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From conventional to green - key elements for development of the city of Kragujevac sustainable mobility strategy

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Table of Contents

Funded by the European Union

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Table of Tables

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Table of Figures

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List of Abbreviations

GT: Green Transition

WB: Western Balkans

PCT: Public city transport

GUP: General urban plan

CKG: City of Kragujevac

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Executive Summary

The Bus Transformation Project is not a corridor study or a service plan. Based on extensive research and public engagement, this project should provide a Strategy with a bold, new vision and a series of recommendations to guide the future of buses in the cities (City of Kragujevac- CKG). Public input from across all demographics and areas in the CKG indicated that transforming the bus system means doing the basics better - that is, providing fast, frequent, reliable, affordable bus service that feels like a unified system and is not beholden to geographic or funding boundaries.

It is impossible to observe public city transport (PCT) separately from the total traffic in the city. The transformation of PCT also means reducing the use of private cars in the city and switching to bus transportation. The average number of cars in Serbia is 300 per 1,000 inhabitants; while in Kragujevac is slightly higher, around 320. In absolute numbers, it is at the level of 30,000 users per day (before the Covid pandemic, it was almost 50,000). Transport policy measures can also reduce levels of car use through the promotion of walking and cycle and development of the new transport hierarchy. This can be achieved through slowing down urban traffic and reallocating space to public transport, through parking controls and road pricing, and through making it easier to use public transport.

Kragujevac has completed a Traffic Study for the needs of the General Urban Plan (GUP). The Traffic Study was used in the initial analysis. The research is therefore also include certain urban and technical solutions that can contribute to the improvement of PCT (traffic organization through the system of street use, dominant traffic routes for buses, greater traffic throughput, traffic signals, the layout of bus stops, parking policy and financial mechanisms for (de)motivating arrival in the central areas of the city, etc.). Research also could be a basis for a gradual transition to a carbon-free public transport system, that is, research might provide inputs as to whether it is possible step by step to prospectively switch to a carbon-free public transport system in the city.

The idea of the research is to define scenarios after an extensive analysis and survey that will provide the best effects for increasing the share of public transportation in the total, changing the number of cars in the central area of the city and reducing pollution in these parts by using electric vehicles. The pilot idea is for passengers to use conventional buses (at this stage) to get to the edge of the central area of the city and then transfer to electric buses, which will distribute consumers to their desired destination in a well-distributed frequency of departures. This will be combined with other policies to (de)motivate the use of certain types of traffic (mobile and stationary), adapted to urban planning parameters, technical solutions, etc. This should be an input for the development of urban plans that will ensure the essential implementation of this idea and adapt it to the wider city context through the eventual construction, expansion or reconstruction of existing roads, fitting into other urban contents, etc.

The policy research paper contains an analysis:

- European guiding documents related to this area (e.g. EC Declaration 1370/2007), national strategies and positive examples of the cities in the region, city sectoral strategies and existing plans and urban policies etc.
- socio-economic transformation of PCT towards a sustainable (green) one. A participatory and open approach will enable specification and calibration of goals and desired solutions.
- the new PCT strategy will be a combination of using conventional traffic with improved performance outside the central area of the city and completely new electric buses in the very center (city core), along with new solutions for stationary traffic and smart improvements in supporting content (stations, signaling, notification system, etc.)
- the basic status of the air pollution in the city (as a whole and in certain parts, especially the central zone),

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basic problems when it comes to the air pollution in the city as well as the factors that contribute to it.

1. Introduction

Republic of Serbia has committed to aligning with the European Green Deal's key elements by endorsing the Green Agenda for the Western Balkan (GAWB) at the Summit in Sofia in 2020, and subsequently the GAWB Action Plan, at the Brdo Summit in October 2021. Since then, Republic of Serbia initiated the process of decarbonization of economy and industry and started preparing measures to promote just green transition. Adopted is the Law on Climate Change prepared by the Ministry of Environment, as well as the set of new laws in the field of energy, including the first Law on Renewable Energy Sources and the new Law on Energy Efficiency and the Rational Use of Energy.

In addition to the above-mentioned policies (which were adopted in 2021), when it comes to the pillar of Decarbonization (Climate, Energy & Mobility), Serbia adopted other, also very important policies at the national level such as Integrated National Climate and Energy Plan for the period 2021 to 2030 with a vision until 2050 (INECP), The Law on the Spatial Plan of the Republic of Serbia, Draft of the Spatial Plan of the Republic of Serbia 2021-2035 (in procedure), Long term building renovation strategy Republic of Serbia 2050, Sustainable Urban Development Strategy of the Republic of Serbia until 2030, Climate Strategy & Action Plan of the Republic of Serbia and Strategy for Development of the Energy Sector of the Republic of Serbia until 2025 with projections until 2030. Ministry of Mining and Energy is in the process of developing two important documents that would enable implementation of the green transition in a just way – Energy development Strategy and Integrated National Plan for Energy and Climate Up Until 2050.

Adopted national policies that are under other four pillars of the GAWB are The Law on Waste Management, The Law on Packaging and Packaging Waste, Waste Management Program of the Republic of Serbia for the period 2022-2031 and Industrial Policy Strategy of the Republic of Serbia from 2021 to 2030 (Circular economy), The Law on Environmental Protection (which basically covers all pillars of GT), Air Protection Law, The Law on Waters, The Law on Soil Protection (Depollution), The Law on Nature Protection, National strategy for sustainable use of natural resources and goods and Biodiversity Strategy of the Republic of Serbia (Biodiversity), Law on Agriculture and Rural Development and The Law on planning and construction (Sustainable Food Systems and Rural Areas). In general, decarbonization pillar went the furthest in terms of applying the postulates of the green transition.

The adoption of these laws and policies in previous years initiated a series of activities and projects related to JGT. Nationally important are EU for Green Agenda in Serbia, advancing medium and long-term adaptation planning in the Republic of Serbia, ALTERENERGY - Energy sustainability for Adriatic small communities (projects), Roadmap for circular economy in Serbia, Initiative for a Just Green Transition and Decarbonization in Serbia, ECO SYSTEM Programme, Zero Waste Municipalities (initiatives and practices), etc.

The current overviews of the policies that are concerning the issue of JGT in Serbia are mainly on a national level but there are examples of policies on the regional and local one. Significant regional policies and practices are related to the administrative areas of the City of Belgrade and the autonomous region of Vojvodina (Sustainable Energy and Climate Action Plan for the City of Belgrade – SECAP, Sustainable Urban Mobility Plan for the City of Belgrade, Green City Action Plan for the City of Belgrade, AP Vojvodina Environmental Protection Program for the Period 2016-2025 etc.) while local activities and policies are mostly concentrated in larger and better developed municipalities and cities (Novi Sad, Niš, Kragujevac, Kraljevo, Subotica etc.).

The situation in terms of activities, practices and policies in the research territory, the city of Kragujevac (more specifically, the urban settlement of Kragujevac) is better than in most local governments in Serbia. In the previous decade, the city of Kragujevac adopted a few documents/policies at the local level that are important or directly related to the JGT, such as: Spatial Plan of the City of Kragujevac, Local Waste Management Plan of the City of Kragujevac, Program of Local Economic Development of the City of Kragujevac, Strategy of integral urban development of the central city zone - Kragujevac 2030, etc. The main problem in Kragujevac is that most of these documents have expired or their validity period will expire soon. The preparation and adoption of new policies, for which there is a desire in the local self-government (for some of them the initiative has already been launched), represents an excellent opportunity to incorporate the JGT principles into them and thus create a model/example for other local governments in Serbia.

The research case of UB-GEF within the Green Force action will focus on the first pillar of the Green Agenda for the WB (cleaning energy sources & protecting the climate), especially on the aspect of just transition in the sector of Smart and Sustainable Mobility. As Woodcock et al., 2007. stated:" sustainable mobility offers improvements in individual health as well as a cleaner and healthier environment". So, indirectly the objectives of the case study will go in line with the pillar Depollution in a sense that the actions within the research study will try to demonstrate how the integration of the proposed solutions into innovative land-use management, urban design and planning could reduce health-related environmental burdens in inner urban zones, foster equitable access to public transport, enhance their quality and use and promote sustainable urban mobility patterns.

Green Force social aspect aims to upgrade citizens' relation to place and each other, instigate a sense of identity and empowerment and achieve new social equilibrium in the city ownership and management. The relationship with space is embodied by the sense of place concept – a multidimensional construct encompassing cognitive, emotional and behavioral facets of place attachment. A sense of place can be used as a base for comprehending their well-being since it is thought to be one of the main explanations for people's tendency to stay in each place and provides them with sense of safety and feeling of rootedness. Different dimensions of sense of place play a different role in establishing positive relations with place and will be therefore included in our research approach. Through a participatory approach, verification of the procedure, data and concept will be ensured, but the feeling of belonging to the idea and the final solution will be improved. Citizens are especially expected to react to the transformation of classic public city transport into ecologically sustainable ones, in the layout of stations, defining routes, etc.

2. Methodology

Research Design

The integral method was used as the basis for planning sustainable urban systems in the work.The integral method is manifested through the exploration of interrelationships among economic, social, and spatial development factors, as well as the necessity of planning in relation to the broader environment. Through this causal process, the ecological-economic dimension gains its social justification and overall valorization. To establish sustainable harmony between economic development and space/environment, the focus of planning lies in enabling the integration of space and the environment into socio-economic development, for the ecological health of the local community. The function of planning and public responsibility is reduced to a holistic, interactive approach to development, in accordance with environmental capacity. Therefore, integrated planning of key segments is particularly important in the socio-economic and spatial-ecological cohesion of spatial development. Insistence on arranging economic activities within the context of social responsibility passes through the prism of their impact on the natural and living environment. In the spirit of the global paradigm of sustainable development, where the economic gain of a particular area equals the ecological effects of its actions on space, the city planning vision is curved towards successfully overcoming potential conflicts between these two antipodes, with the aim of preventing resource plundering, emphasizing the specificity and identity of the city, and promoting general social awareness of the importance of preserving a high-quality environment.

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Research approach:

- Document research - plans, strategies, sectorial studies etc.
- Analysis of similar experiences from the abroad and in some Serbia cities (benchmarking analysis) and adoption of good examples
- Legislative background analyses
- Interviews – semi-structured with local policy actors and stakeholders
- Field work and survey - close contact with citizens and articulation of their interests
- Cost and benefit analysis

When assessing the costs and benefits, attention was given to the territorial implications, especially the effects that the green transition will have on spatial policies. Recommendations related to spatial planning, urban planning policies and instruments that would contribute to the affirmation of the green agenda (green transition) in Serbia will be clearly highlighted.

Data Collection Methods

After detailed research of all planning documents and studies, numerous meetings with local authorities and significant stakeholders, a survey was created that was disseminated through the official internet channels of the local self-government and through direct contact with users of public transport in Kragujevac. The proposed routes of the future electric buses (three) were established after visiting the field on several occasions, consulting with traffic experts and the city's chief urban planner. In the final phase of the research, the schedule of stations, the number of buses needed, and their departure interval will be specified.

Sampling Strategy:

The questions from the survey (attached) were answered by more than 450 users of public transport. The survey was structured in such a way that they cover the basic pillars of the green transition and give citizens' generated opinions about a possible transition to sustainable public transport, the impact on the environment and their awareness of the necessity of changing the traditional - classic way of doing transport. Also, the effects on human health, social well-being and increasing sustainability are indicated through the results. In this phase of the research, the summary result is prepared in detail and the directions obtained are considered.

In parallel with the survey, it was discussed with the city administration which accompanying activities will contribute to more effective effects of the transition. The ban on traffic in the central area of the city (completely or in some parts of the day) except for electric buses and electric taxis, ban on parking (except for residents), economic incentives for the transition (ticket price, free transportation in the initial phase), installation of solar panels at bus stops was considered, installation of pollution meters in buses, etc.

Data Analysis Procedures:

Majority of the data will be collected from the Open data portal. Other data will be collected from Statistical Office of the Republic of Serbia, Republic Geodetic Authority, The Serbian Business Registers Agency, official documents adopted by the City of Kragujevac, different studies, research etc. In the research, as well for the scenario purposes, the COPERT and GTFS for the City of Kragujevac are going to be used. Also, significant data will be calculated and created during the research using GIS tools for different geospatial analyses.

The central area of the City of Kragujevac is divided in 93 Census Circles (Fig 1.). Each of the Census Circles can be used for the data collection about the number of inhabitants, number of households, age structure and other data relevant for the research. The data collected from the Census can be used for very

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accurate estimation of the population, permanently settled in the central city zone and affected by the scenario. These data are collected by Statistical Office of the Republic of Serbia and available upon request for the research purposes.

Figure 1. Census Circles in the city core zone. *Source: Author's elaboration*

On the other hand, data about the number and structure of the Business Registers gathered from The Serbian Business Registers Agency, also based on the available street codes, can be used for the estimation of the economic impact of the proposed scenario. Additionally, these data can be used for the estimation of the scenario impact on the workers and daily commuters. These data are collected by The Serbian Business Registers Agency and available upon request for the research purposes.

Urban buses have energy and environmental impacts because they are mostly equipped with heavy-duty diesel engines, having higher emission factors and pollution levels. Research will identify bus pollutant emissions including CO, CO_2, HC, and NOX at road sections, intersections, and bus stops for different fuel types; and explore the changes in emissions for different locations in the road sections, bus stops, and intersection influence areas. For different locations and fuel types, the differences in emissions were all statistically significant. MDD values for different locations indicated that there were more obvious differences in emissions between road sections and intersections. In addition, heat maps were applied in this study to better understand changes in bus emissions for different locations in the bus stop influence areas, intersection influence areas, and road sections.

The field data consisted of two parts: (1) bus vehicle characteristic data include fuel type, vehicle speed, and acceleration; and (2) emission situation data include bus pollutant emissions of carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbon (HC), and nitric oxides (NOX).

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Ecological impact will be calculated precisely based on the:

- Number of existing bus lines passing through the city center zone (Fig 2.)
- Number of daily trips
- Spatial distribution of the bus stops (Fig 3.)

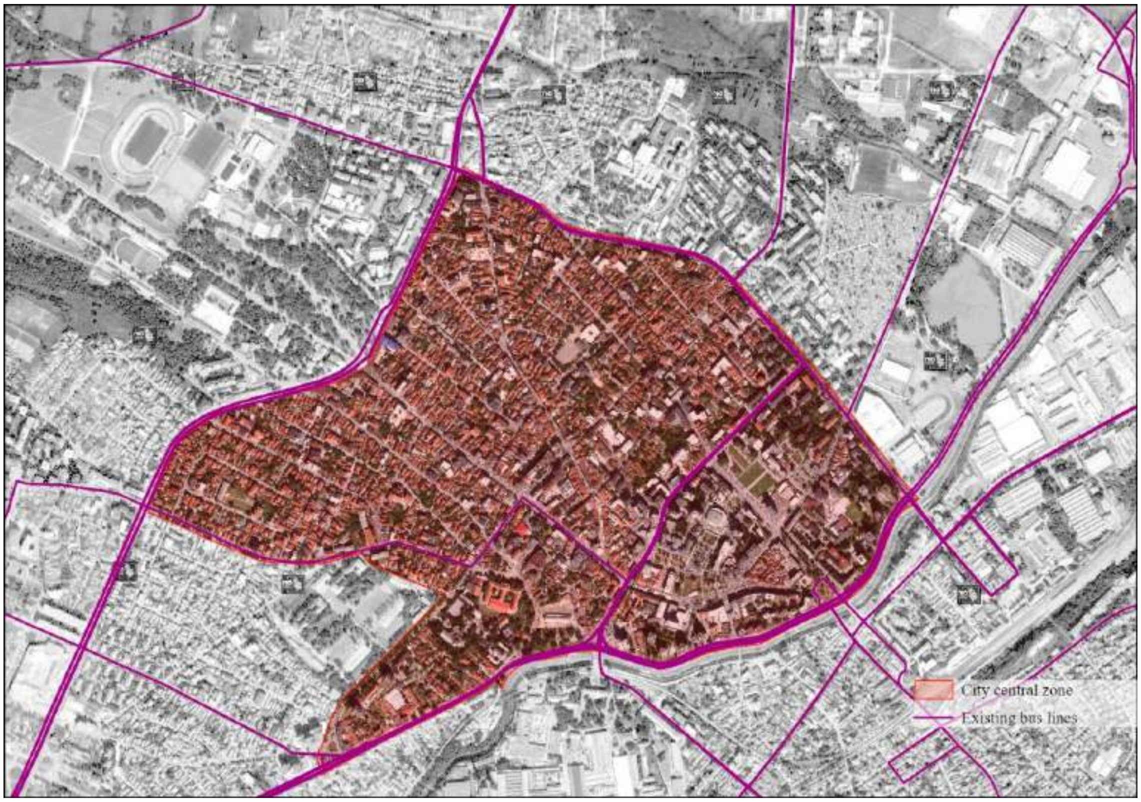

Figure 2. Existing bus lines passing through the city center zone. *Source: Author's elaboration*

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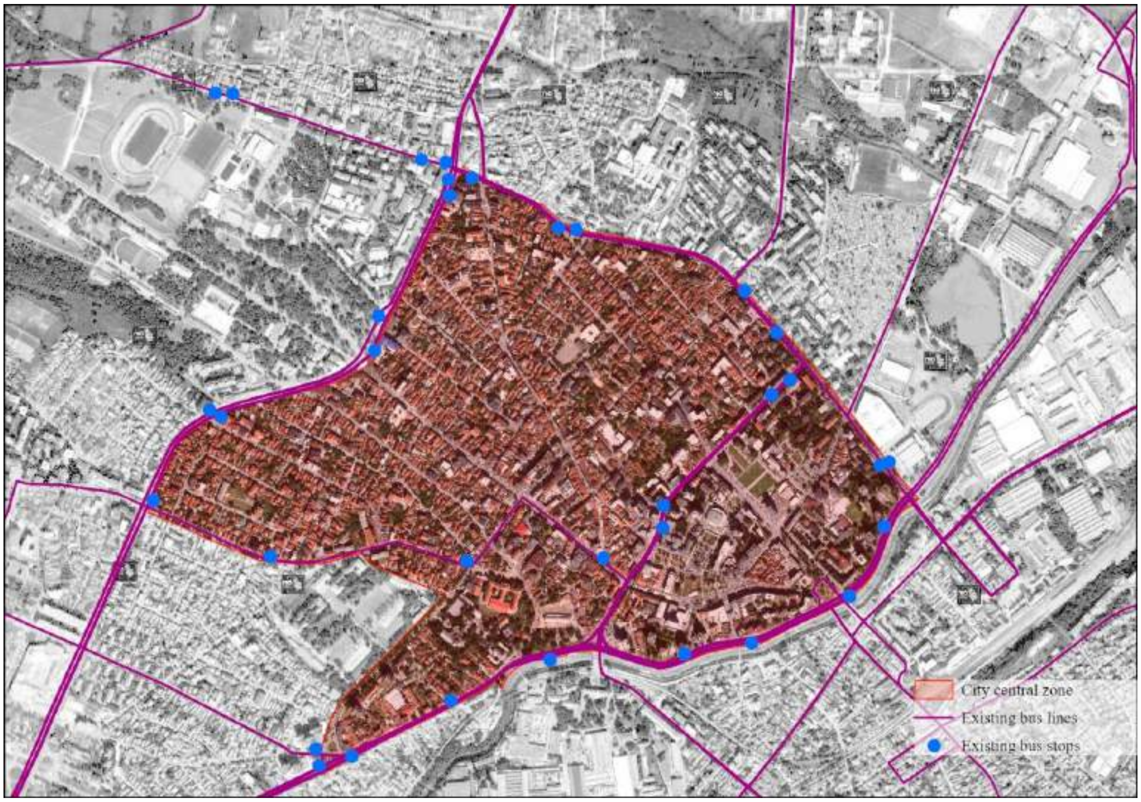

Figure 3. Spatial distribution of the bus stops. *Source: Author's elaboration*

- Spatial distribution of the crossroads
- Length of the bus line
- Emission values for different types of engines with internal combustion (EURO 5, EURO 4 etc.) based on the Wang, C., Sun, Z. and Ye, Z. (2020).
- Walking 5 minutes isochrones distances from the bus stops (Fig 4).

