recorded in the statement that free transport contributed to improving the quality of services provided. A similarly high level of agreement was recorded regarding the increase in the number of passengers and savings for residents. In this case, however, quality is understood in a normative sense as the level of satisfaction of passengers' needs and expectations. Previous studies show that the improvement in the quality of services provided depends on infrastructure factors (stops, barriers, bus mobility, the possibility of using other means of transport) [40-44] and behavioral factors (driver behavior, interactions, passenger behavior) [45-47], but it should also be remembered that this form of transport can lead to acts of vandalism [27]. Interviews with drivers confirmed that this is also the case in the city in question. Therefore, the issue of service quality in the context of changes in passenger behavior should also be the subject of further research.

A significant percentage of the respondents also indicated positive changes in the accessibility of transportation services. Perhaps one of the most important effects is that some people use this form of transport more often. Research by other authors indicates that the introduction of free transport can increase the number of passengers from low-income households and young and old people [23]. Therefore, it is important to take into account the profitability of different passenger groups in further research. Therefore, the proposal to first identify the population group that should be supported [11] is very relevant. It should also be noted that this type of research should take into account the city's income. In some cities, the income resulting from an increase in the number of residents is significantly higher than the lost income from travel fees [12]. However, a large number of factors influence this situation, including the city's economic system, the importance of public transport, ongoing economic development, etc.

Another noted problem is the need to create a benchmarking database for all organizers and operators of free public transport, to begin the process of developing environmental, health, and economic indicators regarding the various effects of public transport. Previous research shows

that formal and informal knowledge exchange networks can be very helpful in adopting the same solutions in other cities that, due to various crises, need to quickly introduce free forms of transport [48].

Our multidimensional scale presented in the PROFIT chart above (Fig. 1) proves that the assessment of economic, environmental, and social motives and effects cannot fail to take into account the moral and ethical values of the passengers. These values are of great importance for pro-environmental behavior [49]. This important area that determines passenger behavior requires further research.

The results of our research also confirm previous findings that show that increasing the share of public transport travel is a long-term activity that requires continuous improvement of the offer [50].

7. LIMITATIONS

Both a systematic review of the literature and survey research are not the best ways to examine the motives and benefits of any issue. Diagnostic research allows us to learn – which is a feature of this type of research – only the opinions of respondents and their declarations, and not their actual behavior [51]. In the future, the authors plan to expand their research using cost-benefit analysis (CBA). CBA allows for the identification and assessment of net benefits associated with alternative solutions dedicated to achieving specific goals [52]. This method enables comparative analyses to be performed (e.g., of the economic and social costs of using bicycle and bus transport) [53].

8. CONCLUSIONS AND PRACTICAL RECOMMENDATIONS

8.1. Conclusions

These results suggest that residents most often attributed the decision to introduce free transport to image-related, pro-environmental and city improvement goals. At the same time, some respondents also saw the potential political calculations behind the decision.

The results of the study indicate that the respondents clearly recognized the positive effects of introducing free public transport, such as improved service quality, increased passenger numbers, savings for residents, and increased attractiveness of the city. At the same time, more controversial or difficult to assess aspects, such as the impact on car traffic or the consequences for the city's budget, clearly provoked greater hesitation and diversity of opinion. Potential negative effects, such as system overload or a decline in interest in other forms of transport, were rejected by most of the respondents or remain unassessed. The PROFIT model clearly shows that preferences for the form of public transport financing are closely related to how residents perceive the objectives and effects of its implementation. The most comprehensive and positively motivated are supporters of full free travel for residents (K1), who recognize both the broad social benefits and the environmental, economic, and functional effects. Respondents in favor of payment (K4) or limited availability (K2) are more critical, highlighting political motives and negative consequences such as system overload. Supporters of selective free travel (K3) take an intermediate position, remaining cautious while recognizing some of the positive aspects of free transport.

8.2. Practical recommendations

Based on the study, several practical recommendations can be formulated in the context of transport policy:

- Maintaining and developing free transport: The positive reception of free public transport and its impact on changing transport behavior (reducing car use, increasing the number of passengers) confirm the validity of continuing to maintain it, especially among new users.
- Benefit-orientated public communication: To strengthen support, it is worth emphasizing the social and environmental benefits and the quality of services in communications, as these have a greater impact on residents' attitudes than political or fiscal factors.
- Adapting solutions to different social groups: Due to differences in assessments between age and occupational groups, transport policy should be flexible and take their needs into account (e.g., better planning of services for younger passengers or the self-employed).
- Monitoring system congestion: Although not widely recognized, some respondents identify congestion as a problem – it is worth investing in infrastructure and considering temporary solutions to support behavioral change (e.g., tickets encouraging drivers to give up their cars).

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