IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 17, Issue 2 Ser. IV (Mar - Apr 2020), PP 44-56
www.iosrjournals.org

Public Transport of Passengers Main Resource of Sustainable Urban Mobility in Sarajevo

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Abstract: *The state of the system on which urban mobility in Bosnia and Herzegovina in all cities depends is unsatisfactory and requires a detailed analysis of the situation and an assessment of the trend in relation to the strategic directions of development in the world. Public transport of passengers is designated as an extremely important system for establishing sustainable mobility.*
The paper identifies key information that reflects the trend of development of public urban transport in the world and analyzes the state of public urban passenger transport at the level of the city of Sarajevo. The transport policy of the City of Sarajevo is analyzed and its commitment to be based on the principles of sustainable development and innovations in transport, transport and communication technology.
Key Word*:Planning; Strategy; Mobility; Public transport; Sustainable development; Innovation; Traffic; Transport; Communications; Choice models; Demand; Intercity transportation; Mode choice; Passenger transportation; Public transit; Route choice; Supply; Travel demand; Trip distribution; Urban transportation; Sarajevo.*

Date of Submission: 25-03-2020 Date of Acceptance: 14-04-2020

I. Introduction

Due to the increasing interaction between transport and the environment in cities, especially in Sarajevo, the capital of Bosnia and Herzegovina, it is necessary to pay attention to the effects that are a direct consequence of the development of transport and to direct environmental and ecological measures in this direction and effectively address this problem. The critical state of air pollution is in winter, December and January, when Sarajevo is the most polluted city among the top 10 polluted cities in the world.

Public pressure has led to the launch of a number of projects to improve the situation, with the main focus being on projects utilizing the resources of public urban transport services. The diverse experiences of cities that have made better use of all available sustainable urban mobility resources imposes the need to see the effectiveness of current projects using a procedure based on the positives of the methods already used for these purposes.

Urban mobility in the city of Sarajevo, as well as in other cities in Bosnia and Herzegovina, is at an unsatisfactory level and requires a detailed analysis of the situation and an assessment of the trend in relation to the strategic directions of development in the world. Public transport of passengers is designated as an extremely important system for establishing sustainable mobility. The range of passenger transport services is organized through a system of 40 trams, 30 trolleybuses, 120 buses, 30 minibuses and an oblique lift, all with a network of 98 lines.

This paper analyzes aspects of utilization of urban mobility resources with reference to the provision of public urban passenger transport services. For this, it was necessary to extract key information that reflects the trend of public urban transport in the world and information that reflects the state of public urban passenger transport at the local community level. In this case, the city of Sarajevo (the area of the Sarajevo Canton) was viewed as a representative of the local community and the adoption of strategic guidelines at lower levels.

The key aspects of the development of public urban passenger transport systems have been analyzed in order to improve the mobility of the population and reduce the negative impact of traffic on the environment.

II. Theoretical Framework

The purpose of the transport situation analysis is to assess the extent to which the existing transport system meets the needs in terms of quality of transport service, in terms of capacity, speed, reliability, price and environmental impact. The process of state analysis requires the collection and processing of a significant amount of information related to traffic - geographical location, socio - economic characteristics of the area, distribution of activities (use of surfaces), characteristics of the transport network, characteristics of movement of population and freight, parameters of movement of population and freight, operation of public and mass transport systems and overall assessment of the situation.

Therefore, the analysis of traffic and transport situation includes demand analysis and supply and traffic supply analysis.

The demand analysis process includes:

1. Defining the problem
2. Collection of data
3. Choice of analysis technique (model calibration, model validation, demand forecast).

Planners often use models for demand analysis that are related to socio - economic parameters and changes in the supply of transport systems. [28]

Representing traffic and transportation demand in a form suitable for the application of the forecast model, a source-to-destination movement matrix is used. The origin-destination travel matrix (O-D), represents travel requirements that are specific, both spatially and temporally, for a particular city or wider area. The distribution of travel according to the mode of travel defines the final requirements - demand for services of transport - transportation systems.

Demand for traffic services in the road network

The traffic network can offer the service level *S* (Service) functions of traffic volume *V* (Volume), traffic capacity *Q* and management *M* (Management) [9], [7], [13], [6], [29]

$S = f\{V, Q, M\}$

Service level S can be expressed in one or more sizes: speed, travel time, generalized travel costs (combination of cost components - travel time, energy costs, comfort, ...).

Q capacity depends on management system and investment level I

$Q = f\{I, M\}$.

By introducing a larger capacity vehicle, the level of service - supply - can be improved.

Analyzing the unit cost and demand function of the number of trips between two zones, it can be concluded that there is a minimum of total costs in terms of demand and supply, and thus the possibility of finding the optimum number of trips, the ratio of travel costs.

From the previous description, it can be concluded that demand *D* (Demand) is a function of service level S and activity in a particular area *A* (Activity)

$D = f\{S, A\}$

Different combinations of supply and demand are possible:

- Fixed demand
- Variable demand with neglect of congestion
- Variable demand with no congestion impact
- Changes in traffic due to changes in the timetable and the influence of external factors.