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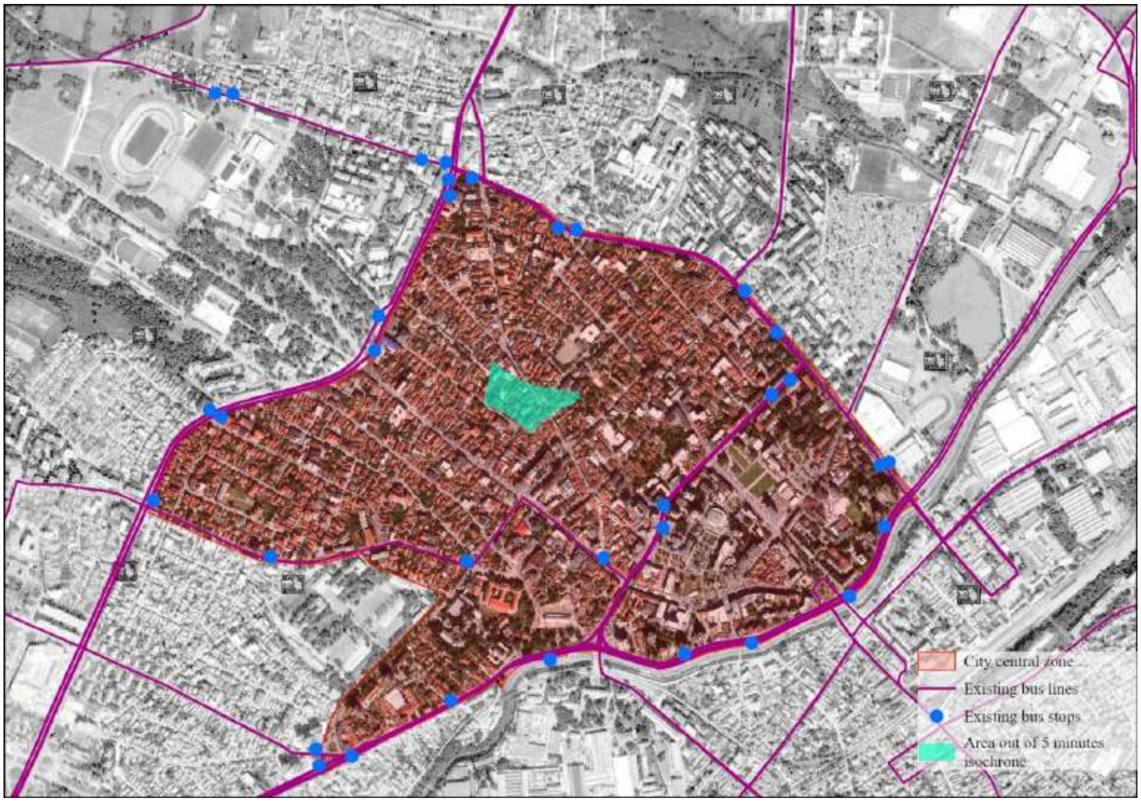

Figure 4. Area marked in red – not accessible in 5 minutes walking distance from the bus stop. *Source: Author's elaboration*

Numerous documents, adopted by the City of Kragujevac or created by the City administration are going to be used for the data collection and better understanding of present state and future goals in city development. These documents are the following:

- City of Kragujevac Traffic Development Strategy 2012-2022
- Traffic Study for the General Plan of the City of Kragujevac 2025
- Traffic infrastructure analyses for the General Plan of the City of Kragujevac 2025
- Public City and Intercity transport in the City of Kragujevac – research study etc.

Ethical Considerations:

During the research and survey, consultations were held with the ethics officer and coordination was done with other members of the consortium regarding the careful selection of the research approach.

Limitations and Assumptions:

During the research, we did not encounter any unexpected obstacles. We were aware of existing shortcomings such as: new material for the administration and local experts, insufficient knowledge of the principles of the Green Transition among citizens, resistance to new systems, financial uncertainty and the need for investment, drastic accompanying measures that would encourage the introduction of environmentally friendly public transport (reduction parking, complete or partial prohibition of traffic within the central zone of the city, coordination with other participants in traffic - taxi vehicles, etc.). However, for now we have encountered complete openness of the local administration, key managers, citizens and other

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interested parties. The preliminary results of the survey show a great interest in activities, a desire to improve and change something, to improve the environment, to use modern modes of transportation, to think about a sustainable future.

Timeline and resources

The timeline was mostly respected with the expected oscillations in the arrival of data. Regular meetings of the team members were held with local actors in Kragujevac and the field was visited on several occasions. In addition, we had consultations with experts from various fields (civil and construction engineers, economists, sociologists, geographers, lawyers...) who made a significant contribution to the research through advice and pointing out important aspects of this complex issue.

3. Policy and Legal Context

From the beginning of the research, it was related to the analysis of legislative, planning and institutional support for the green transition. This is documented in the Regional Mapping Report (D4.2 Regional Mapping Report). After the national and regional view, the analysis continued at the local level.

Numerous documents, adopted by the City of Kragujevac or created by the City administration were used for the data collection and better understanding of the present state and future goals in city development. These documents are the following:

- City of Kragujevac Traffic Development Strategy 2012-2022
- Traffic Study for the General Plan of the City of Kragujevac in 2025
- Traffic infrastructure analyses for the General Plan of the City of Kragujevac in 2025
- Public City and Intercity transport in the City of Kragujevac – research study etc.

Many of them directly or indirectly opened the possibility of applying new concepts to spatial planning in harmony with nature.

4. Theoretical framework

Urban transport has the function of integration, connecting the city's functions of work, housing, entertainment and recreation. Transport is inseparable from the economic development of the city and has a decisive influence on the quality of life of city residents. However, we should never lose sight of the fact that the demand for traffic is, in fact, a derived demand. Mobility itself depends on the spatial arrangement of activities in the city - as the spatial-physical structure of the city changes, so does the demand for traffic.

Sustainable urban mobility refers to a transport strategy that minimizes negative environmental effects, economic inefficiency and social inequality.

The most important negative environmental effects of city traffic at the local and regional level are; local air pollution, noise pollution, traffic congestion and traffic accidents, confiscation of city land. At the global level, these are: energy consumption and GHG gas emissions.

Reducing the negative effects of city traffic can be achieved by applying various measures from the domain of urban planning and land use as well as traffic policy. For the effectiveness of measures to be fully manifested, the timing of their implementation is extremely important. Therefore, it is not only necessary to implement all groups of measures together, but the coordination of traffic strategy and spatial development must reach a very high level.

5. Stakeholder engagement

Apart from several online meetings with various experts, good cooperation with the administration of the city of Kragujevac has already been noted. The survey that was conducted was structured in such a way as to include various ethnic, gender and educational categories of the population. Special care was taken to talk to people who are frequent users of public transport, those who live in the central area of the city, but also those who come to work every day from distant parts of the city or outside it. Concrete (preliminary) data are given in the attachment. (Annex)

6. Scenario Development

After a detailed analysis of existing spatial and development documentation, legal assumptions and constraints, discussions with stakeholders and authorities, development scenarios for public urban transport in the central zone of Kragujevac were created. The definition of scenarios was preceded by an extensive survey that reflected the opinions of residents and transport users regarding the state of public urban transportation and future expectations.

Survey on the Satisfaction Level of Public Transport Users and Preferences Towards the Introduction of Electric Buses

Research question: Determine the level of satisfaction of the citizens of Kragujevac with the functioning of the public transport system, as well as the possibility of introducing electric buses. The goal is to identify current problems as well as aspects of public transport in Kragujevac that can be improved. Data is collected using interview methods.

A total of 424 individuals participated in the survey, which employed a non-probabilistic convenience sampling method. Data collection was carried out through a combination of online self-administered questionnaires and face-to-face field interviews:

- Online survey: 257 respondents completed the questionnaire via a dedicated survey link, shared through social media platforms and direct email invitations.
- Field survey: 167 participants were interviewed in person at major public transport locations across Kragujevac, including key roundabouts and the busiest bus stations. These interviews were conducted during both peak hours (7:00–9:00 AM and 3:00–5:00 PM) and off-peak times to reflect diverse usage patterns. Interviewers used paper-based forms, which were later digitized for analysis.

This mixed-method approach was adopted to improve the reliability of data collection by reaching both online and offline respondents, particularly those who might not engage with digital channels.

Although the non-probabilistic sampling approach limits the generalizability of findings to the broader population of Kragujevac, the survey was specifically designed to reflect the views of active public transport users—the key stakeholders in evaluating service quality and identifying areas for improvement. While the sample size (n = 424) allows for a 5% margin of error at a 95% confidence level, the results should be seen as indicative of user perceptions rather than a statistically representative picture of the entire population.

Satisfaction and importance of certain attributes of public transport were measured using a five-point Likert scale. Although the seven-point scale is also often in use, it is considered that the five-point scale corresponds more to the conditions of conducting the survey in Serbia, as well as to the specific circumstances of filling out this questionnaire on the field. The Likert scale is considered suitable as it enables clear expression of respondents' opinions using the same number of positive and negative categories.

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The questionnaire consists of one sheet of A4 format with closed-ended questions. The number and type of questions are a function of the high rate of completed questionnaires. The expected time for filling out the questionnaire was about 5 minutes.

The following statistical analysis, as well as all calculations, were done in the SPSS.

Statistical analysis

Descriptive statistics

We have used frequencies and descriptive statistics to understand the distribution of responses for every survey question.

Table 1. Age of respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14-25	86	20.3	20.3	20.3
	26-45	176	41.5	41.5	61.8
	46-65	135	31.8	31.8	93.6
	65+	27	6.4	6.4	100.0
	Total	424	100.0	100.0	

The largest age group among respondents is the 26-45 years old category, comprising 41.5% of the total respondents. The second-largest group is the 46-65 years old category, making up 31.8% of the respondents. The 14-25 years old group represents 20.3% of the respondents. The smallest group is those aged 65 and older, accounting for 6.4% of the respondents.

Most of our survey respondents are in the 26-45 and 46-65 age groups, indicating a middle-aged demographic predominance in our sample. This age distribution can be very informative, as different age groups may have varying perspectives and preferences regarding public transport and electric buses.

Table 2. Education level of respondent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Elementary school	12	2.8	2.9	2.9
	High school	346	81.6	82.6	85.4
	University degree	61	14.4	14.6	100.0
	Total	419	98.8	100.0	
Missing	System	5	1.2		
Total		424	100.0		

Among the valid responses the majority of respondents, 82.6%, have only completed high school. A significant minority, 14.6%, have obtained a university degree. A very small portion, 2.9%, have only completed elementary school.

The high proportion of respondents with a high school education suggests that the survey sample predominantly consists of individuals with a moderate level of education. The smaller proportions of respondents with elementary or university education indicate that there may be differing levels of engagement with public

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transport, potentially influenced by educational attainment. This distribution can be used to understand and segment the data for further analysis, particularly when examining preferences and satisfaction with public transport services among different educational groups.

Table 3. Frequency of public transport use

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Daily	171	40.3	40.4	40.4
	4 to 6 days a week	63	14.9	14.9	55.3
	1 to 3 days a week	66	15.6	15.6	70.9
	1 to 3 days a month	43	10.1	10.2	81.1
	Less than one day a month	48	11.3	11.3	92.4
	I do not use it at all	32	7.5	7.6	100.0
	Total	423	99.8	100.0	
Missing	System	1	.2		
Total		424	100.0		

Among the valid responses the largest group, 40.4% of the respondents, use public transport daily; 14.9% of the respondents use public transport 4 to 6 days a week (frequent users); 15.6% of the respondents use public transport 1 to 3 days a week (moderate users); 10.2% of the respondents use public transport 1 to 3 days a month (occasional users); 11.3% of the respondents use public transport less than one day a month (rare users); 7.6% of the respondents do not use public transport at all (non-users).

A significant portion of respondents use public transport frequently, with 40.3% using it daily and an additional 30.5% using it between 1 to 6 days a week. Over half (55.3%) of the respondents use public transport at least 4 days a week, indicating a high dependence on public transport.

Given that 18.8% use it occasionally (1 to 3 days a month or less), there is a potential to convert these occasional users into more frequent users through improved services or incentives. The 7.5% of non-users represent a group that could be targeted with initiatives to encourage public transport use, such as improved service quality.

Table 4. Most common purpose of travel

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Traveling to/from work	200	47.2	48.1	48.1
	Going to school/university	61	14.4	14.7	62.7
	Shopping	21	5.0	5.0	67.8
	Recreational reasons	35	8.3	8.4	76.2
	Visiting family/friends	34	8.0	8.2	84.4
	Other reasons	65	15.3	15.6	100.0
	Total	416	98.1	100.0	
Missing	System	8	1.9		
Total		424	100.0		

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Among the valid responses nearly half (48.1%) use public transport for commuting to/from work; 14.7% of respondents use public transport for educational purposes. Those are primary and secondary purpose. Among other purposes 5% of respondents use public transport for shopping; 8.3% use it for recreational reasons; 8.0% use public transport to visit family and friends. In addition to this 15.3% of respondents indicated other reasons for using public transport.

The high percentage of respondents using public transport for commuting to/from work indicates that any improvements to public transport services will primarily benefit the working population. While work and school commutes are predominant, there are still substantial numbers of respondents using public transport for shopping, recreation, and visiting family/friends. The relatively high percentage of "Other reasons" (15.6%) suggests there are various unspecified uses of public transport that could be further explored to understand the full range of public transport needs and preferences.

Table 5. Type of ticket

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Single ticket	173	40.8	41.3	41.3
	Monthly pass	206	48.6	49.2	90.5
	I do not buy a transport ticket	40	9.4	9.5	100.0
	Total	419	98.8	100.0	
Missing	System	5	1.2		
Total		424	100.0		

Among the valid responses a significant portion of respondents (41.3%) use single tickets, while the majority (49.2%) use monthly passes. A smaller portion (9.5%) do not buy a transport ticket at all.

The highest percentage of respondents use monthly passes, suggesting that a large number of users are frequent and regular public transport users. This group may benefit most from consistent and reliable services. Also, a substantial proportion of respondents use single tickets, indicating that there is a significant number of occasional or less frequent public transport users. The 9.4% of respondents who do not buy transport tickets could indicate evasion, or other reasons not covered by the survey.

Understanding the distribution between single ticket users and monthly pass holders is crucial for revenue planning and service optimization. Monthly pass holders often expect different service levels compared to single ticket users.

Among the valid responses the majority of respondents (65.1%) do not change bus lines during their journey; a smaller portion of respondents (18.9%) change bus lines once during their journey; a minority of respondents (16%) change bus lines multiple times.

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Table 6. Changing bus lines on journey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes, multiple times	67	15.8	16.0	16.0
	Yes, once	79	18.6	18.9	34.9
	No	272	64.2	65.1	100.0
	Total	418	98.6	100.0	
Missing	System	6	1.4		
Total		424	100.0		

The high percentage of respondents who do not change bus lines suggests a preference for direct routes. This indicates that most users have access to direct routes or prefer routes without transfers. The combined percentage of respondents who change bus lines (almost 35%) indicates that a significant portion of users need to transfer at least once during their journey. This highlights the importance of efficient and well-coordinated transfer points in the public transport system. For the 16% who change buses multiple times, improving the connectivity and reducing the need for multiple transfers could enhance their travel satisfaction.

Table 7. Willingness to pay higher price for better quality

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	212	50.0	50.5	50.5
	No	208	49.1	49.5	100.0
	Total	420	99.1	100.0	
Missing	System	4	.9		
Total		424	100.0		

Among the valid responses little more than a half of the respondents (50.5%) are willing to pay a higher price for better quality public transport; just under half of the respondents (49.5%) are not willing to pay a higher price.

The respondents are almost evenly split in their willingness to pay a higher price for better quality public transport, with half valuing improved quality enough to pay more, while the other half may be more price-sensitive or satisfied with the current quality.
Since half of the respondents are willing to pay more, there is potential for introducing higher-priced options for enhanced services or implementing quality improvements (increased frequency, better comfort, reduced travel time etc.) with a justified price increase.

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Table 8. Amount willing to pay compared to current price

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Up to 25% higher	167	39.4	77.3	77.3
	Up to 50% higher	32	7.5	14.8	92.1
	Up to 2 times higher	13	3.1	6.0	98.1
	More than 2 times higher	4	.9	1.9	100.0
	Total	216	50.9	100.0	
Missing	System	208	49.1		
Total		424	100.0		

Of the number of respondents willing to pay higher price for better quality of public transport the majority (77.3%) are only willing to pay up to 25% higher than the current price. This, of course, suggests that a modest price increase is more acceptable to the majority. A smaller portion (14.8%) are willing to pay up to 50% higher, indicating that some respondents are open to a more significant price increase for better quality. Only 6% are willing to pay up to 2 times higher, and a fraction (1.9%) are willing to pay more than 2 times higher, indicating that such a high price increase would not be well-received by the majority.

