Ministry of Traffic of Canton Sarajevo

Bosnia and Herzegovina

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan

Final Report

Volume I

Public Transport Policy Improvement Plan

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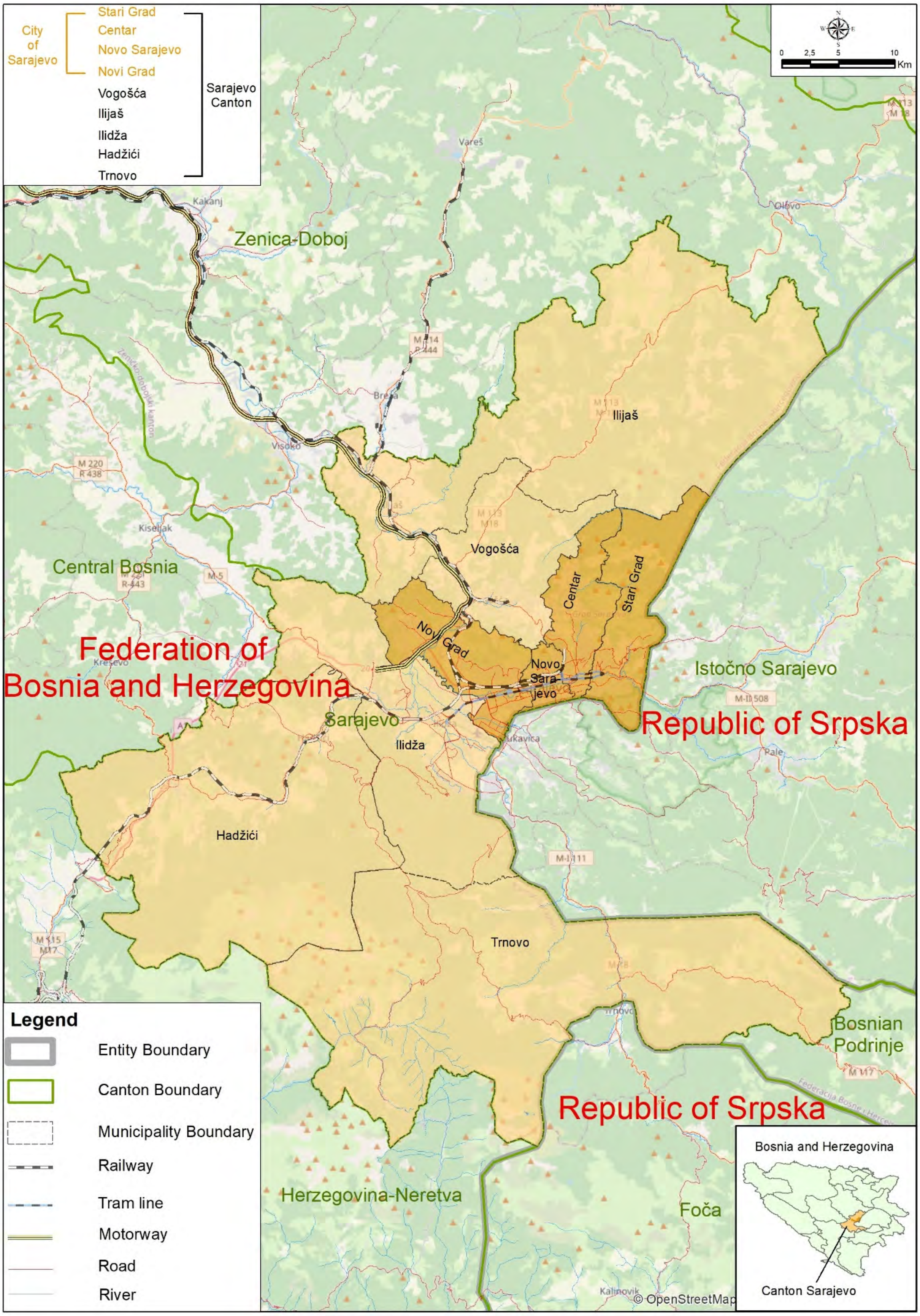
List of Abbreviations

ADS	Activity Diary Survey
AGT	Automated Guided Transit
AMS	Assets Management System
APCs	Automatic Passenger Counters
ASC	Alternative Specific Constant
ATAF	Florentine Area Transportation Company (*Azienda Trasporti Area Fiorentina*)
AVL	Automatic Vehicle Location
B2G	Business to Government
BAM	Bosnia and Herzegovina convertible mark
BiH	Bosnia and Herzegovina *(Bosne i Hercegovine)*
BIHAMK	Bosnia and Herzegovina Auto-Moto Club
BPR	Bureau of Public Roads
BRT	Bus Rapid Transit
C/P	Counterpart
CAGR	Compound Annual Growth Rate
CCTV	Closed-circuit Television
CMMS	Computerized Maintenance Management System
CNG	Compressed Natural Gas
COVID19	Corona Virus Disease of 2019
CS	Canton Sarajevo
DCM	Destination Choice Model
DFID	Department for International Development
DPPSM	Division of Policy Planning and Sustainable Mobility
DPPT	Department of Passenger Public Transport
DSSC	Development Strategy of the Canton Sarajevo
EA	Enumeration Area
EBRD	European Bank for Reconstruction and Development
ECM	Entities in charge of Maintenance
EIB	European Investment Bank
ERP	Economic Reform Program
EU	European Union
EUR	Euro
EV	Electric Vehicle
FBiH	Federation of Bosnia and Herzegovina
FISIM	Financial Intermediation Services Indirectly Measured
FOT	Faculty of Transport and Communications
FTEs	Full-time Equivalents
FTS	Framework Transport Strategy
GDP	Gross Domestic Product
GEST	Management and Operation of the Tramway System (*Gestione ed Esercizio del Sistema Tramviario S.p.A*)
GIS	Geographical Information System
GIZ	*Deutsche Gesellschaft für Internationale Zusammenarbeit*
GKB	Graz-Köflacher Railway and Bus Service (*Graz-Köflacher Bahn und Busbetrieb GmbH*)

GLA	Greater London Authority
GPS	Global Positioning System
GRAS	*Gradski Saobraćaj*
GRDP	Gross Regional Domestic Product
GS	Mayors of City
GTFS	General Transit Feed Specification
HBO	Home-based Others
HBS	Home-based School
HBW	Home-based Work
HHVO	Households without Car Ownership
HQ	Headquarter
IC	Integrated Circuit
ICT	Information and Communication Technology
IPF	Iterative Proportional Fitting
ITP	Institute of Transport Policy
ITS	Intelligent Transportation System
JCC	Joint Coordinating Committee
JICA	Japan International Cooperation Agency
JPS	Public Transport Sarajevo (*Javni prijevoz Sarajevo*)
KJKP	Cantonal Public Utility Company (*Kantonalno Javno Komunalno Preduzeće*)
KM	Convertible Mark
KPI	Key Performance Indicator
LEZ	Low Emission Zone
LPTP	Law on Public Transport of Passengers
LRT	Light Rail Transit
LTAZ	Large Traffic Analysis Zone
MaaS	Mobility as a Service
MCM	Modal Choice Model
MM	Mobility Management
MOE	Ministry of Education and Science
MOF	Ministry of Finance
MOKE	Main Other Key Entities
MOT	Ministry of Traffic
MPZKS	Minister of Physical Planning, Construction and Environmental Protection
MRT	Mass Rapid Transit
MUN	Municipalities
NHB	Non-Home Based
NMT	Non-motorized Transport
NUC	Supervisory Management Center (*Nadzomi Upravljacki Centar*)
O&M	Operation and Maintenance
ÖBB	Austrian Federal Railways (*Österreichische Bundesbahnen*)
OCA	Other Cantonal Administrations
OD	Origin and Destination
OECD	Organization for Economic Co-operation and Development
OP	Operators
OV	Municipal Council
P+R	Park and Ride

PhD	Doctor of Philosophy
PO	Possible Option
PPP	Public-Private Partnership
PCU	Passenger Car Unit
PR/R	Progress Report
PSC	Public Service Contract
PT	Public Transport
PTO	Public Transport Operators
PTU	Public Transport Unit
PuT	Public Transport
PV	Private Vehicle
R/D	Record of Discussion
RS	Recommended Scheme
RSHs	Relevant Stakeholders
SC	Canton Sarajevo
SCG	Sarajevo Canton Government
SECO	Swiss State Secretariat for Economic Affairs
SIDA	Swedish International Development Cooperation Agency
SIE	Sarajevo Institute of Economics
SILFI	Florence Lighting and Services Company (*Societa' Illuminazione Firenze e Servizi*)
SKS	Canton Sarajevo Assembly
SLS	Screen Line Survey
SMMAG	Mixed Syndicate for Mobility in the Grenoble area (*Syndicat Mixte des Mobilités de l'Aire Grenobloise*)
SPTC	Sarajevo Public Transport Company
SSB	Stuttgart Tramways (*Stuttgarter Straßenbahnen*)
STV	Styrian Transport Association (*Steirische Verkehrsverbund*)
SUMP	Sustainable Urban Mobility Planning
SUMSEEC II	Sustainable Urban Mobility in Southeast European Country II
SWB	Bonn Public Utility (*Stadtwerke Bonn*)
SYTRAL	Greater Lyon Transport Authority (*Syndicat des Transports de l'Agglomération Lyonnaise*)
TA	Transport Authority
TAZ	Traffic Analysis Zone
TCL	Public Transport Network in Lyon (*transport en Commun de Lyon*)
TCT	Third Country Training
TDM	Transportation Demand Management
TFM	Trip Frequency Model
TGV	High Speed Train (*Train à Grande Vitesse*)
TISAR	Traveler Information System for the Adriatic Region
TPER	Passenger Transport Emilia-Romagna (*Trasporto Passeggeri Emilia-Romagna*)
TRAMODE	Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan
UK	United Kingdom
USD	United States Dollar
UTPS	Urban Transformation Project Sarajevo

V/C	Volume / Capacity
VOM	Vehicle Ownership Model
ZFBiH	Federal Railway Company (*Zeljeznice Federacije Bosne i Hercegovine*)
ZFE	low emission zone (*Zones à Faibles Emissions*)
ZPA	Emergency Low-emissions Zone (*Zone de la Protection de l'Air*)
ZPRKS	Development Planning Institute of Canton Sarajevo *(Zavad za Planiranje Razvoja Kantona Sarajevo)*



Project Study Area

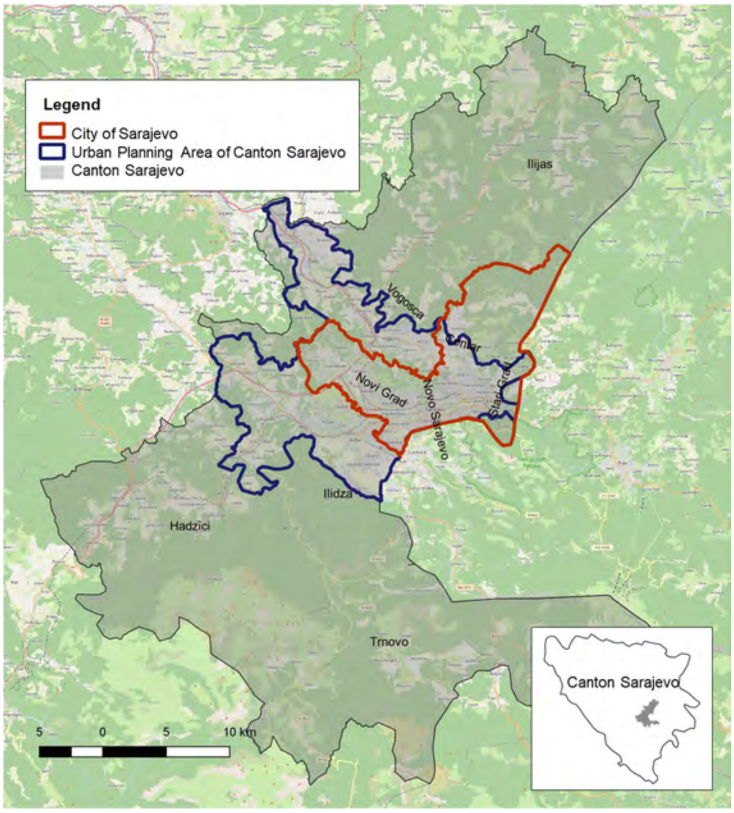
1 Current Plans and Policies on Public Transport

1.1 Development Policies in Canton Sarajevo

At the Canton level, the Canton Sarajevo Development Strategy by 2020, as a five-year official plan, was formulated in 2016. This development strategy describes a vision of development: "The Canton Sarajevo is a European, dynamic, creative and culturally diverse region of pleasant living and profitable business".

The spatial plan of Canton Sarajevo for the period from 2003 to 2023 was formulated in 2006. After establishing the Development Strategy of Canton Sarajevo in 2016, the spatial plan in 2006 was revised in 2016 to fit with current development conditions and the development strategy. The latest Sarajevo Canton Development Strategy 2021-2027 was published in April 2021.

Aside from "Urban Plan of the City of Sarajevo[1] for the period from 2016 to 2036", as mentioned in the Spatial Plan section, urban areas of Hadžići, Ilijaš, Trnovo municipalities also compose "Urban Plan of Canton Sarajevo".



Source: JICA Expert Team

Figure 1 Area of Sarajevo

1.2 Public Transport Policy and Transport Planning

1) Organizations

MOT as main regulator for public transport, and there are 5 public transport operators as regulated organizations: GRAS (public cantonal company, unless the company is liquidated), CENTROTRANS d.d. (private), the Sarajevo Public Transport Company (SPTC, public cantonal company) to be established, the ZFBiH (federal public railways company) and the cable car operator J.P. Sarajevo d.o.o, (a public company under City of Sarajevo). Except for the ZFBiH, all operators are regulated by the MOT.

[1] City of Sarajevo covers Stari Grad, Centar, Novo Sarajevo and Novi Grad, while the urban plan of the city of Sarajevo considers the urban area: Stari Grad, Centar, Novo Sarajevo, Novi Grad, and part of Ilidža and Vogošća.

2) Ongoing Transport Improvements

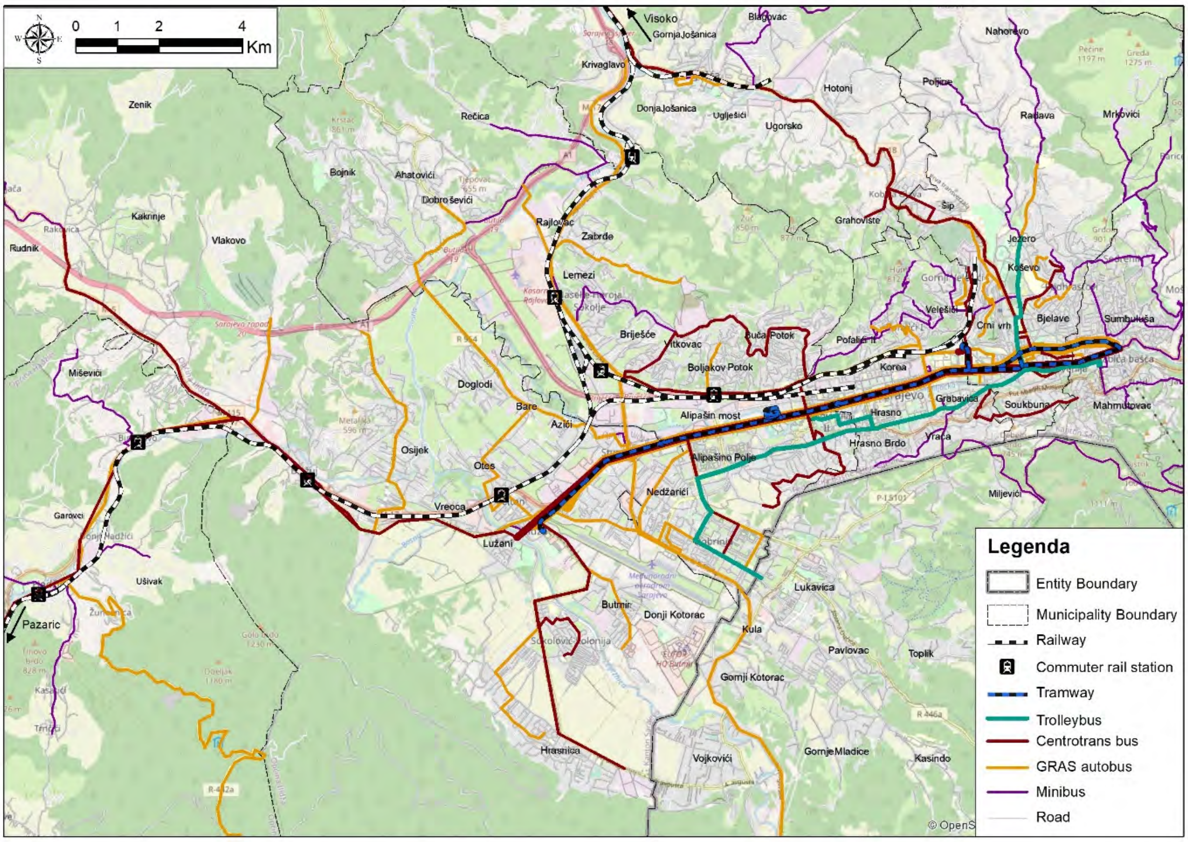
Public transport operation faces challenges such as the deterioration of services and weakening of GRAS that accumulated debts. MOT will establish an internal body to deal with public transport operation for all processes (tariff system, allocation of lines, performance conditions/requirements, etc.). Ongoing improvements are summarized.

- Tram tracks: reconstruction of 60-year-old tram tracks from Ilidža to the center, new tracks to Hrasnica, and a feasibility study for new tram lines to Šip and Dobrinja.
- Trolleybus: a plan to re-open the trolleybus line to Vogošća, and new trolleybuses replacement.
- Contactless ticket system: valid in all public transport operators, subsidized tickets, and mobile phone credit top-up function.
- Road development: IX Transversal Project, and roundabout construction.

3) Public Transport Network

Sarajevo's urban center is located in a long, narrow east-west basin in a mountainous area, The existing public transport network based on the plan is presented in Figure 2. As trunk transport modes, tramway and trolleybus line are running mainly east-west, serving the central area of Canton Sarajevo.

The tramway also connects to the main railway station and Sarajevo intercity and international bus terminal. The trolleybus line extends to the north toward the Olympic stadium. Conventional bus and minibus lines serve the entire urban area. Minibuses often serve hillside residential areas serving as feeder lines to the trunk transport modes. Furthermore, commuter trains run on ZFBiH line for connecting with suburban area (Sarajevo-Pazarić, Sarajevo-Visoko).



Source: JICA Expert Team summarized with the plan provided by the Ministry of Traffic of Canton Sarajevo

Figure 2 Existing Public Transport Network

2 Current Situation of Public Transport in Canton Sarajevo

2.1 Traffic Data and Characteristics

The transportation characteristics of Canton Sarajevo are strongly related to the geographical situation of valley and hilly terrain, urban layout, and quite significant historical value. Sarajevo has a diverse transportation system that incorporates multiple modes of transportation, including trams, buses, taxis, private vehicles, and non-motorized transport including walking.

Like many urban areas, Canton Sarajevo experiences traffic congestion especially in peak hours. This congestion is influenced by factors such as the city's narrow streets, increasing private vehicle ownership, and growing demand for public transportation post pandemic. The number of registered vehicles nationwide and in Canton Sarajevo over the recent decade shows the trend of positive increase. The future linear projection after 2022 is at 2.5% and 2% increment each year up to 2030 for nationwide and Canton Sarajevo, respectively. This shall result more than 1.4 million and 0.19 million of vehicles shall be registered in Bosnia and Herzegovina and Canton Sarajevo, respectively, by 2030.

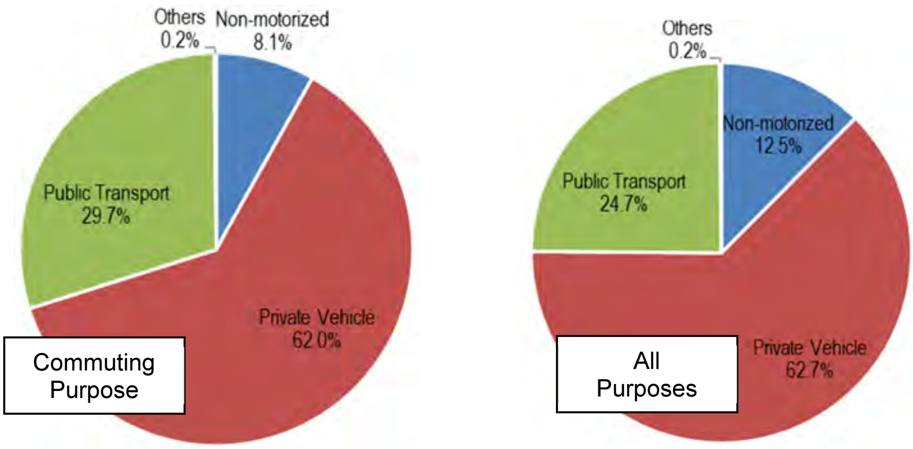
2.2 Findings from Transport Surveys

1) Activity Diary Survey (ADS)

The 2013 Census data does not include trip information related to daily travel, and there are privacy restrictions on personal attribute data needed for model construction and analysis. During the project implementation period, it should be taken into account that people's behavior (such as a shift to working from home) changes by day due to the impact of the COVID-19 pandemic, and it is important to understand travel modes using a disaggregate approach. Therefore, JICA Expert Team decided to conduct an ADS that is highly compatible with the disaggregate model development.

Average monthly household income for 6,034 households is around 2,000 KM. This may be the reflection of income of both parents in which individually makes up to around 1,000 KM. Notably higher percentages (total of 60% of all households) are spread between the ranges of 750 KM to 2,500 KM as medium-high income classes.

From the interview results with 6,034 households, information of modal share can be classified into two categories: for commuting purpose and for all purposes. Thus, the simplified modes to the question of commuting purpose led to the nested answer of public transport, private vehicle, and walk/bicycle only. Below are the charts of those two. For both purposes, the shares of public transport are about 30% for commuting purpose and about 25% for all purposes. In contrary, higher share of private vehicle indicates the domination of the use of private vehicle.



Source: ADS 2022

Figure 3 ADS Modal Share by Purpose

2) Screenline Survey

Screenline survey collects the data of current traffic situation (i.e.: traffic volume and occupancy) at 8 locations along imaginary lines of east-west and north-south that quarterly divide Canton Sarajevo. The results of the traffic count in all locations are converted to PCU to compare at the same standard for different types of vehicles, and suggest the composition of traffic is dominated by private vehicle (84.6%), taxi (6.2%), pick-up/box (4.3%), and other modes less than 1%.

3) Cordon Line Survey

Cordon line survey gathers data of traffic situation and OD information of inbound and outbound trips that cross the boundary of Canton Sarajevo such as and purposes at Sarajevo Bus Terminal, Roadside at boundary of Canton Sarajevo, Sarajevo Railway Station, and Sarajevo International Airport. Results suggest among all trips, it averagely accounts for 30% international and 70% inter-cantonal movements.

4) Trip Generation/Attraction Survey at Large-Scale Establishment

This survey obtains trip generation and attraction rates of 3,400 respondents including employees or tenants or visitors for 10 large-scale establishment (i.e.: office, shop, mall, etc.) within Canton Sarajevo, and is applied for demand forecasting and calibration as an adjustment to OD matrices for samples with higher income. Movement pattern for shopping malls remains a smooth curve, while the office at morning and afternoon has higher people flows.