Demand viewed through an individual's behavior in traffic and transportation depends on a number of influential objective and subjective factors. User determination can be represented by probability. [30]

$$P(X / \mathrm{A}) = \frac{e^{[U(A)]}}{\sum e^{[U(A)]}}$$

Where is:

X - vector of the selected combination

A - feature vector

P - probability of choosing a particular variant if conditions *A* are met

U - A utility function that is based on all meanings.

This means that the disaggregated choice model shows the likelihood that the transport service user will choose an available option that is consistent with the characteristics of those options and the characteristics of the service user himself.

The primary reason for stochastic choice is to limit deterministic choice in real-life situations.

In the case of stochastic selection, it is the choice of the alternative (variant) of the service user, based on the maximum random benefit. The general form of the choice model, that is, the function uses it

$U_{it} = V_{it} + \varepsilon_{it}$

Where is:

U_{it} - stohastic benefit of alternative *i* user *t*

V_{it} - systematic part benefits

ε_{it} - stohastic part benefits.

The systematic benefit of V_{it} is a function of the attribute of the alternative X_i and the characteristics of the individual (user) of S_t.

Impact of the transport system on the environment

In order to estimate total urban emissions, known as emission inventories [13] [7] [33], the MOBILE model is used to determine the extent of emissions. The emission level is then multiplied by the corresponding activity level (eg vehicle-kilometers) predicted by the travel demand model. Simply expressed as

Emission Inventory = (Activity - Specific Emission Level) x (Emission - produced by vehicle activity)

The second model category, known as dispersion models, uses emission data, meteorological conditions, and topographic features to calculate the dispersion of pollutants into the atmosphere. A good example of a dispersion model is the CALINE-4 model.

The procedure for determining traffic noise levels is prescribed in the form of directives, guidelines, standards and legal frameworks. There are several models developed in the countries of the European Union.

In Bosnia and Herzegovina the guidelines propose the use of a model where the total noise level of L_u is calculated for both daytime L_d and nighttime $L_n$conditions, for a straight path to the term

$L_u = L_{dn}^{(25)} + D_h + D_n + D_{op} + D_l + D_v + D_t + D_k$ *(dBA).*

Reliable assessment of exposure of European Union (EU) citizens to noise is a prerequisite for noise reduction policy at European level. One of the objectives of the European Directive on the assessment and management of environmental noise (2002/49 / EC) is to establish a common approach for the assessment of noise exposure across the EU. To this end, the Directive defines a number of common noise indicators, namely the "day-night-night" level, L_{den}.

EU Member States are required to draw up strategic noise maps for all major roads, railways, airports and agglomerations in accordance with Article 7 (1) starting on 30 June 2007. The results of the development of these maps have been used to identify the priorities of action by EU Member States authorities, and by the European Commission (EC) to estimate the number of people exposed to noise and to inform the public.

In 2009, the European Commission decided to develop the CNOSSOS-EU (Common Noise aSSessmentMethOdS) method for noise mapping of road transport, rail transport, air transport and industry.

In the period 2009-2012.a common CNOSSOS-EU methodology was developed, and in the second phase (B) from 2012-2015, the implementation of the model was completed. The ultimate goal is to produce strategic noise maps in 2017.

New technologies for supply and demand planning in transportation

TRANSTOOLS (Tools for Transport Forecasting and Scenario Testing) is a tool based on the 6th RTD Framework Program, implemented in the period 10/2004-09/2006. It aims to produce a European transport network model that covers both passengers and freight as well as intermodal transport, which would overcome the shortcomings of existing European transport network models. The aim of the project was to build on the experience of existing transport models and to make improvements that will be the basis for developing integrated support for planning tools at EU level for transport policy.

The basic modules of the TRANSTULS model are:

1. Demand module for freight traffic and transportation with submodules: for the market based on ETIS i-c matrix, Split module based on NEAC model and logistics module based on SLAM model.
2. The demand module for passenger transport and transportation focused on the SCENES, VACLAV and ASTRA models.
3. Economic modules
4. Module for attributing traffic to the road network.

Guidelines for enhancing urban mobility

Reforming urban mobility is one of the biggest challenges facing policymakers, stakeholders and users today, and to achieve this, the Urban Mobility Index has required a relatively ambitious approach. [26]

Obviously, there is no single miracle cure when it comes to tackling the problem of creating a sustainable urban mobility system. Each city should think of 25 imperatives [27] and identify the most appropriate actions to be taken in their local context. However, a number of cities around the world have introduced some interesting practices that could be an inspiration to others. [32]

Practices can be grouped into groups called [27]: "Rethinking the System", "Networking System" and "Establishing a Sustainable Core". Sustainable mobility strategies should cover four dimensions: "Visioning and the ecosystem", "Supply mobility (solutions and lifestyles)", "Demand mobility management" and "Financing public transport" [27].

