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SMART SOLUTIONS IN TRAFFIC MANAGEMENT – OPINIONS OF DRIVERS, CYCLISTS, AND PEDESTRIANS

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Purpose: The aim of the article is to present the results of a study on the perception and evaluation of intelligent communication and transportation systems, as well as their management, by residents of cities in the Silesian Voivodeship who travel by car, bicycle (scooter), or on foot, as factors contributing to safe and fast movement within the city.
Design/methodology/approach: The study was conducted using a proprietary survey based on the Consumer Satisfaction Index (CSI) methodology, and the analysis of the survey results was preceded by a brief literature review on the subject.
Findings: The study made it possible to determine how road users evaluate the functioning of the intelligent communication and transportation system in their cities, which factors are the most and least satisfactory for them, as well as the importance they assign to these solutions.
Research limitations/implications: The study had a limited scope as it was a one-time survey. It is advisable to continue and expand the sample size for future studies to allow for comparative analyses.
Practical implications: The article may provide managers of intelligent communication and transportation systems in cities with knowledge about the expected outcomes of their operation for road users.
Social implications: Utilizing the research results may enable better adaptation of ITS to the needs of road users and enhance road safety.
Originality/value: The study included drivers, cyclists (scooter riders), and pedestrians. In contrast, most similar studies are limited to verifying the opinions of drivers.
Keywords: smart city, smart mobility, management intelligent transports system, cyclists, drivers, pedestrians.
Category of the paper: research paper.

1. Introduction

Urban traffic and communication management are increasingly based on intelligent information systems. These systems enable traffic regulation by incorporating real-time data on traffic flow and potential disruptions. Such traffic management systems, known as Intelligent

Transportation Systems (ITS), encompass interconnected networks of public roads, traffic sensors, cameras, controllers, road information systems, and other information and communication tools typical of smart cities (Sami, Sara, 2023). The data collected and processed by artificial intelligence, using machine learning and advanced algorithms, allows for the implementation of smart solutions related to traffic light control, pedestrian crossings, and the activation or deactivation of additional traffic lanes. This, in turn, enables more efficient management of road infrastructure and the prediction of problems and risks associated with road traffic, which is a characteristic feature of smart roads (Lewicki, 2012; Garg, Kaur, 2023).

The tools used by cities in integrated, smart traffic management systems enable parking management, real-time generation of optimal routes for vehicles, development of eco-friendly forms of individual and public transport, promotion of alternative means of transportation (bikes, scooters, etc.), and the creation of interactive solutions for public transport users (Narayanaswami, 2022). The use of these solutions improves mobility comfort in the city, reduces environmental risks, increases the safety of public space users, and indirectly helps lower stress levels for urban traffic participants. It is also important to note that these systems are intended for all traffic participants, both motorized and non-motorized.

Many experts working on smart traffic management systems in cities focus on their design and functionality to ensure smooth vehicle traffic and eliminate bottlenecks through optimal use of intelligent transport (Sami, Sara, 2023), while paying considerably less attention to other road users. Increasingly, both international and domestic publications feature analyses on managing transportation systems as a key factor in smart city mobility. These systems provide a safe and friendly environment for residents, offering more convenient, safer, healthier, and longer lives, while also contributing to the creation of cities that are attractive to businesses and investors (Tomaszewska, 2022; Garg, Kaur, 2023). The importance and popularity of this topic among researchers are confirmed by the number of articles dedicated to it. In 2020, the Scopus database contained over 22,000 articles mentioning the term “intelligent transportation system” (Zulkarnain, Putri, 2021), and by the second half of 2024, that number had risen to over 22,700.

However, few studies focus on solutions and actions aimed at other urban traffic participants besides motor vehicle users: cyclists, pedestrians, scooter users, and others using personal mobility devices. This prompted the author to conduct a study to answer the question of how residents of cities in the Silesian Voivodeship, who travel by car, bike, scooter, or on foot, perceive the implemented and operational smart traffic management systems and their impact on the ability to move safely and quickly around the city. The study was conducted using a custom survey based on the CSI methodology. The results, preceded by a brief literature review, will be presented in the following sections of the article.