5) Public Transport Corridor Survey

In order to get passenger, occupancy, and operational service performance along 5 major urban and suburban lines, Tram 3, Bus 16B and 33, Trolleybus 102, and Trolleybus 107 are equipped with video camera for seven days during the operational hours.

Survey findings reflect that Tram 3 (Ilidža – Baščaršija) loops over 12 times per day. Higher demands can be observed between Otoka and Marjin Dvor in the vicinity of business and commercial areas. Trolleybus 102 (Jezero – Otoka) loops over 13 times per day. Hamze Hume and Pijaca Ciglane with the highest boarding and alighting due to intersection/intermodal connection for passengers. Bus 33 (Ilidža – Vukovići) loops over 7 times per day. The highest dwelling time is located at Hadzici which is near commercial areas and transit point. Some stops are skipped during bus operation if there is no passenger getting off or on.

Table 1 Public Transport Corridor Survey Results (7-9AM)

Route	Operation Speed (km/hr)	Passenger Number
Tram 3	17	15,141
Trolleybus 102	24	1,764
Trolleybus 107	22	2,527
Bus 33	24	796
Bus 16B	26	141

Source: JICA Expert Team

2.3 Challenges and Issues of Public Transport in Canton Sarajevo

Several challenges and issues of public transport can be observed.

1) Geographical challenge (contour of hilly roads)

Surrounded by hills, many residential areas located in hilly place, and the sharp slopes make it difficult for tram, trolleybus or regular buses accessing. Instead, minibuses with small capacity but higher mobility operate in these areas to serve the transport needs with lower frequencies. However, limited flat space, low demand and low service frequency make it difficult to station a bus stop or terminal, resulting in longer access time and inconvenience for users to use minibus. Minibuses run on steep slopes, which also causes problems with high wear and tear.

2) Overlapping routes along the river (tram, trolleybus, bus, etc.)

The transport network is highly relied on the main arterial road along the river, and co-existing of tram, trolleybus and bus makes the traffic flow complex and hard to manage. Although this provides passengers more options to select the transport mode, overlapping routes may result in low transport efficiency.

3) Limited accessibility to major points (i.e.: airport, railway station)

Current public transport lack of good intermodal connection. Passengers who would like to access major points such as airport, railway station, usually use private car or taxi. This suggests bus and tram operators should also consider the connectivity with railway and airport to make an integrated facility or interchange for smooth transfer. Nowadays, there is an airport connection, Airport – Bentbaša line, providing the bus service to improve the accessibility.

4) Insufficient timetable operation and information provision

Level of service is highly concerned by users. Timetable, reliability and punctuality hugely dominate their willingness to use public transport or not. However, although Sarajevo's public transportation (trams, trolleybuses, buses, and minibuses) currently have timetables, the lack of vehicles has resulted in no operation. Also, only some of the fleet are equipped with GPS where users can see the live location through mobile app.

5) Free riding

Free riding causes a big issue of revenues for operators. At this point in time, MOT recognizes this is a serious problem, but GRAS is not in a hurry to actively take action. However, CENTROTRANS as private company relies on revenue. Therefore, efforts on the prevention of the system from leaking are more scrutinized. Controls of entering/exiting flow of passenger and fare payment are more manageable on those fleets. In the other hand, GRAS' trolleybus and tram would face the delay if entrances and exits are not opened at once – which at the same time does not discourage free-riding mentality.

Enforcement may reduce the cases, but eliminating free riders should be prioritized. Particularly, operators require funds to upgrade the infrastructure/fleet/maintenance and improve the service, so measures to avoid this issue is considered to be urgent.

6) High number of car user

Low level of service by public transport has a negative impact on users' mode selection. What people concern include cost, convenience, safety, security, punctuality, service, and increased purchasing power due to increased income levels, etc. and these factors discourage people to use public transport and tend to use private vehicles. In addition, traffic congestion leads to a negative spiral of reduced speed of buses and other vehicles, which in turn reduces the capacity of public transport. Therefore, traffic congestion gets more serious. Prioritized lanes for public transport and other improvement measures are desired.

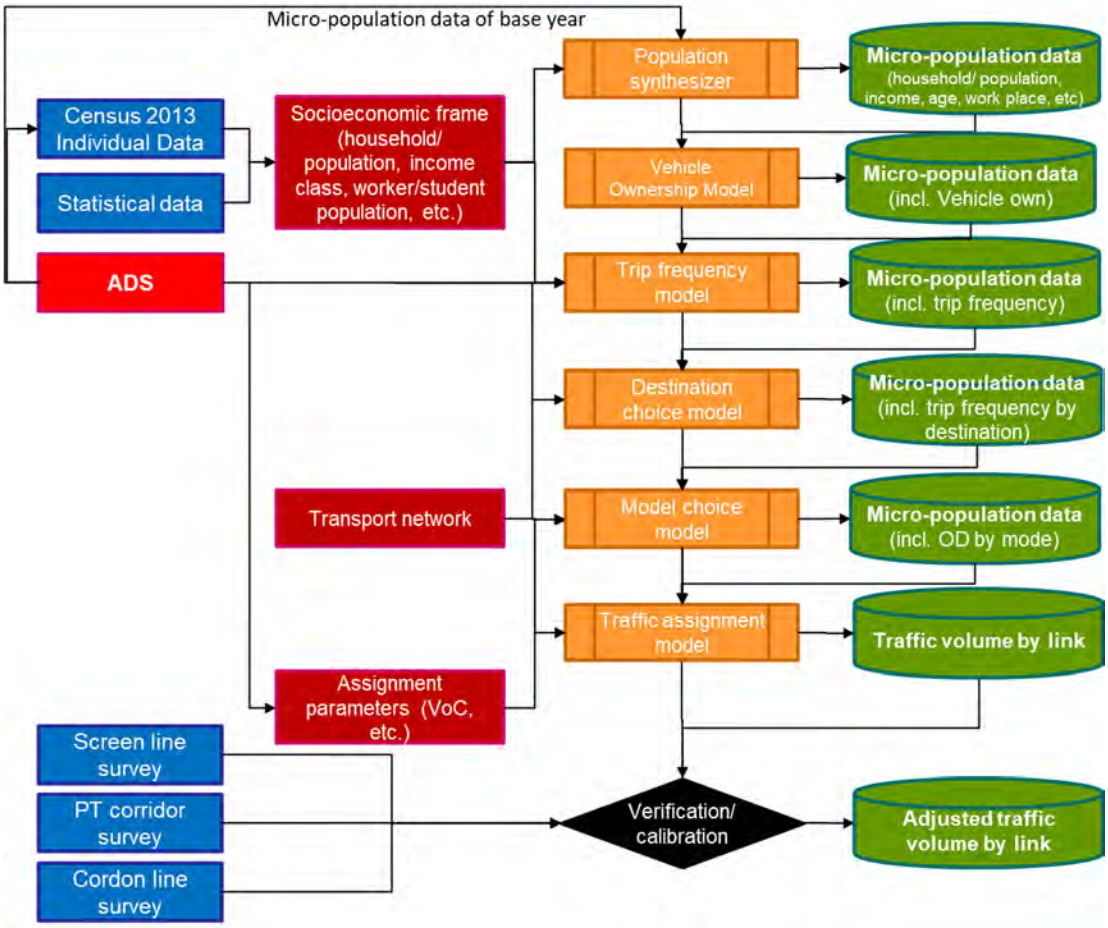
3 Travel Demand Forecast

3.1 Socioeconomic Framework

The total population of Canton Sarajevo was 419,762 in 2021, of which City of Sarajevo, composed of four Municipalities (Stari Grad, Centar, Novo Sarajevo and Novi Grad) was 273,184 (65% of total). While the population growth rate between 2014 and 2020 in Canton Sarajevo was 0.26%, the growth rate in the City of Sarajevo was -0.12%. The annual employment growth rate is sluggish in the City of Sarajevo (0.09%) as compared to the whole Canton Sarajevo (2.14%). The slowdown in the growth rate of the economically active population (15-64 years old) and in the employment growth rate in the City of Sarajevo shows a sign of population outflow.

3.2 Development of a Travel Demand Forecast Model

Travel demand forecast model was developed by a disaggregate four-step model based on the above ADS results in order to analyze changes in the travel behavior caused by various transport policies such as revision of the tariff system and introduction of a low-emission zone (LEZ). Flow of the travel demand forecast is shown in following figure.



Source: JICA Expert Team

Figure 4 Flow of Travel Demand Forecast

1) Traffic Analysis Zone (TAZ)

Canton Sarajevo is divided into 139 zones for traffic analysis in this study. The traffic analysis zone (TAZ) is compatible with the local community zone. Besides the 139 zones, 6 special zones are defined within the Canton Sarajevo for the trip generation points from/to outside of the Canton Sarajevo such as Sarajevo International Airport. The TAZs are combined into nine large zones (LAZs) used in the destination choice model, which is explained below, and are compatible with municipalities.

2) Transport Network

JICA Expert Team developed the existing highway network and public transport network with VISUM software. Public bus network is developed using VISUM software, GRAS bus network is generated by the General Transit Feed Specification (GTFS) database, then integrated with CENTROTRANS network which were developed in VISUM.

3) Population Synthesis

Socioeconomic data of population census in 2013 by Enumeration Area (EA) was provided from the statistics department of Canton Sarajevo. However, the individual data of population census in 2013 was not provided due to the privacy policy. Therefore, 420,000 individual data with household information were synthesized through the population synthesizer with an input of the result of ADS.

4) Vehicle Ownership Model (VOM)

A household vehicle ownership model is developed as a discrete choice model using household samples of the ADS. The model divides households into 3 groups: "NCO" households not owning any car, "CO1" households owning one car, and "CO2+" households owning two or more cars.

5) Trip Frequency Model (TFM)

A trip frequency model is developed for 4 trip purposes (HBW: home-based work, HBS: home-based school, HBO: home-based other, NHB: non-home-based) using samples from the ADS. More than 99% of the samples for all purposes fall within the range of 0 to 2 trip frequencies, so a discrete selection model that selects 0, 1, and 2 trip frequencies for each purpose was employed. The explanatory variables for the trip frequency model were gender, occupation, and household income.

6) Destination Choice Model (DCM)

The three-step destination choice model, which consists of Large TAZ (LTAZ) level destination model, Intra TAZ trip model and split by socio-economic attributes. Firstly, the LTAZ level destination model, which is a multinomial choice model, selects a destination from 9 LTAZs. Secondly, the Intra TAZ trip model, which is a binomial choice model, splits Intra TAZ trips and Inter TAZ trips in case that LTAZ of an origin and a destination are the same. Lastly, the Inter TAZ trips are split by socio-economic attributes of TAZ.

7) Modal Choice Model (MCM)

The Modal choice model was developed with the Revealed Preference (RP) data, actual modal choice data collected in the ADS. Considering the available transportation mode in Sarajevo, a 3-item choice model was employed, namely Non-motorized Transport (NMT), Private Vehicle (PV) and Public Transport (PuT). The explanatory variables of the model are total travel time and total travel cost of each mode as well as constants for each choice.

8) Validation and Calibration

The estimated traffic volume of private vehicle is validated with the screen line survey results. The difference between the estimated traffic volume and observed traffic volume in AM Peak Hour are less than 7%, and the whole demand forecast model has been validated.

3.3 Demand Forecasting

1) Household Income Distribution

Existing traffic demand is estimated with the above-mentioned travel demand forecast model. It was estimated that the share of high-income household in central area is larger than suburban municipalities.

2) Vehicle Ownership Estimation

Vehicle ownership is estimated with the above-mentioned Vehicle Ownership Model (VOM) and household income distribution by TAZ. It is estimated that the 124,000 houeholds,83 % of all households owns one or more cars.

3) Trip Estimation

Highest volume is estimated for Home-based Work (HBW) trip, followed by Home-based Other (HBO) trip, Home-based School (HBS) trip and Non-home-based (NHB) trip. In total, 736,000 trips are generated from Canton Sarajevo. It means the gross trip rate is 1.75 trips per day per person.

4) Trip Destination Estimation

Median, 50th percentile, of total trips is estimated 4.08km excluding intra-TAZ trips[2].

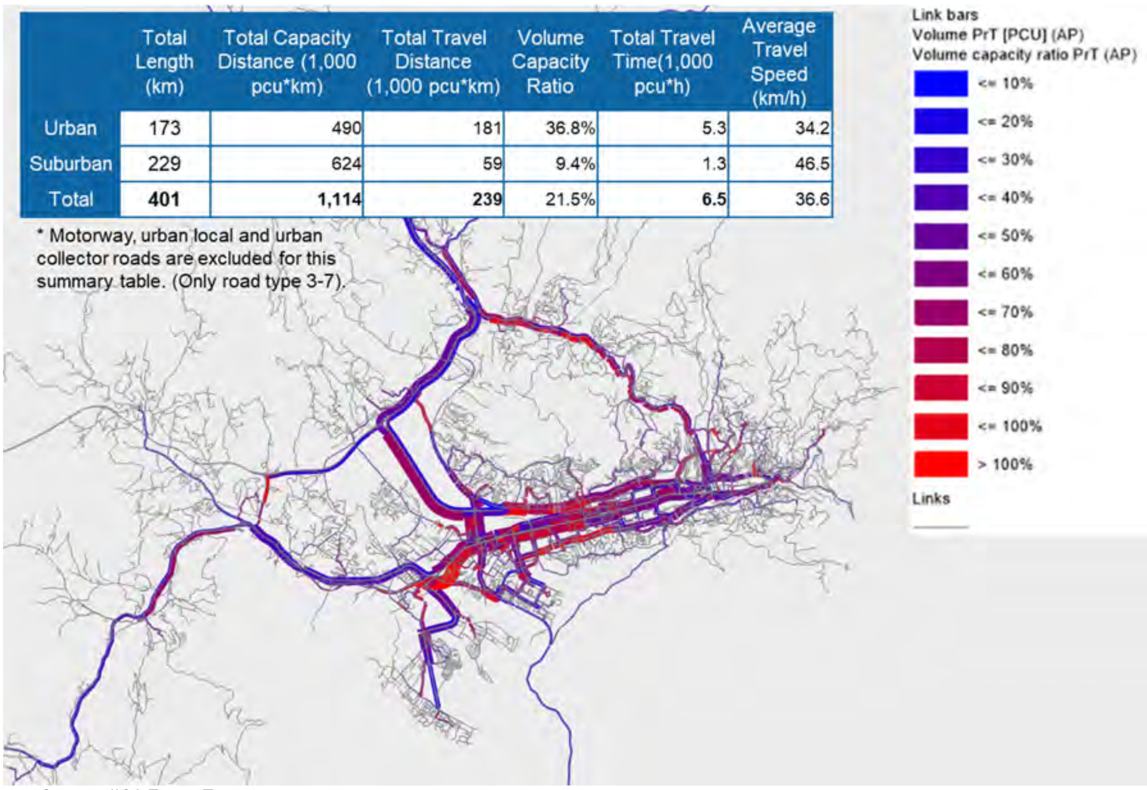
[2] The demand forecast model assumes that all trips within a TAZ originate from the zone centroid (one point), and travel distance within the TAZ cannot be estimated. Therefore, intra-TAZ trips were excluded.

5) Modal Share Estimation

Modal share of public transport in Canto Sarajevo in AM Peak is estimated at 24.8%.

6) Traffic Demand Forecasting

Following figures shows the assignment result for private vehicle and public transport including the table describes the performance index of the road network in AM Peak Hour in the study area. In the tables below, “urban” represents road links inside urban area in the urban plan. The estimated V/C (Volume / Capacity) ratio is 36.8% in urban and 9.4% in suburban area. Compared to V/C in urban and V/C in suburban, this result indicates the congestion is severe in urban areas.



	Total Length (km)	Total Capacity Distance (1,000 pcu*km)	Total Travel Distance (1,000 pcu*km)	Volume Capacity Ratio	Total Travel Time(1,000 pcu*h)	Average Travel Speed (km/h)
Urban	173	490	181	36.8%	5.3	34.2
Suburban	229	624	59	9.4%	1.3	46.5
Total	**401**	**1,114**	**239**	21.5%	**6.5**	36.6

* Motorway, urban local and urban collector roads are excluded for this summary table. (Only road type 3-7).

Source: JICA Expert Team

Figure 5 Assignment Result for Private Vehicle in AM Peak Hour (Volume / Capacity Ratio)

Source: JICA Expert Team

Figure 6 Assignment Result for Public Transport Passenger in AM Peak Hour (7-8AM)

3.4 Database Handover

Upon completion of this project, the database has been shared with the counterpart. Content of the database to handover is the prime data which is collected and produced throughout the project period. The majority of the tabular-style data is provided in the format of Microsoft Excel or Microsoft Access, and other files to be opened by the specific software. After the Project, professors from the University of Sarajevo will take over the use and maintenance of the data and models.

4 Overall Public Transport Operation Plan

4.1 Service Specifications of Public Transport Modes

Following the development of the travel demand forecast model from the surveys, output from the public transport network in the model was used. The following model outputs for the 1-hour periods of 7:00 AM–8:00 AM and 11:00 AM–12:00 PM that were chosen as representatives of the AM peak and off-peak periods of the day were used:

- Distance and Average Speed of the links from the network assignment result to derive journey time of the public transport lines.
- Computed journey time plus Rest Time to derive turnaround time.
- Rest Time is assumed to be 5% or 5 mins (whichever is more) for AM Peak, and 8% or 8 mins (whichever is more) for Off-Peak.
- Number of departures to derive Headway.
- Turnaround and Headway to compute number of vehicles for both the AM peak and Off-peak periods.

The output was used to test the following scenarios with these vehicle requirements to develop a recommended operations plan:

- Full-Service Case – based on registered public transport timetables provided in the modelled network.

- Hypothetical Service Case – based on headways suitable to make public transport more attractive. This scenario attempts to set policy based maximum headway tiered by mode, based on the demand characteristics of public transport in Sarajevo. This is also in line with how major developed cities worldwide structure their frequent public transport network such that the majority of citizens do not have to plan their trips around a timetable at least during the peak (better still all day).
- Optimal Service Case – based on selected service improvements and capacity optimization. This scenario attempts to adjust frequencies of selected tram/trolleybus/bus routes, as well as to set service frequencies of the minibus routes from a social perspective of a “civil minimum” (citizens’ minimum standards).

Comparison of peak vehicle requirement is shown in table below.

Table 2 Service Specifications of Public Transport Modes by Cases

Mode	Current Operational Fleet	Optimal Service Case	Full Service Case	Hypothetical Service Case
Tram (GRAS)	38	42	47	60
Trolleybus (GRAS)	19	32	31	55
Bus (GRAS+CENTROTRANS)	87	106	86	193
Minibus (GRAS+CENTROTRANS)	34	45	38	62
Total	**178**	**225**	**202**	**370**

Source: JICA Expert Team

Having assessed the pros and cons of these scenarios, the Optimal Service Case is recommended having carefully considered the trade-offs among all scenarios, infrastructure limitations, and operators’ financial situation. The pros and cons of each scenario are examined as follows to validate the adoption of the Optimal service case:

Table 3 Peak Vehicles for Full-Service, Hypothetical Service and Optimal Service Cases

Case	Pros	Cons
Full-Service Case	- High level of service - Shorter waiting time - Less crowded vehicles	- Difficult to fulfil full vehicle requirements. - Existing tramline design can only accommodate up to 45 trams along a single file without severe reduction in operational speed due to spacing of vehicles becoming too close. - Upgrade of tram lines and system required to accommodate proposed tram fleet resulting in high cost.
Hypothetical Service Case	- Highest level of service comparable with major cities in the world - Shortest waiting time - Least crowded vehicles	- Current tram and trolleybus infrastructure not able to support the vehicle requirements due to all tram and trolleybus lines having to share a single track on their respective networks, which limits the number of vehicles that can be operated without reducing operating speed. - Major changes to infrastructure (depots, tram rails and signaling system upgrades etc.) required resulting in highest cost - New trams/trolleybuses in the pipeline of current sponsorship is not enough to meet the requirements of this scenario
Optimal Service Case	- Achievable with existing infrastructure with lesser investments hence lower cost. - Consistent with upcoming fleet renewal program. - Services calibrated to meet demand along various routes and neighborhoods and can be further fine-tuned as better passenger data are made available with new ticket payment systems in future.	- City will experience an improvement in service level from the current service case but not as good as major cities worldwide.

Case	Pros	Cons
	- No congestion or slowdown in tramway operation due to the oversupply of tram vehicles is expected to occur.	

Source: JICA Expert Team

4.2 Operations Planning and Management Processes

In Canton Sarajevo, the lack of efficient data for managing public transportation is mainly due to manual paper-based ticketing and limited use of smart card systems. MOT also lacks clear quantitative indicators for assessing operator performance and struggles to regulate GRAS effectively. The absence of contracts between the government and operators for bus and minibus traffic is also a concern.

Improvements are needed for MOT to determine public transport service specifications effectively. Taking observations of the current situation into account, the Manual on Public Transport Operation Planning and Monitoring as part of the Appendices attempts to impart the following topics to improve Operations Planning and Management Processes: Route Planning (General Conditions of Routes, Service Specifications, Structuring the Public Transport Network) and Route Management (Establishment of operation standards, Policy of setting bus stops, Environment for transfers, Installation of facilities, Policy of route modifications / introducing new routes).

Additionally, optimizing public transport infrastructure is crucial to enhance connectivity between modes. Taking observations of the current situation into account, the Manual on Public Transport Operation Planning and Monitoring as part of the Appendices attempts to impart the good practices in Route Planning and Route Management to improve operations planning and management processes to optimize the public transport network.

4.3 Monitoring Framework to Improve Public Transport Operations

To address the lack of quantitative indicators used by MOT to assess operator performance and their limited regulatory powers and staff, good data is needed to establish a monitoring framework. The locally developed operations monitoring center for public transport has potential for utilizing big data in performance monitoring.

Additionally, there's a lack of systematic customer feedback monitoring. Current feedback channels from operators like GRAS and CENTROTRANS are limited to email and phone, making it difficult to classify and distribute feedback. As a result, customer feedback doesn't play a substantial role in operations planning, with municipality representatives being the primary source of feedback for refining public transport operations.

The Manual on Public Transport Operation Planning and Monitoring in the appendices aims to impart good practices on data-driven analysis, monitoring, and customer feedback in enhancing public transport operations through the following topics: Monitoring Method for Operations of Public Transport (Data collection method: analysis of operation records, Monitoring of operators' performance) and Customer Survey & Relations (Questionnaire survey, Users' interview by class, Feedback via Internet or Mobile Channels, Extraction of operational issues and directions for solution).

The Monitoring Method for Operations of Public Transport chapter of the manual attempts to suggest the basic building blocks of operational performance indicators which is the time stamps at every stop used to calculate headway, reliability and revenue kilometers. An array of operational reports can be developed around these indicators to suit the needs of both the regulator and the operators. Following up on these indicators is a framework for regulators to monitor the operators' performance and for operators to improve when necessary.

The Customer Survey & Relations chapter of the manual attempts to impart the survey methods used in this project for future regular updating of the demand forecasting model which is also applicable to making future improvements to the public transport network and operations. As these methods are labor-intensive and more suitable to implement at most annually, Feedback via Internet or Mobile Channels are recommended for daily operations, through the use of well-designed forms and QR codes that automate the classification and routing process to the relevant departments. This follows on with a process to extract operational issues to identify roots causes and trends in public transport satisfaction to facilitate the development of appropriate actions and solutions.