The majority's willingness to pay up to 25% higher suggests that a modest increase in fares could be feasible without significant pushback, provided that the quality improvements are evident. This data helps in understanding the extent to which respondents are willing to financially support quality improvements in public transport, informing pricing strategies and service enhancement plans in Kragujevac.

Table 9. Car ownership or access

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	249	58.7	58.7	58.7
	No	175	41.3	41.3	100.0
	Total	424	100.0	100.0	

Most of the respondents (58.7%) have access to a car. This indicates that more than half of the survey participants either own a car or have the possibility to use one. A significant portion of respondents (41.3%) do not have access to a car. This indicates that a substantial number of people rely on other modes of transportation, such as public transport, walking, or cycling.

The 41.3% of respondents without car access may be more reliant on public transport, making it crucial for the city to ensure that public transport services are efficient, reliable, and meet the needs of these users. The 58.7% with car access might be potential users of public transport if it is improved. Strategies to attract these car users to public transport could include highlighting the benefits of reduced congestion, environmental benefits etc. The high percentage of car access suggests a potential challenge in terms of parking space availability and traffic congestion, especially in the central zone.

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Next 12 questions refer to the user satisfaction with various aspects of public transport in Kragujevac.

Table 10. User satisfaction with various aspects of public transport

		Satisfaction with frequency	Satisfaction with travel time	Satisfaction with comfort of waiting	Satisfaction with comfort of the journey	Satisfaction with availability of seats	Satisfaction with cleanliness
N	Valid	421	420	418	419	418	417
	Missing	3	4	6	5	6	7
Mean		2.8124	3.2310	2.3828	2.7303	2.7057	2.9448
Median		3.0000	3.0000	2.0000	3.0000	3.0000	3.0000
Std. Deviation		1.28004	1.20322	1.34357	1.27031	1.22407	1.33709
Variance		1.639	1.448	1.805	1.614	1.498	1.788

		Satisfaction with information availability	Satisfaction with ease of connection	Satisfaction with station proximity	Satisfaction with safety	Satisfaction with environmental impact	Satisfaction with cost of transportation
N	Valid	419	417	418	418	418	418
	Missing	5	7	6	6	6	6
Mean		3.1313	2.9257	3.4569	3.1914	2.8541	3.1531
Median		3.0000	3.0000	3.0000	3.0000	3.0000	3.0000
Std. Deviation		1.38497	1.18959	1.25207	1.20221	1.20162	1.26775
Variance		1.918	1.415	1.568	1.445	1.444	1.607

Generally, median values around 3 suggest that most respondents rate satisfaction as moderate across most aspects. Higher standard deviations and variance suggest more variability in opinions among respondents, with some aspects having higher variability than others.

"Satisfaction with station proximity" has the highest mean (3.4569), suggesting it is the most critical factor for respondents (next are "Satisfaction with travel time", and "Satisfaction with safety"). "Satisfaction with comfort of waiting" has the lowest mean (2.3828), well below neutral.

"Satisfaction with information availability" and "Satisfaction with comfort of waiting" have higher standard deviations (1.38497 and 1.34357, respectively) and higher variance, indicating a wider spread of responses around the mean. " Satisfaction with ease of connection " has the lowest standard deviation (1.18959), indicating that most respondents have similar opinions about this aspect.

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Our data provides insights into the perceived satisfaction levels across various dimensions of public transport. Understanding these ratings helps in identifying areas where improvements are needed to enhance overall satisfaction among users. Those areas, primarily, are: comfort of waiting, comfort of the journey, availability of seats and frequency of public transport.

Table 11. Satisfaction with frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	76	17.9	18.1	18.1
	Mostly dissatisfied	105	24.8	24.9	43.0
	Both satisfied and dissatisfied	120	28.3	28.5	71.5
	Mostly satisfied	62	14.6	14.7	86.2
	Completely satisfied	58	13.7	13.8	100.0
	Total	421	99.3	100.0	
Missing	System	3	.7		
Total		424	100.0		

Most respondents (43%) are not satisfied at all or mostly dissatisfied with the frequency of public transport; a significant portion (28.5%) are satisfied or completely satisfied with the frequency of public transport.

The 18.1% who are not satisfied at all and the 24.9% who are mostly dissatisfied indicate areas where improvements in frequency are needed. Also, understanding the 28.5% who have both satisfied and dissatisfied feelings can help in targeting improvements to specific aspects of frequency that could enhance overall satisfaction.

Table 12. Satisfaction with travel time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	40	9.4	9.5	9.5
	Mostly dissatisfied	72	17.0	17.1	26.7
	Both satisfied and dissatisfied	133	31.4	31.7	58.3
	Mostly satisfied	101	23.8	24.0	82.4
	Completely satisfied	74	17.5	17.6	100.0
	Total	420	99.1	100.0	
Missing	System	4	.9		
Total		424	100.0		

A majority (41.6%) are satisfied or completely satisfied with travel time while a significant portion (31.7%) have both satisfied and dissatisfied feelings about travel time. Only minority of respondents (9.5%) are not satisfied at all with travel time. Understanding that 9.5% of respondents are not satisfied at all and 17.1% are mostly dissatisfied indicates areas where improvements in travel time could be focused.

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Table 13. Satisfaction with comfort of waiting

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	157	37.0	37.6	37.6
	Mostly dissatisfied	71	16.7	17.0	54.5
	Both satisfied and dissatisfied	106	25.0	25.4	79.9
	Mostly satisfied	41	9.7	9.8	89.7
	Completely satisfied	43	10.1	10.3	100.0
	Total	418	98.6	100.0	
Missing	System	6	1.4		
Total		424	100.0		

A significant portion (37.6%) are not satisfied at all with the comfort of waiting; about 25.4% have both satisfied and dissatisfied feelings about the comfort of waiting. Only 20.1% are mostly satisfied or completely satisfied with the comfort of waiting.

The 37.6% who are not satisfied at all and the 16.7% who are mostly dissatisfied indicate areas where improvements in the comfort of waiting are needed. Strategies to increase this satisfaction level could focus on providing more comfortable waiting environments, such as shelter, seating, and amenities.

Table 14. Satisfaction with comfort of the journey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	84	19.8	20.0	20.0
	Mostly dissatisfied	106	25.0	25.3	45.3
	Both satisfied and dissatisfied	119	28.1	28.4	73.7
	Mostly satisfied	59	13.9	14.1	87.8
	Completely satisfied	51	12.0	12.2	100.0
	Total	419	98.8	100.0	
Missing	System	5	1.2		
Total		424	100.0		

Almost half of all respondents (45.3%) are not satisfied at all or mostly dissatisfied with the comfort of the journey. On the other hand, only 12.2% are completely satisfied with the comfort of the journey.

The 20.0% who are not satisfied at all and the 25.0% who are mostly dissatisfied indicate areas where improvements in the comfort of the journey are needed. Strategies to build and increase this satisfaction level could focus on improving seating comfort, temperature control, minimizing disruptions during travel etc.

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Table 15. Satisfaction with availability of seats

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	78	18.4	18.7	18.7
	Mostly dissatisfied	112	26.4	26.8	45.5
	Both satisfied and dissatisfied	129	30.4	30.9	76.3
	Mostly satisfied	53	12.5	12.7	89.0
	Completely satisfied	46	10.8	11.0	100.0
	Total	418	98.6	100.0	
Missing	System	6	1.4		
Total		424	100.0		

A majority of respondents (45.5%) are not satisfied at all or mostly dissatisfied with the availability of seats. Only 23.7% are mostly satisfied or completely satisfied with the availability of seats.

The 18.7% who are not satisfied at all and the 26.4% who are mostly dissatisfied indicate areas where improvements in the availability of seats are needed. Policies to potentially increase this satisfaction level could focus on ensuring adequate seating capacity during peak times and improving the layout of seating within vehicles.

Table 16. Satisfaction with cleanliness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	74	17.5	17.7	17.7
	Mostly dissatisfied	91	21.5	21.8	39.6
	Both satisfied and dissatisfied	107	25.2	25.7	65.2
	Mostly satisfied	74	17.5	17.7	83.0
	Completely satisfied	71	16.7	17.0	100.0
	Total	417	98.3	100.0	
Missing	System	7	1.7		
Total		424	100.0		

Almost 40% of respondents are dissatisfied (either not satisfied at all or mostly dissatisfied) with cleanliness; 34.7% of respondents are satisfied (either mostly satisfied or completely satisfied). A significant portion (25.7%) has mixed feelings about cleanliness.

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Table 17. Satisfaction with information availability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	68	16.0	16.2	16.2
	Mostly dissatisfied	77	18.2	18.4	34.6
	Both satisfied and dissatisfied	102	24.1	24.3	58.9
	Mostly satisfied	76	17.9	18.1	77.1
	Completely satisfied	96	22.6	22.9	100.0
	Total	419	98.8	100.0	
Missing	System	5	1.2		
Total		424	100.0		

Most of respondents (41%) are satisfied (either mostly satisfied or completely satisfied); 34.6% of respondents are dissatisfied (either not satisfied at all or mostly dissatisfied) with information availability. Also, a significant portion (24.3%) has mixed feelings about information availability. The respondents who are dissatisfied highlight a critical area for improvement. Steps should be taken to identify specific issues causing dissatisfaction and address them effectively. Strategies that could help in this direction are Real-Time information systems, enhanced communication channels (e.g. social media) etc.

Table 18. Satisfaction with ease of connection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	54	12.7	12.9	12.9
	Mostly dissatisfied	99	23.3	23.7	36.7
	Both satisfied and dissatisfied	138	32.5	33.1	69.8
	Mostly satisfied	76	17.9	18.2	88.0
	Completely satisfied	50	11.8	12.0	100.0
	Total	417	98.3	100.0	
Missing	System	7	1.7		
Total		424	100.0		

A significant portion of respondents, 36.6%,, are dissatisfied with the ease of connection. This indicates that more than one-third of the respondent's experience difficulties when transferring between buses or other forms of transport. This may reflect issues such as long waiting times, poorly synchronized schedules, or complicated transfer processes. Almost third of respondents (30%) are generally satisfied with the ease of connection. Also, 32.5% of respondents have mixed feelings about the ease of connection. These individuals might have experienced inconsistent service or found the connection process acceptable but not optimal.

Based on our data, numerous steps can be taken to improve satisfaction with ease of connection such as: improved scheduling, Real-Time updates, increased frequency etc.

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Table 19. Satisfaction with station proximity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	39	9.2	9.3	9.3
	Mostly dissatisfied	48	11.3	11.5	20.8
	Both satisfied and dissatisfied	124	29.2	29.7	50.5
	Mostly satisfied	97	22.9	23.2	73.7
	Completely satisfied	110	25.9	26.3	100.0
	Total	418	98.6	100.0	
Missing	System	6	1.4		
Total		424	100.0		

Majority of respondents, almost one half, are mostly satisfied and completely satisfied with the proximity of public transport stations. They likely find stations conveniently located, accessible, and well-integrated into their travel patterns.

On the other hand, these categories (Not satisfied at all and mostly dissatisfied) account for 20.8% of responses. This indicates that about fifth of respondents are dissatisfied with the proximity of public transport stations. Reasons could include stations being far from residential or commercial areas, inconvenient access points, etc.

Based on our data, we can recommend some policies to improve satisfaction with station proximity such as integration with urban planning and accessibility improvements.

Table 20. Satisfaction with safety

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	39	9.2	9.3	9.3
	Mostly dissatisfied	77	18.2	18.4	27.8
	Both satisfied and dissatisfied	142	33.5	34.0	61.7
	Mostly satisfied	85	20.0	20.3	82.1
	Completely satisfied	75	17.7	17.9	100.0
	Total	418	98.6	100.0	
Missing	System	6	1.4		
Total		424	100.0		

Majority of respondents (38.2%) are mostly satisfied and completely satisfied. About a quarter of respondents are dissatisfied with the safety of public transport. Reasons could include concerns about crime, lack of security measures etc. Policy recommendations to enhance satisfaction with the safety of public transport can include infrastructure improvements and better security measures.

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Table 21. Satisfaction with environmental impact

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	66	15.6	15.8	15.8
	Mostly dissatisfied	90	21.2	21.5	37.3
	Both satisfied and dissatisfied	149	35.1	35.6	73.0
	Mostly satisfied	65	15.3	15.6	88.5
	Completely satisfied	48	11.3	11.5	100.0
	Total	418	98.6	100.0	
Missing	System	6	1.4		
Total		424	100.0		

Dissatisfied respondents account for 37.3% of responses. This suggests that over a third of respondents are not satisfied or have significant concerns about the environmental impact of public transport. Reasons could include emissions, noise pollution etc. Mostly satisfied and completely satisfied make up 27.1% of responses, indicating that just over a quarter of respondents are satisfied with the environmental impact of public transport. They likely perceive public transport as best available option regarding environmental impact.

The data reflects a mixed sentiment regarding satisfaction with the environmental impact of public transport. Some of the most efficient policies to enhance satisfaction with the environmental impact of public transport are transition to cleaner technologies, promotion of sustainable practices and awareness campaigns.

Table 22. Satisfaction with cost of transportation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not satisfied at all	46	10.8	11.0	11.0
	Mostly dissatisfied	87	20.5	20.8	31.8
	Both satisfied and dissatisfied	125	29.5	29.9	61.7
	Mostly satisfied	77	18.2	18.4	80.1
	Completely satisfied	83	19.6	19.9	100.0
	Total	418	98.6	100.0	
Missing	System	6	1.4		
Total		424	100.0		

Responses are, somewhat, equally distributed. Most of respondents (38.3%) are satisfied with the cost of transportation. They likely find the cost reasonable or feel they receive adequate value for the money spent. On the other hand, categories "Not satisfied at all" and "Mostly dissatisfied" account for 31.8% of responses. This suggests that a significant proportion of respondents have concerns or are dissatisfied with the current cost of transportation. Reasons could include affordability issues, perceived lack of value for money, or comparison with other transport options.

Based on our data, recommendations can include service improvements and price adjustment (even making public transport free through subsidies) in order to make public transport just and available for everyone, including low-income individuals.

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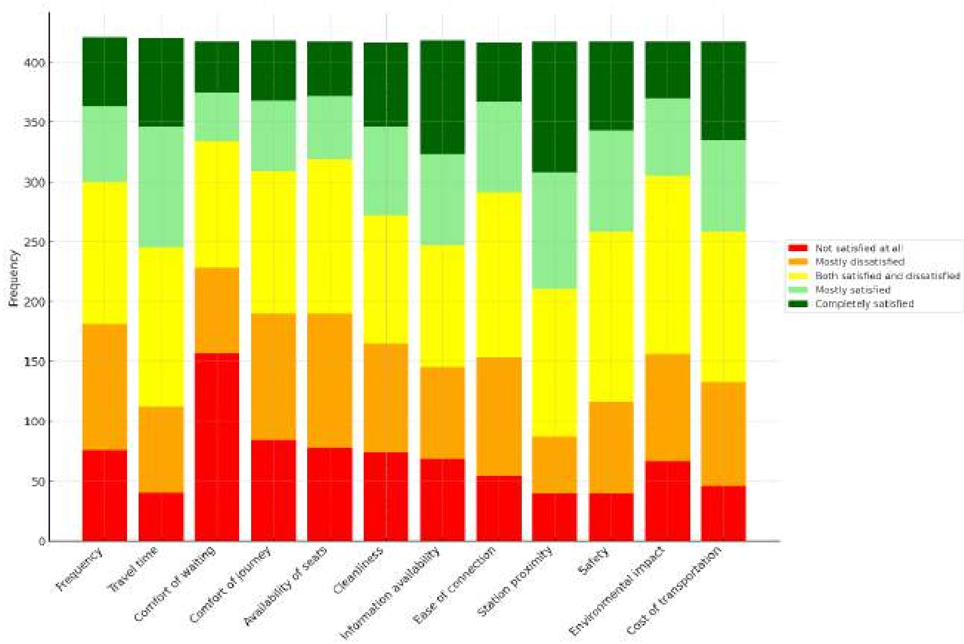

Figure 5. User satisfaction with various aspect of public transport. *Source: Author's elaboration*

Next 12 questions refer to what respondents consider or perceive as important regarding various aspects of public transport in Kragujevac.

Table 23. Importance of various aspects of public transport

		Importance of frequency	Importance of travel time	Importance of comfort of waiting	Importance of comfort of the journey	Importance of availability of seats	Importance of cleanliness
N	Valid	415	414	415	414	414	414
	Missing	9	10	9	10	10	10
Mean		4.3614	4.2826	4.0843	4.6377	3.9807	4.4130
Median		5.0000	5.0000	5.0000	5.0000	4.0000	5.0000
Std. Deviation		1.01413	.99141	1.18775	.70221	1.17875	.93928
Variance		1.028	.983	1.411	.493	1.389	.882

		Importance of information availability	Importance of ease of connection	Importance of station proximity	Importance of safety	Importance of environmental impact	Importance of cost of transportation
N	Valid	415	415	415	414	415	415
	Missing	9	9	9	10	9	9
Mean		4.4530	4.1976	4.2771	4.4831	4.2048	4.2627
Median		5.0000	5.0000	5.0000	5.0000	5.0000	5.0000
Std. Deviation		.97410	1.03769	.94426	.94316	.99709	1.06137
Variance		.949	1.077	.892	.890	.994	1.127

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All factors have means above 4, indicating they are generally considered important by respondents. "Importance of Comfort of the Journey" has the highest mean (4.6377), suggesting it is the most critical factor for respondents (next are "Safety", and "Cleanliness"). "Importance of Availability of Seats" has the lowest mean (3.9807), indicating it is still important but comparatively less so compared to the other factors.

The median for most variables is 5, which means that at least half of the respondents rated these factors as "Very Important". The median for the "Importance of Availability of Seats" is 4, indicating a slight difference in central tendency compared to the other variables.

"Importance of Comfort of Waiting" and "Importance of Availability of Seats" have higher standard deviations (1.18775 and 1.17875, respectively) and higher variance, indicating a wider spread of responses around the mean. "Importance of Comfort of the Journey" has the lowest standard deviation (0.70221), indicating that most respondents have similar opinions about this factor.

The high means and medians suggest a general consensus that all twelve factors are important to respondents for an effective public transportation system. Policymakers should prioritize improvements in the most highly rated areas, particularly comfort of the journey, safety, and cleanliness, while also considering the diverse opinions on factors like the availability of seats and comfort of waiting.

Table 24. Importance of frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	12	2.8	2.9	2.9
	Mostly unimportant	18	4.2	4.3	7.2
	Equally important and unimportant	39	9.2	9.4	16.6
	Mostly important	85	20.0	20.5	37.1
	Very important	261	61.6	62.9	100.0
	Total	415	97.9	100.0	
Missing	System	9	2.1		
Total		424	100.0		

Main point here is that the vast majority (83.4%) of respondents consider frequency of public transport to be either "Mostly important" or "Very important". This data suggests that improving the frequency of public transportation is likely to be well-received by most of the population, as it is a crucial factor for most respondents.