2. Literature Review

As mentioned in the introduction, the introduction of modern telematics solutions in urban traffic management contributes to the creation of a resident-, investor-, and business-friendly environment. It is also a factor in the harmonious and sustainable development of these cities, as well as the improvement of their functionality, which leads to a higher quality of life for residents (Wach-Kloskowska, Rześny-Cieplińska, 2018; Gusikhin, 2021). The use of telematics in transportation increases its efficiency, speed, and safety (Stankiewicz, Michalski, 2018; Kręt, 2020), and thus enhances the effectiveness of managing Intelligent Transportation Systems (ITS).

By implementing ITS, cities are realizing the concept of Smart City, in which smart mobility is used to increase traffic flow, thereby improving the comfort of movement within the city. This leads to reduced stress associated with city travel and the promotion of eco-friendly transport options, minimizing environmental degradation (Tomaszewska, 2015; Boichuk, 2021). According to Tomaszewska (2020), a Smart City cannot exist without Smart Mobility, where city managers take into account both technology and a consumer (resident)-oriented approach (Boichuk, 2021). This means that those managing intelligent traffic systems in cities must consider the needs of all traffic participants and implement solutions to minimize the negative impact of the transport system on the environment (Wróbel, 2023). Particularly important factors include reducing emissions, limiting noise, shortening travel times, improving safety, and minimizing road infrastructure degradation (Wach-Kloskowska, Rześny-Cieplińska, 2018; Kamiński, 2021; Zhao, Jia, 2021; and others).

City managers must also be aware that planning and building ITS is a complex and costly process, but it is significantly cheaper and easier than expanding and modernizing the existing road network and related infrastructure (Wałek, 2016). Among the factors supporting the implementation of ITS in cities are legal regulations, including the Directive 2010/40/EU of the European Parliament and Council of 7 July 2010, concerning the deployment of Intelligent Transportation Systems in road transport and their interfaces with other transport modes, as well as the Polish Public Roads Act of 27 July 2012. According to the Directive, ITS should enable the integration of telecommunications, electronics, and information technology with transport engineering for the planning, design, operation, maintenance, and management of transportation systems. The quality of transport solutions must also meet the requirements of the ISO 37120 standard, which lists indicators that allow the assessment of a city's connectivity with different means of transport, transport accessibility, bicycle infrastructure, the use of private cars for commuting, public transport usage, and transport safety levels (Wróbel, 2023).

An analysis of the regulations in the cited documents suggests that they are primarily focused on participants in motorized transport. Cities' adherence to these guidelines ensures that motor vehicle users receive information about traffic jams and ways to avoid them, the speed needed for smooth travel, roadworks, and even available parking spaces (Napora, Muzhevych, 2023).

Depending on traffic intensity, intelligent light control systems adjust signal cycle times to smooth traffic flow and prevent congestion. Induction loops embedded in the asphalt (coordination bundles) detect vehicle movement and send traffic data to control centers. In these centers, applications process the data and automatically adjust traffic light cycle times (Stankiewicz, Michalski, 2018), enabling the implementation of synchronized traffic lights, known as the "green wave" (Lewicki, 2012). The system is complemented by road cameras that record traffic and transmit real-time data to control and management units.

However, despite continuous progress and the introduction of newer, more convenient, and safer solutions, the potential effectiveness of various ITS applications has not been conclusively confirmed (Appaji, Raviraj, 2024). At the same time, studies indicate that the use of alternative means of transport is considered by system managers as a supplementary element, with less significance than motorized traffic. This situation limits the potential for the development of shared mobility, which reduces the use of combustion vehicles and promotes alternative transport modes and walking, thus reducing noise and air pollution, increasing safety, and encouraging pro-health behaviors among residents (Wróbel, 2021). At the same time, the guidelines for the development of smart mobility call on urban transportation system managers to create conditions for the broadest possible use of alternative transport modes and ensure their safe use. These actions include expanding roads and bike paths, creating intersections with traffic lights for cyclists, scooter users, and others.