5 Public Transport Policy Analysis

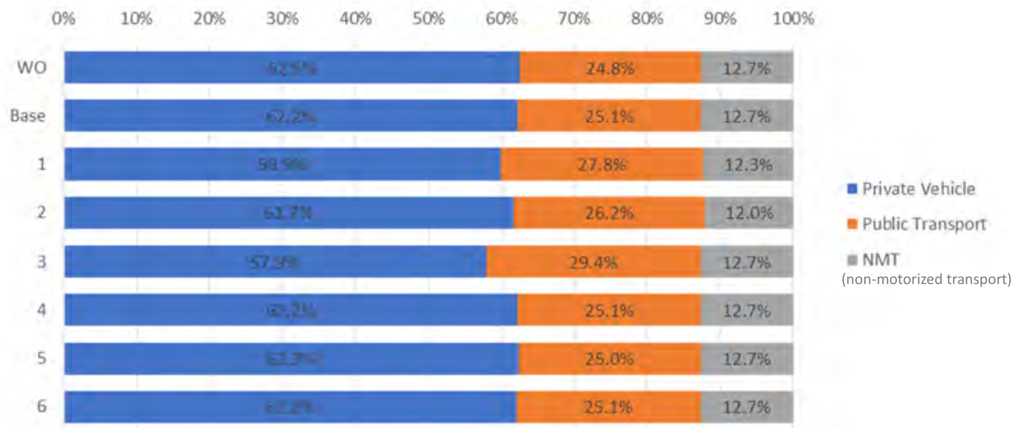
5.1 Base Case with Ongoing Projects

For policy analyses using the travel demand forecast model, a base scenario has been set by including the following three ongoing projects: renewal of 25 trolleybus vehicles (to be completed in 2023); renewal of 15 sets of tram vehicles (to be completed in 2024); reconstruction of the tram tracks (completed in 2023).

5.2 Demand Analysis of Public Transport Improvement Plans

Each of the following six public transport improvement policies has been added to the base scenario: i. Introduction of transfer discount (50%) (Scenario 1); ii. Distance-proportional fare system (Scenario 2); iii. Introduction of a Low Emission Zone (LEZ)[3] (Scenario 3); iv. Enhancement of minibus services (Scenario 4); v. Drastic rationalization of minibus services (Scenario 5); and vi. Improved operation plan (Optimal Service Case) proposed by TRAMODE (Scenario 6).

Scenario 3 brings the largest impact on the modal share of public transport, followed by Scenario 1 and Scenario 2, as shown in Figure 7.



Source: JICA Expert Team

Figure 7 Estimated Modal Share by Scenario in AM Peak Hour

LEZ policy for regulation of car use in specific areas seems to be the most effective to increase the public transport ridership or modal share, and, with respect to the performance indicators, the smallest PCU-km is forecasted as shown in Table 4. Change in the tariff system may also have an impact on the travel behavior of the citizens in Sarajevo. As for enhancement and rationalization of minibus services, their impact on the modal share was limited, implying that the service standards should rather be set from a social perspective of a “civil minimum” (citizens’ minimum standards). The operation improvement plan proposed by the JICA Expert Team (optimal service case) is forecasted to have little impact on the modal share, while some passengers may shift to higher-frequency lines.

[3] At the initial stage of the proposed LEZ, restricted vehicles are up to Euro3 vehicles.

Table 4 Comparison of Performance Indicators in AM Peak Hour

	Private Vehicle	Public Transport			
	PCU*-km (1000)	No. of Passengers (1000: Unlinked**)	Passenger-km (1000)	Fare Revenue (1000 BAM)	Vehicle-km (1000)
WO	241.0	21.1	81.9	36.7	3.6
Base	240.3	21.3	83.2	37.1	3.6
1	231.1	24.7	97.7	35.2	3.6
2	242.4	22.2	80.4	35.2	3.6
3	227.6	23.2	97.8	39.7	3.6
4	240.1	21.5	83.8	37.3	4.1
5	240.8	21.1	82.1	36.7	3.4
6	239.8	21.6	84.2	37.4	4.1

*PCU: Passenger Car Unit
**Unlinked means that the passenger who transferred public transport is counted as separate passengers.

5.3 Future Base Case with Confirmed Projects

After the consultation with MOT and ZPRKS, it was concluded that the population forecast developed in the Urban Plan is too optimistic considering the recent trends of declining population growth in City of Sarajevo: -0.11% between 2014 and 2021 as well as the neighboring cities like Zagreb and Belgrade. These cities, which serve as regional centers with wider gravitational area, have either minimal population growth or a decrease. Thus, the population forecast was decided to be developed by the JICA Expert Team in consultation with the stakeholders.

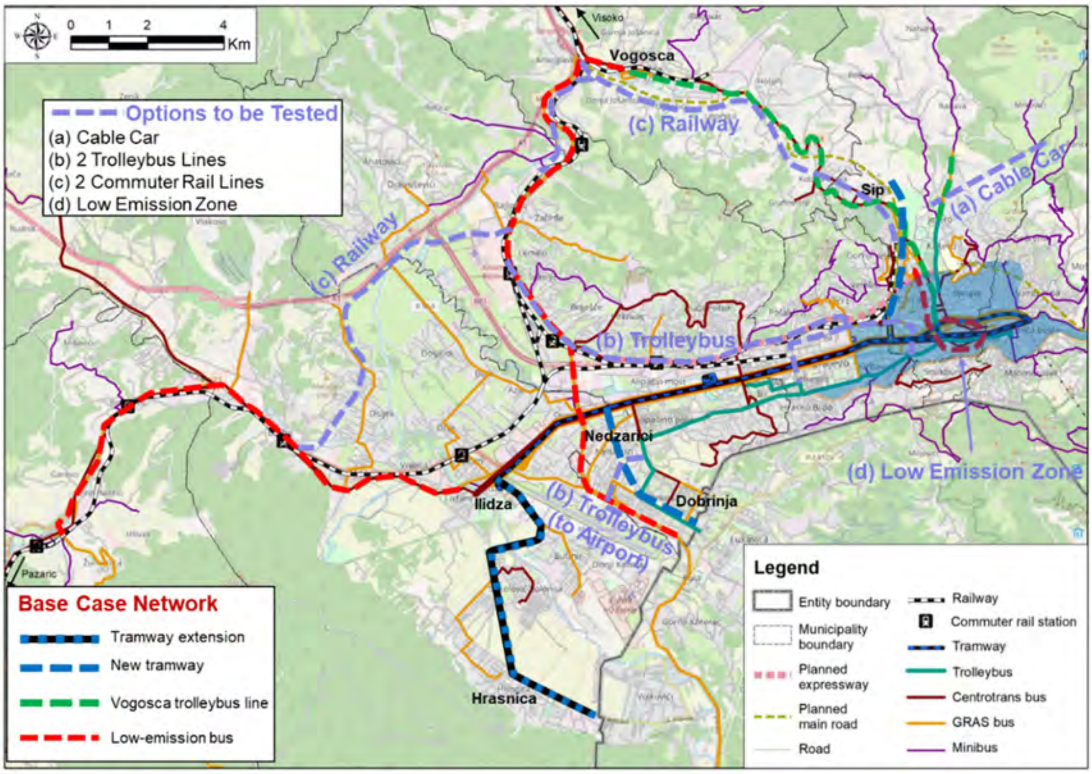
The three scenarios were developed to forecast the population of Canton Sarajevo up to 2036, and Scenario 1 (Trend base scenario), where the population growth trend between 2013 and 2021 is applied to estimate the figure in 2036 and the additional development is not expected, has been selected for the Project.

The GRDP per capita in Canton Sarajevo for 2036 was estimated with the following steps: (a) The GDP deflator of BiH was applied to estimate the constant price of Canton Sarajevo. (b) Using the obtained data, GRDP per capita of Canton Sarajevo in 2021 was estimated (current: 19,003 KM, constant: 18,128 KM). (c) Following the trend base scenario applied in the population projection. (d) The estimated GRDP per capita in Canton Sarajevo

Future base case network has been set by adding the following confirmed (committed or nearly committed) projects to the present base network: extension of the tram lines (Ilidza - Hrasnica), development of a new tram line (Nedzarici – Dobrinja, Sarajevo station - Sip), operation of low-emission bus services, and reconstruction of Vogosca trolleybus line.

5.4 Demand Analysis of Future Public Transport Development Options

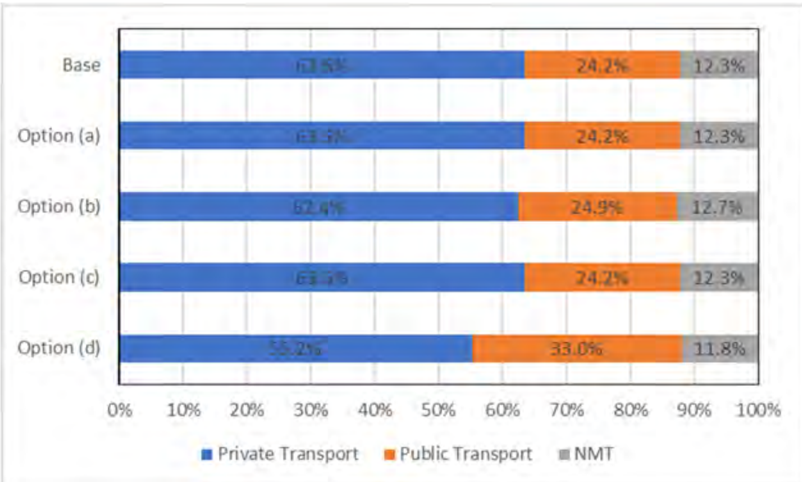
Canton Sarajevo has several options for public transportation development. Those which are tested in the demand forecast are listed as: (a) Cable car (telepherique) for commuters (Pionirska Dolina - Barice), (b) New trolleybus lines (Airport Line, Safeta Zajke - Drinska), (c) New commuter rail lines, (d) Further implementation of a Low Emission Zone (LEZ) (regulation up to Euro5 vehicles), as shown in Figure 8.



Source: JICA Expert Team

Figure 8 Public Transport Options to be Tested in the Future Demand Forecast

The demand forecast result of each public transport development idea is shown as a change in the mode share from that of the future base case. Particularly for (a)-(c), forecasted number of users as well as the assumed fare is presented.



Source: JICA Expert Team

Figure 9 Forecasted Modal Share of Future Public Transport Development Options

Table 5 Forecasted Number of Users for Future Options (a)-(c)

Option	Year 2036		
	Number (7-8 AM)	Fare (KM)	Annual Fare Revenue (million KM)
(a)	10	4	0.15
(b)	444	1.6	2.66
(c)	20	1.6	0.12

Note: Fare and revenue are based on the present value and peak-hour ratio of 8%. Subsidized fare is not considered.
Source: JICA Expert Team

Above table reflects the number of projected or forecasted passengers for the three options. The number of passengers in the morning peak hour can be seen is the highest along the future development of trolleybus lines (option (b)) and subsequently would receive highest revenue among the three options. It is noteworthy that one of the plans in option (b) is the new trolleybus to the airport. Despite the number of passengers during peak hour is lower than tram, functionality of this line itself is arguably beneficial.

The new cable car (option (a)) is shown to have the lowest number of passengers. It may be considered more for a touristic purpose rather than for daily or commuting use. Such kind of passenger demand is hard to be reflected in this model. The areas to which the new commuter railway (option (c)) connects are not generating/attracting significant number of passengers. Derived passenger demand after realization of these lines should occur in parallel with further area development in those areas.

5.5 Further Possibilities of Public Transport Policy Analysis

Several transport policies were analyzed with the travel demand forecast model which was developed in this Project. There is a possibility that the model can be used further for the following objectives: impact analysis on changing transport policy, feasibility study on developing new public transport line, traffic impact analysis on urban development, and promoting citizens' understanding of transportation policies (Mobility Management).

6 Organizational and Institutional Arrangements

6.1 The MOT: Presentation and Assessment

The MOT is the main line agency administrating public transport in Sarajevo, in particular through its Department of Passenger Public Transport (staffed: 6). This prerogative was re-affirmed by the first cantonal Law on Public Transport of Passengers (enacted in 2022). The MOT oversees all land transport modes, except the railway network.

The MOT does not lack of strengths: A much committed Minister, a strong cohesion between its internal units and strong technical skills deployed during recent achievements - acquisition of equipment, vehicles and the construction of infrastructure - or through efforts to find solutions to service deficiencies caused by GRAS difficulties.

A limited staff represents its main current weakness and the high polyvalence currently demonstrated by MOT officers should reach limits: Overall, an estimated staff of around 47 in 2022 (around 70 when including the Road Directorate). This number is low compared with many urban transport authorities in Europe, and with respect to Sarajevo’s size and public transport challenges. According to recruitments reflected in recent MOT’s Rulebooks, the Sarajevo Canton Government (hereafter Canton Government) is aware of this understaffing.

In a context where the quasi-monopole of GRAS as operator of bus and minibus services gradually erodes since the mid-2010s, the MOT should develop further the regulatory functions it already assumes partially, in order to leverage public transport overall performance and reconciliate residents with their use.

The recent cantonal regulations[4], and transfers of knowledge from external expertise financed by development partners (JICA, EBRD, DFID, etc.), pave the way for a consolidation of these regulatory functions.

[4] Among these regulations are the Law on Public Transport of Passengers but also the Law on Communal Activities (2004, amended up to 2019), the Law on Ministries and other Bodies of Administration of the Canton (2021, 2022), or the Law on Concessions (last amendment: 2022). Two other important cantonal laws clarify the scope of MOT functions: The Law on Roads (2022) and the Law on Traffic Regulation the Sarajevo Canton (2017).

6.2 Evolutions Proposed for the MOT

To adapt to the public transport current and expected challenges in Sarajevo, and without changing its current internal organization chart, the evolution of the MOT should make it performing in routine 12 regulatory functions (Table 6), several of them being already among its regular tasks.

Table 6 Proposed Regulatory Functions of the MOT by 2024-2025

No	Functions
1	Oversight of the management of land transport modes (railways excluded), traffic and parking, transport/mobility planning
2	Administer delivery/suspension/revocation of licenses to operators. Development of a certification system for lines and companies, etc.
3	Administer tendering process to select bus and microbus operators
4	Preparation and implementation of public transport operation contracts with both private and public service providers and in accordance with the regulation (in particular time tables)
5	Regular monitoring and evaluation of fare revenue collection & management scheme, proposal to the Canton Government of tariff system modifications (incl. zoning, fares subsidies), and regular reviews/analysis of public transport service (full) costs
6	Preparation and management of fares revision mechanisms (to be approved by the Canton Government) considering expected operation cost increases
7	Formulation of service performance indicators/metrics and KPIs. Development of a benchmarking-oriented framework
8	Methodological guidance for reporting by operators (cost estimates, indicators, users' satisfaction surveys, etc.).
9	Monitoring of users' satisfaction and level of service; Arbitration of occasional disputes (between operators, users) with conciliation mechanisms made available to the public
10	Prospective studies in line with strategic planning.
11	Oversight of transport assets declared public goods in 2021: tracks and contact network/catenaries
12	External communication, public relation; and encouragement to operators to develop customer charters (as in Oslo or in Ireland)

Source: JICA Expert Team

More specifically, 6 professional skills could be developed further; i) public transport operation cost control and public transport assets management; ii) Legal affairs in relation with contractual matters linked to public transport operation iii) Transport economics, in particular in relation with land and environmental aspects iv) Information and communication technologies systems and digitalization (incl. MaaS-related applications v) Public relation and arbitration (complains); and vi) Transport demand modelling and microsimulation.

Overall, and for the next 10 years, a pragmatic approach is recommended, and in consistence with the Law on Public Transport of Passengers: developing the regulatory functions without changing the current organizational framework by prioritizing MOT's capacities strengthening and systematic contractualization of the public transport service with private and public operators. Regulatory functions to be improved relate in particular to the regular monitoring and evaluation of fare revenue collection and management scheme, to the modifications of tariff system through thorough review of public transport operation costs evolutions, to ensure passengers' satisfaction and overall quality of service. The pro and cons of the recommended scheme are presented below.

Table 7 Pros and Cons of the Recommended Scheme for the Next 8-10 years

Scheme Description in Brief	Advantages and Opportunities	Objections, Risks or Difficulties
To keep the arrangement as existing (regulatory functions under MOT- in particular DPPT - exclusively)	- No major organizational change or modification of the MOT's internal chain of command - Existing MOT team experienced and working in a collaborative spirit - Regulatory functions not disconnected from other functions of the MOT (e. g. preparation of policies and regulations)	- MOT staff remains committed in other tasks than regulatory functions. This may slowdown the development of these functions unless additional staff is provided - Unlike in the case of independent regulators, regulatory functions through MOT remain essentially tools in Canton Government's hand,

Scheme Description in Brief	Advantages and Opportunities	Objections, Risks or Difficulties
	- Affirms the oversight of the public transport by the MOT - Limits transaction costs (to achieve consensus between local governments)	therefore subject to excessive political interferences - Lack of resources allocated to MOT to perform regulatory functions

Source: JICA Expert Team

Regular evaluations of this recommended scheme should outline, in about 10 years from now, the advantages to consolidate it or to rather opt for an alternative scheme. Table 8 presents the pro and cons of four possible options[5], ranked according to their decreasing feasibility and relevance as estimated today by the JICA Expert Team.

Table 8 Possible Alternative Schemes to Ensure Public Transport Regulatory Functions after a Decade

Alternative Schemes	Advantages and Opportunities	Objections, Risks or Difficulties
Alternative Option 1 To establish a semi-autonomous Transport Regulatory Unit under direct MOT's supervision Option to be considered only after recommended scenario is successfully implemented.	- Facilitate the delineation of regulatory functions, their cost and their evaluation - Staff more efficient because exclusively dedicated to these functions. Facilitates further professionalization of the regulatory functions (and possibly fare collection by the authority in the future) - Represent a gradual evolution of recommended overall scheme (Table 7)	- Same as for the recommended scheme (Table 7) - Possibly the semi-autonomy will remain virtual, e. g. in terms of recruitment policy and effective influence on fare setting - Functional difficulty to separate the DPPT and the regulatory unit.
Alternative Option 2 To establish a separate regulatory body for public services tariffs only under the joint-oversight of three Ministries of i) Budget, ii) Traffic iii) Utilities –	- Comprehensive vision of the tariffs (and therefore costs) of different public services and implementation of a coherent approach of tariffs for all utilities as defined in the Law on Communal Activities - Stimulate among ministries a shared understanding of the use of public cantonal assets (services performance, O&M costs, etc.)	- Requires a total reform of public tariffs setting in all sectors - Risk of disconnection between technical and financial aspects - The coherence of tariff policies seems not a priority today for public transport
Alternative Option 3 To establish a Transport/Mobility authority with MOT and Municipalities involved in its governance (appointed representative members of the board of the authority)	- The Canton Government, represented by the MOT, can keep a substantial power in the decision process (voting) and be even granted veto power - Makes possible the contribution of municipalities to regulatory functions financing - Fits with the principles of local governance widely followed in many EU countries - Participation of municipalities may help giving more attention to transport users and residents in the implementation of regulatory functions - Regulatory functions more "visible" to residents	- This option seems not consistent with the current cantonal regulation - Requires a well-designed scheme effectively inclusive of the various interests of all municipalities, - Difficulties to reach consensus due to conflicts with / between municipalities (risk of politization of the regulatory function affecting its action)
Alternative Option 4 To establish a separate cantonal public transport regulatory board entity formed by appointed independent Commissioners, following	- Same as Option 1 plus: - The entity is encouraged to be more cost effective - Clearer identification of regulatory functions costs - Opportunity to recruit staff with managerial/business culture	- The entity must be empowered by a cantonal law, which may be difficult to get promulgated - This should lead to modify MOT organization staff and functions, to proceed with staff transfers more or less accepted by concerned persons, etc.

[5] These schemes do not consider possible future public transport sector structural reforms which may impact the regulatory scheme. For instance, a government decision to separate public assets ownership from operation, by establishing a separate entity in charge of both regulatory functions and publicly-owned assets management.

Alternative Schemes	Advantages and Opportunities	Objections, Risks or Difficulties
the ROŽBIH model for railways.	- Greater autonomy of regulatory functions vs excessive political and administrative interferences - Regulatory functions made more "visible" to residents	- The ROŽBIH model may not be relevant for Canton Sarajevo because having an independent authority for public transport, institutionally separated from ministries, may make it difficult in the current smooth coordination between cantonal ministries to develop a comprehensive approach to mobility (MOT and other ministries in charge of urban planning, utilities and environment).

Source: JICA Expert Team

6.3 Division of Roles between the Public Transport Regulator and Operators for Fleet and Infrastructure Management

This division should comply with the principle of managerial independence of all operators, private or under public control [6]. Political and administrative interferences in the management of fleet and infrastructure[7] should be limited and obligations of operators defined contractually. According to international experiences (OECD countries), managerial autonomy of public services enterprises is compatible with supports from the public budget to operators.

In particular, the current full ownership of assets by the operators should be maintained, at least for fleet and depots. This would fit with the current net cost revenue scheme (financial responsibility of maintenance/improvement), proposed to remain unchanged in the coming years: i) the fare revenue risk of the service will remain essentially assumed by the operators and ii) For the MOT, monitoring a net cost revenue scheme will be easier until it is armed enough to monitor in-depth service costs – which is necessary to regulate any gross revenue-type scheme.

The consultation process, important aspect of the mindset of the division of roles, may have various purposes: for the operator to get MOT formal approval, its non-objection or just opinions. Regarding the management of fleet and depots, it should lead the operators to work on a collaborative manner with the MOT, essentially to ensure the leverage effect of assets management on the quality of service. MOT should be consulted at design stages (basic and detailed) of fleet/depots acquisition, and to planning of routine and heavy renewal and maintenance (fleet and depots). This consultation should stimulate a constructive partnership between operators, public transport regulator and other stakeholder institutions, to ensure overall service performance and users' satisfaction.

Assets management is a relevant example of initiatives where operators and MOT can cooperate in a manner compatible with a clear division of roles, in particular when assets are owned by a public company [8]. Compared with a Computerized Maintenance Management System, assets management approach is more integrating and potentially impacts significantly the organization of the enterprise. It focuses more on use and quality of service as a whole and helps to plan and implement repairing, maintenance, renewal/modernization and also recycling/disposal of physical assets. Developing an

[6] In accordance with the Law on Public Transport of Passengers, the Canton Government should establish soon a public company (KJKP JPS) to operate the tramway, trolleybuses and possibly e-buses, as well as related facilities (depots, power sub-stations, etc.) Importantly, the current model of public enterprises in Bosnia-Herzegovina suffers from structural financial weaknesses. In the future, radical decisions might be taken (through regulation measures), to improve their financial situation. For instance, by facilitating recapitalization through increased equitization, or development of joint-ventures as done in Republic Srpska or attempted in the Canton of Tuzla.

[7] This encompasses in particular: i) Legal assets ownership, ii) Maintenance and renewal planning iii) Heavy maintenance and renewal, iv) Service operation and routine maintenance, v) Financing of renewal (and loan repayments), vi) Payment of renewal suppliers and contractors. vii) Basic and detailed design for acquisition of fleet and acquisition of infrastructure, viii) Identification of suppliers and contractors and preparation of tendering documents, ix) Selection of suppliers and contractors, x) Supervision of construction works, inspection and certification of satisfactory completion.

[8] Digital technologies enable now local governments to refine considerably the processing and visualization of public assets-related information (detailed design, valuation, geo-spatial data, photos, maintenance reports, report on incidents, etc.) and to facilitate decision regarding options for assets management.

assets management system (AMS) requires a close collaboration between stakeholders concerned, through (but not only) a data sharing system and operational collaborative platforms.