Method of choosing the preferred sustainable urban mobility plan

Of the commonly used comparative assessment methods, the one-goal maximizing net economic benefit method and the multi-criteria multi-objective method, the multi-criteria method known as the 'goal

achieved matrix' has been proposed to select a sustainable urban mobility plan. A preferred plan is the plan with the best result.

The matrix of goals achieved attaches relative weights to each criterion (goal). These weights are multiplied by the values of each criterion and then summed across all targets. The weights (weights) assigned to the goals or evaluation criteria are usually determined in discussion with experts or representatives of community groups.

Modifying the Goal Completion Matrix involves an evaluation scale to determine whether an objective is an improvement (+1), a decrease (-1), or if there is no effect (0). The weights of the individual targets and their frequency make it possible to determine the overall index of each plan.

In this paper, another approach is used where rankings are made according to the relative importance of specific characteristics or projects (for example, rankings on a scale from 1 to 5), (Source: Mobility Improvement Assessment Study, Toronto, Ministry of Transport, 1990).

III. Research Metodology

This paper presents the parameters, components and methods for improving the mobility of the population with a focus on public urban transport. Detailed clarification of the problem was made possible by the use of professional literature, analysis of norms, rules and procedures for planning sustainable urban mobility.

The main problem with the overall research is the state of urban mobility, with the specific case of mobility in the city of Sarajevo. Insufficient analysis and improvement of urban mobility prompted consideration of possible shortcomings, deficiencies, as well as segments for the implementation of solutions, methods and models to improve the existing situation, with a detailed presentation and analysis of urban mobility data in Sarajevo.

The main motive for addressing this topic is to analyze the current situation of urban mobility in Sarajevo and possible ways to improve the existing situation, with a more detailed account of the processing and improvement of the situation. In analyzing the situation of urban mobility, it is necessary to extract the key information that reflects the trend of development of public urban transport in the world and information that reflects the state of public urban transport of passengers at the local community level. In this case, the City of Sarajevo (the area of the Sarajevo Canton) was viewed as a representative of the local community and the adoption of strategic guidelines at lower levels.

The aim of this paper is to analyze the situation and parameters that define urban mobility and, based on the current scientific and professional knowledge and application in practice, to analyze the existing situation of urban mobility in Sarajevo with reference to public urban passenger transportation resources. If there are resources in the area of public transport, propose guidelines for the development of a sustainable urban mobility plan. Research goals come in two forms, as scientific goals and social goals. The scientific objective of this paper is presented through guidance and assistance for the purpose of future analysis and proposed solutions that are closely related to urban mobility. The social aim is reflected in the effects of practical application as well as its application for educational purposes.

The general assumption (hypothesis) in the paper is that, based on the analysis of the parameters of existing urban mobility in the city, as well as in the city of Sarajevo, the improvement of the urban public transport system can significantly improve the urban mobility of the population and that its self-sustainability can be achieved.

The system of indicators is presented through the analysis of different values of variables, which was performed on the basis of the results of individual studies during which the existing values of individual variables were compared with their corrected values.

In this paper, the following methods were used to achieve the set goals and to answer the hypothesis: descriptors, comparative method, analysis method, synthesis method, statistical method and compilation method.

This research focuses on the period of the previous five and the next ten years. The data were collected from previous surveys, statistics from the Sarajevo passenger transport company and relevant institutions.

IV. Research Results and Discussion

Today we are entering what might be called the fourth industrial revolution, represented by industrial and technological convergence, leading to the emergence of clean energy vehicles or connected mobile solutions. This evolution has been particularly noticeable in recent years in the network industries (such as telecommunications and media, utilities and mobility), as well as in B2C industries (such as retail and healthcare) where, driven by growing customer needs and enabled by rapid technology development business models are constantly evolving.

1. Općitrendoviparametara urbane mobilnosti

Current trends indicate that more people will choose to use private motorized transport, leading to a staggering 6.2 billion private motorized trips every day in cities around the world. If the world fails to change mobility habits, the future of our planet looks extremely bleak. By 2025, global transport-related greenhouse gas emissions will be 30% higher than 2005 levels. Transport energy bills will also rise and higher levels of energy consumption may pose a threat to global energy security. Traffic jams will stall cities around the world. Most alarmingly, half a million people will be killed in traffic accidents each year. [27]

Fortunately, growing and better public transport offers a path to a better future. By doubling the market share of public transportation around the world by 2025, cities will be able to stimulate growth, help combat climate change and create comfortable urban environments where people and businesses can thrive. Doubling the market share of public transport will allow stabilization of greenhouse gas emissions from urban transport and energy consumption, despite an increase in overall mobility. In 2025, 60,000 lives will be saved, as a more balanced combination of mobility will reduce the number of deaths in urban traffic. Doubling market share in public transport would also create seven million green jobs.

The world's population is increasingly in the city. 53% of the population currently live in urban areas and by 2050 this number is expected to reach 67%. Today, 64% of all trips made take place in urban areas, and it is expected that by 2050, the total number of kilometers traveled will be tripled. Giving urban mobility to cope with this increased demand will therefore require large investments in the future.