It seems evident that ITS should also provide information to users of alternative transport devices in the same way it currently does for motor vehicle drivers (Dźwigoł, 2015). How residents perceive the adaptation of urban intelligent communication and transport systems management to the needs of those moving by car, bicycle (including scooters), and on foot in the cities of the Silesian Voivodeship will be presented in the following sections of the article.

3. Materials and methods

Preparation for conducting the study to achieve the above goal required defining its subjects and object (Hall, 2013; Szarucki, 2018). The subjects were individuals living in large cities in the Silesian Voivodeship who travel primarily by car, bicycle, scooter, on foot, or by public transportation. The object of the study was their opinions regarding the evaluation of the solutions related to the management of intelligent transportation systems in their cities, aimed at improving the quality and safety of using public roads and communication routes in their cities.

In the next phase, hypotheses were formulated, which were verified during the analysis of the study results. It was assumed that:

1. Depending on the dominant mode of transportation, respondents would identify different elements of the intelligent transportation management system as the most satisfying for them.
2. Drivers would attach the greatest importance to the functioning of ITS, while cyclists/scooter users would attach the least.
3. For all groups of study participants, solutions that enhance the safety of road users would be of the greatest importance.

The study was conducted in October 2023 in large cities of the Silesian Voivodeship, using one of the survey techniques CSR (Sułkowski, Lenart-Gansiniec, 2012; Strużyna, 2013; Huang, 2020). This index is based on the principle of weighted assessment, and its result consists of the evaluation of individual elements and their assigned weights (Yussoff, Nayan, 2020; Woźniak, Zimon, 2016). The CSI was calculated using a weighted average – $\bar{x}_w$, and the CSI index was computed based on formulas (Woźniak, Zimon, 2016; Sobczyk, 2020):

$$CSI = \sum_{i=1}^{n} w_i o_i \quad (1)$$

where:

i, 1, ... n - elements of respondent's satisfaction,

w_i - the weight of the respondent's satisfaction element,

o_i - assessment of the respondent's satisfaction element.

$$CSI_{max} = \sum_{i=n}^{n} w_{io_{i\,max}} \quad (2)$$

$$CSI\% = \frac{CSI}{CSI_{max}} \times 100\% \quad (3)$$

According to Woźniak and Zimon's (2016) recommendations, the results were expressed as percentages to facilitate the analysis:

- 0-40% – very bad, respondent completely dissatisfied,
- 41-60% – bad, respondent dissatisfied,
- 61-75% – average, there are problems with the level of respondent's satisfaction,
- 76-90% – good, no problems were found with the respondent's satisfaction level,
- 91-100% – very good, highly satisfied respondent.

The research process included the following stages (Mróz, 2017): defining the research objective and hypotheses, preparing the survey questionnaire, conducting the survey, analyzing the obtained data, calculating CSI indicators and comparing them and developing a quality map.

The questionnaire consisted of a demographic section and a substantive section. The first section provided independent variables to describe respondents in terms of: gender, age, education level, and dominant mode of transportation in the city. The dependent variables were used to investigate respondents' opinions on their level of satisfaction with selected

ITS solutions and the significance of these solutions, as well as the relationships between them (Minta, Cempiel, 2017).

The first question was not related to the main study but served as a screening question; respondents were asked if they knew what an intelligent transportation system is and if it operates in their city. Respondents who answered affirmatively to both questions proceeded to the next part of the survey. Fifteen factors were identified to assess satisfaction with nine popular ITS solutions and six of their effects, as well as their significance. The selection of respondents was random, and the sample size was relatively small, which does not allow for the conclusion that the study was representative. Respondents rated individual issues using a five-point Likert scale (Sobczyk, 2020). For satisfaction, the scale ranged from 1 – very dissatisfied, through 2 – somewhat dissatisfied, 3 – neutral, 4 – somewhat satisfied, to 5 – very satisfied. The significance (importance) of individual elements was rated as follows: 1 – insignificant, 2 – somewhat insignificant, 3 – neutral, 4 – significant, 5 – very significant. Based on these scales, statistical analysis was conducted following the CSI procedure (Mróz, 2017), which determined the level of satisfaction and the importance of individual factors for the respondents. After performing statistical and descriptive analysis of the survey results, a quality map was developed, as illustrated in Figure 1.