Table 25. Importance of travel time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	10	2.4	2.4	2.4
	Mostly unimportant	16	3.8	3.9	6.3
	Equally important and unimportant	53	12.5	12.8	19.1
	Mostly important	103	24.3	24.9	44.0
	Very important	232	54.7	56.0	100.0
	Total	414	97.6	100.0	
Missing	System	10	2.4		
Total		424	100.0		

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A vast majority (80.9%) of respondents consider travel time to be either "Mostly important" or "Very important". On the other hand, much smaller portion (19.1%) of respondents are neutral or consider travel time to be of low importance. Our data suggests that improving travel time by public transport is s a significant factor for most respondents.

Table 26. Importance of comfort of waiting

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	26	6.1	6.3	6.3
	Mostly unimportant	17	4.0	4.1	10.4
	Equally important and unimportant	69	16.3	16.6	27.0
	Mostly important	87	20.5	21.0	48.0
	Very important	216	50.9	52.0	100.0
	Total	415	97.9	100.0	
Missing	System	9	2.1		
Total		424	100.0		

A majority (73%) of respondents consider the comfort of waiting to be either "Mostly important" or "Very important". Only a small fraction of respondents considers the comfort of waiting to be of low importance, with 4.1% saying it is "Mostly unimportant" and 6.3% indicating it is "Not important at all".

Table 27. Importance of comfort of the journey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	3	.7	.7	.7
	Mostly unimportant	5	1.2	1.2	1.9
	Equally important and unimportant	21	5.0	5.1	7.0
	Mostly important	81	19.1	19.6	26.6
	Very important	304	71.7	73.4	100.0
	Total	414	97.6	100.0	
Missing	System	10	2.4		
Total		424	100.0		

Almost all (93%) of respondents consider the comfort of the journey to be either "Mostly important" or "Very important", while only 7% of respondents are neutral or consider the comfort of the journey to be of low importance.

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Table 28. Importance of availability of seats

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	24	5.7	5.8	5.8
	Mostly unimportant	24	5.7	5.8	11.6
	Equally important and unimportant	75	17.7	18.1	29.7
	Mostly important	104	24.5	25.1	54.8
	Very important	187	44.1	45.2	100.0
	Total	414	97.6	100.0	
Missing	System	10	2.4		
Total		424	100.0		

More than 70% of respondents consider the availability of seats to be either "Mostly important" or "Very important", while less than 30% of respondents are neutral or consider the availability of seats to be of low importance.

Table 29. Importance of cleanliness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	13	3.1	3.1	3.1
	Mostly unimportant	6	1.4	1.4	4.6
	Equally important and unimportant	36	8.5	8.7	13.3
	Mostly important	101	23.8	24.4	37.7
	Very important	258	60.8	62.3	100.0
	Total	414	97.6	100.0	
Missing	System	10	2.4		
Total		424	100.0		

Almost 87% of respondents consider cleanliness to be either "Mostly important" or "Very important", while 13.2% of respondents are neutral or consider cleanliness to be of low importance.

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Table 30. Importance of information availability

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	11	2.6	2.7	2.7
	Mostly unimportant	16	3.8	3.9	6.5
	Equally important and unimportant	31	7.3	7.5	14.0
	Mostly important	73	17.2	17.6	31.6
	Very important	284	67.0	68.4	100.0
	Total	415	97.9	100.0	
Missing	System	9	2.1		
Total		424	100.0		

A significant majority (86%) of respondents consider the availability of information to be either "Mostly important" or "Very important", while about 14% of respondents are neutral or consider the availability of information to be of low importance.

Table 31. Importance of ease of connection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	11	2.6	2.7	2.7
	Mostly unimportant	21	5.0	5.1	7.7
	Equally important and unimportant	61	14.4	14.7	22.4
	Mostly important	104	24.5	25.1	47.5
	Very important	218	51.4	52.5	100.0
	Total	415	97.9	100.0	
Missing	System	9	2.1		
Total		424	100.0		

A significant majority (77.6%) of respondents consider ease of connection to be either "Mostly important" or "Very important". On the other hand, around 23% of respondents are neutral or consider ease of connection to be of low importance.

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Table 32. Importance of station proximity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	8	1.9	1.9	1.9
	Mostly unimportant	12	2.8	2.9	4.8
	Equally important and unimportant	59	13.9	14.2	19.0
	Mostly important	114	26.9	27.5	46.5
	Very important	222	52.4	53.5	100.0
	Total	415	97.9	100.0	
Missing	System	9	2.1		
Total		424	100.0		

Very significant portion (81%) of respondents consider station proximity to be either "Mostly important" or "Very important", while around 19% of respondents are neutral or consider station proximity to be of low importance.

Table 33. Importance of safety

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	12	2.8	2.9	2.9
	Mostly unimportant	9	2.1	2.2	5.1
	Equally important and unimportant	33	7.8	8.0	13.0
	Mostly important	73	17.2	17.6	30.7
	Very important	287	67.7	69.3	100.0
	Total	414	97.6	100.0	
Missing	System	10	2.4		
Total		424	100.0		

A vast majority (86.9%) of respondents consider safety to be either "Mostly important" or "Very important", while 13.1% of respondents are neutral or consider safety to be of low importance.

Table 34. Importance of environmental impact

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	12	2.8	2.9	2.9
	Mostly unimportant	12	2.8	2.9	5.8
	Equally important and unimportant	64	15.1	15.4	21.2
	Mostly important	118	27.8	28.4	49.6
	Very important	209	49.3	50.4	100.0
	Total	415	97.9	100.0	
Missing	System	9	2.1		
Total		424	100.0		

Over 78% of respondents consider environmental impact to be either "Mostly important" or "Very important". On

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the other hand, 21.8% of respondents are neutral or consider environmental impact to be of low importance.

Table 35. Importance of cost of transportation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important at all	17	4.0	4.1	4.1
	Mostly unimportant	12	2.8	2.9	7.0
	Equally important and unimportant	55	13.0	13.3	20.2
	Mostly important	92	21.7	22.2	42.4
	Very important	239	56.4	57.6	100.0
	Total	415	97.9	100.0	
Missing	System	9	2.1		
Total		424	100.0		

Almost 80% of respondents consider the cost of transportation to be either "Mostly important" or "Very important", while around 20% of respondents are neutral or consider the cost of transportation to be of low importance.

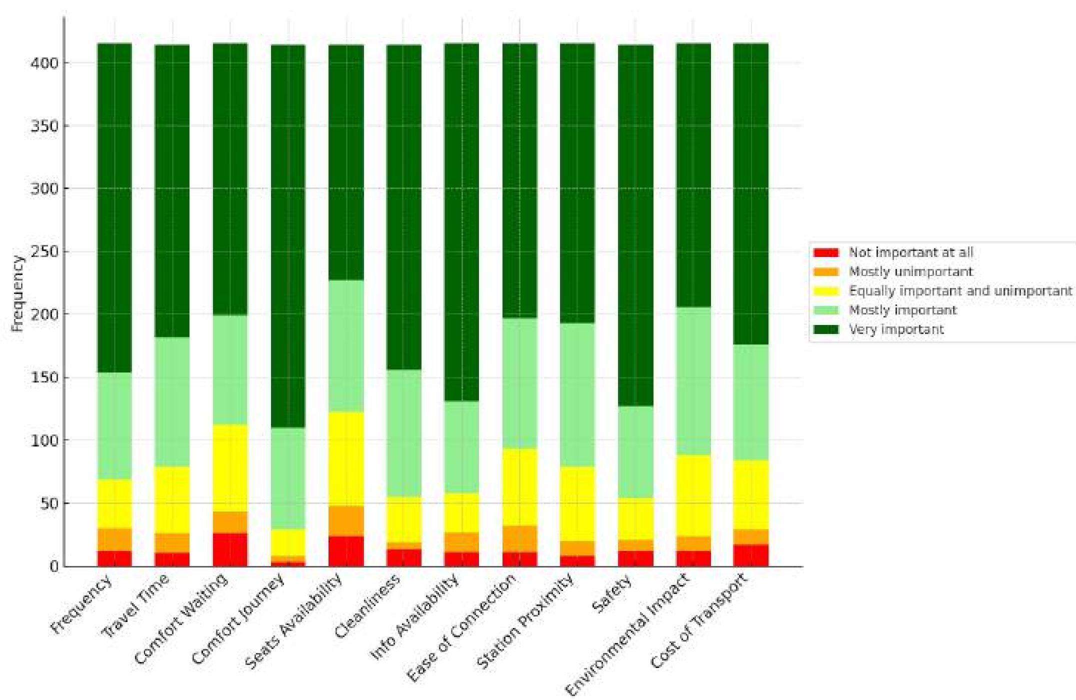

Figure 6. User perceptions of the importance of various aspects of public transport. *Source: Author's elaboration*

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Table 36. Advantages of electric buses

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	147	34.7	36.2	36.2
	No	259	61.1	63.8	100.0
	Total	406	95.8	100.0	
Missing	System	18	4.2		
Total		424	100.0		

A majority of respondents (63.8%) are not familiar or does not recognize advantages of electric buses. On the other hand, 36.2% of respondents see benefits or advantages in using electric buses. Understanding the reasons behind the negative perception or (most likely) lack of information can help in addressing concerns related to the adoption of electric buses, such as cost or performance. Promoting the advantages that electric buses offer, such as reduced emissions and lower operating costs, could potentially increase familiarity and acceptance among respondents and the broader community.

Table 37. Willingness to use electric buses

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	376	88.7	89.7	89.7
	No	43	10.1	10.3	100.0
	Total	419	98.8	100.0	
Missing	System	5	1.2		
Total		424	100.0		

A significant majority, 89.7% of the valid respondents, indicated they are willing to use electric buses. This indicates strong support for the adoption of electric buses among the survey participants. Only 10.3% of the valid respondents are not willing to use electric buses.

The high willingness to use electric buses suggests that introducing electric buses in Kragujevac could be well-received by the public. This provides a solid foundation for implementing such an initiative. Understanding the concerns of the 10.3% who are unwilling to use electric buses can help in creating targeted communication and addressing any barriers to adoption, such as concerns about cost or reliability. The strong support for electric buses can be used to justify policy decisions, investments, and initiatives aimed at improving the public transport system with more sustainable options.

Our data highlights the overall positive attitude towards electric buses, indicating a favorable environment for introducing electric bus services in Kragujevac.

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Table 38. Opinion on additional transfer affecting decision

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	115	27.1	30.0	30.0
	No	268	63.2	70.0	100.0
	Total	383	90.3	100.0	
Missing	System	41	9.7		
Total		424	100.0		

Of all valid respondents that are willing to use electric buses only 30% indicated that an additional transfer would affect their decision to use electric buses. This suggests that for almost a third of the respondents, the convenience of their journey is a significant factor. A majority (70%) of valid respondents indicated that an additional transfer would not affect their decision. This suggests a willingness to accommodate minor inconveniences for the benefits offered by electric buses. Either way, ensuring minimal transfers or providing convenient transfer options (e.g. investing in infrastructure that facilitates easy transfers such as well-designed hubs) could enhance satisfaction and adoption rates.

Cross-tabulation and Chi-square Tests

We have used cross-tabulation to examine relationships between two variables. With Chi-square test we assessed the statistical significance of the relationships. We performed chi-square tests for key pairs of categorical variables, so we can uncover significant relationships and patterns in our survey data. Only instances where there is statistically significant association between the two categorical variables are reported.

First, we will examine relationship between age group and all other variables. There is a significant relationship between age group and:

1. frequency of public transport use ($\chi^2 = 40.092$, $p < .001$);
2. most common purpose of travel ($\chi^2 = 285.640$, $p < .001$);
3. the type of ticket ($\chi^2 = 53.521$, $p < .001$);
4. changing bus lines on the journey ($\chi^2 = 15.266$, $p < .05$);
5. willingness to pay a higher price ($\chi^2 = 42.183$, $p < .001$);
6. car ownership or access ($\chi^2 = 29.372$, $p < .001$);
7. satisfaction with comfort of journey ($\chi^2 = 25.103$, $p < .05$);
8. satisfaction with availability of seats ($\chi^2 = 26.195$, $p < .05$);
9. importance of frequency ($\chi^2 = 28.572$, $p < .05$);
10. importance of comfort of waiting ($\chi^2 = 22.563$, $p < .05$);
11. importance of information availability ($\chi^2 = 22.047$, $p < .05$);
12. importance of information safety ($\chi^2 = 21.114$, $p < .05$);

Also, we will examine relationship between education level and all other variables. There is a significant relationship between education level and:

1. frequency of public transport use ($\chi^2 = 37.730$, $p < .001$);
2. most common purpose of travel ($\chi^2 = 28.519$, $p < .05$);
3. the type of ticket ($\chi^2 = 14.536$, $p < .05$);
4. changing bus lines on the journey ($\chi^2 = 14.105$, $p < .05$);
5. willingness to pay a higher price ($\chi^2 = 27.013$, $p < .001$);
6. amount willing to pay compared to current price ($\chi^2 = 17.719$, $p < .05$);

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7. car ownership or access (χ^2 = 24.167, p < .001);
8. satisfaction with frequency (χ^2 = 30.466, p < .001);
9. satisfaction with comfort of waiting (χ^2 = 63.266, p < .001);
10. satisfaction with comfort of journey (χ^2 = 28.118, p < .001);
11. satisfaction with cleanliness (χ^2 = 23.320, p < .05);
12. satisfaction with ease of connection (χ^2 = 23.550, p < .05);
13. satisfaction with safety (χ^2 = 24.767, p < .05);
14. satisfaction with environmental impact (χ^2 = 28.417, p < .001);
15. importance of travel time (χ^2 = 17.716, p < .05);
16. importance of comfort of waiting (χ^2 = 24.654, p < .05);
17. importance of availability of seats (χ^2 = 23.449, p < .05);
18. importance of cleanliness (χ^2 = 25.230, p < .05);
19. importance of environmental impact (χ^2 = 17.408, p < .05);

However, in few cases the presence of low expected counts in some categories is a limitation, as it can affect the test's validity. This suggests a need for caution in interpreting the results.

Next, it is important to examine relationship between familiarity with advantages of electric buses and other variables. It's interesting to notice that there is only significant relationship between familiarity with advantages of electric buses and:

1. most common purpose of travel (χ^2 = 14.377, p < .05);
2. the type of ticket (χ^2 = 8.465, p < .05);
3. car ownership or access (χ^2 = 11.503, p < .05);
4. satisfaction with environmental impact (χ^2 = 11.949, p < .05);
5. satisfaction with cleanliness (χ^2 = 11.838, p < .05);
6. satisfaction with availability of seats (χ^2 = 10.644, p < .05);

On the other hand, there is a significant relationship between willingness to use electric buses and many other variables in our survey:

1. frequency of public transport use (χ^2 = 14.289, p < .05);
2. most common purpose of travel (χ^2 = 12.537, p < .05);
3. the type of ticket (χ^2 = 10.283, p < .05);
4. satisfaction with comfort of journey (χ^2 = 9.623, p < .05);
5. satisfaction with cleanliness (χ^2 = 10.393, p < .05);
6. importance of frequency (χ^2 = 18.968, p < .05);
7. importance of travel time (χ^2 = 20.242, p < .001);
8. importance of comfort of waiting (χ^2 = 15.720, p < .05);
9. importance of comfort of journey (χ^2 = 12.065, p < .05);
10. importance of cleanliness (χ^2 = 27.701, p < .001);
11. importance of information availability (χ^2 = 12.958, p < .05);
12. importance of with ease of connection (χ^2 = 12.119, p < .05);
13. importance of information safety (χ^2 = 11.175, p < .05);
14. importance of environmental impact (χ^2 = 14.006, p < .05);
15. importance of cost of transportation (χ^2 = 12.357, p < .05);

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T-tests/Analysis of Variance (ANOVA)

We are using independent samples t-tests or ANOVA to compare groups. First, we will compare mean willingness to use electric buses across different groups - car owners/users vs. non-car owners/users. For this we will conduct independent samples t-test.

Table 39. Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Willingness to use electric buses	Equal variances assumed	.052	.820	-.114	417	.909	-.00344	.03021	-.06282	.05594
	Equal variances not assumed			-.113	364.341	.910	-.00344	.03029	-.06301	.05614

Levene's Test for Equality of Variances - In this case, the p-value (.820) is greater than .05. This suggests that there is no significant difference in variances between the groups.

The t-test shows a t-value of -0.114 and a p-value of .909. This indicates that there is no significant difference in willingness to use electric buses between the groups. Based on the results, there is no evidence to suggest a statistically significant difference in willingness to use electric buses between the groups car owners/users vs. non-car owners/users.

Next, before we use ANOVA to compare the means of six groups (question - How often do you use public transport services?) to determine if there are statistically significant differences between them we should test homogeneity of variances.

Table 40. Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Willingness to use electric buses	Based on Mean	9.647	5	412	.000
	Based on Median	2.917	5	412	.013
	Based on Median and with adjusted df	2.917	5	346.004	.014
	Based on trimmed mean	9.566	5	412	.000

All four tests indicate significant differences in variances among the groups based on the frequency of public transport use. Since the assumption of homogeneity of variances is violated (p-value < 0.05), we will use the Kruskal-Wallis test, for analyzing the differences in willingness to use electric buses among different groups.

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Table 41. Ranks

	Frequency of public transport use	N	Mean Rank
Willingness to use electric buses	Daily	168	209.15
	4 to 6 days a week	63	201.27
	1 to 3 days a week	65	204.08
	1 to 3 days a month	43	197.72
	Less than one day a month	48	240.25
	I do not use it at all	31	208.23
	Total	418	

Table 42. Test Statistics[a,b]

	Willingness to use electric buses
Kruskal-Wallis H	14.255
df	5
Asymp. Sig.	.014

a. Kruskal Wallis Test

b. Grouping Variable: Frequency of public transport use

These ranks provide a relative measure of willingness to use electric buses across different frequencies of public transport use. Generally, higher ranks indicate a higher willingness, while lower ranks indicate a lower willingness based on the survey respondents' responses.

Daily: The mean rank is 209.15, suggesting that on average, respondents who use public transport daily have a higher willingness to use electric buses compared to other frequency categories.

- 4 to 6 days a week: The mean rank is 201.27.
- 1 to 3 days a week: The mean rank is 204.08.
- 1 to 3 days a month: The mean rank is 197.72, indicating a lower willingness compared to more frequent users.
- Less than one day a month: The mean rank is 240.25, suggesting these users have the highest willingness among all categories.
- I do not use it at all: The mean rank is 208.23.