Regarding canton-owned public transport infrastructure and fleet, and once GRAS future clarified and the new tram/trolleybus operator established, a four-stage process could be encouraged by the MOT (possibly jointly with the Ministry of Finance):

- Stage 1: By end of Q2/2024, the MOT to develop a concept paper on assets management in close consultation with public operator(s). This paper, to be approved by the Canton Government, would be useful to consider the internal organization of public operators.
- Stage 2: Q4/2024-Q4/2025. Technical assistance (business management firm + IT firm) to support public operators, possibly financed by grants from development partners i) to prepare assets management strategy and plan ii) feasibility study for assets management system (AMS) to be hosted by public operator(s) iii) to prepare a tender to recruit a technical assistance for stage 3 and iv) to provide training on assets management.
- Stage 3: Q2/2026-Q2/2027. Software acquisition for AMS hosted by public operators and initial development of the tool (by IT firm + software provider), comparable to detailed design in the construction sector to tailor the needs of the operators[9].
- Stage 4: Q3/2027-Onwards. Development and full implementation of the AMS by public operators. The MOT is regularly informed about the implementation and provides comments to operators.

6.4 The Contract

The Law on Public Transport of Passengers defines the obligations of the operator (and the conditions to become an operator) in particular through its compliance with timetables (Section E, in particular from Art. 13). The validity of timetable is 3 years but extensible (Art. 9). Competing for public calls requires from the operator to comply with conditions, for instance regarding the number of vehicles owned (Art.32). This law also introduces the notion on contracts by referring to the Law on Concession. It also designates the MOT as the line ministry for transport of passengers (Art. 6) in charge of controlling the concessionaire's compliance with its contract (Art. 32). To ensure efficient, competitive, and sustainable public transportation services for the city's residents, five main recommendations for contractual arrangements are summarized below.

1) Contracting Principles

Operators should be selected through a competitive process, regardless of their public or private status. The MOT, as public transport regulator, must define the Terms of Reference for operation contracts to ensure fairness in competition.

2) Operating Plan

Each operation contract should include an Operating Plan that details the transport services to be provided for different types of days and hours. This plan must be flexible to adapt to changing demand patterns. The MOT, as public transport regulator, should categorize days based on demand similarities and adjust hours to match peak profiles accurately. This flexibility allows for efficient use of buses and resources.

3) Market Challenges and Contract Structure

While an ideal scenario involves a competitive process to select a single operator for the entire urban network, practical challenges may limit interest from other operators. International operators may find Sarajevo's market less attractive due to its size. Local

[9] Many software tools are available on the market at a licensing cost ranging from 20,000 to 30,000 EUR. But adjusting these tools to the particular data sources and to the local needs remains time consuming at the stage.

competitors may lack the capacity to compete effectively. Therefore, CENTROTRANS remains the dominant player. To address the potential lack of competition, it is recommended to structure the Public Service Contract (PSC) with specific provisions: establishment of a dedicated operating company; the public transport regulator's authority to conduct financial and technical audits of the dedicated company; implementation of a profit cap; and flexible remuneration mechanisms to accommodate changes in the Operating Plan[10].

4) Remuneration Scheme

A net cost contract is recommended, where operators retain ticket sales income, taking on traffic risk. This incentivizes operators to adjust the Operating Plan in response to actual demand. Contracts should have a duration of 8 to 10 years and allow the use of used buses (6 to 8 years old at the start of operation), economically sourced from other countries. The remuneration structure should be based on a cost split, covering kilometer costs (fuel, oil, maintenance), driving costs (number of drivers), amortization costs (number of buses), and general expenses/profit.

5) Ensuring Operator Efficiency

Regular checks by specialized consultants are recommended, at least before launching a tender and preferably every couple of years. These checks can verify that operators are optimizing production factors effectively. In the absence of regular checks, the MOT should rely on operator performance and their ability to optimize resources.

6.5 Overall Scheme for Contracts in Brief

The tentative scheme proposed in Chapter 6 is summarized in Table 9.

Table 9 Overall Contractual Arrangements Proposed for the Next Decade

Modes	Main Laws Applicable	Tendering Process	Contract	Duration	Type
Tramway/Trolleybus/Depots – public operator	Law on Public Transport of Passengers /Law on Public Companies	No	Yes	25-30 years	Net Cost
Bus – public operator	Law on Public Transport of Passengers /Law on Concessions/Law on Public Companies/Law on Communal Activities	Yes, following public invitation as per Law on Public Transport of Passengers in the next 10 years, possibly under the Law on Concession after 10 years	Yes	8-10 years	
Bus – private operator	Law on Public Transport of Passengers/ Law on Concessions/ Law on Communal Activities				

Source: JICA Expert Team

[10] Contracts can provide for a cap of profits and readjustment of prices in case audits demonstrate some costs have changed considerably since the commercial offer.

MAIN TEXT

0 Methodology of the Study

Volume I of the final report covers the Public Transport Policy Improvement Plan that describes the ideal public transport system for Canton Sarajevo, including policy analyses on tariff system, operation planning and traffic regulation, as well as studies on the division of responsibilities between the regulator and the operators, ensuring competitiveness and fairness among multiple operators, etc.

First of all, existing related documents and information on current public transport and automobile traffic are reviewed and studied in Chapter 1. In addition, various public transport plans formulated by the BiH government and Canton Sarajevo government are comprehensively reviewed and analyzed.

Chapter 2 describes the analysis of the current situation of public transport in Sarajevo by reviewing the existing data on public transport and automobile traffic. Furthermore, findings from a variety of transport surveys conducted in this Project are described. Among others, the result from the Activity-travel Diary Survey (ADS) targeting around 6,000 households in Canton Sarajevo have not only revealed the travel behavior of the citizens as well as their current socioeconomic situation but also served as base data for population synthesis in the travel demand forecast in Chapter 3. Comprehensive analyses of the transport surveys are attached as Appendix 1. Then, the challenges and issues of the current public transport in Canton Sarajevo are summarized.

Chapter 3 explains the development of a travel demand forecast model through a disaggregate four-step modelling approach. By using a disaggregate model, it is possible to efficiently estimate transportation demand with a smaller number of household samples compared to the conventional (aggregate) method. Moreover, by taking into consideration personal attributes such as workplace, household composition, and income level, the disaggregate model enables evaluation of policies that will involve complex changes in travel behavior, such as revision of the public transport tariff system, introduction of environmental tax, transportation demand management (TDM), etc. Present origin-destination (OD) tables have been estimated based on the developed demand forecast with population synthesis. A more detailed explanation of the travel demand forecast modeling is attached as Appendix 2.

Based on the above demand forecast, the overall operation plan is prepared in Chapter 4, including the planning method through a series of processes from survey/analysis to operation planning and operation management that is to be transferred to the Sarajevo side. A Manual for Public Transport Planning and Operations that summarizes important items in operation planning by processing the "visualization" of routes through data analysis, identification of problems for each route, countermeasures for solutions, and vehicle and personnel allocation is also presented in Appendix 3, which also includes manuals for personnel management and customer experience.

For public transport policy analysis in Chapter 5 by utilizing the travel demand forecast model, a base scenario has been set by including three ongoing projects (i.e., renewal of 25 trolleybus vehicles, renewal of 15 sets of tram vehicles, and reconstruction of the tram tracks) in the present case. The target year is 2025 when all three projects have been completed. In order to compare the demand forecast results with this base scenario, each of the six public transport improvement policies, including the proposed overall operation plan, has been added to the base scenario to make a new scenario, as agreed with the

Sarajevo side. To evaluate the impact of public transport policies, the modal share of public transport is mainly estimated for the above six scenarios. Furthermore, future public transport development options are also analyzed through the demand forecast model. Further possibilities of the public transport policy analysis are also discussed to maintain the continuity of the demand forecast model and the transport survey database after the completion of this Project.

Finally, Chapter 6 discusses the organizational and institutional arrangements. The current organization and work conditions of the Cantonal Ministry of Traffic (MOT) are reviewed, and the desirable organization and work system as a regulatory authority is formulated and proposed to the MOT. As for the basic division of responsibilities between the regulator and the operators, some alternative models for public/private sector involvement in public transport are presented. Among others, the current fleet and infrastructure management system, technical capabilities, and budget of the regulator and the operators are reviewed, and a realistic division of the roles is proposed. In case contracts with operators need to be made, an analysis of alternative arrangements in public service contracts (e.g., gross cost contract, net cost contract, etc.) is conducted and a recommendation is presented.

1 Current Plans and Policies on Public Transport

1.1 Development Policies and Transportation in Canton Sarajevo

1) Urban Planning and Management and Administrative Competence

Urban planning in Canton Sarajevo is composed of the following four-layer statutory plans:

- Development Strategy,
- Spatial Plan at the levels of canton, municipalities, and special interest areas,
- Urban Plan adapted to urban areas for particular urban issues designated by the spatial plan, and
- Detailed plans for the implementation of spatial and urban plans, such as regulatory plans (zoning and regulation) with legally binding power, urban projects, and subdivision plans.

Transportation, infrastructure, environment, and natural resource protection are important sectors that are planned by wide area planning authorities above the municipal level, such as the Canton or FBiH. Table 1.1.1 summarizes the roles of each administration, planning area, period, scale, and approval authorities by plan.

Table 1.1.1 Roles in Planning by Administration at the Canton Level

		(Socio-economic) Development Strategy	Spatial Plan	Urban Plan*	Detailed Plan		Transportation Plan and Other Sector Plans
					Regulatory Plan	Project/Sub-division Plan	
Administrative level	FBiH	○	○	○	○	○	●A
	Canton	●B	●B	○	○	○	●B
	City of Sarajevo	●B	●B	●B	○	●B	○B/C
	Municipality	●C	●C	●C	●	●C	○C
Planning Area		J.A.A	J.A.A	D.U.A	J.A.A	Within D.U.A	J.A.A
Minimum Planning Period		3~5 years	20 years	20 years	5 years	5 years	n.c.s
Planning Scale		Non scale	1/10,000~ 1/50,000	1/2,500~1/ 5,000	1/250~ 1/1,000	1/250~ 1/1,000	n.c.s
Approval	Authority	SKS/GS/OV	SKS	GS//OV*	OV	GS//OV*	n.c.s
	Consultation	RSHs	MPZKS /GS	MPZKS /GS	GS/OV*	MPZKS/GS	n.c.s

Note: FBiH = Federation of Bosnia and Herzegovina, Urban Plan is adapted to the urban area to be delineated. City of Sarajevo covers the municipalities of Stari Grad, Centar, Novo Sarajevo, Novi Grad.
Legend: ●＝Main role and responsibility, ○＝Supporting role, and responsibility (e.g., budgeting, reviewing, coordinating, consulting, Gazetting)
A = inter-Canton aspect (e.g. infrastructure and telecommunication, environment and natural resource protection), B = inter-Municipal, C = aspect within local government (Municipality)
J.A.A = Jurisdictional area of each administration (e.g. canton, city, municipality, etc.), D.U.A = designated urban area
MPZKS = Minister of Ministry of Physical Planning, Construction and Environmental Protection -Canton Sarajevo, SKS = Canton Sarajevo Assembly, GS = Mayors of city, OV = Municipal Council, RSHs = relevant stakeholders * in case of outside of City of Sarajevo, n.c.s = not clearly stipulated in the relevant laws for spatial planning and land management
Source: JICA Expert Team based on the Law on Physical Planning and Land Use (FBiH Gazette 2/06, 72/07, 32/08, 4/10, 13/10), Law on Spatial Management of the Canton Sarajevo (KS Gazette 24/17)

2) Overview of Development Frameworks for Canton Sarajevo

The overall development strategy of Canton Sarajevo is formulated based on the Economic

Reform Program at the national and federation levels. In the transportation sector, the Framework Transport Strategy is established at the national level. Figure 1.1.1 illustrates the outline of these related development strategies and programs.

	Bosnia and Herzegovina	Federation of BiH	Canton Sarajevo
Socio-economic Development	**ERP-BiH 2017-2019** • Improving quality of public finance • Harmonizing and coordinating industrial policies • Enhancing competitive tourism • Strategy for transport, energy and environment sectors • Public administration reform	**ERP-FBiH 2017-2018** • Integrated growth with international connectivity • Smart growth with competitive economy • Sustainable growth with nature and its potentials • Inclusive growth with health improvement • Smart management with EU funding	**DSSC 2020** Five strategic objectives • To improve the administrative and business environment • To increase employment and create new, better-rated, jobs • To create conditions for inclusive social and economic growth • To improve the development management system
Transportation Development	**FTS-BiH 2015-2030** • Financial sustainable actions (institution, funding, etc.) • Comply with EU standard and regulations • Vehicle emission by EU standard • Safety and information by legislative intervention	**(In FBiH Section)** • Financial sustainability in railway and airport operations • FBiH legislation to EU directives in railway system • FBiH legislation on vehicle emission • Alignment to EU policies for road safety	To manage the environment, space, natural and infrastructural resources - Low emission bus and vehicles - Rehabilitation of public transport - Others

Source: ERP-BiH2017–2019 = the Economic Reform Program of BiH (2017–2019), ERP-FBiH 2017–2018=the Economic Reform Program of FBiH (2017–2018), DSSC 2020 = Development Strategy of the Canton Sarajevo until 2020, FTS-BiH 2015–2030 = the Framework Transport Strategy of Bosnia and Herzegovina 2015–2030

Figure 1.1.1 Development Strategy for Canton Sarajevo and Upper-tier Plans

3) Development Strategy of Canton Sarajevo until 2020

At the Canton level, the Canton Sarajevo Development Strategy by 2020, as a five-year official plan, was formulated in 2016. This development strategy describes a vision of development "The Canton Sarajevo is a European, dynamic, creative and culturally diverse region of pleasant living and profitable business." It also shows five strategic objectives involving 22 priority objects in association with 69 measures and 238 projects for CS to achieve the development vision, taking account of the thematic and regional development frameworks of the European Union ("EU").

The five strategic objectives mentioned are:

- To improve the administrative and business environment to accelerate economic growth and improve the economic structure to increase exports of goods and services,
- To increase employment and create new and better rated jobs,
- To create conditions for inclusive social and economic growth and poverty reduction and to improve availability and reliability of all public services,
- To manage the environment, space, natural and infrastructural resources in a responsible manner, and

- To improve the development management system of CS.

Table 1.1.2 shows the key excerpts of projects for the transport sector and urban developments in the Development Strategy.

Table 1.1.2 Strategic Objectives and Key Selected Projects in the Canton Sarajevo Development Strategy by 2020

Strategic Objectives	Key Selected Projects for the Transportation Sector and Urban Development Sector
1. To improve the administrative and business environment and improve the economic structure	• Building a technical infrastructure system for analysis of product compliance with EU standards and criteria
	• Creating a research infrastructure development plan as a prerequisite for joining the EU Research Infrastructure Network
	• Design and installation of tourist traffic maps in foreign languages with bus, railway, and tram lines
	• Improvement of existing infrastructure and construction of new business zones for SMEs in Canton Sarajevo
	• Establishment of strategic human resource management in Cantonal Public Companies
2. To increase employment and create new, better-rated, jobs	• Public works and public investment projects with employment
	• No other relevant projects specifically for the sectors
3. To create conditions for inclusive social and economic growth and poverty reduction and to improve availability and reliability of all public services	• Creation of a program for addressing the housing needs in the state of social need, according to the principle of social housing in CS for the period 2016–2020
	• Construction and improvement of sports infrastructure in CS
	• Improve the protection of cultural and historical heritage
4. To manage the environment, space, natural and infrastructural resources in a responsible manner	• Prevention, rehabilitation, and monitoring of landslides
	• Conversion of existing and procurement of new buses and vehicles powered by compressed natural gas (CNG) in public and private companies in CS
	• Realization of the project "Green Energy for the Green City"
	• Reconstruction, construction and maintenance of roads, underpasses, overpasses, and intersections, including Route-5 improvement under the public investment program
	• Rehabilitation and optimization of public transport
	• Improvement of pedestrian and bicycle traffic
	• Construction of treatment plants and sewer networks
	• Natural gas network development and promotion in household use
5. To improve the development management system	• Introduction of fees for the use of urban construction land
	• Introduction of PPP mechanisms and models to increase public investment volume
	• Develop a Special Research Program of relevance for CS (for purposes of physical planning, urban planning, monitoring, and strategic planning evaluation)

Source: Development Strategy of the Canton Sarajevo until 2020

4) Canton Sarajevo Development Strategy 2021-2027

Sarajevo Canton Development Strategy for the period 2021-2027 formulated in April 2021 is a strategic document at the level of the Canton Sarajevo, which directs development, establishes priorities in development and represents a roadmap for the overall development of the Canton Sarajevo. The obligation to prepare this document is prescribed by law, and it is the basis for harmonizing and developing the development strategy of local self-government units. Within the strategy, four strategic objectives with 165 strategic projects were identified.

The four strategic objectives of this new strategy are as following:

- To improve the competitiveness of the economy and increase employment,

- To create conditions for inclusive socio-economic growth and poverty reduction and improve the availability and reliability of all public services (health, education, social policies, culture and sports),
- To responsibly manage the environment, space, natural and infrastructure resources, and
- To improve the efficiency and responsibility of the public sector.

The following table shows the key projects for the transportation and urban development sector.

Table 1.1.3 Strategic Objectives and Key Selected Projects in the Canton Sarajevo Development Strategy 2021-2027

Strategic Objectives	Key Selected Projects for the Transportation Sector and Urban Development Sector
1. To improve the competitiveness of the economy and increase employment	• Improvement of the legal and institutional framework for the realization of PPP projects
	• Organizational and financial restructuring of public utility enterprises
	• Defining quality standards of public utility services
	• Redesign of the policy of subsidizing utility users
	• Change in the system of calculation and collection of services (according to the principle of justified costs) from the domain of shared utility consumption
	• Implementation of a unique information system for all utility enterprises
	• Establishment of a new organizational structure at the level of the utility (communal) sector – holding of the utility (communal) economy in Sarajevo Canton
2. To create conditions for inclusive socio-economic growth and poverty reduction and improve the availability and reliability of all public services (health, education, social policies, culture and sports)	• No relevant projects specifically for the transport sector
3. To responsibly manage the environment, space, natural and infrastructure resources	• Implementation of the “Strategy for limiting the use of coal and solid fuels”
	• Establishment of a green corridor along the Miljacka River and the corridor of the main road from Veliki Park to Hamdije Čemerlića street
	• Establishment of a public information system of the register of polluters of Sarajevo Canton
	• A study on the behavior of air flow under the inversion layer and the influence of heat islands for all urban parts of Sarajevo Canton
	• Increasing traffic safety and improving infrastructure for people with disabilities
	• Investment in infrastructure and vehicles of public regular passenger transport
	• Development of non-motorized modes of transport and movement (mobility)
	• Construction of primary urban roads
	• Improvement and regulation of parking
	• Development of urban city logistics
	• Inclusion of the railway in the unique system of public passenger transport
4. To improve the efficiency and responsibility of the public sector	• Modernization of the traffic control and management system in Sarajevo Canton
	• Modernization of the infrastructure for the administrative business
	• Procurement of helicopter and formation of a helicopter unit
	• Increase the level of traffic safety
	• Amendment of existing legal regulations in the field of traffic safety
	• Establishment of a unique database for collecting and processing data on traffic accidents

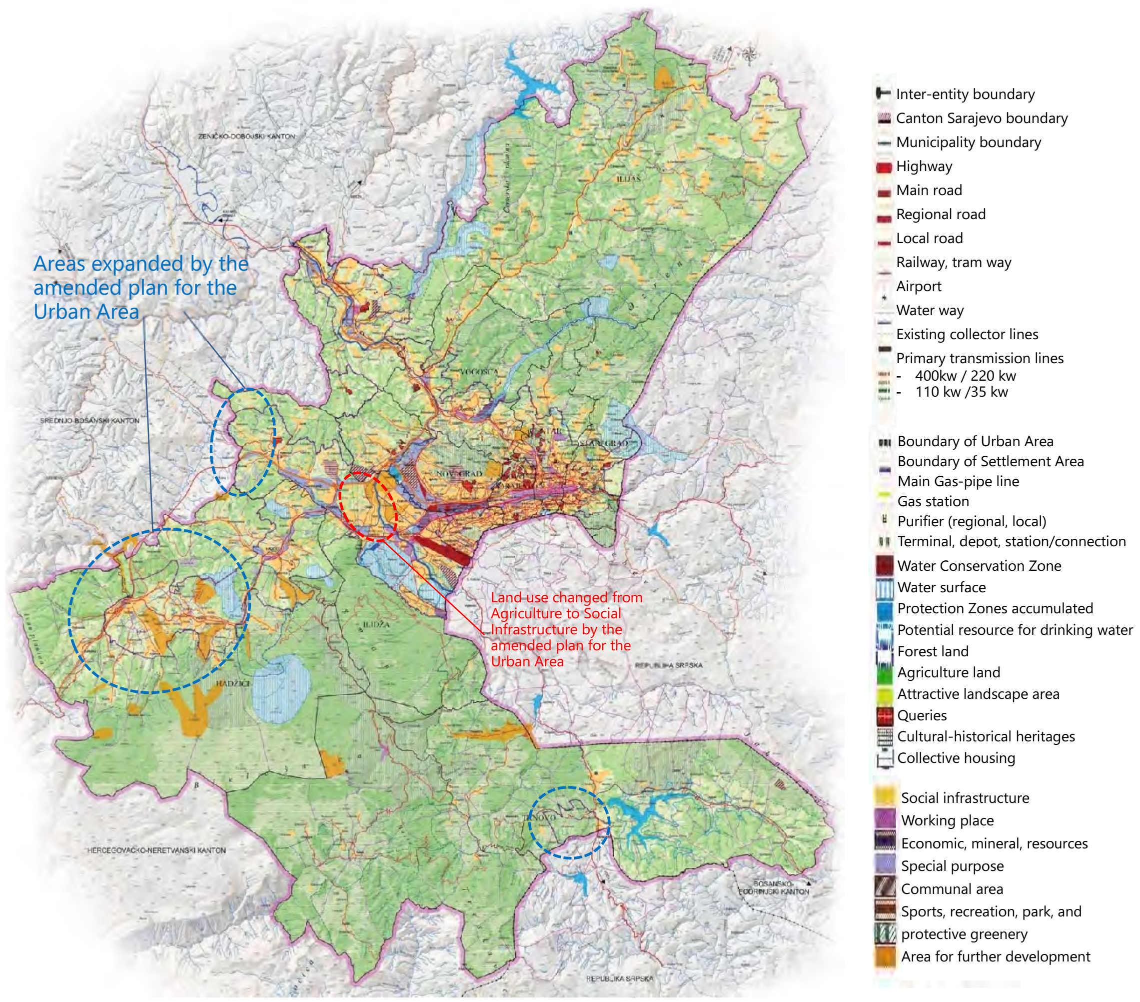
Source: Development Strategy of the Canton Sarajevo for the period 2021-2027

5) Spatial Plan of Canton Sarajevo for the Period from 2003 to 2023

The spatial plan of CS for the period 2003 to 2023 was formulated in 2006 in accordance with the laws on Physical Planning of the Federation of Bosnia and Herzegovina (Official Gazette of the FBiH: No. 52/02) and Physical Planning of Canton Sarajevo (Official Gazette of the SC No. 10/04).

After establishing the Development Strategy of Canton Sarajevo in 2016, the spatial plan in 2006 was revised in 2016 to fit with current development conditions and the development strategy. The designated urban area and the future development zones are different, as shown below and in Figure 1.1.2.