satisfaction			
	high	quarter 1 ***Field of excessive care*** not very important, but giving great satisfaction	quarter 3 ***Field of sustaining engagement*** *very important* *and giving great satisfaction*
	low	quarter 2 ***Field of trivialities*** *not very important* *and giving little satisfaction*	quarter 4 ***Field of concentration*** *very important* *but giving little satisfaction*
		low	high
		importance	

Figure 1. Evaluation areas considering discrepancies between importance and engagement.

Source: compiled by the author based on: Woźniak, Zimon, 2016, p. 144.

The subsequent part of the article will discuss the study results and summarize the findings along with the verification of the hypotheses.

4. Results

The analysis of the survey began with the verification of the questionnaires and the elimination of incomplete or incorrectly filled ones. Subsequently, the data from the qualified questionnaires were entered into an MS Excel spreadsheet, which facilitated calculations and the preparation of the research report. The preparation and discussion of the study results are preceded by a description of the respondents (Table 1).

A total of 811 respondents participated in the study: 168 cyclists, 372 drivers, and 271 pedestrians. Among cyclists and pedestrians, women predominated – 122 female cyclists (76.2%) and 192 female pedestrians (70.9%), while men constituted 46 (27.4%) and 79 (29.1%) respectively. Among drivers, the trend was reversed, with more men – 197 (53%) and 175 women (47%).

Age varied significantly among respondents. There were no cyclists over the age of 65, while the largest age group among pedestrians was those over 65 – 108 (39.8%). In contrast, this was the smallest group among drivers – 18 respondents. Among drivers, 19 indicated that they were under 25 years old, while among pedestrians, 52 were in this age group, with the fewest cyclists in this age group – only 4. Most cyclists reported that their age was between 36 and 45 years – 73 people, while among drivers, those aged 46-55 were the majority – 146 participants. Among pedestrians, in addition to those over 65 and under 25, there were 23 respondents aged 26-35, 16 aged 36-45, 43 aged 46-55, and 29 who were 56-65 years old.

For the last demographic characteristic – education – most cyclists and drivers indicated that they had higher education, while among pedestrians, 63 respondents had this level of education, totaling 54.2% of all respondents – 440 individuals. Among pedestrians, those with secondary education predominated – 187 people (69%), with some still studying at the time of the survey.

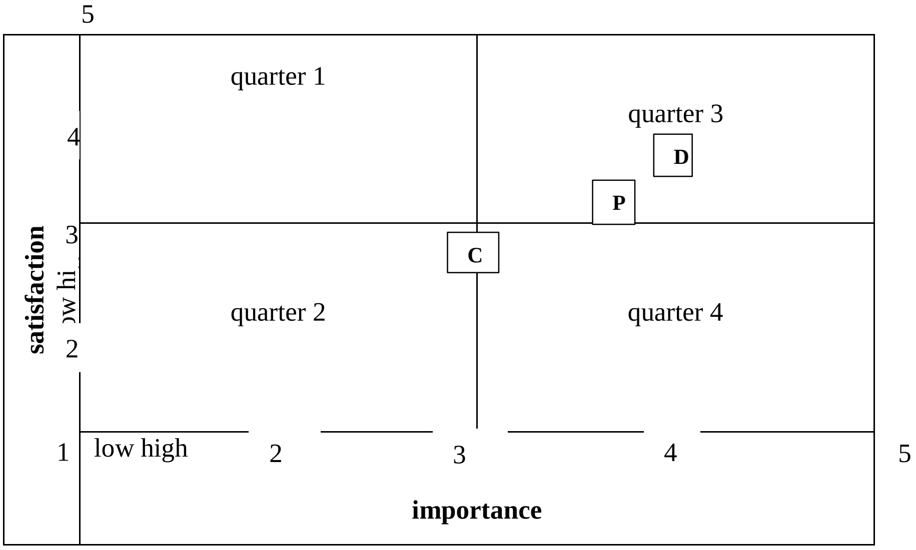
In the further analysis of the study results, the importance of ITS solutions functioning in their cities and the level of satisfaction with telematics solutions aimed at improving people’s mobility and enhancing the quality of communication and transportation processes were assessed (Tables 2 and 3). First, the level of satisfaction with the studied solutions was evaluated. The data for calculating the satisfaction levels of individual respondent groups with the assessed solutions and effects of managing the intelligent communication and transportation system are presented in Table 2.