Since the p-value (0.014) is less than the conventional significance level of 0.05, we reject the null hypothesis. Based on the Kruskal-Wallis test results, there is sufficient evidence to conclude that there are statistically significant differences in willingness to use electric buses across the different frequencies of public transport use groups. This means that the frequency with which individuals use public transport appears to influence their willingness to use electric buses, with some groups showing higher or lower levels of willingness compared to others.

Finally, we will do the same analysis for another variable – question What is the most common purpose of your travel when using public transport?

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Table 43. Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Willingness to use electric buses	Based on Mean	10.905	5	406	.000
	Based on Median	2.548	5	406	.028
	Based on Median and with adjusted df	2.548	5	333.798	.028
	Based on trimmed mean	9.725	5	406	.000

Table 44. Ranks

	Most common purpose of travel	N	Mean Rank
Willingness to use electric buses	Traveling to/from work	200	207.13
	Going to school/university	59	192.48
	Shopping	21	224.74
	Recreational reasons	35	197.27
	Visiting family/friends	33	191.74
	Other reasons	64	224.13
	Total	412	

Table 45. Test Statistics[a,b]

	Willingness to use electric buses
Kruskal-Wallis H	12.506
df	5
Asymp. Sig.	.028

a. Kruskal Wallis Test

b. Grouping Variable: Most common purpose of travel

Results are as follows:

In all variants of Levene's test (based on mean, median, adjusted median, and trimmed mean), the p-values are less than .05. Therefore, we conclude that there are statistically significant differences in the variances of willingness to use electric buses across different categories of the most common purpose of travel. Since the assumption of homogeneity of variances required for ANOVA may not hold we will also perform Kruskal-Wallis test.

- Traveling to/from work: The mean rank is 207.13
- Going to school/university: The mean rank is 192.48
- Shopping: The mean rank is 224.74, suggesting these users have the highest willingness among all categories.
- Recreational reasons: The mean rank is 197.27
- Visiting family/friends: The mean rank is 191.74, indicating a lower willingness compared to other groups.

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- Other reasons: The mean rank is 224.13

Since the p-value (.028) is less than .05, we reject the null hypothesis. This indicates that there is a statistically significant difference in willingness to use electric buses across different categories of the most common purpose of travel (e.g., traveling to/from work, going to school/university, shopping, recreational reasons, visiting family/friends, and other reasons). The results suggest that the purpose for which individuals use public transport significantly influences their willingness to use electric buses.

Correlation Analysis

We are using correlation analysis to explore relationships between satisfaction and importance ratings. Only the statistically significant at 5% significance level are reported.

Table 46. Pearson correlation matrix

	Satisfaction with frequency	Satisfaction with travel time	Satisfaction with comfort of waiting	Satisfaction with comfort of the journey	Satisfaction with availability of seats	Satisfaction with cleanliness	Satisfaction with information availability	Satisfaction with ease of connection	Satisfaction with station proximity	Satisfaction with safety	Satisfaction with environmental impact	Satisfaction with cost of transportation	Importance of frequency	Importance of travel time	Importance of comfort of waiting	Importance of comfort of the journey	Importance of availability of seats	Importance of cleanliness	Importance of information availability	Importance of ease of connection	Importance of station proximity	Importance of safety	Importance of environmental impact	Importance of cost of transportation
Satisfaction with frequency																								
Satisfaction with travel time	0.7																							
Satisfaction with comfort of waiting	0.517	0.421																						
Satisfaction with comfort of the journey	0.531	0.537	0.608																					
Satisfaction with availability of seats	0.503	0.487	0.541	0.654																				
Satisfaction with cleanliness	0.429	0.475	0.433	0.668	0.554																			
Satisfaction with information availability	0.447	0.39	0.439	0.43	0.4	0.5																		
Satisfaction with ease of connection	0.587	0.564	0.462	0.442	0.516	0.425	0.512																	
Satisfaction with station proximity	0.453	0.448	0.355	0.362	0.407	0.329	0.372	0.517																
Satisfaction with safety	0.438	0.431	0.49	0.504	0.484	0.548	0.451	0.472	0.486															
Satisfaction with environmental impact	0.479	0.445	0.497	0.522	0.503	0.539	0.341	0.477	0.355	0.6														
Satisfaction with cost of transportation	0.441	0.495	0.361	0.494	0.432	0.492	0.369	0.449	0.361	0.445	0.443													
Importance of frequency	0.171	0.132		0.132				0.139	0.139	0.106	0.108	0.112												
Importance of travel time	0.161	0.176	0.128	0.16		0.131	0.166	0.182		0.13	0.158	0.157	0.581											
Importance of comfort of waiting	0.113		0.144	0.212	0.12			0.128		0.105	0.157	0.169	0.5	0.556										
Importance of comfort of the journey													0.231	0.168	0.257									
Importance of availability of seats	0.105		0.195	0.154	0.148		0.139	0.163			0.196	0.139	0.332	0.471	0.51	0.16								
Importance of cleanliness	0.17	0.158	0.143	0.195	0.121	0.14	0.126	0.191	0.106	0.153	0.176	0.251	0.519	0.579	0.605	0.238	0.537							
Importance of information availability	0.144	0.146	0.128	0.124	0.107	0.141	0.214	0.159	0.163	0.139	0.13	0.158	0.496	0.509	0.57	0.197	0.423	0.672						
Importance of ease of connection			0.11	0.12	0.11		0.143	0.19			0.122	0.13	0.494	0.522	0.612	0.228	0.442	0.549	0.58					
Importance of station proximity	0.118	0.169	0.128	0.219	0.149	0.12	0.132	0.243	0.119	0.115	0.148	0.19	0.453	0.485	0.526	0.179	0.489	0.499	0.556	0.585				
Importance of safety	0.129	0.163	0.12	0.17			0.106	0.185	0.16	0.17	0.172	0.159	0.491	0.529	0.58	0.172	0.423	0.597	0.655	0.588	0.611			
Importance of environmental impact	0.103		0.199				0.126	0.157				0.169	0.359	0.421	0.491	0.151	0.379	0.497	0.479	0.458	0.435	0.596		
Importance of cost of transportation		0.162	0.113					0.164	0.121	0.112	0.117	0.163	0.34	0.462	0.442	0.189	0.329	0.491	0.441	0.435	0.498	0.467	0.392	

Positive Very Strong relationship (0.90-1.00)
Positive Strong relationship (0.70-0.89)
Positive Moderate relationship (0.40-0.69)
Positive Weak relationship (0.10-0.39)

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Table 46 highlights the most important statistically significant moderate Pearson correlations, ranging from 0.40 to 0.69. **Satisfaction with comfort of the journey & Importance of information availability (r = 0.668):** People who value having information available tend to be more satisfied with the comfort of their journeys. It suggests that real-time updates or clear communication enhances comfort perception. **Importance of information availability & Importance of safety (r = 0.655):** Those who highly value safety also tend to prioritize access to information—possibly seeing both as part of a reliable and secure transit experience. **Importance of comfort of waiting & Importance of ease of connection (r = 0.612):** Individuals who care about waiting comfort also care about how easily they can connect to other services. Both relate to the smoothness of the overall transit experience. **Importance of comfort of waiting & Importance of cleanliness (r = 0.605):** Cleanliness appears tied to waiting comfort—highlighting how aesthetic and hygienic conditions can influence overall satisfaction. **Importance of cleanliness & Importance of safety (r = 0.597):** Clean environments might psychologically signal safety, leading to a perception that these two go hand-in-hand. **Importance of ease of connection & Importance of safety (r = 0.588):** Easy transfers and connections may contribute to feelings of security—especially when navigating complex or unfamiliar systems. **Satisfaction with frequency & Satisfaction with ease of connection (r = 0.587):** Frequent service often enables better connections—so satisfaction with one likely boosts satisfaction with the other. **Importance of comfort of waiting & Importance of safety (r = 0.580):** Those concerned with wait-time comfort also care about safety, possibly reflecting concerns during longer wait periods in public spaces. **Importance of travel time & Importance of cleanliness (r = 0.579):** Those who prioritize shorter travel times also value clean environments—indicating a broader preference for efficiency and quality. **Importance of comfort of waiting & Importance of information availability (r = 0.570):** Access to timely information likely improves the comfort of waiting, reducing anxiety and uncertainty.

Scenario development

Reducing the negative effects of urban transport and achieving sustainable urban mobility can be realized by applying various policies from the domain of urban planning and land use as well as transport policy.

These measures and their immediate effects can be described as follows:

1. measures to reduce the total needs for transport in the city - reduction of the total volume of vehicle-kilometers traveled or the total volume of passenger kilometers traveled by urban transport;
2. measures to improve the technical-technological efficiency of vehicles and fuel - reduction of air pollutants, energy consumption and/or CO_2 emissions per vehicle-kilometer driven by different types of urban transport;
3. measures limiting the use of private motor vehicles - reducing the total volume of vehicle-kilometers traveled by cars and motorcycles;
4. measures promoting sustainable forms of urban transport (public transport, bicycle and walking) – increasing the share of public transport, bicycle use and walking in the total number of trips and the total volume of passenger kilometers traveled (Vračarević, 2023).

In defining our scenarios, we focused on the area of transport policy, although actions from that domain alone obviously cannot unlock the full potential of sustainable urban mobility. The reason for this is that policies from the domain of urban planning are more difficult to realize in practice and a very long period of time is needed to be properly defined through adequate planning and strategic documents and later (at least partially) implemented. The importance of what has been said is even greater in the conditions and ambient that characterizes our country - a very large bureaucracy, significant political influence and thus marked uncertainty.

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The impact of urban development and urban form on transport patterns in Kragujevac, as well as their interdependence, can be the basis of future research that will rely on the results of this one.

Therefore, in addition to curbing need for mobility, it is also necessary to carry out a structural shift towards the use of those types of urban transport, which are the most desirable from the environmental and social point of view - to public transport and non-motorized transport. Since most trips in urban areas do not exceed a length of five kilometers, it is clear that there is considerable space for stimulating walking and bicycle use. For longer journeys, an alternative to the car is public transport (Vračarević, 2023).

Of great importance for our analysis is the significantly higher energy efficiency of public transport compared to private cars. Private vehicles consume on average 2-3 MJ/pkm, diesel buses nearly 1 MJ/pkm while light rail systems consume only 0.3 MJ/pkm (Schafer and Victor, 1999). These drastic differences in energy consumption also result in significantly lower CO_2 emissions per passenger kilometer traveled by public transport. While cars produce between 124.2g and 130.9g (depending on whether they use oil or gasoline), buses emit 89.1g and rail systems only 60.2g of CO_2 per passenger kilometer (Santos, Behrendt and Teytelboym, 2010).

The essence of all mentioned policies aimed at sustainable urban development and sustainable urban mobility is perhaps best described by Banister (Banister, 2008) when he points out that a complete change of approach in transport planning is necessary - from physical dimensions - to social ones, from a mobility paradigm - to an accessibility paradigm, from motorized - to all types of urban transport, from the segregation of people and transport - to their integration.

Based on the policy context and structured discussions with stakeholders, we have developed four scenarios to explore the impact of possible transition pathways within the scope of sustainable urban mobility in Kragujevac. These scenarios aim to address the challenges and opportunities related to different aspects of urban transport. They are ordered from the easiest to the most difficult to achieve in practice.

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Table 47. Scenario development

Scenario 0 - (Baseline Scenario)	Scenario 1 – "Green baby steps"	Scenario 2 – "Moderate transition"	Scenario 3 – "(Almost) sustainable mobility"
Continuation of current trends in urban transport and urban development without any new interventions and policies.	City central zone served by free electric buses, because of which the expected goals will be reached: reduced air pollution and greenhouse gas emissions, lower energy consumption, stimulated public transport use, decreased traffic congestion.	City central zone served by free electric buses and limited parking opportunities in and around the central zone as a result of which the expected goals will be reached: reduced air pollution and greenhouse gas emissions, lower energy consumption, stimulated public transport use, decreased traffic congestion, discouraged private car use, promoted walking and cycling, reclaimed urban space for public use.	City central zone served by free electric buses, limited parking opportunities in and around the central zone and lower number of private vehicles in central zone with decreased traffic intensity as a result of which the expected goals will be reached: reduced air pollution and greenhouse gas emissions, lower energy consumption, stimulated public transport use, decreased traffic congestion, discouraged private car use, promoted walking and cycling, reclaimed urban space for public use, generated revenue for sustainable mobility investments, improved urban mobility and quality of life through an integrated approach.

Scenario 0 - (Baseline Scenario)

The urban system of Kragujevac, as well as the cities of a similar size, is heavily burdened by intense traffic and frequent traffic jams, which result in increased travel time to a certain destination, higher fuel consumption, significant air and soil pollution, as well as dissatisfaction of citizens and other transport consumers. Special problems occur in the central areas of the city, which suffer from special pressure and additional load. Public transport, which is reduced to the use of conventional buses and taxis, faces similar problems, multiplied by an insufficiently dispersed urban matrix, narrow and impassable streets, the absence of yellow lanes on all routes, etc. The area that was treated is rectangular in shape, with an area of 154 ha, and includes mainly commercial and residential content, along with many public buildings, a pedestrian zone, a part of greenery and protected cultural content. That's why it is attractive to many users who do business or live there. Accessibility to this zone is ensured, apart from individual vehicles, through 45 lines of city traffic, which bring a large percentage of consumers of about 30,000 users of public transport per day. A pronounced concentration is especially present on border traffic dominants (Nikole Pašića Street and others). Kragujevac average inhabitants` mobility, determined by the household survey, amounts to 2.21 trips per day, which if applied to the number of the population of Kragujevac (about 152,400), results in 336,750-day trips. The network of system lines of the public urban and suburban passenger transport in the city of Kragujevac consists of 35 network lines with a total operational length of 641.66km. Looking at the subsystems, the city network consists of 23 lines with a total operational length of 301.38km. The suburban subsystem has a network of 12 lines with an operational length of 340.28 km. The first departures in public city and suburban transport start at 03:50 AM, and the last departure is at 11:15 PM. Peak periods are from 05:00 to 08:00 AM, 12:30 to 4:00 PM, and 6:00 to 8:00 PM. During these times, the highest number of departures occur. Public city and suburban transport in Kragujevac operate with 65 vehicles in service, including 31 diesel-powered and 34 CNG-powered vehicles. Approximately 40% of the total daily mileage covered by diesel vehicles is within the central zone, totalling around 3,400 km per working day. In the entire central zone, there are approximately 4,000 marked parking spaces, which represents potentially sufficient space for stationary traffic. Although most spaces are nearly permanently occupied by residential parking, the low parking fees and the presence of parking lots in the city center itself further motivate increased traffic into this zone.

Strictly speaking, for the central zone of the city of Kragujevac (defined area, around 1.200ha), there are no precise measurements of noise pollution, air pollution levels during peak hours, etc., but they are more pronounced than in other areas. The same applies to the counting of total traffic. This is planned to be conducted during the preparation of the Traffic Study for the city of Kragujevac.

In the broader urban area of Kragujevac, approximately 146,000 residents live, marking a decrease of about 7.5% compared to the previous census year (2011). However, it is expected that due to ongoing migratory movements, especially from rural to urban areas, this negative trend will stabilize. Kragujevac, as the economic center of the region and even the Republic, with a significant car industry and complementary industrial base (FIAT), an established economic zone for high-tech industries and science (MIND park) and completed transportation links with Serbia's major development corridors (European Corridor X), anticipates in the city's planning documents that the population will increase by 10% by 2030.

As this is predominantly a commercial, administrative and residential zone, overall traffic (both public and private) is at an extremely high level. During certain peak hours, congestion is significant, travel times are extended, and pollution levels increase. Consequently, this reduces the quality of life and work in the area, potentially leading to an increase in respiratory and other illnesses and necessitating high costs for remediation of such situations.

We reject the baseline scenario as unacceptable because the city is developing in an unsustainable way and suffers a lot of negative effects of urban transport at the local, regional level, as well as contributing to key environmental problems at the global level.

Scenario 1, The idea involves combining technical innovations, urban planning solutions, synchronized development policies and the support of the city administration and local public institutions. Further on, the implementation of such a scenario would be the basis for the development of the Public Urban Mobility Strategy and its incorporation into the General Urban Plan that will soon be developed for the construction area of the Kragujevac settlement.

The research will include the development of a possible scenario that follows. Conventional buses (diesel fuel) will drive to the border of the treated territory and drop off passengers at a properly distributed number of stops. It was also assumed that the existing parking lots will be used and a minimum of two new ones will be built for individual vehicles (at the border itself or within the zone, which is the current situation). The third thing is the construction of at least one new street that would improve the accessibility of the central area and relieve the already overloaded roads. The second part includes a detailed elaboration of the idea to completely ban the use of classic city transport vehicles within it and introduce electric buses to replace them. They would move along the border of the territory, but also within it, where the aim would be to ensure a 5-minute isochron from every place in the center to the electric bus station. Individual vehicles would have the possibility of entry, but with the policy of charging for parking, demotivating staying or reducing the time of communication or access to certain parts of the zone, it would be gradually reduced. What's more, with the final realization of the scenario, it would be expected to increase citizens' interest in using this type of transport and restore confidence in the reliability of public transport. Technically, it is necessary to work out special places for charging and servicing buses near the route, speed of reaction in cases of unplanned events, replacement vehicles, when necessary, etc. In parallel with the traffic transformation process, the use of smart technologies that contribute to its better implementation will be ensured (solar panels at stations, information system, sensors on buses that measure pollution, an improved ticket sales and verification system, horizontal and vertical markings, etc.)