The conclusions were drawn from data from cities (84 cities worldwide in 2010, 2014) [27]. Cities are clustered around their development phase and have received a number of strategic recommendations to overcome existing constraints in order to achieve the goal of "networked mobility".

Arthur D. Little points out what “drives cities back” and with his partner UITP - International Public Transport Association:

- Identifies 3 strategic directions for cities to better shape the future of urban mobility
- Describes 25 imperatives to consider when defining sustainable urban mobility policies and
- Analyzes case studies of cities that show good practice.

Three strategic directions for cities

1. Revise the system: Cities in developed countries with a high percentage of motorized individual transport must design policy agendas to fundamentally reshape their mobility systems so that they become more oriented towards sustainable public transport. Most cities in the index (53 out of 84) belong to this group.

2. Network system: For developed cities with a high proportion of sustainable modes of transport, the next step must be to fully integrate the value chain to support seamless, multimodal mobility with face-to-face mobility and to increase the overall attractiveness of public transport with the extension of services. This group includes most cities in Europe, as well as Hong Kong, Singapore, Seoul, Tokyo, Toronto and Buenos Aires.

3. Establish a Sustainable Core: For cities in developing countries with partially underdeveloped mobility systems, the aim must be to establish a sustainable mobility core that can meet short-term demand at a reasonable cost without replicating errors from developed countries. With access to new transportation infrastructure and technologies, these cities have the opportunity to become a testing ground and fertile ground for future urban mobility systems.

An imperative to consider when defining sustainable urban mobility policies [27]

The imperatives that cities should consider as a basis for defining sustainable urban mobility policies are:

1. Establishing transport, a sustainable and stable regulatory framework for PT, integrating national and regional benefits and ensuring a clean allocation of roles and responsibilities

2. Professionalize PTO and formalize public transport

3. Develop a political vision and goals for urban mobility based on strategic alignment of all key actors

4. Develop a visionary urban mobility strategy and master plan that strikes the right balance between stretching and feasibility and shifting the focus from supply-oriented to demand-driven measures. "

5. Ensure coordination of transportation planning with other policies

6. Develop an integrated approach for transport planning and other urban policies to move from isolated decision making to integrated urban governance

7. Initiate fair competition between modes and business models

8. Invest in establishing a sustainable mobility offering and not repeat the mistakes of developed cities

9. Develop a competitive public transport position by evolving from a "transport provider" to a "solution provider" through the introduction of innovative business models and partnerships

10. Switch the PTO culture from a "fleet manager" to a customer-oriented culture and gradually improve the quality of public transport offer and customer experience

11. Further improve the customer experience by providing services through partnerships and alliances with third parties

12. Promoting interoperability and developing multimodal packages

13. Integrate the value chain of travel through the development of integrated mobility platforms

14. Engage with citizens and the business community in a pragmatic, well-informed and sustainable choice of travel and location

15. Introduce traffic calming measures to optimize street conditions and increase the quality of life for residents and businesses

16. Introduce pricing measures to target mobility demand through financial incentives and better match supply and demand

17. Introduce and implement parking policies as a key instrument to guide mobility choices, while gradually increasing the sophistication of the fee structure and regulation

18. Define appropriate land-use policies to influence long-term mobility patterns and encourage development focused on public urban transport

19. Encourage businesses to develop an active corporate mobility strategy to improve the mobility of individuals and goods while minimizing costs

20. Encourage demand for public transport to maximize freight revenue by focusing on incrementally increasing quality-of-service and ensuring price adjustment transparency

21. Further individualize the mobility offering by providing packages of services targeted at different customer groups at different prices

22. Assess opportunities to leverage PT assets to generate additional revenue through consolidation of third party services

23. Give priority to public financing of capital investments in projects with good business cases demonstrating policy benefits and long-term sustainability

24. Explore the perceptions of fees from indirect PT users and mark them for PT funding

25. Further stimulate partnerships with private investors, while focusing on maintaining the solidity of the business model in relation to short-term financing

Analyzes case studies of cities that show good practice

The City of Sarajevo should address the issue of creating a sustainable mobility system by applying the aforementioned imperatives and on this basis identify the most appropriate activities to be undertaken in their local context. However, a number of cities have introduced some interesting practices that could be an inspiration to Sarajevo.

The results of the case studies, Table no 1, were presented for 8 cities. [27]

1. Lagos (Nigeria)
2. Lima (Peru)
3. Tehran (Iran)
4. Istanbul (Turkey)
5. Stuttgart (Germaby)
6. London (UK)
7. Stockholm (Sweden)
8. Hong Kong

Table no 1: Cities that included the dimensions and strategic directions of urban mobility

Strateškipravac Dimenzije	"Develop Sustainable Core"	"Rething the System"	"Network the System"
Visionary Strategy and Eco-system	1	2 3 4 5	6 7 8
Supplay management (solutions&lifestyles)	1	2 3 4 5	6 7 8
Mobility Demand Management		2 3 4 5	6 7 8
Public Transport Financing	1	2 3 4 5	6 7 8

Urban Mobility Resource Utilization Indices

The reform of the urban mobility system in Sarajevo is one of the biggest challenges facing policymakers, stakeholders and users today. In order to be successful, it is necessary to adopt indices that measure the completion and performance of the system, Table no 2.