Drivers considered the reduction in the number of accidents ($\overline{x}_w$ = 3.86) as the most satisfying outcome of the intelligent communication and transportation system management, while the least satisfying element for them was intelligent traffic lights ($\overline{x}_w$ = 1.92). Cyclists/scooter users surprisingly rated the interactive parking system ($\overline{x}_w$ = 4.4) as the most satisfying, and the green wave for drivers ($\overline{x}_w$ = 2.6) as the least satisfying. Pedestrians, on the other hand, rated the road event monitoring system ($\overline{x}_w$ = 4) as the most satisfying solution, and the reduction of traffic congestion in the city streets ($\overline{x}_w$ = 2.88) as the least satisfying.

After verifying the information regarding the ranking of individual factors surveyed in the questionnaire, it was found that for drivers, the most significant factor was the "green wave" ($\overline{x}_w$ = 4.33), while the least significant was road event monitoring ($\overline{x}_w$ = 3.13). Cyclists considered the reduction in the number of accidents ($\overline{x}_w$ = 3.98) as the most important, whereas weather information availability was the least significant to them ($\overline{x}_w$ = 2.4). For pedestrians, as with cyclists, the reduction in the number of accidents ($\overline{x}_w$ = 4.27) was of key importance, which certainly enhances their sense of safety. The "green wave" ($\overline{x}_w$ = 3.04) was the least significant factor for them, which seems logical since this solution primarily benefits drivers.

Comparing the values reflecting the evaluation of individual issues shown in the tables may help explain the low satisfaction rating from drivers regarding the "green wave" solution. The high ranking of this solution, combined with a relatively low satisfaction rating, indicates that it is desirable but likely does not meet drivers' expectations. The low ratings from cyclists and pedestrians for this solution also seem quite understandable. It should also be emphasized that both cyclists and pedestrians place great importance on increasing road safety and reducing the number of dangerous traffic incidents. Their concern for improving safety is fully justified, as their health and lives are particularly at risk.

The next step in the research procedure is to calculate the CSI and its percentage value (Table 4). The overall CSI value for drivers was 3.19 (63.8%), for cyclists it was 3.115 (62.3%), and for pedestrians, it was 3.657 (73.14%). Comparing these values with the data presented in Table 1, it was found that the overall level of satisfaction with the functioning of the intelligent transportation system in the studied cities falls within the average range for all three respondent groups. The final step in the CSI procedure was to plot the average satisfaction ratings resulting from the use of ITS and the importance of selected functional solutions and their effects on the quality map (Fig. 2).



Legend:
c – cyclists (2,89; 3,09),
d – drivers (3,95; 4,13),
p – pedestrians (3,37; 3,63),

Figure 2. The ITS quality map was created based on the opinions of cyclists and drivers.

Source: Own study based on the survey.

Placing the average satisfaction values of the assessed solutions and their importance for respondents on the quality map grid illustrates the differences in perspectives among the studied groups of ITS users. It can also serve as a starting point for discussions about future directions for the development of this system and its individual solutions, aiming to better meet the needs of residents and contribute to creating a system that ensures even greater efficiency, safety, and quality of life for city inhabitants.

In concluding the analysis, it should be noted that it only addressed a fragment of the reality of managing intelligent transportation systems in Polish cities. Therefore, further research on the issues discussed in the article appears to be warranted.