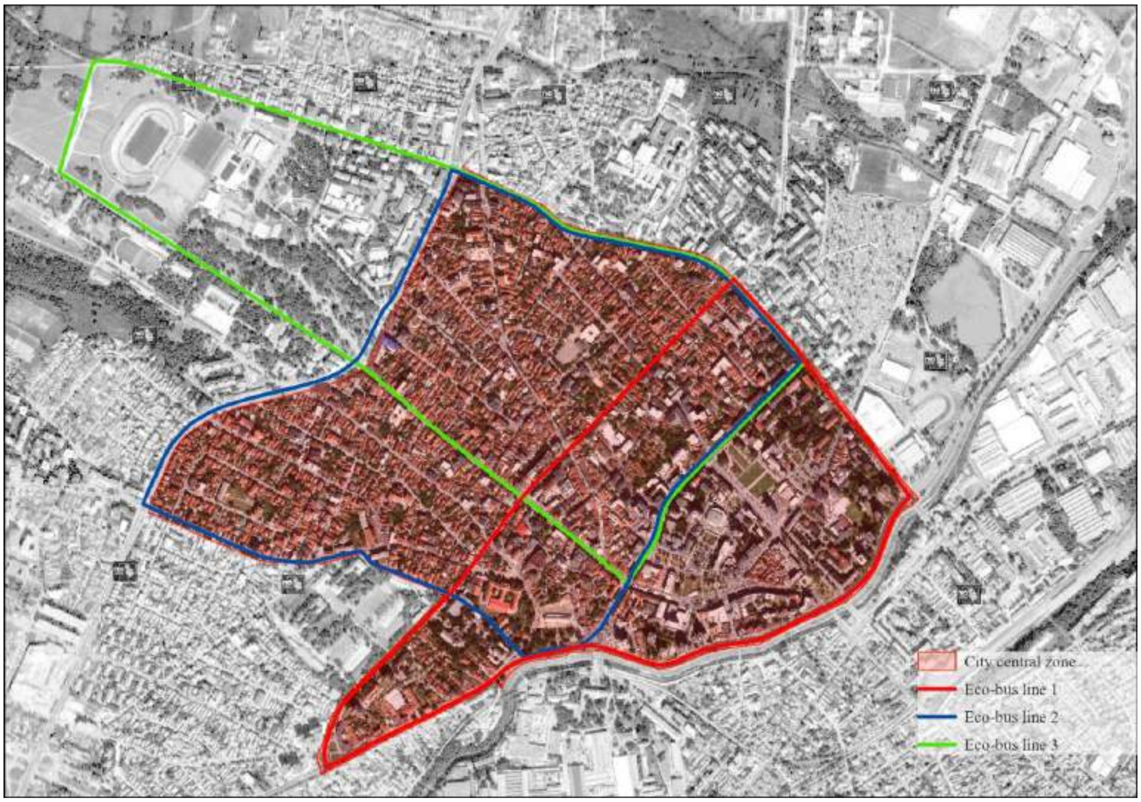

Figure 7. Three eco bus lines in the city of Kragujevac. *Source: Author's elaboration*

Legend: blue - eco line 1

Red - eco line 2

Green - possible eco line 3

In particular, effects can be expected in terms of reducing air and soil pollution, reducing noise and eliminating potential stress and illness caused by these phenomena. An increased need for hiking and cycling, through specially marked paths and routes, is to be expected.

Finally, the economic effects will be visible not only through fuel savings, but also through the improvement of the overall content of the central zone, a cleaner and better-quality environment, which will lead to an increase in the price of real estate and free space. In line with that, positive effects because of redistribution in transport movements would directly affect the economic aspects of system functioning through increasing its own income

(income from the sale of transport services) and ecological sustainability of the city transport system in Kragujevac expressed through the reduction of harmful emissions caused by passenger cars. In this way, the city of Kragujevac would directly implement the EU strategy related to achieving sustainable goals development and quality of life in relation to transport systems, through the realization and management of the policy based on the principle of realizing the residents` mobility with limited use of passenger cars.

New dimension in **scenario 2** is limited parking opportunities in and around the central zone. This will primarily be achieved by parking restrictions and lowering number of parking spaces on the street.

Parking fees and limiting the number of parking spaces are often proposed in literature as an instrument that can be a good alternative for solving congestion problems in situations where it is impossible to effectively implement congestion charges (Verhoef, Nijkamp and Rietveld, 1995). However, we should not lose sight of the fact that congestion in cities can partly be caused by the lack of free parking spaces. Many studies (Arnott, Palma and Lindsey, 1991; Calthrop, Proost and Dender, 2000) have shown that the best effect on reducing congestion will be achieved precisely if congestion charges and parking charges (restrictions) are set simultaneously.

A parking lot, like a city road, can be considered a common resource in the sense that it will be overused (congested) if it is free. Parking restrictions can indirectly very successfully discourage the use of cars in urban areas. It is an instrument that is rather simple to implement. Nevertheless, this measure will be successful only if there are alternatives to private transport, i.e. an efficient public transport system. In conclusion, limiting parking spaces can very successfully reduce the use of cars and redirect city dwellers to the use of public transport. In this way, instead of a parking space, the surfaces can be used for other purposes (Vračarević, 2023).

In our case, we decided to reduce the number of parking spaces in key locations within the central zone and near it. Detailed spatial distribution of parking spaces and the number to be revoked is as follows.

We divided the entire area into 7 urban units (each is limited by the routes of the three planned public transport lines – electric buses):

– Unit 1 (Great Park): 640 existing parking spaces (hereinafter PS). Parking and/or garage facilities are planned for the reconstruction of the city stadium (300 PS). Interventions aimed at abolishing parking spaces are related to the zone of the city sports center (about 50 PS are abolished, and the same capacity is planned at another location).
– Unit 2 (Old Town): 475 existing PS. On the perimeter of unit 2, new parking/garage facilities are planned for the needs of the reconstruction of the clinical center (250 new PS). Interventions aimed at abolishing parking spaces refer to the abolition of 60 PS in the linear parking lot along Kralja Aleksandar I Karađorđevića Street, with the aim of forming a two-way bicycle path that connects the city center with Great Park and further with the city sports center (city stadium, city swimming pools etc.) and the central city park "Šumarice", and through them also with settlements in the contact area. In addition, 30 PS are going to be revoked next to the Clinical Center in order to create a green area.
– Unit 3 ("Erdoglija"): 130 existing PS. On the perimeter of unit 3, new parking/garage facilities are planned within the military complex, which is expected to be repurposed (capacity of 400 PS for public use). Interventions refer to the expansion of the transport network, i.e. the extension of the existing profile and the building of the new route of Daničićeva Street, which is the planned "blue line" of public transport.
– Unit 4 ("Mala Vaga"): 50 existing PS. On the perimeter of unit 4, new parking/garage facilities are planned within the military complex whose conversion is expected (capacity of 200 PS for public use) and public garages along the Lepenica river (capacity of 200 PS). Interventions aimed at expanding the traffic network refer to the expansion of the existing profile of Kneza Miloša Street (to 4 lanes), which is the planned "red line" of public transport. This implies the extension of the profile of Kneza Miloša Street in the unit 5 and

Milovana Gušića Street in the unit 6.

- Unit 5 (“Milošev venac”): 125 existing PS. No new parking/garage facilities planned for public use. The interventions refer to the expansion of the traffic network, i.e. the building of the new route of Daničićeva Street, which is the planned "blue line" of public transport, as well as the extension of the existing profile of Kneza Miloša Street (to 4 lanes), which is the planned "red line" of public transport (the latter also implies the extension of the profile of Kneza Miloša Street in unit 4 and Milovana Gušića Street in unit 6). Also, the realization of the planned block road (connection between Branko Radičevića Street and City Market), opens up the possibility of closing parts of some block roads (Vuk Karadžića Street and Branko Radičevića Street) and their transformation into pedestrian streets or streets with a special mode of use. In the entire block (given the high level of environmental protection), all streets (Branko Radičević, Crveni barjak, Dečanska, Njegoševa, Bitoljska) should have a special usage regime (10 km/h zone for vehicular traffic and similar measures, which will be restrictive or disincentive to vehicle traffic). This consequently eliminates around 35 PS on these roads.
- Unit 6 ("Svetozar Marković" block): 715 existing PS and garage spaces (hereinafter GS) (including the capacity of the existing multi-storey parking garage with 180 GS). No new parking/garage facilities planned for public use. Interventions aimed at abolishing parking spaces refer to the abolition of 30 PS in the linear parking lot along Kralja Aleksandra I Karađorđevića Street, with the aim of forming a two-way bicycle path that connects the city center with Great Park (with part of this street in unit 2, a total of about 90 PS will be abolished). Interventions aimed at expanding the traffic network, refer to the expansion of the existing profile of Milovana Gušića Street (to 4 lanes), which is the planned "red line" of public transport. This implies the extension of the profile of Kneza Miloša Street (unit 5 and unit 4).
- Unit 7 (City Center): 1530 existing PS. On the perimeter of unit 7, there are significant retail parking and garage capacities (185 PS and 115 GS) and sports zones (80 PS), i.e. a total of 380 parking lotes, which employees in this unit and users of public and other city center services also gladly use for parking. Although apparently there is plenty of parking capacity in this zone, over 1,000 public PS are in parking lots whose dominant users are residents of the city center. So that for employees and users of the city center in the city center itself (unit 7) there are around 500 PS, which is certainly insufficient capacity. That is why the largest new capacities are planned here, which can only be realized through multi-storey above-ground or underground public garages. 6 locations (mainly around the perimeter of unit 7) have been registered where it is possible to plan and realize around 1400 PS for public use. Interventions, as in unit 6, will be focused on freeing up areas of the central city core for landscaping and greening, that is, for primary use by active traffic participants (pedestrians, cyclists, e-scooters...). All this (elimination of vehicular and stationary traffic in the city center and construction of public garages at the position of the existing parking lot) will abolish a total of 350-450 existing PS, so that the total capacity for non-residents (after the construction of all buildings) will be around 1500 PS. New housing is not planned in the city center, so the number of residents will not increase, but the need for parking will certainly increase, which will be limited by current capacities.

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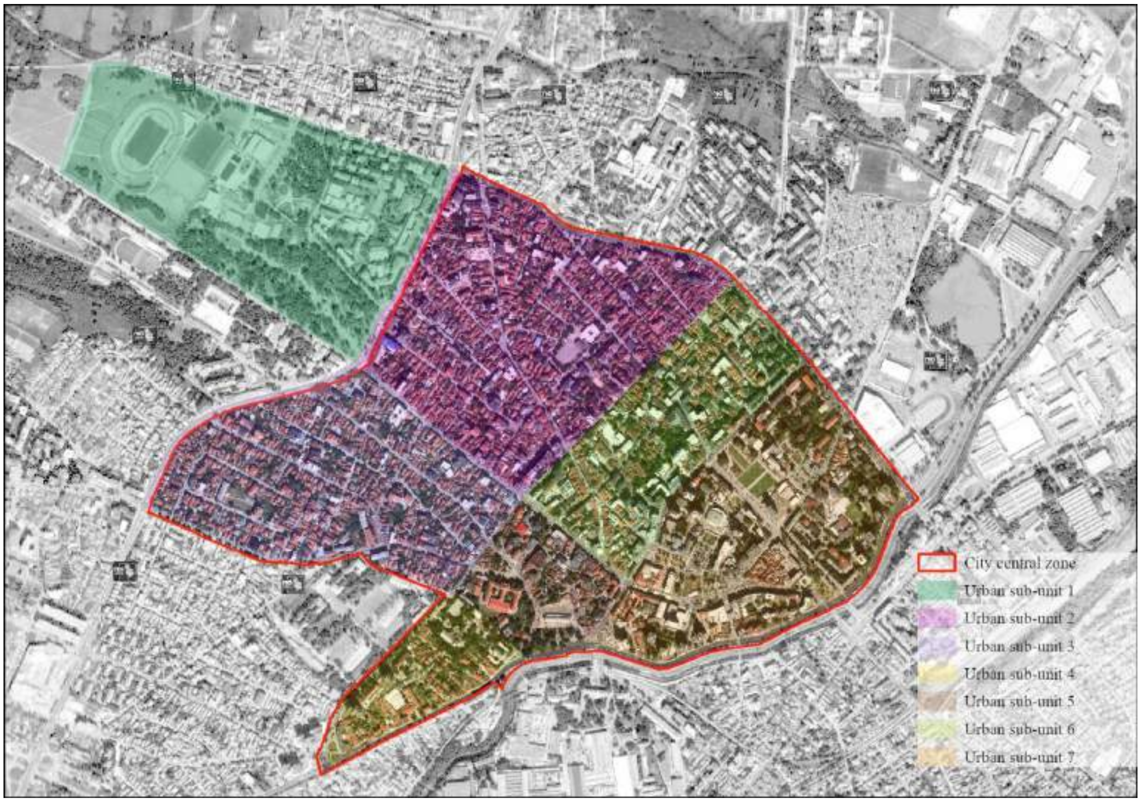

Figure 8. Seven urban sub-units in the city of Kragujevac. *Source: Author's elaboration*

Scenario 3 is hardest to achieve, mostly since it entails discouraging private transport, which in practice is the most difficult to implement due to the great resistance of the public and citizens, considering that traveling by car still provides the greatest comfort and freedom of movement. Many, especially in developing countries such as Serbia, consider automobile a status symbol. One of the most effective instruments to achieve this is congestion pricing/charges.

Congestion charges are a corrective instrument aimed at reducing traffic congestion and thus increasing average driving speed. In a situation where certain goods are free, people tend to consume them more than when they have to pay for them a price that reflects the cost of use. By introducing the congestion charge, the road (a good whose supply is otherwise limited) would be allocated to those who value it the most (the well-known principle of willingness to pay). In theory, this charge should be equal to the marginal costs of congestion imposed on other drivers (excessive cost of petrol, time, etc.). Initially the marginal cost of an additional vehicle is negligible because it does not cause significant congestion, however as road capacity approaches its maximum the marginal cost practically tends to infinity (Newbery, 1990). As such, it would represent an economically optimal solution, but in practice it is impossible to apply it in this way due to numerous limitations, therefore, it is generally only applied either on certain parts of the road or is aimed at certain road users. The congestion charge will be optimally effective only if it is adapted to the time and location, i.e. if it is not the same for all users in all parts of the day. It is unnecessary to emphasize how different the external effect of one additional vehicle in the peak hour in an urban environment is, from the one that occurs in an area with less traffic intensity in hours when congestion does not traditionally occur (Vračarević, 2023). Overall, the congestion charge ensures that decision-makers face the full social cost of travel so roads will be used efficiently, it internalizes an externality, leading to efficiency gains and urban growth (O'Sullivan, 2018).

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Given that they can also bring significant tax revenues, congestion charges will be designed differently primarily depending on the goal they are intended to achieve. The systems in Singapore, Great Britain and the USA have as their primary objective the reduction of traffic congestion, while those in Norway, for example, are mainly aimed at generating income and increasing safety (Timilsina and Dulal, 2010).

Until the 1960s, urban road planning was in the hands of traffic engineers who paid little attention to pricing policy. However, in recent decades the situation has changed significantly and many cities around the world have introduced various forms of congestion charges. It is symptomatic that those congestion charge systems in cities with a well-developed public transport systems (such as Stockholm, Singapore, London, etc.) performed best. Therefore, the link between the availability of an efficient public transport and the good functioning of congestion charges is evident. Thomson rightly noted a long time ago that public transport provides the function of a "safety valve" for traffic congestion (Thomson, 1977). Investments in public transport are complementary to congestion charges, considering that they enable the movement of that part of users who renounce the use of cars.

Congestion charge systems are most often related to the parts of the day with the highest load (peak hours) and when it is possible to divert a large part of commuting to the central business zone to public transport systems (Lehe, 2019). In practice, the best results in solving traffic congestion problems are achieved precisely by combining congestion charges and parking charges.

Singapore is considered the world's best example of the application of measures to limit the use of motor vehicles. The system of congestion charges was introduced in 1975 and quite innovatively - in the form of permits that vehicle owners had to buy to enter the central city zone. The effects were visible very quickly. In just one year, the number of cars entering the central zone during peak hours decreased from 43,000 to 11,000 (Seah, 1980), and the speed of vehicle movement doubled (Chin, 1996). In ten years, this system manages to reduce the annual growth rate of motorization from 4.2% to 2.8% (Timilsina and Dulal, 2010). Guided by Singapore's pioneering effort, many European cities have introduced a system of congestion charges that very quickly led to a number of positive effects. The average speed of movement and the number of trips by public transport have increased, the time spent in traffic has decreased, as well as the emission of local and global pollutants, the volume of transport and traffic accidents.

In our case congestion charges will be introduced for a smaller part of the central zone. As for the entries to the zone where we will charge for admittance, i.e. where congestion charges infrastructure will be placed, we suggest that there should be a total of eight of them, at strategic points, and they would cover the restriction of unit 7 (to Zorana Đinđića Street), unit 6 (to Zorana Đinđića Street and Janka Veselinovića Street) and unit 5 (complete, assuming cancellation of automobile traffic in Vuka Karadžića Street, after the extension of Daničićeva Street - "blue line" of public transport). In this way entries to the part of the central zone will be completely controlled with minimum expenditures and infrastructure investments.

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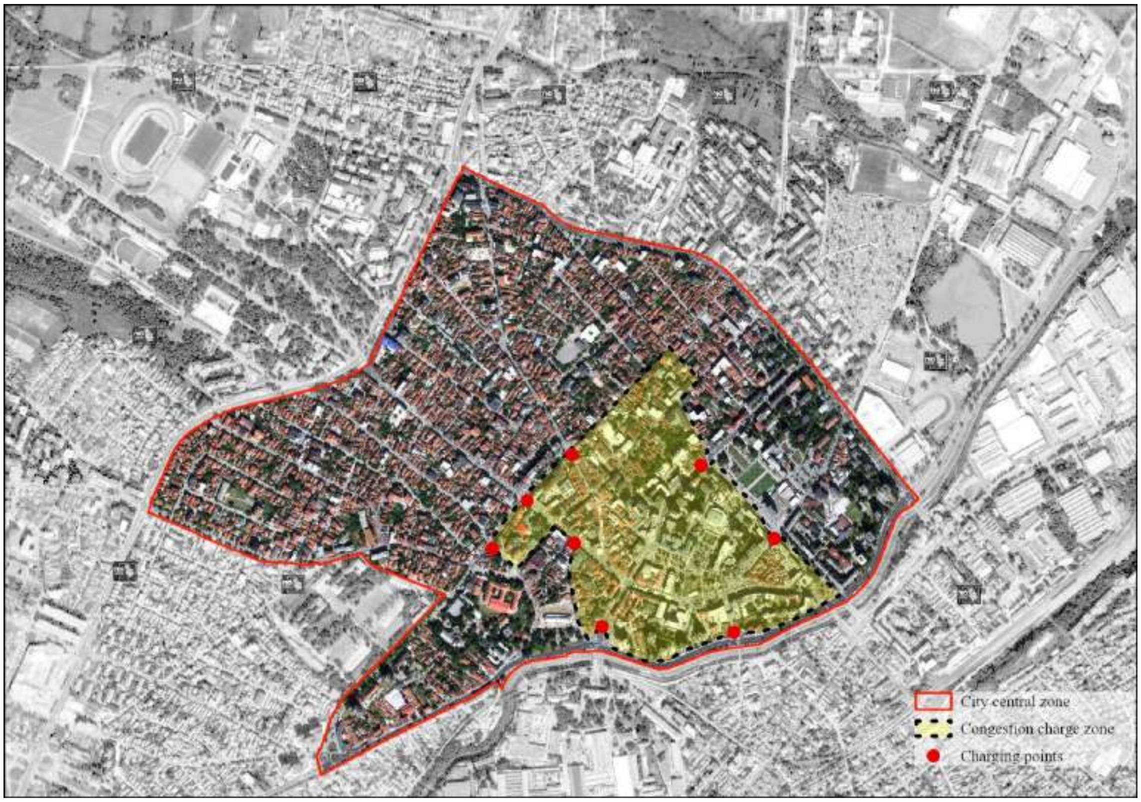

Figure 9. Congestion charge zone in the city of Kragujevac. *Source: Author's elaboration*

7. Research findings

Scenario analysis – Cost benefit analysis (CBA)

A cost-benefit analysis (CBA) aims to quantify all the costs and benefits of a proposed project or policy in monetary terms. Of course, we first listed all the costs and benefits in relation to a proposed action. For costs and benefits ordinarily measured in monetary units, we obtained reliable estimates, for costs and benefits not ordinarily measured in monetary units, due to budgetary, time constraints and also unavailability of primary data, instead of doing nonmarket valuation techniques we used transferred values or expert opinions. Finally, we added up all the costs and all the benefits, under a range of scenarios, and compared total costs to total benefits to obtain a policy recommendation (Harris and Roach, 2018).