Table no 2: Urban Mobility Resource Utilization Indices

Completeness [max. 58 points]		Performance [max. 42 points]	
The criteria	Weight[1]	The criteria	Weight[1]
1. Financial attractiveness of public transport	4	12. Transport related CO_2 emissions	4
2. The share of public transport in the modal division	6	13. NO_2 concentration	4
3. The share of zero emission modes in the modal division	6	14. PM_{10} concentration	4
4. Road density	4	15. Traffic-related deaths	6
5. Density of the footpath network	6	16. Increasing the share of public transportation in the modal division	6

6. Group agglomeration	2	17. Increasing the share of emission-free modes	6
7. Smart card penetration	6	18. Travel time to work	6
8. Bicycle Sharing Performance	6	19. Density of registered vehicles	6
9. The effect of car sharing	6		
10. Frequency of public transport	6		
11. Public sector initiatives	6		

1) A maximum of 100 points defines each city in the sample for each criterion. Source: Arthur D. Little Urban Mobility Index 2.0

2. Transport demand in public urban passenger transport in Sarajevo Canton

Population mobility in the period 2020-2030.year was determined on the basis of estimated population density and expression for population mobility (*m*) as a function of population density (*g*)

$m = 0.0396 \cdot g + 1.6556$ (movements/resident), *g* (resident/acre) - population density

The estimate of the number of daily movements in the Sarajevo Canton was obtained by multiplying the population and the mobility of the population, Table no 3.

Table no 3: Number of daily movements of residents, non-motorized and motorized (individual and public city transport), in the Canton of Sarajevo for the period 2020-2030.

Year										
2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Population movements per day (x1000)										
1187,78	1193,75	1199,78	1205,87	1212,02	1218,24	1224,53	1230,88	1237,31	1243,81	1250,39

Daily movements of the population in the Canton of Sarajevo take place in many ways, motorized and non-motorized.

Divide the number of movements in the Sarajevo Canton by mode (Split model)

The total daily movements presented in the table (Table 9) are realized in different ways:

1. Non-motorized (by foot, non-motorized means) [31], N_{NM}
2. Individual vehicle, N_{PV}
3. Public urban transport, N_{JGP}.

The total daily movementsN_U are

$N_U=N_{NM}+N_{PV}+N_{JGP}$.

Izborpojedinihnačina, odnosnovidovaprevozadefinišuslijedećiparametriputovanja: dužina, trajanje, svrha, primanja, stepenmotorizacije, brzina, cijenaprevoza, pristupačnost, komforitd.

ZapodručjeKantonaempirijski je određenamjerapreferencijezaodređeni vid prevoza:

$Z=0,1+0,4 \cdot X_1+0,3 \cdot X_2+0,2 \cdot X_3$

X_1 - is the difference in the walking time of the UPT (urban public trasport) and the IV (individual vehicle)*[h]*,

X_2 - is the difference in waiting time *[h]*,

X_3 - is the difference in driving time *[h]*.

For estimated values $X_1 = 4\,min$, $X_2 = 9\,min$ i $X_3 = 11\,min$, the probability of choosing UPT as a mode of transportation is determined.

$Z=0,1+0,4 \cdot 4/60+0,3 \cdot 9/60+0,2 \cdot 11/60=0,208$

$$P(z) = \frac{e^{0,208}}{(1+e^{0,208})} = 0,55$$

The probability of choosing an UPT is 0.55 and the individual vehicle IV is 0.45, which means that the percentage share of the total movements is

$JGP:PV=55\% : 45\%$.

$k_1$denotes the relation between the number of movements in the public transport system and the individual vehicle and its value

$k_1 = 55/45=1,222$.

The number of non-motorized movements in Sarajevo Canton can be determined by expression

$N_{NM} = N_U - N_{JGP} \cdot (1+1/k_1)$.

The percentage of movements by mode is given inTable no 4.

Table no 4: Number of movements realized in different ways in Sarajevo Canton, 2020-2030.