- The designated urban area expanded in the hilly areas along the road of M17 and the highway of A1 and Doglodi, which was previously agricultural land in Ilidža municipality.
- New designated urban areas have been created in the Hadžići, Trnovo, and Ilijas municipalities in the amended plan, while boundaries of the designated urban area have been retained in the municipalities of Vogošća and Ilidža and in the City of Sarajevo.



Source: Development Planning Institute of Canton Sarajevo

Figure 1.1.2 Spatial Plan 2013-2023 (amended in 2016) for Canton Sarajevo

6) Urban Plan of Canton Sarajevo for the Period from 2016 to 2036

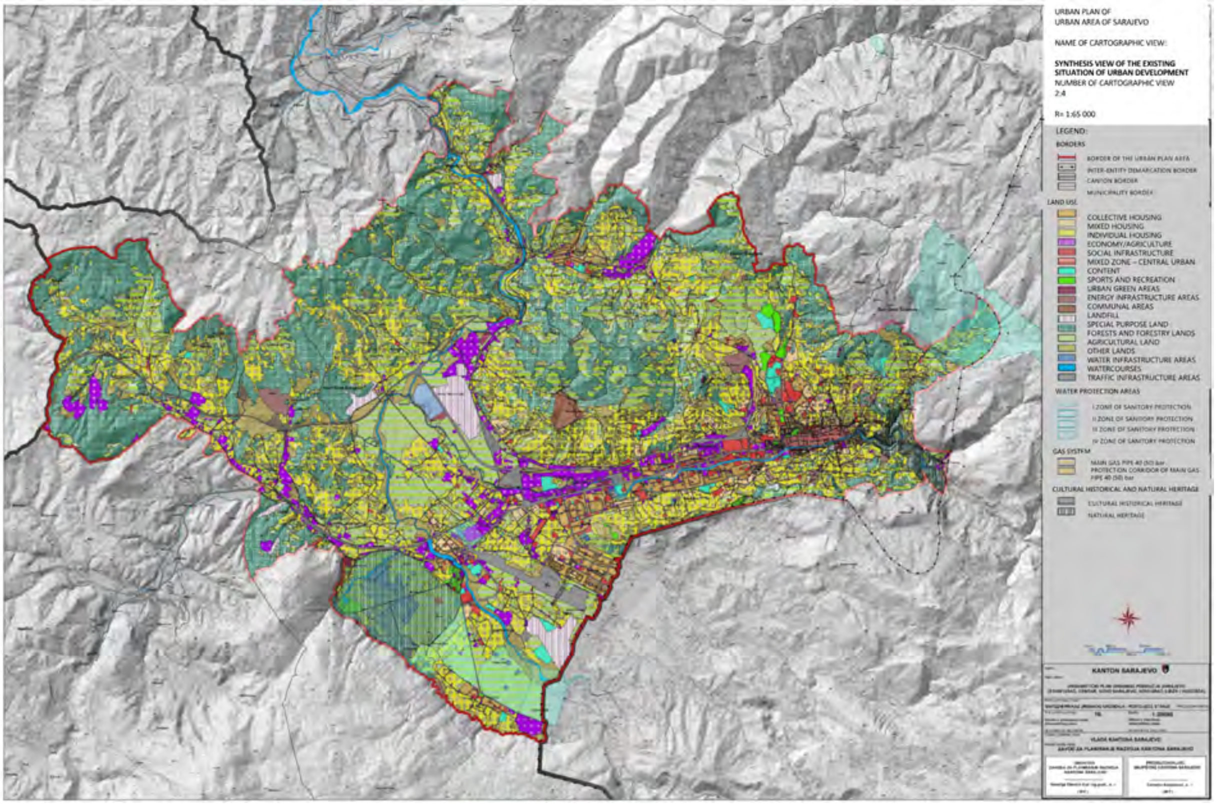
The “Urban Plan of the City of Sarajevo[1] (Stari Grad, Centar, Novo Sarajevo, Novi Grad, Ilidža, and Vogošća) for the period from 2016 to 2036” has been in progress based on the “Decision on Access to the Drawing of the Urban Plan” in October 2016. The first draft was submitted to the Assembly and is currently under review.

As mentioned in the Spatial Plan section, urban areas of Hadžići, Ilijaš, Trnovo municipalities also compose Urban Plan of Canton Sarajevo, and there are separate documents called “Urban Plan Hadžići”, “Urban Plan Ilijaš” and “Urban Plan Trnovo” respectively.

The following are the direction and goals of the development of the Urban Plan for Canton Sarajevo.

- Elaboration of the provisions of the valid Spatial Plan of the Canton Sarajevo, i.e., current Amendments and Supplements of the Spatial Plan of the Canton Sarajevo.
- Use the final results of the population census in the preparation phase. This approach is necessary for the reason that even according to the current statistical estimates of the number of inhabitants, there is an evident change in the demographic picture in the urban areas of Canton Sarajevo, both in terms of quantity and spatial distribution, which is essential for the timely direction of quality solutions for the necessary communal and social infrastructure.
- Prepare and draw up the Urban Plan in accordance with the provisions of Article 36, paragraph (2) of the Law on Spatial Planning (“Official Gazette of the Canton Sarajevo,” number 7/05) and the Regulation on a unified methodology for the preparation of planning documents (“Official Gazette of the Federation BiH,” no. 63/04 and 50/07 and 84/10).

[1] City of Sarajevo covers Stari Grad, Centar, Novo Sarajevo, and Novi Grad, while the urban plan of the City of Sarajevo considers the urban areas of Stari Grad, Centar, Novo Sarajevo, Novi Grad, and part of Ilidža and Vogošća.



Source: Development Planning Institute of Canton Sarajevo

Figure 1.1.3 Urban Plan 2016-2036 for the City of Sarajevo

1.2 Public Transport Policy and Transport Planning

This section explains, from the legal base, the roles of regulators and operators and ongoing transport projects.

1) Legislation

Due to the lack of relevant legislation on the cantonal level, MOT has prepared the following four laws (two amendments and two new laws):

- Amendments to the law on taxi services,
- Amendments to the law on traffic regulation,
- Law on public transport of passengers, and
- Law on roads in Canton Sarajevo.

2) The Cantonal Ministry of Transport as Main Regulator for Public Transport

The MOT assumes the functions of three natures:

- Economic and technical: Transport planning, allocation of lines and timetables, traffic management and public transport (including pricing), contractual arrangements with third parties (ZFBiH, etc.);
- Legal and regulatory: Enforcement of the regulation, issuance of guidance and rulebooks, preparation of cantonal transport/traffic related laws and regulations, and public transport operating licenses and driving licenses; and
- Project management and procurement: Construction works, acquisition of vehicles, traffic control systems, service contracts, road maintenance, etc.

Although MOT has excellent power on key aspects of the service due to the regulation, such as timetables, the extent of its functions is sometimes more limited compared with the practice of regulation authorities in OECD countries, for instance, regarding the protection of transport users' interest, control of operators (dispute resolving, application of fair competition principles, use of KPIs and benchmarking, enforcement of transparency obligations incumbent upon operators). MOT's external communication on these aspects with the public and users remains limited.

3) Operators as Regulated Organizations

There should be five public transport operators: GRAS (public cantonal company, unless the company is liquidated), CENTROTRANS d.d. (private), the Sarajevo Public Transport Company (hereafter SPTC, public cantonal company) to be established, the ZFBiH (federal public railways company) and the cable car operator J.P. Sarajevo d.o.o, (a public company under City of Sarajevo). Except for ZFBiH, all operators are regulated by the MOT. They may experience significant changes in the near future:

- GRAS [2] might be redeemed/restructured, bankrupted, or merely liquidated. Currently, its assets are mortgaged to the Tax Administration of FBiH and Indirect Taxation Authority of BiH, its payments strictly controlled - limited essentially to salaries and fuel—resulting from juridical incapacity to tender for further line operation. Last March, GRAS submitted to the MOT a restructuring plan: reduction of the service area (zone A) and staff reduction with financial support from the Canton to renew a (reduced) buses and mini-buses fleet. So far, the SCG has not replied to this proposal.
- CENTROTRANS d.d. should continue diversifying business lines besides urban and sub-urban public transport to secure its profitability: communication, stores, advertising, maintenance of heavy vehicles, tourism and long-distance bus, warehousing and imports of second-hand vehicles, parking, etc. However, the combined pandemic and increased operating costs (oil and gas, salaries) now make the company's financial situation difficult.
- The ZFBiH, essentially a freight transport operator, has started operating two suburban transport lines in Sarajevo.[3] The regulation limits the possibility for the ZFBiH to diversify its activities, and the company currently faces a financial distress situation.
- The Sarajevo Public Transport Company d.o.o. (SPTC) should operate tramways and trolleybus, a service to be modernized and extended with international support (EBRD, EIB, possibly JICA). In the future, electric buses may also be placed under SPTC. SPTC was planned for establishment but still needs to be as of August 2023.
- J.P. Sarajevo d.o.o, established in 2018, might benefit from post-COVID recovery (tourism).

The regulatory framework of public transport in Sarajevo is complex and changing (frequent

[2] GRAS is currently under the authority of a Supervisory Group composed of the cantonal Prime Minister, the Minister of Transport, the Minister of Justice, the Minister of Finance, the Minister of Social Policy.
[3] The strategic development of Canton Sarajevo for 2021–2027 insists on the reduction of urban traffic and on the measures to take to limit its environmental impacts. One strategic project proposed inclusion of the railway into the unified system of public transport of passengers, in particular in suburban areas (Hadžići [Pazarić] and Ilijaš). The construction of a tramway line from Sarajevo railway station—to Vogošća, or Semizovac—is proposed. Such orientations would affirm ZFBiH as urban public transport operator. One obstacle will eventually its financial capacities; the company is presently significantly indebted, particularly vis-à-vis the tax administration.

amendments). Past and current efforts of authorities to construct a robust and comprehensive regulatory framework for urban transport must be acknowledged. Although this requires further confirmation, the regulations relating to 1) transport and roads and 2) spatial and urban planning are made separately.

4) Ongoing Transport Improvements

Public transport operation has challenged MOT and the government for many years. All are aware of the deteriorating services over the years and the weakening of the cantonal public corporation (GRAS) that accumulated over 240 million KM debt (as on Dec. 2020)[4]. Following the work on the law on public transport, MOT will establish an internal body to deal with public transport operations. It will be responsible for all processes in public transport (tariff system, allocation of lines, performance conditions/requirements, etc.). Ongoing transport improvements are summarized.

(1) Tram Tracks

Reconstruction of the 60-year-old tram tracks from Ilidža to the center was completed. Furthermore, MOT will build new tracks to Hrasnica, and a feasibility study for new tram lines to Šip and Dobrinja is underway.

(2) Trolleybus

There is a plan to re-open the trolleybus line to Vogošća. New trolleybuses have been arriving in Sarajevo since the beginning of 2022. New vehicles can drive 20 km without catenary. There will be a possibility to operate many bus lines with new ones.

(3) Contactless Ticket System

MOT will begin offering contactless tickets that will be valid in all vehicles of all public transport operators. Monthly subsidized contactless tickets will be first available for pupils, students, and pensioners. Eventually, MOT will start selling contactless tickets to general passengers with an application featuring ticket purchasing, enabling passengers to purchase tickets, real-time information for the next service, and news about public transport. It will also be possible to top-up tickets like mobile phone credit.

(4) Road Development

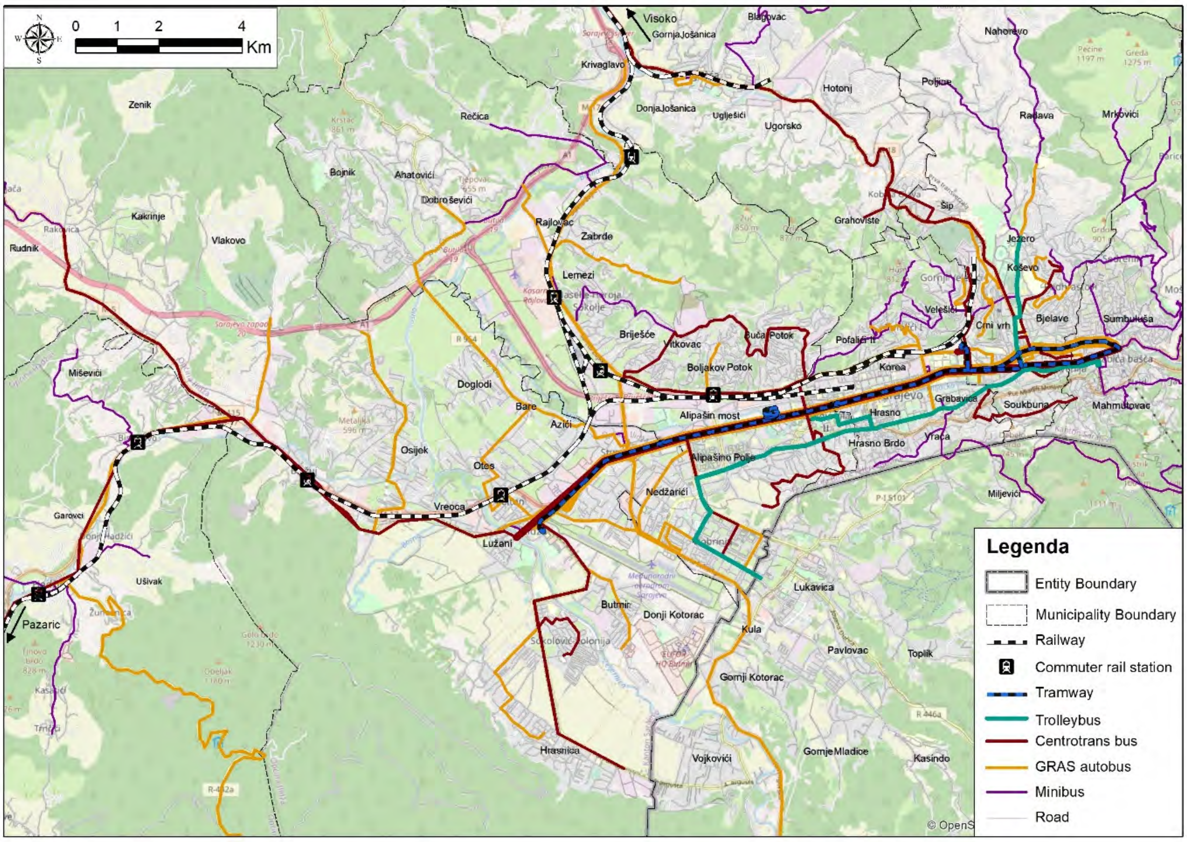
Several road development and improvement work plans should be taken into consideration for the formulation of the public transport improvement plan:

- IX Transversal Project: MOT and municipality Novi grad expanded road in Džemala Bijedića street, now with four lanes, started construction works on the roundabout and connection of IX transversal with the motorway. The trip from Alipašino polje to motorway access is expected to be reduced from the current 30 minutes to 3 minutes when the connection is finished. This will alleviate traffic in the city.
- Construction of a roundabout on A transversal that connects the airport, two more roundabouts in Novo Sarajevo, one in Kranjčevićeva street in Centre, Igman road in Ilidža and roundabout connecting IX transversal and Džemala Bijedića street in Novi grad.

[4] Sarajevo Institute of Economics, 2021, Study on Socio-economic Justification of the Establishment of a New KJKP for the Provision of Tram and Trolleybus Public Transport Services Nov., p. 13

5) Public Transport Network

The existing public transport network based on the plan is presented in Figure 1.2.1. Trunk transport modes, tramways, and trolley bus lines run mainly east–west, serving the central area of Canton Sarajevo.



Source: JICA Expert Team summarized with the plan provided by the Ministry of Traffic of Canton Sarajevo.

Figure 1.2.1 Existing Public Transport Network

The tramway also connects to the main railway station, Sarajevo intercity, and international bus terminal. The trolley bus line extends to the north toward the Olympic stadium. Conventional bus and minibus lines serve the entire urban area. Minibuses often serve the hillside residential areas as feeder lines to the trunk transport modes. Furthermore, commuter trains run on the ZFBiH line to connect with suburban areas (Sarajevo-Pazarić, Sarajevo-Visoko).

1.3 International Cooperation on the Public Transport in Canton Sarajevo

Many international cooperation organizations provide loans, grants, or technical assistance projects to Sarajevo. Activities by the organization as of August 2023 are summarized in Table 1.3.1, and ongoing projects are listed in Table 1.3.2.

Table 1.3.1 Summary of International Cooperation by Organization

Organization	Contents
EBRD	• EBRD's involvement in BiH is related to the traffic management system study and loan for the tram, trolleybus, track, and road expansion and extension. The budget comes from a co-finance scheme between EBRD and EIB. However, delays occurred due to the pandemic. EBRD started those projects in mid-2021 as following description. • EBRD also works on due diligence for the traffic management system. EBRD financed 25 million EUR to MOT for a tram line extension to Hrasnica. • EBRD planned to share a total budget of 10 million EUR for traffic management study and public transport operator restructuring. For the traffic management study, a total of six months to 1 year is set for the project conduct. The product was expected to be given to BiH by mid-2022. • Another electronic ticketing system project that MOT also started in March 2021. • In recent years, EBRD has been working on the project formulation of the legal public transport sector, and the report will be submitted towards the end of 2023.
EIB and EBRD	• "Sarajevo Public Transport Project Phase III: Public Service Contract and Tariff System Reform" is co-financed by EIB (EUR 20 million) and EBRD (EUR 10 million). • The proceeds of the EBRD's and EIB's loans will be used to acquire new trams, which will allow GRAS to replace its old tram fleet and improve the reliability and quality of public transport services and air quality. • The project consists of three main tasks to prepare the advisory by consultancy assignment: a) Public Service Contract ("PSC") between GRAS and the Canton; b) Revision of the existing ticketing system; and c) New tariff methodology for public transport service in the Canton. • It was started in March 2022 for 5 months by a Vectio–Arup–PPG consortium.
World Bank	• WB confirmed technical demand and finalized the design in January 2023. Currently packaging appraisal documents and defining requirements. Three activities are implemented within urban mobility: a) Cycling infrastructure: focus on filling the gaps and connecting the gaps on the existing network with some feasible extensions in the next 4–5 years. b) Green design for public transport: includes nine diesel buses EURO 6 and three e-buses as a demonstration project. The Cantonal Government decided to use 16b bus corridor to demonstrate e-buses. The plan is to improve service frequency to 15 minutes. The World Bank will share with TRAMODE the reproduced GIS net for 16b and 31e routes. World Bank supports the Canton Government in expressing interest in accelerating the procedure for defining diesel bus EURO 6 specifications because it is relatively more straightforward to procure and start operation. c) Technical assistance in nature requires work with both MOT and MOE to prepare them to deploy or create a low-emission zone.
GIZ	• Sustainable Urban Mobility Planning (SUMP)–Sustainable Urban Mobility in Southeast European Country II (SUMSEEC II): GIZ-funded study for the west Balkan countries, including BiH, was completed in August 2020 (original schedule of completion was June 2020). This project adopted commonly applied project methodology by the European Union (EU) by realizing small-scale pilot project construction and involving academics of various sectors. • The pilot project constructed in the study area reflects the needs of each city-level government to improve citizen mobility and minimize private vehicle use. While such a purpose did not directly consider promoting public transport use, 13 out of 23 cities implemented the non-motorized transport facility. In Sarajevo, nine bike shelters were built. • GIZ planned to apply the next phase of a similar project scheme from 2021 to 2024. The project theme was set for the SUMP project list realization and by following efficient energy and climate considerations.
SIDA (Swedish International Development Cooperation Agency)	• SIDA launched an air quality project and capacity building in BiH. This project has six components: data management, development of a laboratory, social experiments in six cities (to track the origin of pollutants), information campaign (exhibition, etc.), and environmental inspection (three experts for field inspection, training module).
SECO (Swiss State Secretariat for	• Urban Transformation Project Sarajevo (UTPS) is based on the cooperation of Swiss and Bosnia and Herzegovina—researchers, professionals, and institutions from both countries examine and develop models of urban transformation.

Organization	Contents
Economic Affairs)	• Development through the affirmation and integration of existing values of the City of Sarajevo and modern urban infrastructure development methods, energy, and mobility. UTPS is implemented by three teams: ETHZ in partnership with the University of Sarajevo and the Canton Sarajevo Development Planning Institute, a consortium of Urbaplan–Enova–Helvetas, and the City of Zurich. • The four-year project ensures the application of new knowledge and the best technologies in urban planning.
Ministry of Industry, Trade and Tourism of Spain	• A project to design the on-street smart parking and low emission zone (LEZ) in Sarajevo was started in June 2023. This project will help the Canton manage parking, improve traffic organization, and reduce air pollution in line with current European sustainable mobility goals. • The project is financed by a non-refundable financing Facility of the Corporate Internationalization Fund (FIEM) and managed by the Ministry of Industry, Trade and Tourism of Spain.