We decided to do cost-benefit analysis for scenarios 1, scenario 2 and scenario 3. While we acknowledge that would be ideal to include a baseline scenario in a cost-benefit analysis to serve as a baseline for comparison, it is possible to proceed without it if much of needed data is unavailable or unreliable as in our case. After all, "most cost-benefit analysis are incomplete to some extent" (Harris and Roach, 2018).

First, we chose 10-year period for our cost-benefit analysis. It is a widely accepted practice because most infrastructure and transportation projects use the same time period for economic evaluations. This is a standard time frame that aligns with typical planning and funding cycles. Also, in our specific case a 10-year period is reasonable considering the operational lifespan of many key elements.

Next, since the discount rate represents the time value of money and reflects the opportunity cost of capital, given the nature of the policies, and international recommendations we decided that 4% discount rate is an appropriate. Although for Serbia, taking into account the reference interest rate set by the National Bank of

Serbia, a typical discount rate for public project evaluations might range from 6% to 8%. We chose the lower discount rate mainly for two reasons: it favours future generations and is at heart of sustainable development goals, and second, The European Commission often recommends a social discount rate of around 3% to 5% for public investments in EU countries (Serbia is a candidate country for EU membership). Also, we must include inflation rate for CBA. The expected average inflation rate in Serbia over the next 10 years is projected to be around 2-3% per year. This projection aligns with targets set by the National Bank of Serbia (NBS) (https://www.nbs.rs/). So, we will be using real discount rates that reflect projected inflation to avoid underestimating future values.

Table 48. Scenarios – Costs and benefits

Scenario 1 – "Green baby steps"	**Scenario 2 – "Moderate transition"**	**Scenario 3 – "(Almost) sustainable mobility"**
Main measures: 1. Introduction of three lines of electric buses (free service) that will operate in central zone of Kragujevac and partly substitute conventional existing buses.	**Main measures:** 1. Introduction of three lines of electric buses (free service) that will operate in central zone of Kragujevac and partly substitute conventional existing buses. 2. Revoking a number of parking spaces on the streets and partly substituting them with garage spaces which will have a higher parking fee	**Main measures**: 1. Introduction of three lines of electric buses (free service) that will operate in central zone of Kragujevac and partly substitute conventional existing buses. 2. Revoking a number of parking spaces on the streets and partly substituting them with garage spaces which will have a higher parking fee. 3. Implementation of congestion charges in a smaller part of a central zone which suffers from heaviest congestions and is in the same time economically and practically viable for this type of policy.

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Potential costs: - The initial investment required to acquire the electric buses. - Installation of charging stations and related infrastructure. - Modifications to existing bus depots to accommodate electric buses. - Regular maintenance of electric buses and charging stations. - Battery disposal costs. - Cost of electricity for charging the buses. - Training for drivers and maintenance staff to handle electric buses. - Loss of income due to free electric buses service.	**Potential costs in addition to scenario 1:** - Expenses for building new parking garages or modifying existing structures. - Costs associated with acquiring land or repurposing existing land for garage construction. - Demolition Costs: Costs of removing existing street-level parking infrastructure and preparing the site for new use. - Ongoing costs for maintaining the new parking garages, including security, cleaning, and repairs. - Costs related to operating the garages, including staffing, utilities, and technology for automated systems. - - Potential Loss of Revenue: Initial decrease in parking revenue if the higher fees discourage use, until a balance is achieved.	**Potential costs in addition to scenario 1 and scenario 2**: - Installation of cameras, sensors, and other equipment necessary for monitoring and enforcing congestion charges. - Costs associated with installing signs and information boards to inform drivers about the congestion charge zone and fees. - Ongoing costs for maintaining the monitoring and payment systems. - Costs associated with ensuring compliance, including administrative expenses for issuing fines and handling disputes. - Hiring and training staff to manage the congestion charge system. - Public Awareness Campaigns: Expenses for campaigns to inform the public about the new policy. - Short-term economic impact on businesses within the congestion charge zone due to changes in customer behaviour.

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Potential benefits:	Potential benefits in addition to scenario 1:	Potential benefits in addition to scenario 1 and scenario 2:
- Significant reduction in greenhouse gas emissions. - Significant reduction in - air pollutants (e.g., NOx, PM). - Lower noise pollution. - Lower incidence of respiratory and cardiovascular diseases due to improved air quality. - Lower operational costs over time compared to conventional buses, due to cheaper energy costs and maintenance. - Energy Efficiency: Electric buses are more energy-efficient, leading to cost savings. - Employment opportunities in the installation and maintenance of electric bus infrastructure. - Increased use of public transport: Free services can attract more users and reduce car dependency and traffic congestion. - Accessibility and fairness: Free transport services make public transport accessible to all citizens regardless of socio-economic status.	- Higher fees for garage parking can generate more revenue compared to on-street parking. - Reduced street-level parking can enhance the visual appeal of the streets, potentially increasing property values. - Freed-up street space can be repurposed for green areas, bike lanes, pedestrian zones, or other community-beneficial uses. - Lower congestion from cars searching for parking spaces can improve traffic flow. - Reduction in emissions from vehicles circling for parking, contributing to improved air quality. - Increased Business Activity: Improved accessibility and aesthetics can attract more foot traffic to local businesses. - Enhanced Public Spaces: More available space for public amenities, parks, and social areas, improving quality of life. - Improved Air Quality: Less traffic congestion can lead to better air quality, reducing respiratory problems among residents. - Increased Physical Activity: Enhanced pedestrian and cycling infrastructure can encourage healthier lifestyles.	- Direct revenue from the charges levied on vehicles entering the congestion zone. - Decreased traffic congestion, leading to improved travel times and reduced vehicle operating costs. - Reduction in greenhouse gas emissions and air pollutants due to decreased traffic and smoother traffic flow. - Better air quality can lead to a reduction in respiratory and cardiovascular diseases. - Encouragement of walking, cycling, and the use of public transportation can contribute to better public health. - Improved travel times can lead to increased productivity for businesses and individuals. - Property Value Increases: Potential increase in property values due to reduced congestion and improved environmental quality. - Improved urban environment and reduced noise pollution can enhance the overall quality of life for residents. - - Equity Improvements: Revenue from congestion charges can be reinvested in public transportation and infrastructure, benefiting the wider community.

Of course, a number of the mentioned costs and benefits, especially external costs and benefits, cannot be reliably calculated, while for some others only a rough estimate is possible. Those costs and benefits for which we could not reliably determine monetary values based on similar studies or from contact with experts and employees of public institution in Kragujevac, governmental reports, vehicle manufacturers, utility providers and relevant literature were omitted from the cost benefit analysis. It represents a kind of limitation but also direction of possible future research.

1. **Introduction of three lines of electric buses (free service) that will operate in central zone of Kragujevac and partly substitute conventional existing buses**

Explanation and assumptions about costs

Bearing in mind the results of our survey and our field research, we formulated the best policy for the introduction of electric buses in the central zone. In order to achieve high-capacity occupancy, which directly influence consumption of electricity per passenger kilometre travelled and considering that the road network in the central area of Kragujevac is narrow and there is not much room for expansion, we decided to use electric buses with lower capacity. These are typically smaller in size compared to standard buses, making them suitable for intra-city routes, and other applications where manoeuvrability and lower passenger capacity are advantageous. Bearing in mind the lowest possible price but also the desired characteristics, the model we decided on is the BYD eBus-7, with a maximum capacity of 26 passengers. The technical characteristics are as follows: battery capacity 174kWh, battery technology LFP and charging system is Plug-in charging (CCS) with a maximum range of around 240km (https://bydeurope.com/byd-ebus-k7). Our estimation based on the length of the three new routes, the desired frequency of about 7 minutes and the working hours of almost 19 hours in order for the lines to fit into the already existing system (the first departures around 4 a.m. and the last around 11 p.m.) is that we need 18 electric buses.

Considering the technical characteristics of the selected electric bus model, our estimate is that 10 charging stations are needed (https://afdc.energy.gov/, https://www.energy.gov/eere/vehicles/reports-and-publications). Furthermore, there is no need to build or modify to existing bus depots to accommodate electric buses because they can support an additional number of vehicles.

For heavy-duty applications like buses, battery life expectancy typically range from 5 to 10 years depending on usage patterns. Since we decided that our fleet will consist of 18 buses we will assume to replace battery every 10+ years so that cost will not be included in our CBA.

Maintenance costs for electric buses can range from 0.11 EUR to 0.17 EUR per km, which includes routine servicing and battery management (https://www.nrel.gov/). If we suppose average bus speed in Kragujevac central zone of around 20km/h and the fact that working hours will be 19 hours on all three new routes buses will travel about 380km daily per route.

As for charging stations we chose DC fast chargers that are used for Level 3 charging, offering much faster charging times. Maintenance costs for DC fast chargers often range from 900 EUR to 2,700 per charger per year (https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf).

For the calculation of cost of electricity for charging the buses we need a couple of data. One of the data is energy efficiency i.e. the energy consumption rate of the bus, usually measured in kWh per kilometer (kWh/km). For our chosen bus model energy efficiency of approximately 1.2 kWh/km under standard operating conditions (https://bydeurope.com/byd-ebus-k7). Also, we will assume standard charger efficiency of around 90% as some energy is lost during the charging process. As for the electricity rate in Serbia for commercial or industrial consumers it typically ranges between 0.07 EUR and 0.10 EUR per kWh depending on various circumstances (https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=Electricity_price_statistics,https://www.eps.rs).

So, since we will be having three buses on every route at all time, the daily cost of electricity for charging the fleet of 3 buses, each traveling 380 km per day with the given assumptions, is around 129 EUR. For all three routes total price will be 387 EUR daily.

As for costs of training for drivers and maintenance staff to handle electric buses first we need to calculate a number of drivers we need. Assuming 3 shifts and 9 buses in operation for 19 hours, with taking to account to ensure continuous operation and for days off, vacations, and potential sick leave, we will need approximately **38 drivers** to cover all shifts. Also, according to industry standards and reports (https://www.nrel.gov/docs/fy21osti/80022.pdf) we will need approximately **8 maintenance staff members** to adequately maintain a fleet of 18 electric buses, covering daily, weekly, and monthly maintenance tasks. According to our calculations based on industry standards and relevant sources (https://www.nrel.gov/docs/fy21osti/80022.pdf) total estimated costs can vary greatly and for our 38 drivers and 8 maintenance staff will range from **20,000 EUR to 100,000 EUR**, depending on the level of training required.

We can assume that we will not have any significant loss of income due to free electric buses service, because they will not replace whole existing lines and they will cover part of city previously without public transport.

Explanation and assumptions about benefits

About 40% of the total daily mileage of diesel-powered vehicles is in the central zone, which is a total of about 3,400 km for a working day. Based on our calculations we assume that we will shorten and substitute about 7.5% in total of this amount with introduction of new routes with electric buses. The average annual mileage on line 4 is 54,745.15 km, on line 3 it is 234,878.45km and on line 15 it is 293,281.60km. Approximated and expected reduction will be 16,423 km on line 4, 47,000km on line 3 and 29,300km on line 15 yearly.

Table 49. Pollutant emission per km

	CNG	ED	ED
Bus line	**3**	**15**	**4**
PM10 (gr/km)	0.236772	0.19674	0.11034
PM2.5 (gr/km)	0.126033	0.09946	0.05497
CO (gr/km)	1.226432	1.9636	1.14252
CO2 (kg/km)	1.672907	1.06709	0.57236
NO2 (gr/km)	0.231749	0.56294	0.34807
NOx (gr/km)	5.793716	5.62947	3.4807

Source: www.ekobus.rs

Table 50. Reduction of pollutants emission per year

	CNG	ED	ED	
Bus line	**3**	**15**	**4**	**Total**
PM10 (gr)	11,128.28	5,764.48	1,812.11	18,704.9
PM2.5 (gr)	5,923.55	2,914.18	902.77	9,740.5
CO (gr)	57,642.3	5,7533.48	18,763.6	133,939.4
CO2 (kg)	78,626.63	31,265.74	9,399.87	119,292.2
NO2 (gr)	10,892.2	16,494.14	5,716.35	33,102.7
NOx (gr)	27,2304.7	16,4943.5	5,7163.54	494,411.7

Source: Author's calculation

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Table 51. Cost of reducing emissions of pollutants

	Cost (EUR/gr)	Total reduction of pollution	Cost of pollution per year in EUR
PM10 (gr)	0.087000	18,704.9	1,627.33
CO (gr)	0.000035	133,939.4	4.69
CO2 (kg)	0.056000	119,292.2	6,680.36
NO2 (gr)	0.030000	33,102.7	993.08
NOx (gr)	0.004400	494,411.7	2,175.41

Source: Author's calculation based on various sources cited in the text and expert assessment

The cost of noise pollution per kilometre travelled by a diesel bus can be difficult to quantify objectively, as it depends on various factors. According to study of the European Commission (European Commission, 2020), the cost of noise pollution from road transport can vary widely but typically falls within the range of 0.01 EUR to 0.03 EUR per vehicle-kilometre. This estimate includes health impacts, property value depreciation, and other social costs associated with noise. Given that diesel buses are generally louder than smaller vehicles, the upper end of this range might be more applicable.

The average fuel consumption of public transport buses in Kragujevac is 42 liters of diesel (in Serbia it's called euro diesel, EURO 5 standard) per 100km. Average price of euro diesel in Serbia is 1.8 EUR per liter.

Further, current disease Incidence of respiratory and cardiovascular diseases in Serbia is 350 and 700 per 100,000 people annually, respectively (https://www.batut.org.rs/). For other necessary data we must take some assumptions because precise data for Serbia are unavailable or unreliable, to our knowledge. We will use concentration-response functions (CRFs) to estimate the reduction in disease incidence due to the reductions in PM2.5 from relevant studies (Pope et al. 2002). Also, we assume the cost per case for respiratory disease is around 5,000 EUR and the cost per case for cardiovascular disease is around 10,000 EUR, based on common healthcare expenditure data (https://www.who.int/). Using all our other data rough estimates are: total economic benefit for respiratory diseases is around 26,000 EUR per year, and total economic benefit for cardiovascular diseases is around 105,000 EUR per year. Of course, this is incomplete economic assessment of health benefits but still provide us with some much needed data.

The costs of other pollutants are estimated as follows. For NO_2 estimated costs are in the range of 0.01 EUR to 0.05 EUR per gram due to healthcare costs and reduced quality of life from respiratory and cardiovascular diseases (https://www.eea.europa.eu/data-and-maps/figures/nitrogen-dioxide-annual-limit-values-for-the-protection-of-human-health). As for CO_2 since the environmental and social cost of one kilogram of CO_2 varies significantly depending on the specific carbon pricing mechanism and regions, we decided to assume costs according to EU Emissions Trading System (ETS) that currently prices CO_2 around 56 EUR per ton (https://carbonpricingdashboard.worldbank.org/compliance/price). Costs for CO, NOx and PM10 are based on values reported by Meyers (Meyers, 2021)

It's important to note that these values represent a broad range, as the actual costs can depend significantly on local healthcare costs, pollution levels, population density, etc.

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CBA 1

Present Value of Costs

1. **Initial Investment Costs** (Year 0):
   - Electric Buses: 3,600,000 EUR
   - Charging Stations: 700,000 EUR
   - Training: 60,000 EUR
   - Total Initial Investment: 4,360,000 EUR
2. **Annual Costs**:
   - Maintenance: 348,642 EUR+18,000 EUR=366,642 EUR/year
   - Electricity: 141,255 EUR/year
   - Total Annual Costs=366,642 EUR/year+141,255 EUR/year=507,897 EUR/year
3. **Present Value of Annual Costs:**
   - PV of Annual Costs= 4,443,737 EUR

Present Value of Benefits

1. **Annual Benefits**:
   - Environmental Benefits: 1,627.33 + 4.69 + 6,680.36 + 993.08 + 2,175.41 = 11,481.87 EUR/year
   - Health Benefits: 26,000 + 105,000 = 131,000 EUR/year
   - Operational Savings: 70,564.7 EUR/year
   - Noise Pollution Reduction: 74,460 EUR/year
   - Total Annual Benefits=11,481.87+131,000+70,564.7+74,460=287,506.57EUR/year

2. **Present Value of Annual Benefits**:
   - PV of Annual Benefits=287,506.57×(1−(1+0.0146)−100.0146)=287,506.57×8.7514=2,515,795EUR

Net Present Value (NPV)

NPV=2,515,795EUR−8,803,737EUR=−6,287,942EUR

However, it is crucial to consider the non-monetary benefits and long-term sustainability advantages that might not be properly and fully captured in economic analysis.

2. Revoking a number of parking spaces on the streets and partly substituting them with garage spaces which will have a higher parking fee

Explanation and assumptions about costs and benefits

In addition to scenario 1, new policies introduced in scenario 2, also, have their costs and benefits. To sum it up, we are planning to revoke a total of 475-575 PS, of which 400 PS will be compensated - considering that two garages with 200 PS each are currently being built instead of the existing parking lots that collectively have 160 PS. So, 75-175 PS will be revoked and 400 will be substituted with GS. In this instance, there will be no initial Investment - costs of construction of garage spaces, since construction works began early and are coming to an end. The current **street parking fee is** 0.3 EUR in zone 1 and 0.4 EUR in zone 2 and proposed garage parking fee (for new garages) will be 0.6 EUR per hour. Based on the current situation regarding garage lots in Kragujevac estimated annual operating costs are following - maintenance cost per garage space: 50 EUR/year, security and staffing per garage space: 100 EUR/year, utilities per garage space: 20 EUR/year.