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of movements UPT per day (N_{JGP})	343390	354821	366252	377683	389114	400545	411976	423407	434838	446269	457700
The number of all movements per day x1000 $N_U=N_{NM}+N_{PV}+N_{JGP}$	1187,78	1193,75	1199,78	1205,87	1212,02	1218,24	1224,53	1230,88	1237,31	1243,81	1250,39
UPT participation N_{JGP}/N_u (%)	28,91	29,72	30,53	31,32	32,10	32,88	33,64	34,40	35,14	35,88	36,60
Participation of individual movements N_{PV}/N_u (%)	23,66	24,32	24,98	25,63	26,27	26,91	27,53	28,15	28,76	29,36	29,95
Participation of motorized movements $(N_{PV}+N_{JGP})/N_u$ (%)	52,57	54,05	55,51	56,95	58,38	59,78	61,18	62,55	63,90	65,24	66,56
Participation non-motorized movements N_{NM}/N_u (%)	47,43	45,95	44,49	43,05	41,62	40,22	38,82	37,45	36,10	34,76	33,44

Note: Individual vehicle participation should be reduced by preferring measures that improve public transport or non-motorized movements

Planned transport work by modes of transport is defined as the product of the average number of passenger movements realized by public urban transport on weekdays and the average length of passenger travel.

Table no 5:Planirani prevozni rad po vidovima prevoza u Kantonu Sarajevo u periodu 2020-2030.g.

Year Parametar	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of trips average daily (P_d)	343390	354821	366252	377683	389114	400545	411976	423407	434838	446269	457700
Number of trips per year (P_g) x1000	125337	129510	133682	137854	142027	146199	150371	154544	158716	162888	167061
Number of passengers carried by type of day (working day, Saturday, Sunday)	The ratio of the number of passengers carried by type is given: $k_1=P_r:P_n$ = 371115:212471 =1,75 $k_2=P_s:P_n$ = 273287:212471 =1,29 Number of days per year: 260 - working days; 52-Saturday; 53-Sunday										
Number of trips on Sundays $P_n=P_g/(k_1\cdot 260+k_2\cdot 52+53)$	217948	225203	232458	239713	246968	254224	261479	268734	275989	283244	290500
Number of trips on Saturdays$P_s=k_2\cdot P_n$	281153	290512	299871	309230	318589	327948	337308	346667	356026	365385	374744
Number of trips per weekday$P_r=k_1\cdot P_n$	381408	394105	406802	419498	432195	444891	457588	470285	482981	495678	508374
Medium passenger travel length (l_{srv}) *[km]*	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2	3,2
Planned transport work (U_B) x1000*[put· km]*	1220,5	1261,1	1301,8	1342,4	1383,0	1423,7	1464,3	1504,9	1545,5	1586,2	1626,8
Planned transport work by modes of transport on working day(U_B) x1000 *[p· km]*											
Tram	476,0	491,8	507,7	523,5	539,4	555,2	571,1	586,9	602,8	618,6	634,5
Trolleybus	219,7	227,0	234,3	241,6	248,9	256,3	263,6	270,9	278,2	285,5	292,8
Bus	451,6	466,6	481,7	496,7	511,7	526,8	541,8	556,8	571,8	586,9	601,9
Minibus	73,2	75,7	78,1	80,5	83,0	85,4	87,9	90,3	92,7	95,2	97,6

3. Denamd Public Passenger Transport Service in Sarajevo Canton

Transportation requirements during the working day and the number of vehicles at work required to transport them over an average distance, with the average utilization rate of planned transport work, mean daily mileage and number of seats in the vehicle as in Table no 6, are presented in Table no 7.

Table no 6: Participation of modes of transport in annual transport work performed, number of seats in the vehicle, mean daily mileage, coefficient of dynamic utilization of the number of seats in the vehicle, 2011.

Type of transport	Participation of mode of transport in total transport p_i [%]	Average number of seats in a vehicle (sitting+standing) m	Average daily mileage K_{SD} [km]	Dynamic utilization coefficient for the number of places Ki
Tram	39	200	250	0,19
Trolleybus	18	140	250	0,17
Bus	37	117	260	0,17
Minibus	6	50	250	0,17
TOTAL	100			

Table no 7:Planned demand and supply of public transport services in Sarajevo Canton, 2020-2030.

Parameter Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of trips average daily, working day (P_d)	381408	394105	406802	419498	432195	444891	457588	470285	482981	495678	508374
Number of vehicles at work per day, working day(N_R)	209	216	223	230	237	244	251	257	264	271	278
Number of passengers transported per vehicle at work per day	1825	1825	1824	1824	1824	1823	1823	1830	1829	1829	1829

3. Investment Plan for Public Urban Transport System, 2020-2030.g.

Investment Plan for the period 2020-2030. in public urban transport in the Canton of Sarajevo is presented by investment groups in Table no 8 and no 9.