Source: JICA Expert Team

Table 1.3.2 Summary of Ongoing Projects (As of June 2023)

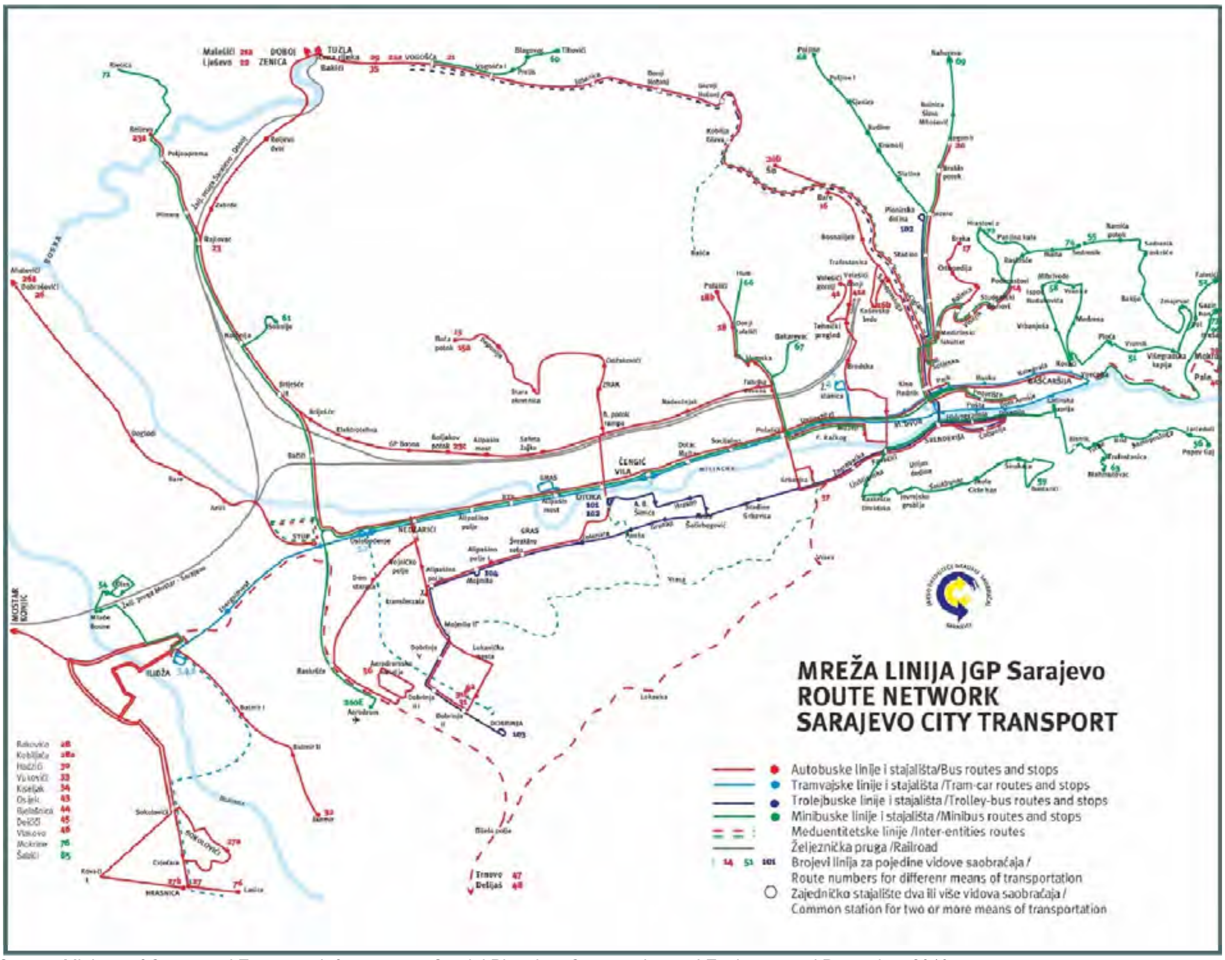
Project	Financing Source	Contractor
Public Service Contract &Tariff System Reform	EBRD TA (grant)	Vectio/ARUP/PPG
Legal Public Transport Sector Reform	EBRD TA (grant)	KPMG
Consultancy Services for Preparation of Conditions and Terms of Awarding More Bus and Minibus Lines to Private Companies Under the Existing Regulatory Framework	EBRD (grant)	Deloitte
Consultancy Services for Assistance with Establishing the New Company for Public Transport Services in Canton Sarajevo, Including Legal Assistance, setting up an Organization, Hiring and Management Policies and GAP	EBRD (grant)	KPMG
Consultancy services related to survey and monitoring of the quality of public transport services in Canton Sarajevo	EBRD Loan	Tendering was targeting January 2023
Project contents include: - Bike lane and bus lane development - Introduction of low-emission zones - Public transport vehicle strategy, including electric vehicles	World Bank	Led by UK expert, former PM of the PWC study
Development and area identification of Low Emission Zone (LEZ) in Sarajevo (completed)	Sweden	Swedish Environmental Research Institute (IVL)
Design and Drafting of the Terms of References for the Implementation and Operation of On Street Smart Parking and Low Emission Zone (LEZ) in the City of Sarajevo	Spain	IDOM (Spain)
Project MOTION contents include: - Demonstration of the Mobility Planning Model - Provision and maintenance of specific datasets essential for the successful implementation of the project	EIT (European Institute of Innovation & Technology, EU)	Paraboly (Turkey)

Source: JICA Expert Team

2 Current Situation of Public Transport in Canton Sarajevo

2.1 Traffic Data and Characteristics

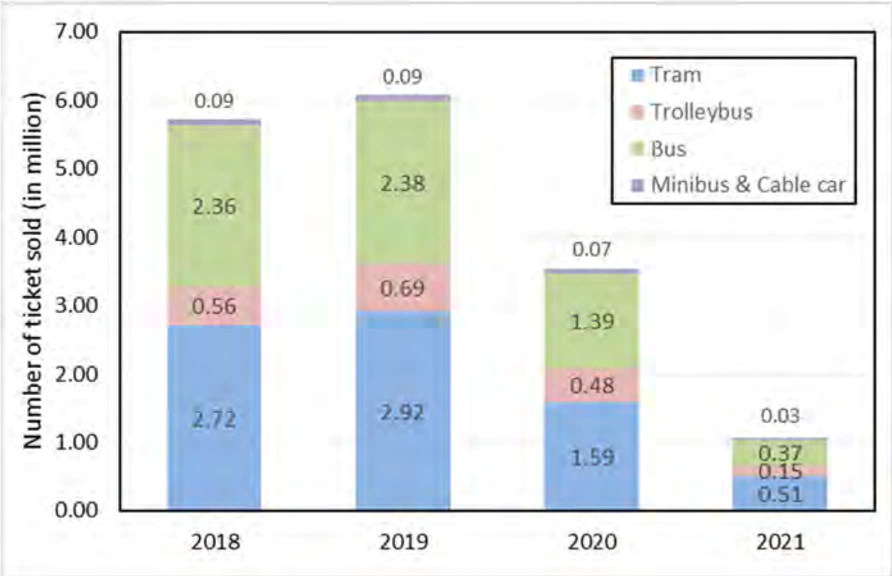
Canton Sarajevo is situated in a valley surrounded by hills that can pose challenges for transportation. The transportation characteristics of Canton Sarajevo are strongly related to the geographical situation of valley and hilly terrain, urban layout, and quite significant historical value. Sarajevo has a diverse transportation system that incorporates multiple modes of transportation, including trams, buses, taxis, private vehicles, non-motorized transport, and walking. The tram network is a distinctive feature of Sarajevo's transportation system, which plays a vital role in connecting different parts of the city centers and suburban areas. Bus and trolley bus networks complement the tram system connecting various regions of Canton Sarajevo.



Source: Minister of Communal Economy, Infrastructure, Spatial Planning, Construction and Environmental Protection, 2019

Figure 2.1.1 The Public Transport Network Map of Canton Sarajevo

The yearly public transport ticket sales increased until 2019—from 5.7 million in 2018 to 6.1 million in 2019. However, the pandemic hit the public transport system in Canton Sarajevo quite significantly, resulting in a more than 40% decrease in 2020 compared to 2019 and an even more drastic decrease of 70% in 2021 compared to 2020. Such a drastic decrease is, of course, related to the pandemic-related countermeasures: individual movement limitation, public transport fleet reduction, and the cut short of operational hours of most business sectors.

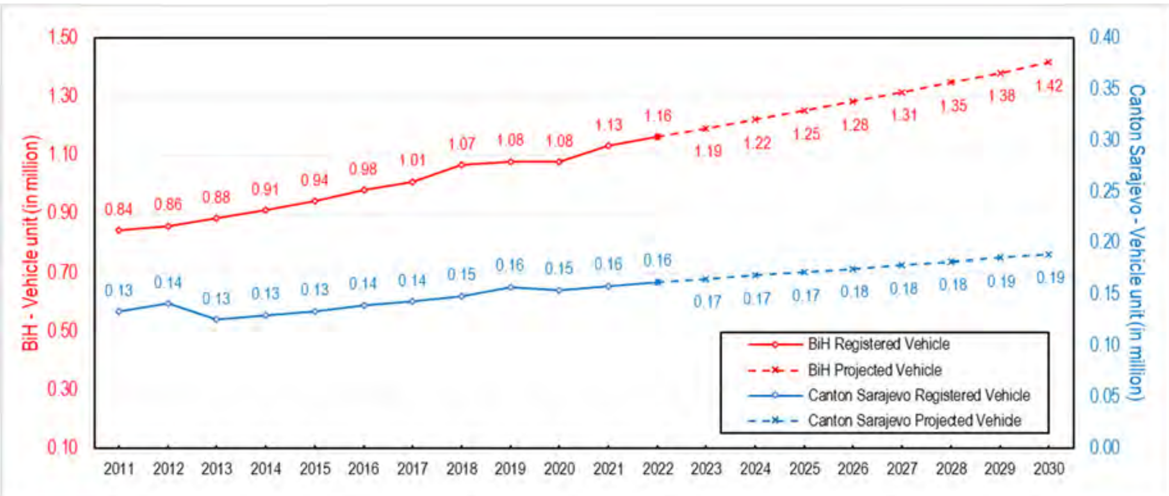


Source: KKJP GRAS, 2022

Figure 2.1.2 Number of Ticket Sales by Mode of Public Transport in Canton Sarajevo (2018–2021)

Unfortunately, similar data from 2022 has not been ready for publication. Therefore, an analysis of the fluctuation of ticket sales for a so-called "post-pandemic" cannot be done.

Like many urban areas, Canton Sarajevo experiences traffic congestion, especially during peak hours. This congestion is influenced by the city's narrow streets, increasing private vehicle ownership, and growing demand for public transportation post-pandemic. The number of registered vehicles nationwide and in Canton Sarajevo over the recent decade shows a trend of positive increase. The future linear projection after 2022 is at 2.5% and 2% increment each year up to 2030 for nationwide and Canton Sarajevo, respectively. This shall result in more than 1.4 million and 0.19 million vehicles registered in Bosnia and Herzegovina and Canton Sarajevo, respectively, by 2030.



Note: Left vertical axis in red represents unit of vehicle in BiH (nationwide) and right vertical axis in blue represents unit of vehicle in cantonal level.
Source: CEIC and BIHAMK, 2022

Figure 2.1.3 Registered (2011-2022) and Projected (2030) Vehicles in Bosnia and Herzegovina and in Canton Sarajevo

According to the registration of vehicle age in BIHAMK (Bosnia and Herzegovina Auto-Moto Club), about 40% of the registered vehicles in 2022 are older than 22 years (model year 2000 and before), and about 60% are older than 12 years (model year 2010 and earlier).

2.2 Findings from Transport Surveys

1) Activity Diary Survey (ADS)

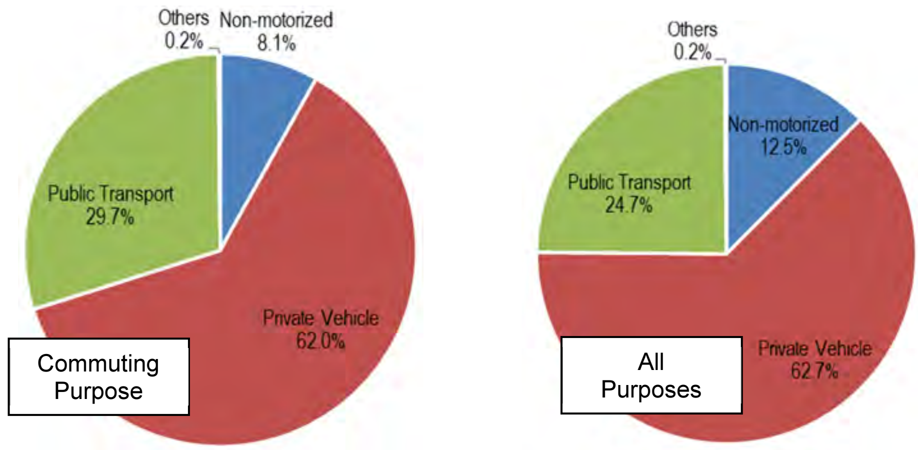
ADS collected data on the socioeconomic and daily activity-travel of the citizens of Canton Sarajevo. It is designed for the simplified sampling method of two households in each Census Block since no available information on demographics could be utilized as a sampling method. The number of Census Block is 3,101 across Canton Sarajevo. Thus, the target ADS respondent number is adjusted to 6,000.

Finally, a total of 6,034 samples of targeted respondents were collected. The distribution of collected samples by municipality is Centar with 757 samples, Hadzici with 171, Ilijas with 186, Novi Grad with 2,199, Vogosca with 223, Ilidza with 754, Novo Sarajevo with 1,303, Stari Grad with 387, and Trnovo with 54.

Findings and Results

The average monthly household income is around 2,000 KM. This may reflect the income of both parents, which individually makes up about 1,000 KM. Notably, higher percentages (60% of all households) are spread between 750 KM to 2,500 KM. This may be inferred as medium-high income classes.

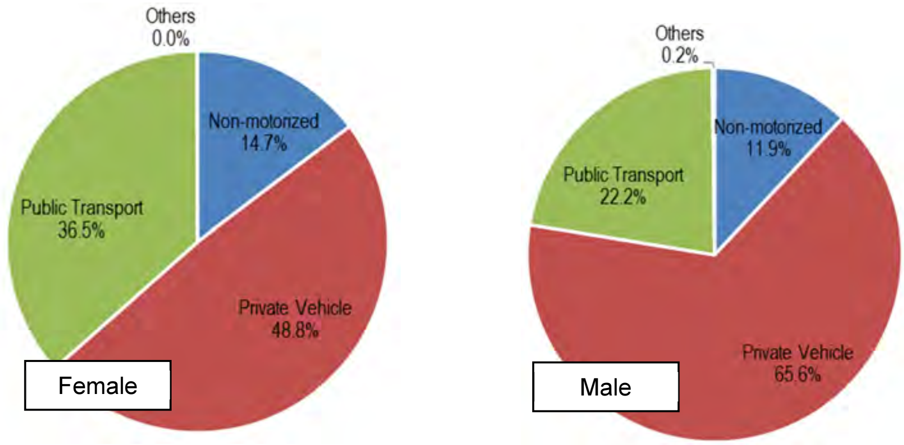
From the structure of the ADS survey form, information on modal share can be classified into two categories: commuting purpose and all purposes. Thus, the simplified modes to the question of commuting purpose led to the nested answer of public transport, private vehicles, and walking/bicycle only. Below are the charts of those two.



Source: ADS 2022

Figure 2.2.1 ADS Modal Share by Purpose

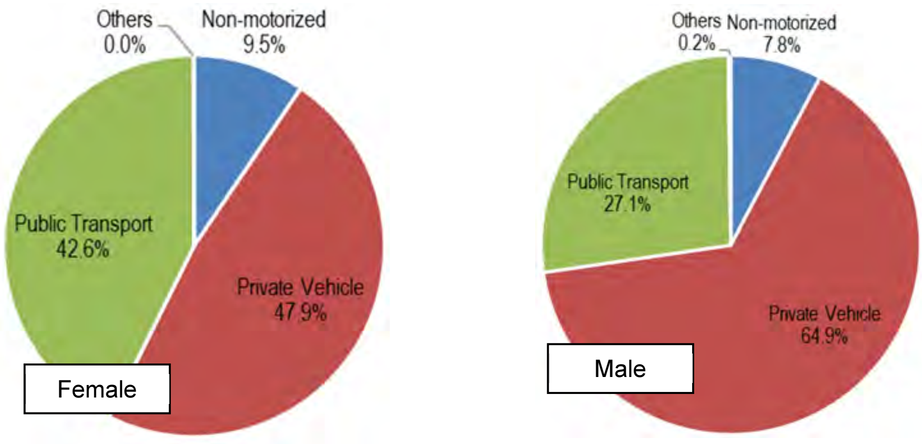
For both purposes, the share of public transport is about 30% for commuting purpose and about 25% for all purposes. In contrast, private vehicle share is higher in both classes. These two facts indicate the domination of the use of private vehicles, and since the public transport share of all purposes is lower than that of commuting purpose, this may indicate that respondents tend to use either non-motorized or private vehicles for non-commuting trips. Above all that, the mode share itself is a rather complex and dependent product of various variables in the formula or calculation.



Source: ADS 2022

Figure 2.2.2 ADS Modal Share for All Purposes by Gender

Furthermore, the modal share by sex of the respondent shows significant differences. Despite a high percentage of private vehicle use among female respondents, it is still lower than male respondents. On the contrary, the share of females using public transport is higher than that of males while the percentage of the non-motorized gap is not too far.



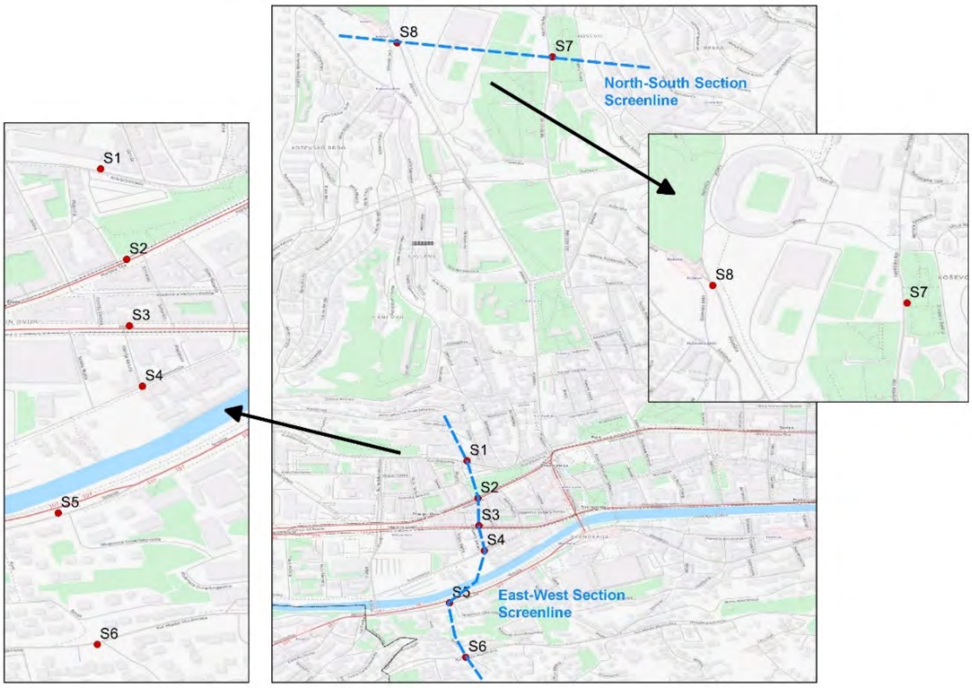
Source: ADS 2022

Figure 2.2.3 ADS Modal Share for Commuting Purpose by Gender

The same tendency of the mode share for all purposes applies to commuting purpose—the use of private vehicles is generally higher for males. It is interesting to highlight that both females and males share more significant shares of public transport use for commuting purpose than for all purposes, and generally, females tend to use non-motorized more than males, which includes walking all the way to the workplace or school.

2) Screenline Survey

Screenline survey is designed for data collection of current traffic situation (i.e., traffic volume and occupancy) along imaginary lines of east–west and north–south that quarterly divide Canton Sarajevo. The next figure and table reflect the location and results of the data collection.



Source: Screenline Survey TRAMODE 2022

Figure 2.2.4 Screenline Survey Location

Table 2.2.1 Traffic Count of Screenline Survey

Location Name & Direction		Motorcycle	Private Car	Taxi	Pick Up, Box	Small Truck	Medium Truck	Large Truck	Small Bus	Medium Bus	Large Bus
S1	A	50	5,470	608	428	27	6	1	6	1	1
	B	14	1,883	142	100	14	18	6	2	-	-
S2	A	220	21,297	2,122	1,452	64	41	5	18	95	208
S3	A	134	22,801	2,884	918	95	8	7	12	81	257
S4	A	46	4,420	237	277	9	2	-	4	1	2
S5	A	60	7,859	538	240	51	23	5	32	35	36
	B	58	8,130	679	421	51	10	3	36	42	45
S6	A	19	4,486	85	256	77	40	169	20	11	6
	B	22	4,248	70	279	44	30	182	24	5	10
S7	A	23	4,041	272	313	26	12	10	49	26	41
	B	32	5,482	254	157	36	4	2	82	-	37
S8	A	-	9,585	1	363	71	57	29	-	133	41
	B	-	7,562	22	270	81	66	74	-	123	42

Source: Screenline Survey TRAMODE 2022

Results of the traffic count in all locations are converted to passenger car unit) to compare at the same standard for different types of vehicle units (PCU) and suggest the composition of traffic is dominated by private vehicles (84.6%), taxis (6.2%), pickups/boxes (4.3%), and other modes that are less than 1%. Information on occupancy of each type of vehicle is available in Appendix 1.1, section 6, and sub-section 2.

3) Cordon Line Survey

The cordon line survey is intended to get origin–destination data of inbound and outbound trips that cross the boundary of Canton Sarajevo. The survey activities construct the specifications by each survey location below:

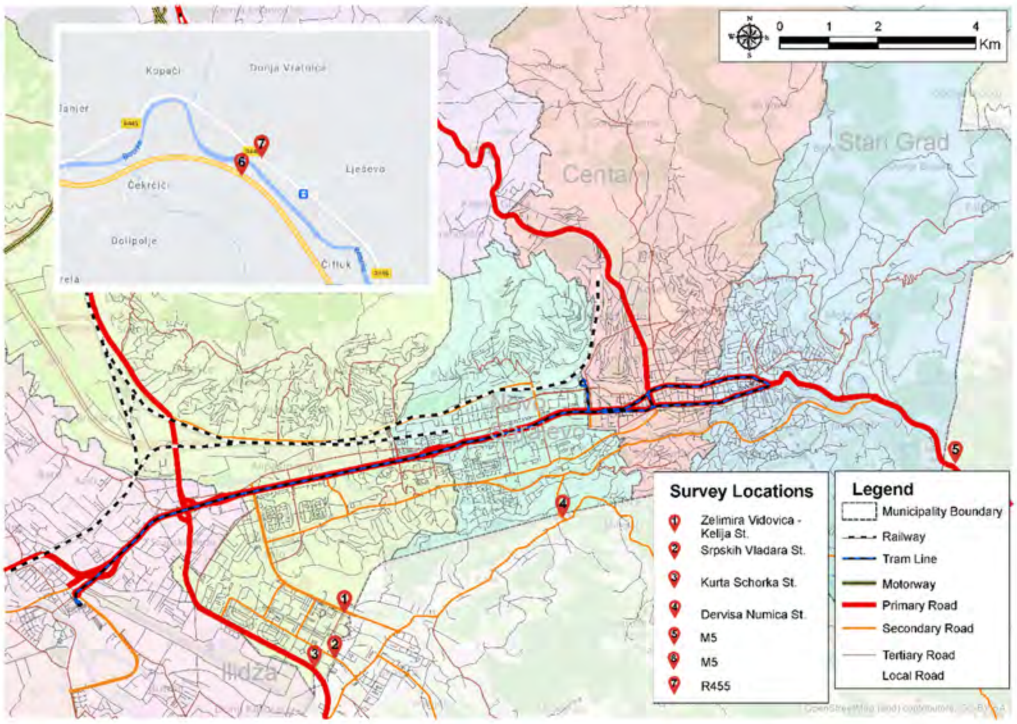
- **Sarajevo Bus Terminal**: All inter-cantonal and international bus services can be captured from inside the Sarajevo Bus Terminal, including those stops at Mojmilo and Dobrinja crossing the line between Canton Sarajevo and Republika Srpska.

Source: Cordon Line TRAMODE 2022

Figure 2.2.5 Distribution of Destination of Bus Passengers

Major destinations of intercantonal passenger buses going within BiH dominate the terminal service, which also serves international locations. Ninety-three percent of passengers using the bus terminal are intercantonal bus passengers. The major destinations outside Canton Sarajevo but still within BiH are Visoko, Zenica, Breza, Kakanj, Bihac, Tuzla, Banja Luka, and Mostar. Those locations are within a five-hour bus ride, and the bus may be considered the only way (other than private vehicles) to reach those locations. There are no domestic flights nor railway options.

- **<u>Roadside at the boundary of Canton Sarajevo</u>**: In order to capture the movement of people at the borderlines, surveys were done at seven locations (see figure below), and the results of occupancy and traffic count are listed in the following table.