5. Summary

Rapidly developing cities and the increasing intensity and density of road traffic associated with their growth demand modern solutions that enable residents to enjoy a high quality of life. The concept of a smart city, which includes Smart Mobility as one of its components, addresses these expectations by focusing on the users of the city's transportation system. Its goal is to provide urban residents with the best conditions for traveling by various means of transport and to improve the efficiency and quality of urban transportation system management. This can be achieved through the implementation of intelligent solutions. For these solutions to fulfill their role and serve city residents and all public road users, they must meet the usability standards expected by public transportation users in cities. Systematic verification of their effectiveness and functionality is essential, as attempted in the above article.

Due to the multifaceted nature of the issue, not all related aspects were examined. The focus was on the most commonly used solutions in cities and their basic effects.

The analysis of the survey results presented in the article allowed for the verification of the hypotheses formulated for the study. The first hypothesis assumed that the predominant mode of transportation of respondents determines which elements of the intelligent transportation management system they perceive as most satisfying. Based on the indications shown in Table 2, this hypothesis was confirmed. For drivers, the most satisfying aspect was the reduction in collisions and accidents; for cyclists (rather surprisingly), it was the existence of an interactive parking system; and for pedestrians, it was the road event monitoring system. The least satisfying elements were: for drivers, intelligent traffic lights; for cyclists, the green wave; and for pedestrians, the reduction of traffic congestion on streets.

The second hypothesis proposed that drivers would attach the greatest importance to the functioning of ITS, while cyclists/scooter users would attach the least. The study revealed that the differences in evaluation among the participant groups were minor, thus this hypothesis was inconclusive. However, the third hypothesis was confirmed: all groups of study participants placed great importance on solutions that enhance their safety as road users. For drivers, the green wave was a more significant solution, but it should be noted that this solution contributes to increased road safety.

Thus, it can also be concluded that the study's objective was achieved. The analysis of the study results provided an answer to the question of how residents of the Silesian Voivodeship, traveling by car, bicycle (or scooter), and on foot, perceive the implemented and functioning intelligent traffic management systems and their impact on the ability to travel safely and quickly around the city. At the same time, there is a clear need to continue this type of research and expand its scope to address additional issues related to this topic.

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Appendix

Table 1.
Demographic characteristics of the respondents

Characteristic		**The number of respondents (%)**			**Total**
		c	**d**	**p**	
sex	women	122 (72,6)	175 (47)	192 (70,8)	489 (60,3)
	men	46 (27,4)	197 (53)	79 (29,2)	322 (39,7)
Σ		**168 (100)**	**372 (100)**	**271 (100)**	**811 (100)**
age	≤25 year	4 (2,4)	19 (5,2)	52 (19,2)	75 (9,2)
	26-35 year	66 (39,3)	43 (11,6)	23 (8,5)	132 (16,3)
	36-45 year	73 (43,4)	85 (22,8)	16 (5,9)	174 (21,5)
	46-55 year	22 (13,1)	146 (39,2)	43 (15,9)	211 (26)
	56-65 year	3 (1,8)	61 (16,4)	29 (10,7)	93 (11,5)
	>65 year	-	18 (4,8)	108 (39,8)	126 (15,5)
Σ		**168 (100)**	**372 (100)**	**271 (100)**	**811 (100)**
education	vocational	17 (10,1)	20 (5,4)	21 (7,7)	58 (7,7)
	l. o.	5 (3)	31 (8,3)	106 (39,1)	142 (17,5)
	techn. sec. school	29 (17,3)	61 (16,4)	81 (29,9)	171 (21,1)
	I° studies	53 (31,5)	123 (33,1)	36 (13,3)	212 (26,1)
	II° studies	64 (38,1)	137 (36,8)	27 (10)	228 (28,1)
Σ		**168 (100)**	**372 (100)**	**271 (100)**	**811 (100)**

Legend:
c – cyclists,
d – drivers,
p – pedestrians.

Source: Own study based on the survey.