For environmental and social benefits, we will assume a reduction in emissions and congestion costs valued at

5,000 EUR/year. Considering the typical impacts observed in other studies and the proportion of the city's parking capacity affected by the policy changes (3.4% of the total parking capacity lowered and 10.9% of the total capacity substituted with higher fees parking). For example, a study by the Victoria Transport Policy Institute found that reducing parking spaces and increasing fees can reduce vehicle miles traveled and emissions by 10-30% in urban areas (https://www.vtpi.org/vmt_red.pdf). The reduction in emissions and congestion depends on reduction in cruising for parking and higher parking fees that might discourage car usage and encourage the use of alternative transportation, further reducing emissions.

CBA 2

Present Value of Costs

1. **Annual Operating Costs**
   - Maintenance cost per garage space: 50 EUR/year
   - Security and staffing per garage space: 100 EUR/year
   - Utilities per garage space: 20 EUR/year
   - Total Annual Operating Cost=170×400=68,000 EUR/year

2. **Present Value of Annual Costs:**
   - PV of Annual Costs =595,895.2

Present Value of Benefits

1. **Revenue from Parking Fees**
   - Annual Revenue from Street Parking=125×0.35×365=15,937.5 EUR
   - Annual Revenue from Garage Parking (difference)=400×0.25×365=36,000 EUR
   - Net Annual Revenue Increase=20,062.5 EUR

2. **Environmental and Social Benefits**
   - Reduction in emissions and congestion costs valued at 5,000 EUR/year.

3. **Present Value of Annual Benefits**
   - PV of Annual Revenue Increase= 191,853 EUR
   - PV of Environmental and Social Benefits=43,757 EUR
   - Total PV of Benefits=235,610 EUR

Net Present Value (NPV)

NPV=235,610 −595,895.2=−360,285.2 EUR

3. Implementation of congestion charges in a smaller part of a central zone which suffers from heaviest congestions and is in the same time economically and practically viable for this type of policy

Explanation and assumptions about costs

Regarding the choice between cameras and physical toll booths, although analysis of local factors and consultation with stakeholders slightly refers to the selection of physical toll booths, we have decided to go in a direction of installing cameras (Automatic Number Plate Recognition - ANPR) primarily due to lower costs and efficiency. Taking into account the size of congestion charge zone and traffic flow each entry and exit point would require at least one ANPR camera to capture vehicle license plate data effectively. Costs of ANPR Camera

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System, including ANPR camera cost and average installation cost, can vary greatly and range from 2,000 EUR to 4,000 EUR. Total operations and maintenance costs of cameras are estimated as 500 EUR per camera per year (lower than in other cases partly because of significantly lower labour costs in Serbia compared to EU) (https://www.vitronic.com/en-us/traffic-technology/automatic-number-plate-recognition, https://www.nortechcontrol.com/solutions/vehicle/automatic-number-plate-recognition-anpr).

Explanation and assumptions about benefits

Our pricing structure is designed to target the busiest times when congestion is highest (set to discourage unnecessary trips into congested areas), aiming to reduce traffic and improve air quality during those hours.

To determine an appropriate congestion charge for Kragujevac we have to consider average income levels and our goals of reducing congestion and improving air quality. Given an average income of 776 EUR (91,000 din) and compared to other cities like London or Stockholm we decided an appropriate congestion charge for Kragujevac might start with a modest fee, such as 2 EUR per entry into congested areas during peak hours (weekdays, 07 a.m. – 10 a.m.). Later, it can be corrected in accordance with the set goals. Outside of peak hours, including weekends, the congestion charge does not apply.

Since we only have data on vehicle ownership (320 per 1,000 people), average travel time (15 minutes) and average distance of a trip (5-8 km) and do not have the precise and specific data on traffic volumes and congestion we have to take some major assumptions and base our numbers on experience of other similar cities.
Regarding travel patterns, taking into account employment distribution, retail centers' locations, residential densities, and public transport availability we can somewhat safely estimate that roughly 60% of automobiles enters the central zone for work, shopping, or other activities on a daily basis. Projected impact of implementation of congestion charge can be based on experience of London (number of vehicles entering the zone decreased by approximately 15-20% which resulted in rough **reduction in congestion** of 15%) (https://tfl.gov.uk/modes/driving/congestion-charge) and that of Stockholm (number of vehicles entering the zone decreased by approximately 20-25% which also resulted in rough **reduction in congestion** of 15%) (https://skatteverket.se/servicelankar/otherlanguages/inenglishengelska/individualsandemployees/congestiontax.4.32a87cee16d2b11f30e440f.html).

The average automobile in Kragujevac, due to its older age and the prevalence of diesel engines, tends to have a higher environmental impact compared to the average vehicle in EU. The impact includes higher CO_2 emissions, NO_x and $PM_{2.5}$ and PM_{10}. An older diesel vehicle might emit around 0.5-1.0 g/km of NO_x, and around 160-200 g/km of CO_2.(https://www.clcv.org/storage/app/media/ICCT-Report-Emissions-Diesel-cars-Europe.pdf, https://single-market-economy.ec.europa.eu/sectors/automotive-industry/environmental-protection/emissions-automotive-sector_en).

Travel time savings are calculated **according to projected reduction in congestion** of 15%. To value the total travel time savings per day, we need to assign a monetary value to the time saved. This is commonly done using the Value of Time, which varies depending on whether the time saved is for work-related travel or leisure travel. For the sake of this analysis, we can use a common estimate for the Value of Time in Europe of around 15 EUR per hour for an average traveler.

(https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Hourly_labour_costs, https://www.destatis.de/Europa/EN/Topic/Population-Labour-Social-Issues/Labour-market/EU_LabourCostPerHourWorked.html)

CBA 3

Present Value of Costs

1. **Initial Investment Costs** (Year 0):
   1. ANPR Camera Installation Costs:

   - Total installation cost = 48,000 EUR

   2. **Annual Operation and Maintenance Costs:**

   - Total annual operation and maintenance cost = 8,000 EUR

Present Value of Benefits

1. **Revenue from Congestion Charges:**
   - Annual revenue (assuming 260 operational days per year): = 11,960,000 EUR
2. **Environmental Benefits:**
   - Annual CO_2 reduction: 1,764.36 tonnes
   - Monetary value of CO_2 reduction: 6,680.36 EUR per year
   - Annual NOx reduction: 7.3515 tonnes
   - Monetary value of NOx reduction: 2,175.41 EUR per year
3. **Travel Time Savings:**
   - Savings per Trip: 2.25 minutes
   - Total Travel Time Savings per Day: 64,800 minutes/day
   - Value of Time Saved: 15 EUR per hour
   - Annual Monetary Value of Time Saved: 4,212,000 EUR
   - Total Annual Benefits: 16,180,855.77 EUR

Net Present Value (NPV):

NPV = 149,417,616 EUR

Table 52. NPV for three scenarios

	NPV
Scenario 1	**−6,287,942 EUR**
Scenario 2	**−6,648,227.2 EUR** (−6,287,942 EUR −360,285.2 EUR)
Scenario 3	**142,769,388.8 EUR** (−6,287,942 EUR −360,285.2 EUR **+** 149,417,616 EUR**)**

Source: Author's calculation

Of course, this analysis does not exhaust all the benefits, especially external ones. Also, complementary and synergistic effects of policies proposed is not considering here. So, reasonable caution should be exercised when interpreting the results of this CBA. However, based only on ones included in our CBA we can conclude that in contrast to the first two scenarios (that are showing a negative NPV), scenario 3 shows a significantly positive NPV. A positive NPV indicates that the project's benefits exceed its costs when discounted to present value. This suggests that Scenario 3 is financially viable, and policies proposed should be implemented.

Next step could include sensitivity analysis to examine how changes in key variables or assumptions affect the NPV for every scenario.

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Table 53. Selected data used for evaluating costs and benefits included in CBA*

Number of electric buses	18
Number of charging stations (DC Fast Chargers)	10
Price of electric bus (BYD eBus-7)	200,000 EUR
Price of charging stations including installation	70,000 EUR
Regular maintenance of electric buses	0.14 EUR per km
Regular maintenance of charging stations	1,800 EUR per charger per year
Distance travelled by electric bus, per every of three routes	380km per day
Electricity rate in Serbia	0.085 EUR per kWh
Cost of electricity for charging the buses	387 EUR per day
Training for drivers and maintenance staff to handle electric buses	60,000 EUR
Reduction of kilometres travelled by diesel buses	255 km per day
Reduction in PM10 (gr)	18,704.88 per year
Reduction in PM2.5 (gr)	9,740.50 per year
Reduction in CO (gr)	133,939.39 per year
Reduction in CO2 (kg)	119,292.23 per year
Reduction in NO2 (gr)	331,02.7 per year
Reduction in NOx (gr)	494,411.66 per year
Cost of reduction in PM10 in EUR	1,627.33 per year
Cost of reduction in CO in EUR	4.69 per year
Cost of reduction in CO2 in EUR	6,680.36 per year
Cost of reduction in NO2 in EUR	993.08 per year
Cost of reduction in NOx in EUR	2175.41 per year
Cost of noise	0.03 EUR per km
The average fuel consumption of public transport buses in Kragujevac	42 liters of diesel per 100km
Average price of euro diesel in Serbia	1.8 EUR per liter
Current Disease Incidence of respiratory diseases in Serbia	350 per 100,000 people annually
Current Disease Incidence cardiovascular diseases in Serbia	700 per 100,000 people annually
Total economic benefit for respiratory diseases caused by PM2.5 reduction	26,000 EUR per year
Total economic benefit for cardiovascular diseases caused by PM2.5 reduction	105,000 EUR per year
Street parking fee	0.35 EUR per hour
Garage parking fee	0.6 EUR per hour
Number of revoked parking spaces	125
Number of replaced street parking spaces with garage parking spaces	400
Annual Revenue from Street Parking (reduced number)	27,375 EUR
Annual Revenue from Garage Parking (increased number)	146,000 EUR
Number of charging points	8
Number of ANPR cameras	16
Costs of ANPR camera with installation	3,000 EUR
Congestion fee	2 EUR
Total operations and maintenance costs of cameras	500 EUR per camera per year
Vehicle ownership	320 per 1,000 people
Average travel time	15 minutes
Average distance of a journey	6.5km
Average CO2 emission per automobile in Kragujevac	180 g/km

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Average NOx emission per automobile in Kragujevac	0.75 g/km
Estimated number of vehicles entering the central zone	28,800 per day
Estimated number of vehicles entering the central zone (after implementation of congestion charge)	23,000 per day
Decreased number of vehicles entering the zone	20%
Projected reduction in congestion	15%
Value of time	15 EUR per hour

*if not indicated differently in text, for data where is a range of values we took the mean value

Source: Author’s calculation based on various sources cited in the text and expert assessment

8. Conclusions

At this moment, it is evident that the research will lead to positive developments in the planning and introduction of new public transport systems in Kragujevac. What's more, after talking with representatives of other local communities, it can be expected that similar metrology will be applied in them as well. The great possibilities that this kind of system opens up motivate both the users of the space and the managers to gladly accept it.

9. Recommendations

Based on the findings so far, the recommendations go in the direction of the fastest and most effective change of the public urban transport system in the researched territory. There is no doubt that the existing problems in the central area of the city are largely related to the functioning system of public city transport. Therefore, changing the system implies a change in philosophy, not only in traffic, but also in the way of life in the inner-city core. This will entail numerous other actions that will ultimately lead to a better ecological and socio-economic situation. (Change in urban planning parameters, limit values of pollutants, transparency of pollution measurement results, better health picture of the population, different, better quality of life in general...).

10. Next steps

In the following period, the final synthesis of the results of the survey and research related to the attitudes of citizens and administration remains to be done. Also the quantification of certain phenomena and the results of the analysis according to selected indicators that will enable relevant recommendations. During this process, several meetings will be held with selected actors in Kragujevac, and after the end of the research, the results will be presented to all interested parties. Discussions regarding the improvement and implementation of the green transition in concrete legal solutions, strategies and recommendations will also be intensified with representatives of competent institutions at the national level, as well as with representatives of local self-governments in order to explain the advantages of new approaches.

It is expected that the research results will serve as the basis for developing a public transportation traffic study for Kragujevac. Additionally, all future planning documents must adapt to the new traffic regime, especially concerning more progressive scenarios. As Kragujevac is a hub for automotive and other complementary industries, local support for implementing such a system can be substantial. The scientific and technological park located in the city (MIND Park) offers technical, software, and intellectual support for the development and maintenance of such a system. Finally, upcoming activities (the city is in negotiations to receive a donation of several hundred electric scooters for public use) will complement and further motivate the introduction of green transportation in central zones of Kragujevac. The administration's openness to innovation and increasing transparency in the city's development planning process through citizen involvement in these activities

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guarantees the implementation of the research results.

11. Monitoring green transition through case-study research

Nr.	Name of indicator	Description	Unit	Measurement	Target value (if applicable)	Current value	Source	Timeframe	Responsible stakeholder
1	The cost of electric buses and their maintenance and comparison with the price of existing conventional ones	The transition of the system implies the costs of purchase, maintenance and transport support, but soon there will be clear calculations for how long it will take to have a positive effect.		It is measured in money (euros), which indicates the total costs and the difference made in relation to the existing system/time.	-	Bus price, equipment price, maintenance price, fuel price, electricity price..	Brochure, specifications, available energy prices	It measures the value until the system is established and monitors its maintenance and operation, as well as energy prices	Experts, local actors and delegated managers
2	Reduction of GHG emissions (0 emission)	The transition of PTS would lead to a significant reduction of pollution in the entire central zone. Especially bearing in mind the accompanying prescribed measures (listed)		Establishing smart technical solutions that measure the concentration of polluting substances would provide instantaneous values (meters on buses, key intersections, traffic lanes, etc.).	Zero pollution	Share of polluting particles	Measurements and sensors	24/7/365	Experts, local actors and delegated managers
3	Noise reduction	The transition of PTS would lead to a significant noise reduction n in the entire central zone. Especially bearing in mind the accompanying prescribed measures		Decibel measurement, Establishing smart technical solutions that measure the concentration of polluting substances would provide instantaneous values	Permissible noise level	Noise level	Measurements and sensors	24/7/365	Experts, local actors and delegated managers

4	Travel time is saved due to the new PTS organization and better accessibility to citizens	Greater availability and better frequency of arrival of electric buses will make significant savings in travel time. It is especially important for getting to and from work and increasing work efficiency. (less delays, reduction of worker fatigue, better air quality/reduction of respiratory and other diseases, etc.)		Time of travel. It is measured through a survey and exact data obtained from employees, institutions, health centers, etc.	Percentage reduction in travel time compared to the existing one.	Time of travel.	Combination of data	The measurement is performed during the working day	Experts, local actors and delegated managers

12. Accomplishments, Impact and Reflection

The assumed ideas and goals from the beginning of the research were rightly set. The types of means of transport were corrected (minibus instead of bus), some realizations came only after a detailed introduction to the terrain, the system, discussions with experts and stakeholders from the field. The recommendations overlap with the views in part 9.

12.1 Summary of research activities

Activity 1. Conducting survey in Kragujevac	
Description of sub-activities (mention tools and resources used and how sub-activities were monitored/evaluated)	Regarding field survey users of public transport services were interviewed at selected roundabouts and busiest stations in different areas of Kragujevac, during peak hours (7am to 9am and 3pm to 5pm) and outside. The questionnaire consisted of one sheet of A4 format with closed-ended questions. The expected time for filling out the questionnaire was about 5 minutes.

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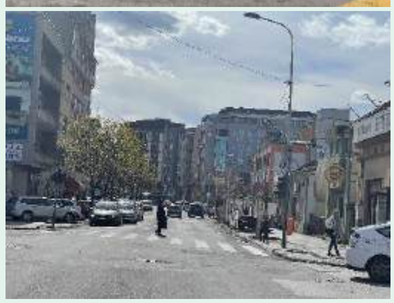
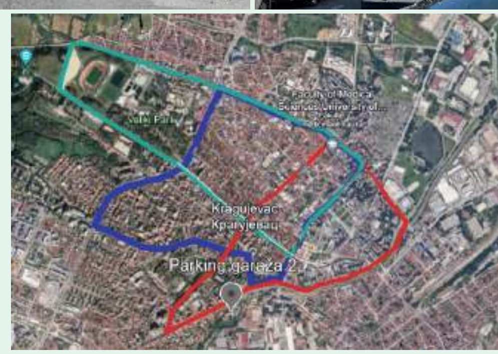
KPIs / results achieved and how they can be documented	Determination of the level of satisfaction of the citizens of Kragujevac with the functioning of the public transport system, as well as the possibility of introducing electric buses. The goal was to identify current problems as well as aspects of public transport in Kragujevac that can be improved. Our sample was 424 respondents which is a satisfactory size considering the population of Kragujevac around 150,000. A number of questionnaires were filled out online (257), while the rest were conducted in the field (167). All online filled surveys are in Annex Excel tables, and the ones filled manualy are part of the overall research documentation (available on demand).
Stakeholders involved (quantification, type, gender where applicable)	- Administration of the City of Kragujevac - JKP "Šumadija Kragujevac" (- 167 respondents in person (+ online 257)
Describe challenges / problems in the implementation	- lower interest of residents in participating in the survey - on the field
Mitigation measures and changes compared to the plan / adaptations	/
Illustrations (Photos, Graphs, etc.)	/
Activity 2. Field work	
Description of sub-activities (mention tools and resources used and how sub-activities were monitored/evaluated)	In the central and peripheral parts of the central zone of Kragujevac, a tour was conducted with representatives of the city administration. Tour was conducted by car (outer ring) and by foot (city center). Photos were taken and mapping was done by mobile phone.
KPIs / results achieved and how they can be documented	During field work, the most critical points and streets with the highest traffic intensity in the city were identified. Based on the field tour and discussions with the representatives, potential routes and stations for electric buses were defined.
Stakeholders involved (quantification, type, gender where applicable)	Administration of the City of Kragujevac – Arch. Ivan Radulović, chief urbanist
Describe challenges / problems in the implementation	/
Mitigation measures and changes compared to the plan / adaptations	/

Illustrations (Photos, Graphs, etc.)	      

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Annexes

1. Report on Co-DESIGN workshops on the Conceptualization of Green Transition in the Western Balkans
2. Survey form
3. Meeting minutes
4. Online survey results tables

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