Source: Cordon Line TRAMODE 2022

Figure 2.2.6 Survey location of Cordon Line–Roadside Survey

Table 2.2.2 Traffic Count of Cordon Line – Roadside Survey

Location Name		Motorcycle	Private Car	Taxi	Pick Up, Box	Small Truck	Medium Truck	Large Truck	Small Bus	Medium Bus	Large Bus
1	Inbound	18	4,457	69	301	20	4	7	4	-	-
	Outbound	12	4,877	78	250	60	10	7	-	-	-
2	Inbound	3	1,984	105	161	13	1	-	-	-	-
	Outbound	1	1,725	56	52	11	-	-	-	-	-
3	Inbound	16	4,702	35	588	112	84	216	17	21	10
	Outbound	14	4,680	46	611	152	114	225	15	12	19
4	Inbound	28	6,193	89	192	33	30	45	30	14	9
	Outbound	29	5,697	73	128	18	22	31	21	10	4
5	Inbound	1	4,054	20	312	112	54	197	48	32	26
	Outbound	10	4,245	18	429	100	64	171	36	22	13
6	Inbound	8	6,947	-	439	374	106	258	596	-	97
	Outbound	14	6,831	-	362	406	101	254	641	-	92
7	Inbound	4	2,324	6	323	35	10	21	-	11	22
	Outbound	7	2,376	4	273	52	8	10	20	10	18

Source: Cordon Line TRAMODE 2022

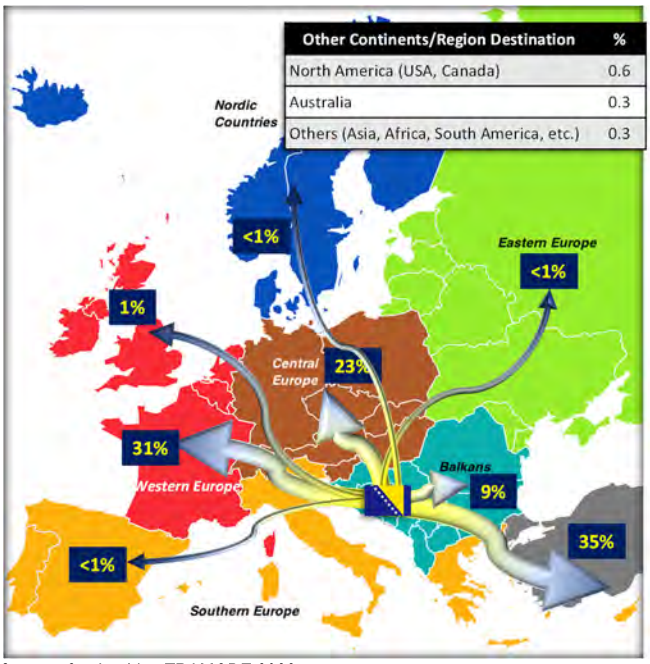
- **<u>Sarajevo Railway Station</u>**: to capture the passenger of the train service that covers only inter-cantonal trips, because there is no train serving international routes.

Source: Cordon Line TRAMODE 2022

Figure 2.2.7 Distribution of Destination of Railway Passenger

Intercantonal railway trip is currently limited to Mostar and Zenica because the available railway track is within those locations only. Referencing the intercantonal bus service, it may be worth considering the expansion of the railway track towards Breza, Bihac, Tuzla, and Banja Luka. This way, people would get alternative options to reach those locations within BiH.

- **Sarajevo International Airport**: To capture airplane passengers that cover only international trips since there is no domestic flight within BiH.



Source: Cordon Line TRAMODE 2022

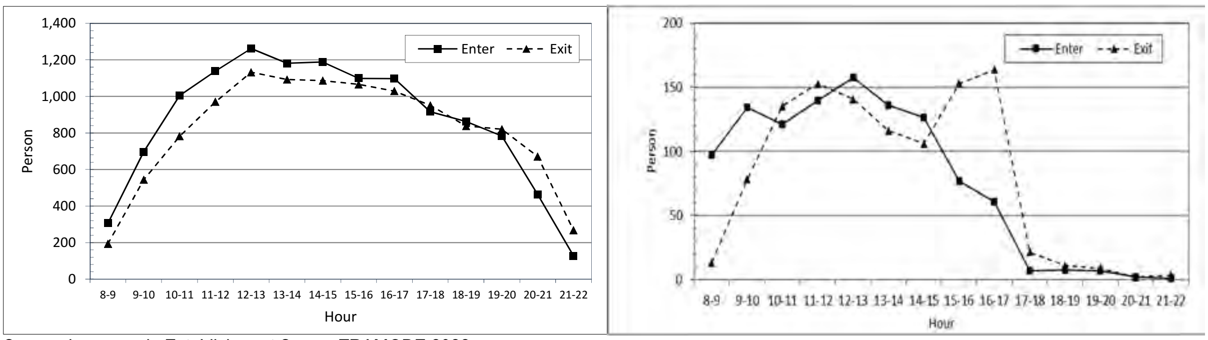
Figure 2.2.8 Distribution of Destination of Air Passenger

Despite the similar tendency of popular destinations throughout the year, some current factors are affecting the pattern of air passenger flights at the time of the survey, such as the conflict between Russia and Ukraine and the COVID-19 pandemic. In addition, the number of direct flights to/from Sarajevo is limited, and it would affect the derived demand of passengers. It may be worth considering in the future expanding the flight network of Sarajevo International Airport.

4) Trip Generation/Attraction Survey at Large-Scale Establishment

The main objective of this survey is to obtain trip generation and attraction rates for large-scale establishments (i.e., offices, shops, malls, etc.). The trip rate shall be applied for demand forecasting as an adjustment to OD matrices, including samples with a higher income level. Eventually, the data will be used for the calibration purpose of the traffic demand model.

The survey was applied at 10 establishments (office and shopping mall) within the study area, including Capital Tower, Bingo City Center, BBI Center, Alta Shopping Center, Sarajevo City Center, Grand Center, Energoinvest, Otoka Shopping Center, United Investment and Trading, and Importanne Shopping Center. Respondents are either employees, tenants, or visitors of those establishments, making up about 10% of the total daily visitors.



Source: Large-scale Establishment Survey TRAMODE 2022

Figure 2.2.9 People's Traffic at Shopping Mall (left) and Offices (right) by Hour

There is a distinct type of people traffic flow pattern at the premises of office and shopping malls: a smooth curve and the other one is concentrated at peak hours (i.e., office). Flow at the office naturally peaks during mornings and afternoons (start of work time and end of work time). Although an exceptionally large number occurs during afternoons (end work time).

5) Public Transport Corridor Survey

The Public Transport Corridor Survey was designed for passenger count, occupancy count, and operational service performance along the lines of significant demands but was not surveyed in the JICA data collection study in 2019.

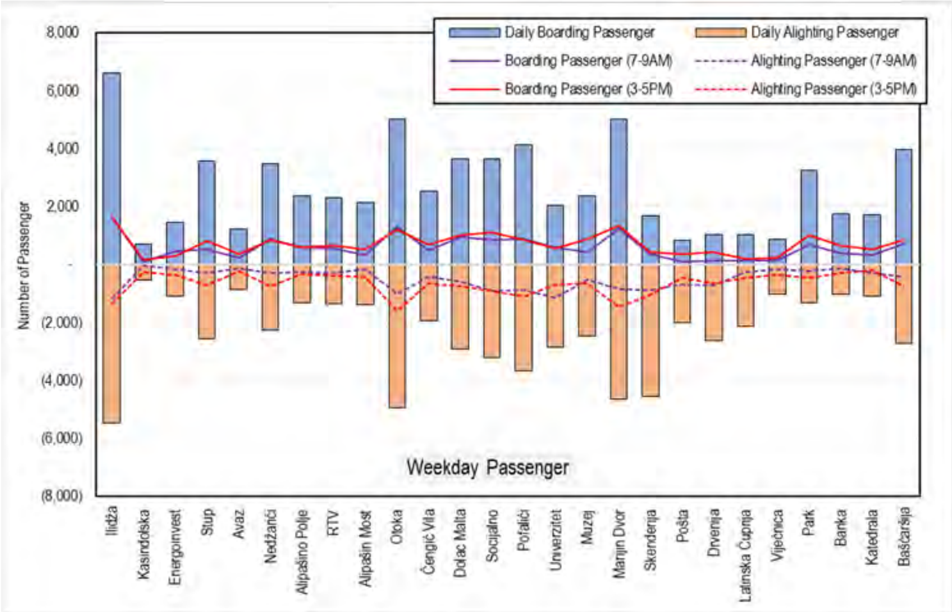
Public Transport Corridor Survey activities construct the specification below:

- This survey was applied to lines Tram 3, Bus 16B and 33, Trolleybus 102, and Trolleybus 107. These are considered the representation of urban and suburban lines and are relevant to the previous study.
- Survey was conducted across seven days and during the operational hours of the public transport service every day.
- Video camera was utilized for data collection.

While complete findings can be found in Appendix 1.4, findings of each representative mode (tram, trolleybus, and bus) are shown as follows.

Tram 3 (Ilidža – Baščaršija)

During the weekdays, the service loops over 12 times per day.



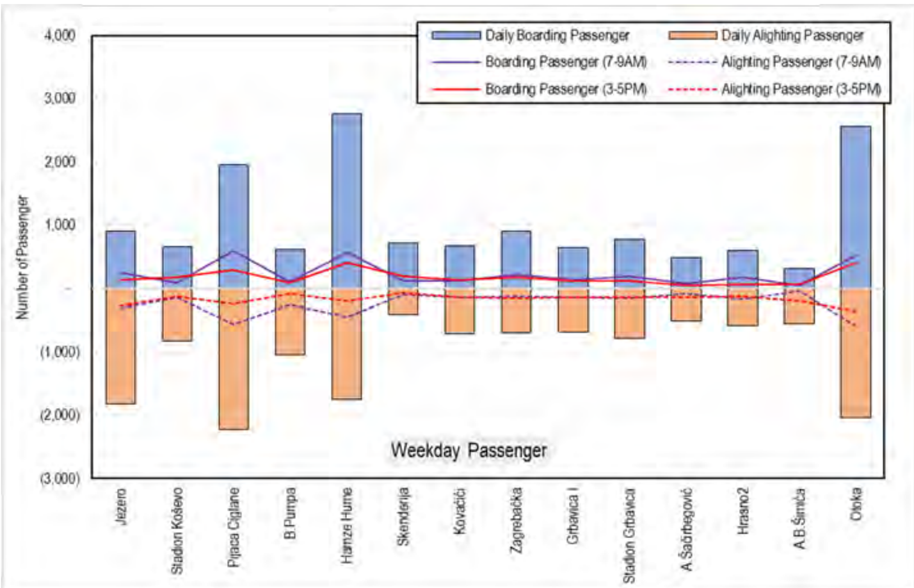
Source: Public Transport Corridor Survey

Figure 2.2.10 Number of Boarding and Alighting Passenger of Tram 3: Daily and Peak Hours on Weekday

Othe than the terminus, high corridor boarding and alighting passenger Tram 3 is between Otoka and Marjin Dvor. This may be related to those stops directly connected to the business and commercial areas. A similar tendency can be seen during the morning and afternoon peak hours.

Trolleybus 102 (Jezero – Otoka)

During the weekdays, the service loops over 13 times per day.



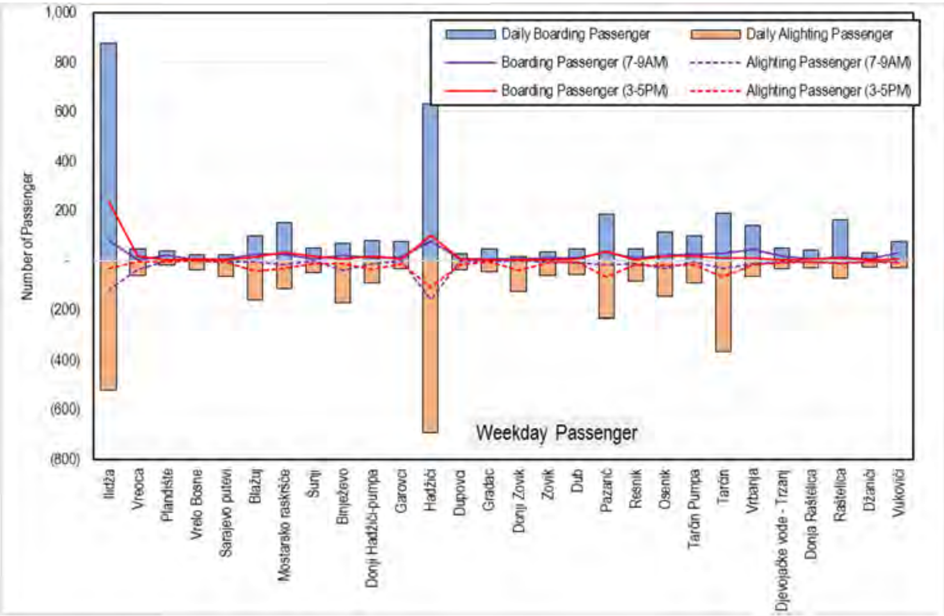
Source: Public Transport Corridor Survey

Figure 2.2.11 Number of Boarding and Alighting Passenger of Trolley 102: Daily and Peak Hours on Weekday

The highest and second highest location of boarding and alighting passengers of Trolleybus 102 is at Hamze Hume and Pijaca Ciglane, accordingly. This may be related to the fact that the stops are a big intersection/transit point for passengers. A similar tendency can be seen during morning and afternoon peak hours.

Bus 33 (Ilidža–Vukovići)

During the weekdays, the service loops over seven times per day.



Source: Public Transport Corridor Survey

Figure 2.2.12 Number of Boarding and Alighting Passenger of Bus 33: Daily and Peak Hours on Weekday

Other than the terminus, the highest dwelling time of Bus 33 is at Hadzici. This may be related to the fact that the stops are connected to shopping centers, commercial areas, and passenger transit points. There is a tendency for some stops to be skipped by the bus because, at any given time, there could be no passenger getting off or on the bus.

2.3 Challenges and Issues of Public Transport in Canton Sarajevo

Several challenges and issues of public transport can be observed as follows.

1) Geographical challenge (contour of hilly roads)

Sarajevo is a liner city in the river valley. Surrounded by hills, many residential areas in hilly places and the sharp slopes make access difficult for trams, trolleybuses, or regular buses. Instead, minibuses with small capacity but higher mobility operate in these areas to serve the transport needs with lower frequencies. However, limited flat space makes it difficult to station at a bus stop or terminal, resulting in longer access time and inconvenience for users to use minibuses. Due to geographical challenge, public feeder transport for Sarajevo now hugely relies on bus service.

Source: JICA Expert Team

Figure 2.3.1 Minibus

Source: JICA Expert Team

Figure 2.3.2 Hilly Road

2) Overlapping routes along the river (tram, trolleybus, bus, etc.)

The transport network is highly relied on the main arterial road along the river, and co-existing of tram, trolleybus and bus makes the traffic flow complex and hard to manage. Although this provides passengers with more options to select the transport mode, overlapping routes may result in low transport efficiency.

3) Limited accessibility to major points (i.e.: airport, railway station)

Current public transport lacks good intermodal connection. Passengers who would like to access major points, such as airport and railway station, usually use private car or taxi, suggesting bus and tram operators should also consider the connectivity with railway and airport to make an integrated facility or interchange for smooth transfer. Nowadays, there is an airport connection, Airport – Bentbaša line, providing the bus service to improve the accessibility.

4) Insufficient timetable operation and information provision

Level of service is highly concerned by users. Timetable, reliability and punctuality hugely dominate their willingness to use public transport or not. However, nowadays not all public transport operators in Sarajevo have a fixed timetable, and only some of the fleets are equipped with GPS where users can see the live location through mobile app.

5) Free riding

Free riding causes a big issue on revenues for operators. Despite such item is never straightforwardly calculated in any documented financial report, simple logic that involves the number of passengers and revenue would expose such a thing. One may argue that the core problem of free riding is a matter of mentality of people than a matter of public transport system itself. However, between GRAS and CENTROTRANS operators, this issue is rather more critical than the other. CENTROTRANS, as private company, relies on revenue; therefore, efforts on preventing the system from leaking are more scrutinized. In addition, CENTROTRANS does not handle the operation of multiple entrances/exits of fleets (i.e., trolleybus and tram). Therefore, controls of entering/exiting flow of passenger and fare payment are more manageable on those fleets of CENTROTRANS. Meanwhile, trolleybus and tram of GRAS would face delays if entrances and exits are not opened at once, which at the same time, does not discourage free-riding mentality.

Enforcement may reduce the cases, but eliminating free riders should be prioritized. Operators require funds to upgrade the infrastructure and fleet and maintain and improve the service, so measures for avoiding this issue is considered urgent.

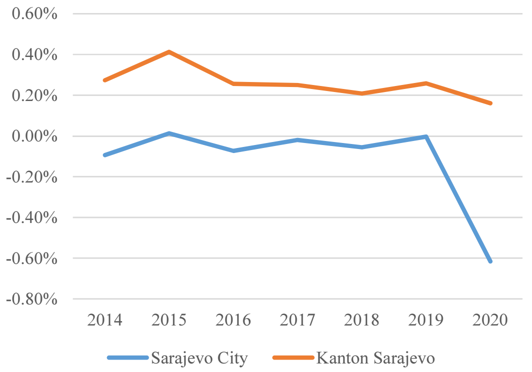
6) High number of car user

The low level of service by public transport negatively impacts users' mode selection. People are concerned about cost, convenience, safety, security, punctuality, service, etc., which discourage people from using public transport and tend to use private vehicles. Therefore, traffic congestion gets more serious. Prioritized lanes for public transport and other improvement measures are desired.

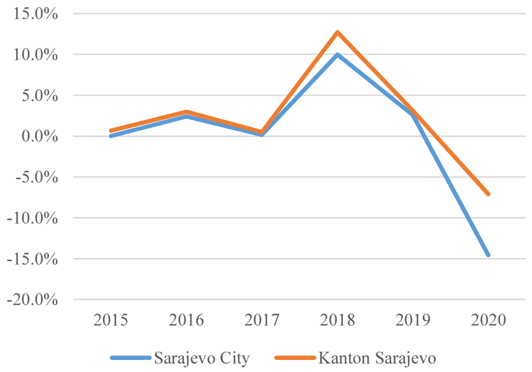
3 Travel Demand Forecast

3.1 Socioeconomic Framework

Socioeconomic data of population census in 2013 by Enumeration Area (EA) was provided from the statistics department of Canton Sarajevo. However, the individual data of population census in 2013 wasn't provided due to the privacy policy. Also, it should be noted that latest available socioeconomic data is limited since the population census is postponed due to the COVID-19 pandemic. Therefore, socioeconomic data collected in ADS is used to supplement the statistical data. The total population of Canton Sarajevo was 419,762 in 2021, of which City of Sarajevo, composed of four Municipalities (Stari Grad, Centar, Novo Sarajevo and Novi Grad) was 273,184 (65% of total). While the population growth rate between 2014 and 2020 in Canton Sarajevo was 0.26%, the growth rate in the City of Sarajevo was -0.12%. The employment growth rate also showed that a negative growth trend in City of Sarajevo is faster than other parts of Canton Sarajevo, indicating a growing migration.



Source: Statistics Bulletin, Canton Sarajevo
Figure 3.1.1 Annual Population Growth Rate in Canton Sarajevo



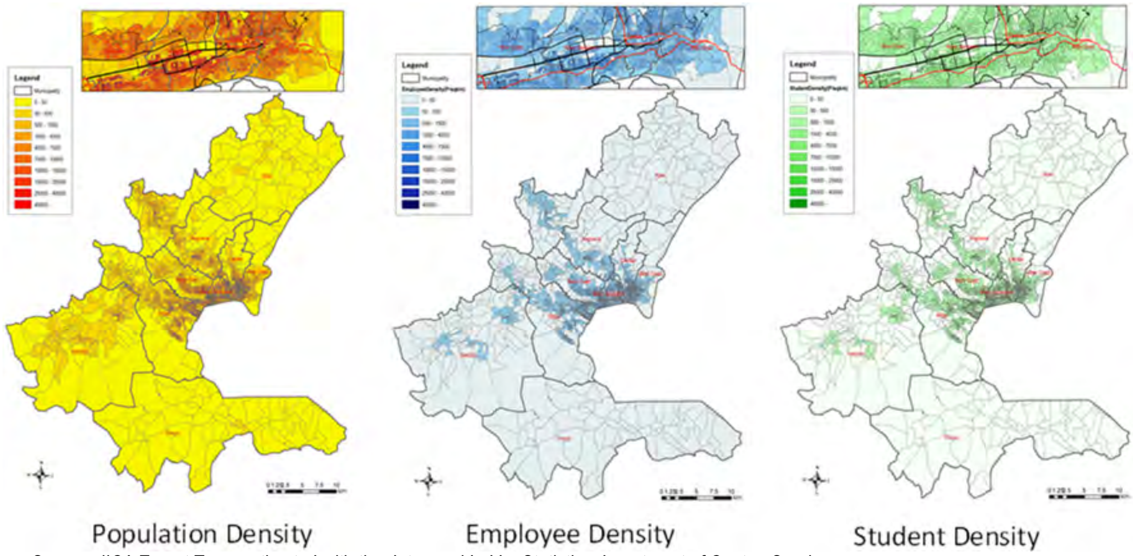
Source: Statistics Bulletin, Canton Sarajevo
Figure 3.1.2 Annual Employment Growth Rate in Canton Sarajevo

The number of worker and student by municipality in 2021 was provided by Statistics department of Canton Sarajevo. To estimate the traffic demand based on the ADS, socioeconomic data as of survey period, year 2022, is estimated considering the growth trend as below.

Table 3.1.1 Estimated Socioeconomic Data

ID	Municipality	Population ('000)		Worker ('000)		Student ('000)	
		2013	2022	2013	2022	2013	2022
1	Centar	55.2	52.4	20.2	20.0	9.3	13.6
2	Novi Grad	118.6	122.8	39.7	41.2	20.3	16.5
3	Novo Sarajevo	64.8	62.8	24.4	23.6	10.6	11.6
4	Stari Grad	37.0	33.9	12.8	12.6	6.1	6.2
5	Hadzici	23.9	24.8	7.0	8.0	4.2	3.5
6	Ilijas	19.6	20.9	4.5	6.0	3.6	3.0
7	Vogosca	26.3	29.4	8.3	9.7	4.9	4.5
8	Ilidza	66.7	71.5	20.7	21.7	12.9	10.6
9	Trnovo	1.5	1.7	0.4	0.8	0.2	0.1
Total		413.6	420.2	137.9	143.8	72.1	69.6

Source: JICA Expert Team estimated with the data provided by Statistics department of Canton Sarajevo



Source: JICA Expert Team estimated with the data provided by Statistics department of Canton Sarajevo

Figure 3.1.3 Distribution of Population, Employee and Student in 2022

3.2 Development of a Travel Demand Forecast Model

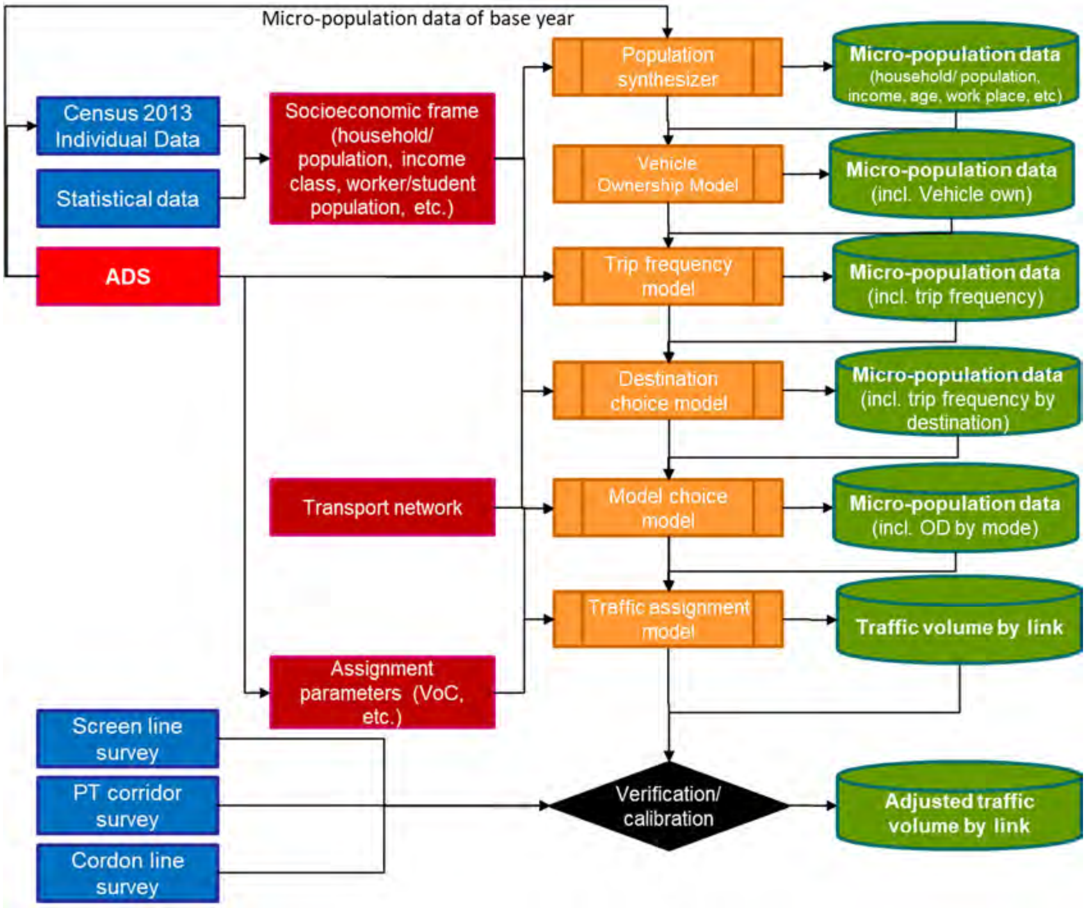
1) Outline

(a) Existing Travel Demand Forecast Model in Sarajevo

A transport model in Sarajevo was developed by SYSTRA in "the study on urban transport optimization and development of a long-term transport plan for Canton Sarajevo" (hereafter called "SYSTRA study.") In the study, a person trip survey was conducted for 2,000 Households in 2009. After the SYSTRA study, Arup conducted the TA project on transport model using VISUM software and updated the SYSTRA model. After a series of discussions with MOT and concern agencies, it was identified that the model isn't available in this study due to missing of the data. Therefore, the JICA Expert Team decided to develop the model from scratch. It should be noted that the details of this sub-chapter are described in the technical report on demand forecasting in Appendix 2.