Table 2.
The level of satisfaction of respondents with ITS elements and their effects in the city

No	**Factor**	**Satisfaction level (W_i)**																	
		1			**2**			**3**			**4**			**5**			**$\bar{x}_w$**		
		c	**d**	**p**	**c**	**d**	**p**	**c**	**d**	**p**	**c**	**d**	**p**	**c**	**d**	**p**	**c**	**d**	**p**
1.	intelligent traffic signals	58	2	26	73	7	64	31	198	47	4	101	97	2	64	37	***1,92***	3,92	3,2
2.	dedicated bike lanes and paths	4	6	9	16	13	17	120	206	108	22	98	83	3	49	54	2,91	3,85	3,58
3.	"green wave" for cars	12	11	9	38	93	31	97	194	208	16	41	17	5	33	6	2,78	***2,6***	2,93
4.	road and intersection monitoring	11	5	5	17	17	21	107	211	49	20	92	116	13	47	33	3,04	3,6	3,04
5.	road incident monitoring	39	2	7	51	12	19	52	146	41	18	117	103	8	95	101	2,5	4	**4**
6.	interactive road signs	18	1	18	32	9	27	95	149	96	19	106	88	4	12	42	2,75	4,08	3,39
7.	weather information	5	0	8	24	6	29	58	139	62	62	141	93	19	86	79	3,39	4,25	3,76
8.	interactive parking system	12	2	8	19	14	15	78	122	157	48	152	47	11	82	44	3,16	**4,4**	3,38
9.	city bike system	19	15	11	28	31	26	89	243	158	23	71	49	9	12	27	2,86	2,65	3,2

Cont. table 2.

10.	traffic flow optimization in the city	7	3	6	73	11	37	53	184	149	28	103	51	7	71	28	2,74	3,98	3,21
11.	fewer cars in the city center	28	5	34	53	9	41	64	192	87	19	98	62	4	68	47	2,51	3,93	3,17
12.	reduced traffic congestion	35	5	26	82	26	79	28	207	91	17	81	53	6	53	22	2,27	3,5	***2,88***
13.	reduced emissions and CO_2	22	2	18	28	21	37	47	194	118	54	96	69	17	59	29	3,09	3,8	3,2
14.	fewer accidents	7	5	9	12	19	31	16	219	24	96	82	117	37	47	90	**3,86**	3,7	3,92
15.	increased road safety	11	9	13	19	15	23	20	234	61	87	73	112	31	41	62	3,61	3,43	3,69

Legend:
c – cyclists,
d – drivers,
p – pedestrians.

Source: Own study based on the survey.

Table 3.
The importance of individual ITS elements and the effects of their operation

No	Factor	Rang (C_i)																	
		1			2			3			4			5			$\bar{x}_w$		
		c	d	p	c	d	p	c	d	p	c	d	p	c	d	p	c	d	p
1.	intelligent traffic signals	0	0	2	7	9	8	151	143	143	6	196	84	1	24	34	3	4,05	3,52
2.	dedicated bike lanes and paths	1	3	3	32	12	29	123	206	92	9	107	68	3	44	79	2,89	3,68	3,7
3.	"green wave" for cars	5	2	2	21	7	63	91	173	142	44	103	51	7	87	13	3,16	**4,33**	***3,04***
4.	road and intersection monitoring	3	2	2	15	15	11	93	148	67	48	184	108	9	23	83	2,72	3,95	3,96
5.	road incident monitoring	13	61	7	27	92	68	120	143	98	6	47	54	2	29	44	2,74	***3,13***	3,22
6.	interactive road signs	5	2	12	17	9	19	109	195	103	35	112	76	2	54	61	3,07	4,15	3,57
7.	weather information	19	5	2	79	11	28	57	169	53	11	122	97	2	65	91	***2,4***	4,25	3,92
8.	interactive parking system	17	3	21	71	15	59	64	181	104	13	111	53	3	62	34	2,49	4,1	3,07
9.	city bike system	10	9	3	18	17	11	86	269	209	39	31	39	15	46	9	3,19	3,4	3,15
10.	traffic flow optimization in the city	5	8	6	17	14	12	121	217	194	22	76	42	3	57	17	3	3,63	3,19
11.	fewer cars in the city center	16	6	6	24	19	18	105	202	83	14	84	91	9	61	73	2,86	3,88	3,76
12.	reduced traffic congestion	7	3	2	42	9	31	67	179	46	38	102	114	14	79	78	3,06	4,23	3,87
13.	reduced emissions and CO_2	3	5	2	9	11	15	32	131	47	95	152	108	29	73	99	3,82	4,13	4,06
14.	fewer accidents	3	11	1	9	24	6	17	243	34	98	83	107	41	11	123	**3,98**	3,58	**4,27**
15.	increased road safety	5	9	2	11	29	6	16	253	22	97	74	143	39	7	98	3,92	3,55	4,21