Table no 8: An overview of the investment plan for the public transport system in the Canton of Sarajevo in the period 2020-2030.g. (x1000KM) (KM – BAM)

R&b.	Purpose of investment	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
I	**ROLLING STOCK**	**72.530**	**46.875**	**38.825**	**10.000**	**100**	**29.940**	**0**	**25.180**	**21.500**	**28.000**	**0**	**272.950**
I-1	**Tram**	**37.530**	**20.675**	**20.025**	**0**	**0**	**0**	**0**	**15.000**	**20.000**	**20.000**	**0**	**133.230**
I-1.1	Procurement of new trams	27.500	20.000	20.000					15.000	15.000	15.000		112.500
I-1.2	Procurement of used trams	10.000											10.000
I-1.3	Completing the tram		650										650
I-1.4	Tram repair / repair	30	25	25									80
I-1.5	Tram overhaul									5.000	5.000		10.000
I-2	**Trolleybus**	**23.900**	**23.000**	**0**	**0**	**0**	**15.500**	**0**	**0**	**500**	**8.000**	**0**	**70.900**
I-2.1	Procurement of new trolleybuses	17.500	15.000				15.000			500			48.000
I-2.2	Procurement of used trolleybuses	6.400	8.000								8.000		22.400
I-2.3	Trolleybus overhaul according to condition						500						500
I-3	**BUS**	**11.000**	**800**	**18.800**	**10.000**	**0**	**13.600**	**0**	**9.200**	**1.000**	**0**	**0**	**64.400**
I-3.1	Procurement of new buses	5.000		18.800	10.000		13.600		9.200	1.000			57.600
I-3.2	Procurement of new e-buses	6.000											6.000
I-3.3	Bus overhaul according to condition		800										800
I-4	**MiniBUS**	**100**	**2.400**	**0**	**0**	**100**	**840**	**0**	**980**	**0**	**0**	**0**	**4.420**
I-4.1	Procurement of new minibuses		2.400				840		980				4.220
I-4.2	Procurement of used minibuses												0
I-4.3	Minibus overhaul according to condition	100				100							200
II	**TRACK**	**2.300**	**2.150**	**10.150**	**8.000**	**8.000**	**8.800**	**8.800**	**5.300**	**7.300**	**7.300**	**7.300**	**75.400**
II-1	Reconstruction of the MariinDvor-Ilidža railway line with a branch for the railway station	300	150	150									600
II-2	Railway reconstruction in Alipašin Most depot	2.000	2.000	2.000									6.000
II-3	Construction of the			8.000	8.000	8.000	8.000	8.000					40.000

R&b.	Purpose of investment	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total
	Ilidža-Hrasnica tram line												
II-4	Construction of the tram line Nedžarići-Dobrinja								4.500	4.500	4.500	4.500	18.000
II-5	Railway construction for Tram-Train system						800	800	800	800	800	800	4.800
II-6	Construction of the railway Dobrinja-Airport									2.000	2.000	2.000	6.000
III	**PUBLIC CITY STATIONS / TERMINALS**	**300**	**700**	**100**	**200**	**200**	**100**	**100**	**50**	**50**	**50**	**50**	**1.900**
IV	**DEPOSIT AND MAINTENANCE OF VEHICLES AND PLANTS**	**3.254**	**285**	**100**	**0**	**100**	**63**	**40**	**0**	**100**	**0**	**0**	**3.933**
IV-1	Investments in facilities and installations in depots	200	70	100			63						433
IV-2	Investment in equipment and maintenance	3.045	215			100		40		100			3.500
V	**ELECTRIC TOWING POWER SYSTEM**	**10**	**2.790**	**1.000**	**500**	**1.600**	**1.200**	**5.600**	**200**	**1.000**			**13.900**
VI	**OFFICIAL AND MAINTENANCE VEHICLES**	**696**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**236**	**932**
VII	**COMPANY INFORMATION SYSTEM**	**30**	**100**		**100**	**50**	**100**			**300**			**932**
VIII	**PUBLIC VEHICLE VEHICLEVEHICLE MANAGEMENT SYSTEM**	**500**	**500**	**250**	**250**				**200**				**680**
IX	**CHARGING SYSTEM**	**1.500**	**1.000**			**100**				**100**			**1.700**
X	**VIDEO CONTROL SYSTEM**	**400**	**200**	**100**		**50**	**100**			**50**			**2.700**
XI	**PASSENGER INFORMATION SYSTEM**	**200**	**100**	**100**		**100**		**100**		**100**		**100**	**500**
XII	**KJKP GRAS D.O.O. PARTICIPATION IN IMPLEMENTATIO N OF MEASURES AND PROJECTS**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**800**
XIII	**RESEARCH OF DEMAND FOR SERVICES OF PASSENGER PUBLIC TRANSPORT IN CITY OF SARAKEVO**	**300**		**15**			**300**		**15**			**300**	**550**
TOTAL		**81.861**	**54.650**	**50.590**	**19.100**	**10.350**	**40.653**	**14.690**	**30.995**	**30.550**	**35.400**	**8.036**	**376.875**

The decision to invest in projects for public urban passenger transport in Sarajevo should be based on appropriate methods for evaluating projects, ie investment decisions. Single-criteria or intuitive decision-making in the present tense can only be coincidentally correct, both because of very complex relationships (economics, social aspects, space, environment) and interactive relationships. In this case, it should be avoided that the criterion - profit be the dominant criterion, but also to consider other benefits of the project - benefit, e.g. full employment, minimum energy consumption, technical and technological reliability, environmental security, quality of service, etc.

The costs of investing in the public urban passenger transport system include the cost of investing in vehicles, the road (rail), equipment and associated systems and facilities.

The ways of financing investment projects in the public transport system in the Canton of Sarajevo can be: budget financing, carrier, liabilities, bank loans, commercial financing, contribution from transport infrastructure development funds, PPP - Public Private Partnership (PPP) .

Negotiations regarding financial loans should be conducted at a competent level so that the conditions for securing loans for the implementation of the project can be discussed.

Indicative funds for realization of planned projects of public urban passenger transport in the Canton of Sarajevo in the period 2020-2030. estimated at KM 376,875,000.00.

Participation of the carrier KJKP "GRAS" d.o.o. Sarajevo in financing the planned projects should be implemented in the part of each project where engagement of the workforce of the qualification possessed by the employees of GRAS is necessary. Therefore, the total investment amount would be reduced by the costs of the employees of GRAS.

1. Assessing the possibilities of improving mobility by implementing the Sarajevo Investment Plan

Another approach is to rank according to the relative importance of specific characteristics or projects (for example, ranking on a scale of 1 to 5), which is represented by the example given in Table no 9.

Table no 9:Study assessing the possibilities of improving mobility in Sarajevo by implementing an investment plan and other available measures

Generate capabilities	Traffic and transport criteria				Socioeconomic criteria				Cost criteria				The total result
	Increasing passenger capacity / improving traffic flow	The rise in choice	Demand reduction	Under sum	Emission control	Economic impact	Public acceptance	Under sum	Cost reduction of goods movement	Capital costs	Operating costs (operating)	Under sum	
Demand management													
Parking Price / Management Policy	2	1	2	**5**	2	2	2	**6**	2	3	3	**8**	**19**
Environmental information /	2	2	2	**6**	2	1	3	**6**	2	3	2	**7**	**19**
energy / balances / concessions	2	1	2	**5**	2	2	3	**7**	1	3	2	**6**	**18**
Shared driving programs	2	1	2	**5**	2	1	2	**5**	2	3	3	**8**	**18**
Hours of operation flexible / schedule	2	2	1	**5**	2	2	3	**7**	1	3	2	**6**	**18**
Urban transport rates integrated / planned	1	0	2	**3**	2	2	1	**5**	1	3	3	**7**	**15**
Reduction of off-peak prices of guard transportation	2	1	2	**5**	1	0	3	**4**	2	2	2	**6**	**15**
Truck Road Use Prices	1	0	3	**4**	1	1	0	**2**	2	3	2	**7**	**13**
Manage suplay													
Procurement of vehicles	3	2	1	**6**	3	2	2	**7**	1	3	2	**6**	**19**
Improvement of express urban transport	3	3	1	**7**	3	3	3	**9**	2	0	1	**3**	**19**
Improve real-time information for users	3	2	1	**6**	2	2	3	**7**	2	2	2	**6**	**19**
Extension of express buses	2	3	2	**7**	2	2	2	**6**	2	2	1	**5**	**18**
Separate lines / priorities for urban transport	2	2	2	**6**	2	2	2	**6**	2	1	2	**5**	**17**
Computerized traffic management system	2	2	1	**5**	2	2	3	**7**	2	1	2	**5**	**17**
Improvement of traffic / operation of urban transport and control	2	1	1	**4**	2	2	3	**7**	2	2	2	**6**	**17**
Financing / implementation													
Financing the rail transport sector	2	2	1	**5**	2	3	2	**7**	2	3	2	**7**	**19**
New road taxes aimed at improving urban transport	2	2	1	**5**	2	3	2	**7**	1	3	2	**6**	**18**
Tax relief for employers to provide public transportation	1	1	2	**4**	2	1	3	**6**	2	3	2	**7**	**17**
Revenue from the increase in traffic applications	2	1	1	**4**	2	2	2	**6**	2	3	2	**7**	**17**
Employer tax for city transportation fund	2	1	1	**4**	2	0	2	**4**	2	3	2	**7**	**15**
Parking fees	1	0	2	**3**	2	2	0	**4**	2	3	2	**7**	**14**

Rating scale (Rating scale): 0 - unfavorable; 1- neutral; 2 - favorable; 3 - highly affordable

V. Conclusion

The analysis of the transport policy and the Government's commitment to base it on the principles of sustainable development and innovations in transport, transport and communication technology revealed that there is a significant lag behind the situation in the average developed European cities.

To meet the key challenges of today and the future, operators in Sarajevo Cannot rely solely on optimizing their operations. In order to be successful and meet customer needs, they must adapt to this new world by constantly finding ways to reinvent themselves. This successful transformation can only be made possible through collaboration at system level and innovation.

The authorities responsible for transporting passengers in Sarajevo must identify why "the city is not moving forward" and include 3 strategic directions in the strategic transport policy, seriously integrate 25 imperatives into urban mobility policy and be guided only by positive practice without repeating the mistakes of other cities.

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Dr. Mustafa Mehanovic,etal. "Public Transport of Passengers Main Resource of Sustainable Urban Mobility in Sarajevo." *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 17(2), 2020, pp. 44-56.