Legend:
c – cyclists,
d – drivers,
p – pedestrians.

Source: Own study based on the survey.

Table 4.
Calculation of the CSI Index and CSI%

Factor	The value of the CSI														
	$n_c = 168$; $n_d = 372$; $n_p = 271$														
	W_i			C_i			W_{iw}			$W_{iw}*C_i$			$W_{iw}*C_i$ max		
	c	d	p	c	d	p	c	d	p	c	d	p	c	d	p
1.	1,92	3,92	3,2	3	4,05	3,52	0,044	0,067	0,063	0,132	0,209	0,464	0,22	0,34	0,77
2.	2,91	3,85	3,58	2,89	3,68	3,7	0,067	0,068	0,057	0,194	0,2	0,21	0,335	0,34	0,36
3.	2,78	2,6	2,93	2,74	3,13	3,04	0,064	0,064	0,054	0,175	0,196	0,164	0,32	0,32	0,3
4.	3,04	3,6	3,04	2,72	3,95	3,96	0,07	0,066	0,054	0,19	0,2	0,214	0,35	0,33	0,39
5.	2,5	4	4	3,16	4,33	3,22	0,058	0,068	0,079	0,183	0,219	0,254	0,29	0,34	0,4
6.	2,75	4,08	3,39	3,07	4,15	3,57	0,063	0,068	0,067	0,193	0,3	0,239	0,315	0,34	0,39
7.	3,39	4,25	3,76	2,4	4,25	3,92	0,078	0,069	0,047	0,187	0,22	0,184	0,39	0,35	0,39
8.	3,16	4,4	3,38	2,49	4,1	3,07	0,073	0,07	0,067	0,182	0,223	0,206	0,365	0,37	0,41
9.	2,86	2,65	3,2	3,19	3,4	3,15	0,066	0,064	0,063	0,21	0,193	0,198	0,33	0,32	0,37
10.	2,74	3,98	3,21	3	3,63	3,19	0,063	0,068	0,64	0,19	0,202	0,217	0,315	0,34	0,36
11.	2,51	3,93	3,17	2,86	3,88	3,76	0,058	0,069	0,063	0,166	0,211	0,237	0,29	0,35	0,29
12.	2,27	3,5	2,88	3,06	4,23	3,87	0,052	0,066	0,057	0,159	0,208	0,221	0,26	0,33	0,36
13.	3,09	3,8	3,2	3,82	4,13	4,06	0,071	0,068	0,063	0,271	0,214	0,256	0,355	0,34	0,34
14.	3,86	3,7	3,92	3,98	3,58	4,27	0,09	0,067	0,078	0,358	0,207	0,286	0,45	0,34	0,36
15.	3,61	3,43	3,68	3,92	3,55	4,21	0,083	0,065	0,073	0,325	0,188	0,307	0,415	0,33	0,39
Σ	43,39	59,21	50,54	46,39	61,91	54,51	-			3,115	3,19	3,657	5	5	5
CSI	-									CSI 3,115	CSI 3,19	CSI 3,657	CSI_{max}	CSI_{max}	CSI_{max}
													62,3%	63,8%	73,14

Legend:
c – cyclists,
d – drivers,
p – pedestrians.

Source: Own study based on the survey.