(b) Workflow to Develop a Travel Demand Forecast Model

The travel demand forecast model was developed using a disaggregate four-step model based on the above ADS results. The flow of the travel demand forecast is shown in Figure 3.2.1.



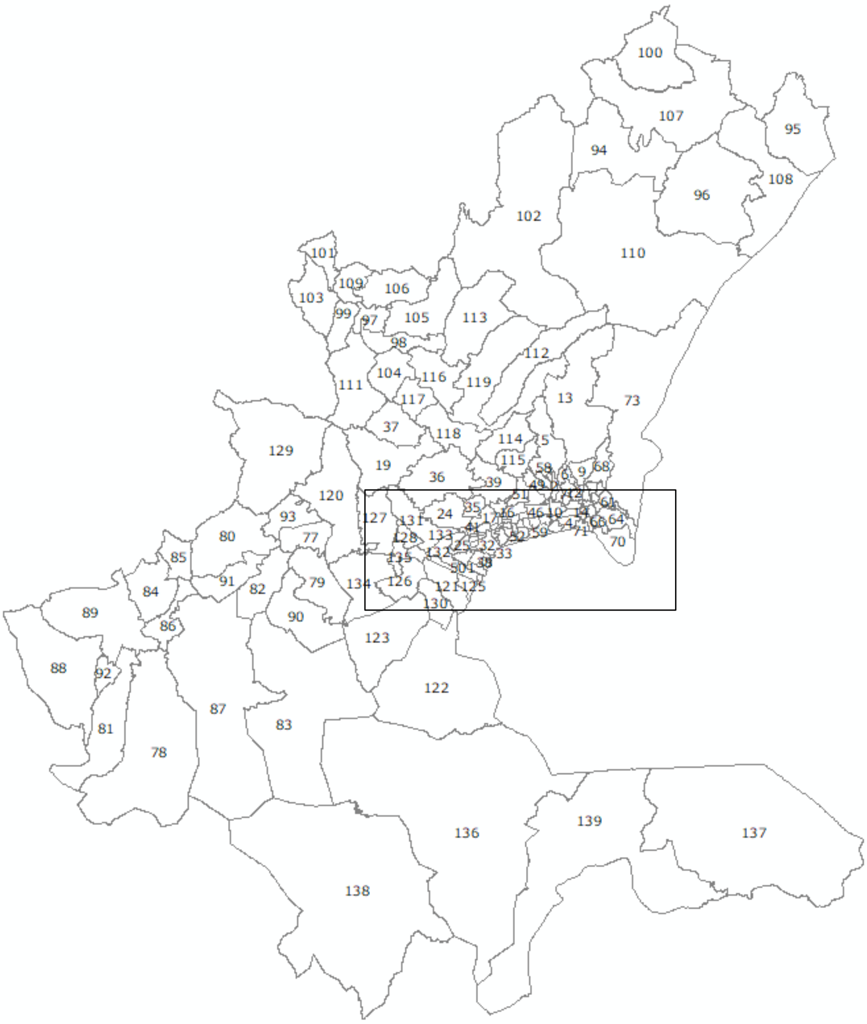
Source: JICA Expert Team

Figure 3.2.1 Flow of Travel Demand Forecast

2) Traffic Analysis Zone (TAZ)

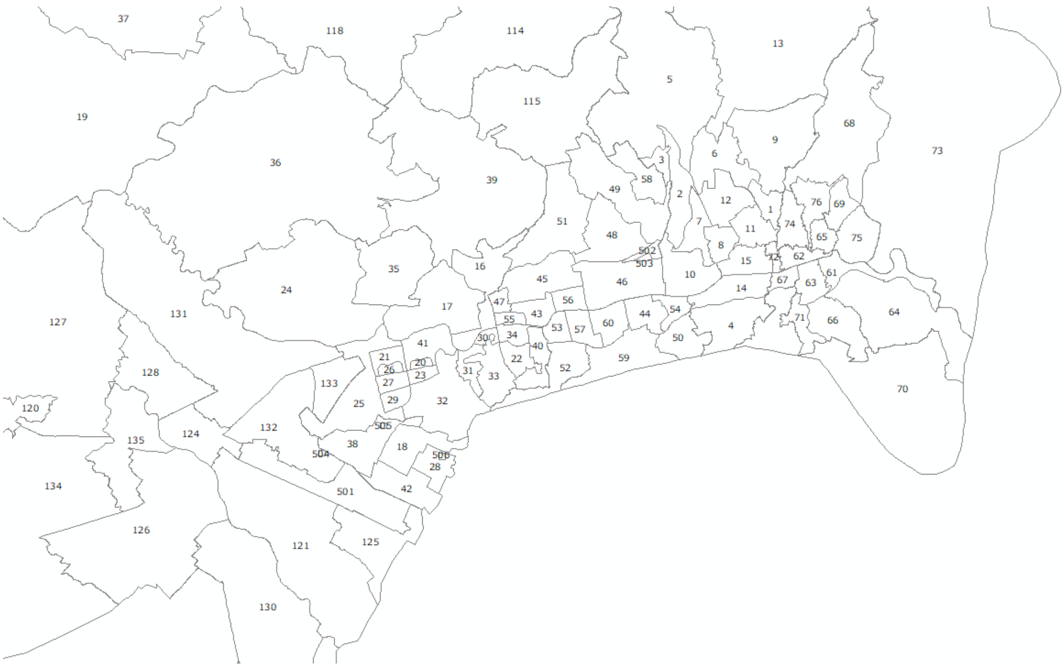
Canton Sarajevo is divided into 139 zones for traffic analysis in this study. The traffic analysis zone (TAZ) is compatible with the local community zone. Besides the 139 zones, 6 special zones are defined within the Canton Sarajevo for the trip generation points to/from outside of the Canton Sarajevo, namely, Sarajevo International Airport, Sarajevo Railway Station, Sarajevo Bus Terminal, Aerodom Bus Stop, Mojmilo II Bus Stop, and Dobrinja Bus Stop.

Large Traffic Analysis Zone (LTAZ) is also defined in this study to understand the overview of the passenger movement. LTAZ is compatible with the administrative boundary of municipalities, with a total of nine LTAZ. To understand the passenger movement to/from the outside of the Canton of Sarajevo, excluding the Canton Sarajevo is divided into 16 external zones as shown below. The external zones are decided considering the major road network to/from the Canton Sarajevo from/to each external area.



Source: JICA Expert Team

Figure 3.2.2 Traffic Analysis Zone (TAZ)



Source: JICA Expert Team

Figure 3.2.3 TAZ in Central Area

3) Transport Network

(1) Highway Network

Transport network data is required to develop the travel demand forecast model. The JICA Expert Team developed the existing highway network and public transport network with VISUM software.

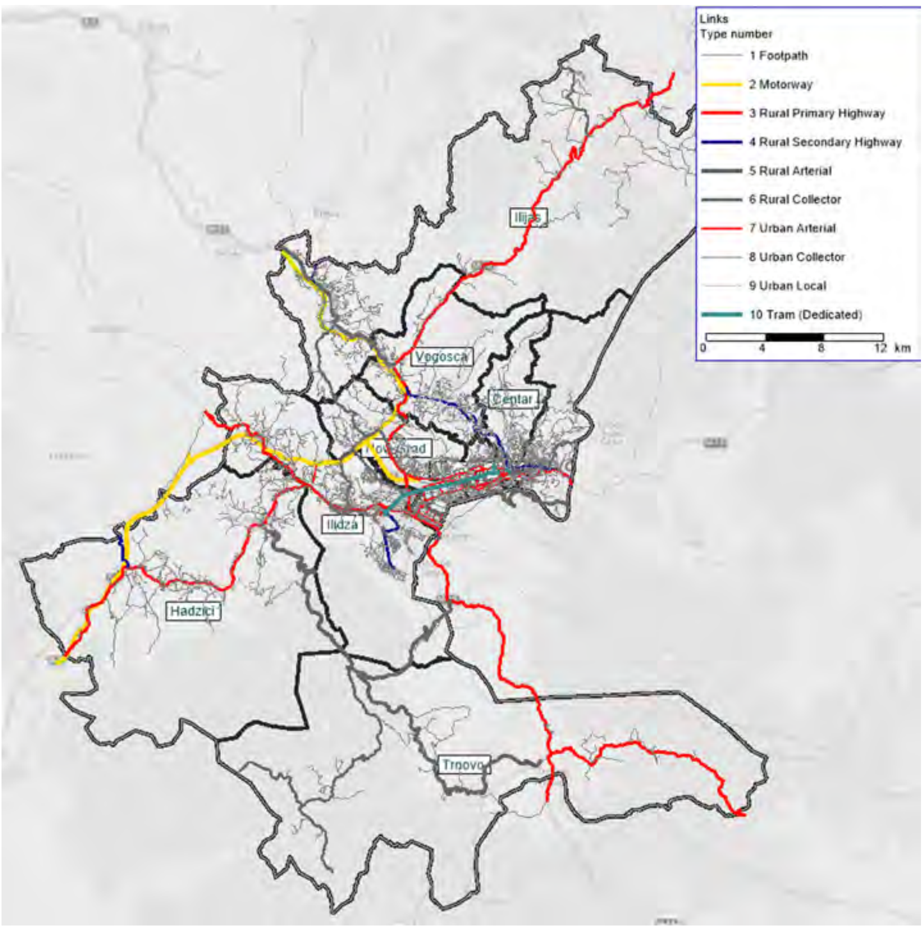
(a) Road Capacity and Free Flow Speed

The following table shows the road capacity and free flow speed (speed without congestion) by road category in this study. Road capacity and speed were decided by referencing the SYSTRA study.

Table 3.2.1 Road Capacity and Free Flow Speed

Road Category	Capacity (PCU/hour/lane)	Free Flow Speed (km/h)
1. Footpath	N/A	4
2. Motorway	2,000	110
3. Rural Primary Highway	1,800	60
4. Rural Secondary Highway	1,500	50
5. Rural Arterial	1,200	45
6. Rural Collector	600	40
7. Urban Arterial	1,000	45
8. Urban Collector	600	35
9. Urban Local	300	25

Source: JICA Expert Team based on the information in the SYSTRA study



Source: JICA Expert Team

Figure 3.2.4 Existing Road Network in Sarajevo

(b) Vehicle Category

The following table shows the vehicle category, passenger car unit (PCU) and average occupancy in this study. The PCU factor was decided with referencing the PCU factors in SYSTRA study and in the "Data collection survey on public transportation in Canton Sarajevo" (JICA, 2020). The average occupancy ratio is based on the result of Screen Line Survey (SLS).

Table 3.2.2 Vehicle Category

	Name	PCU	Average Occupancy (SLS)
1	Motorcycle	0.4	1.08
2	Passenger Car	1	1.44
3	Taxi	1	1.56
4	Pick Up	1	1.44
5	Small Truck	1	1.44
6	Medium Truck	1.5	1.16
7	Large Truck	2	1.05
8	Small Bus	1.5	8.75
9	Medium Bus	2	21.02
10	Large Bus	3.2	33.87

Source: JICA Expert Team

(2) Public Transport Network

(a) Public Bus Route and Bus Operator

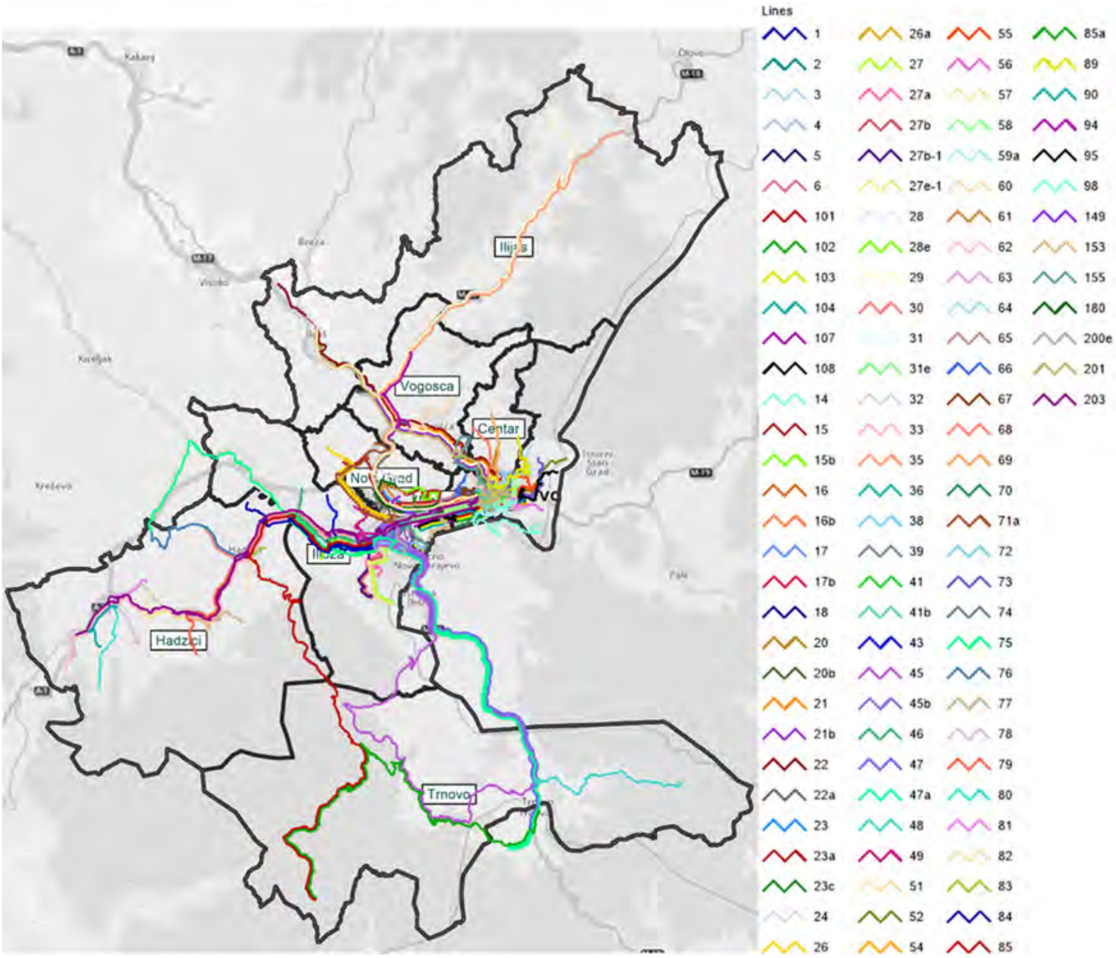
The public transport network in Sarajevo is mainly operated by two operators, i.e., GRAS and CENTROTRANS. Public bus network is developed using VISUM software, GRAS bus network is generated by the General Transit Feed Specification (GTFS) database, then integrated with CENTROTRANS network which were developed in VISUM. The current situation of the public transport network model as shown in Figure 3.2.5.

(b) GRAS

GRAS Sarajevo is the dominant provider of public transport operations and services. It provides several modes of public transport including trams, trolleybuses, buses, and minibuses. Six tram lines in Sarajevo are fully operated by GRAS with total length of 45.7 km, connecting the neighbor districts in the city center (as shown in Appendix 2).

(c) CENTROTRANS

CENTROTRANS d.d., with its fleet of more than 200 buses that meet European and world technical and operational standards, is a private bus company operator in Sarajevo. CENTROTRANS currently operates bus and minibus lines.

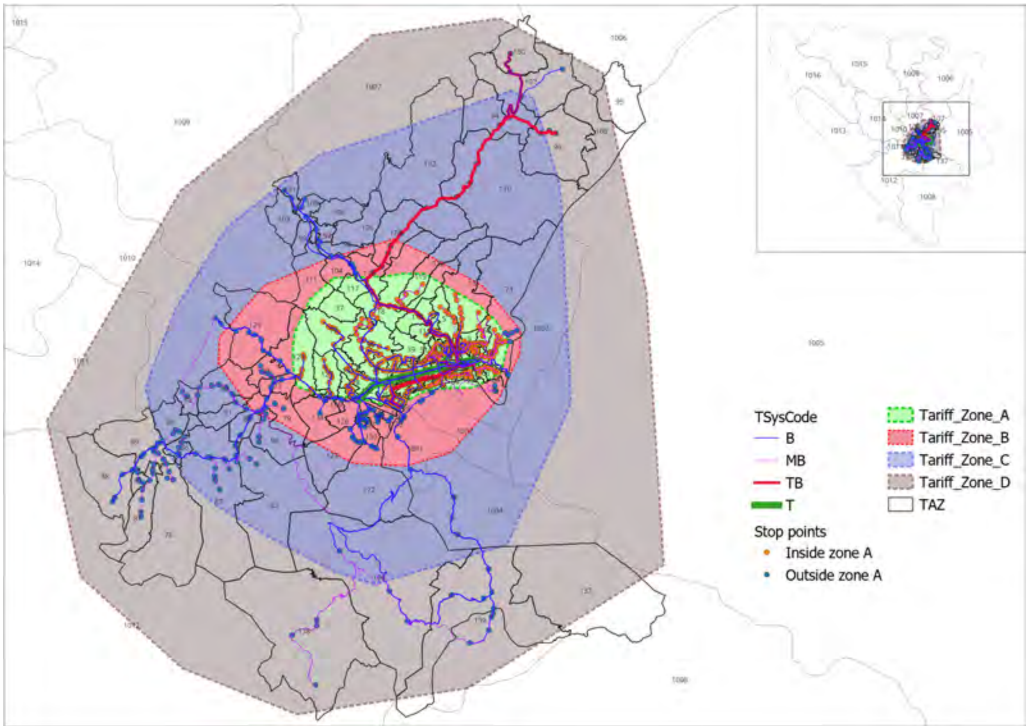


Source: JICA Expert Team

Figure 3.2.5 Public Transports Network

(d) Tariff zone

Tariff zone is divided into four, i.e., zone A, zone B, zone C, and zone D. Zone A defined the bus fare zone in the city center, and zone B, zone C, and Zone D defined the bus fare zone in the suburban area of Sarajevo. To study the bus fare in VISUM model, stops located inside zone A are defined as tariff zone type 1 while stops outside zone A are defined as tariff zone type 2.

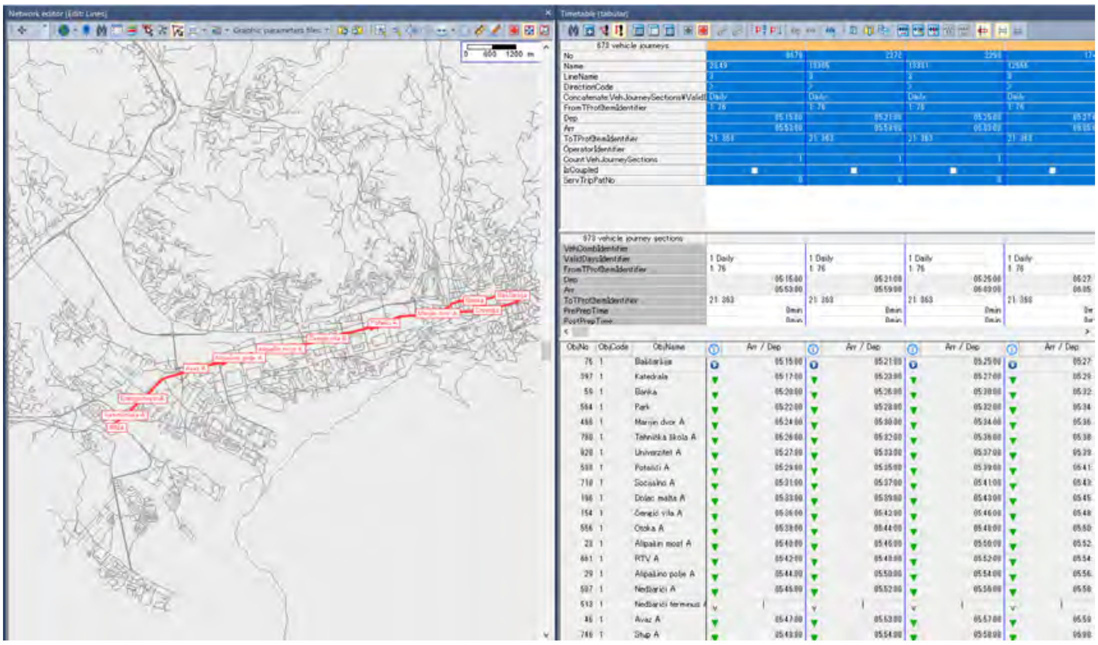


Source: JICA Expert Team

Figure 3.2.6 Tariff Zone

(e) Timetable

The existing timetable of each line route are computerized into VISUM.



Source: JICA Expert Team

Figure 3.2.7 Timetable (Tram Line 3)

4) Population Synthesis

To estimate the disaggregated travel behavior of each household and each person in the Study Area, the attributes of the synthetic population generated must match those of the general population for each TAZ. As a population synthesizer, the software PopGen, developed by Arizona State University and widely utilized for population synthesis in the

United States and other countries, was used in the Study. It utilizes typical iterative proportional fitting (IPF) to match persons and households based on their control total by TAZ.

Marginal control variables by household and personal attributes in 2022, as shown in Table 3.2.3, are estimated for each TAZ.

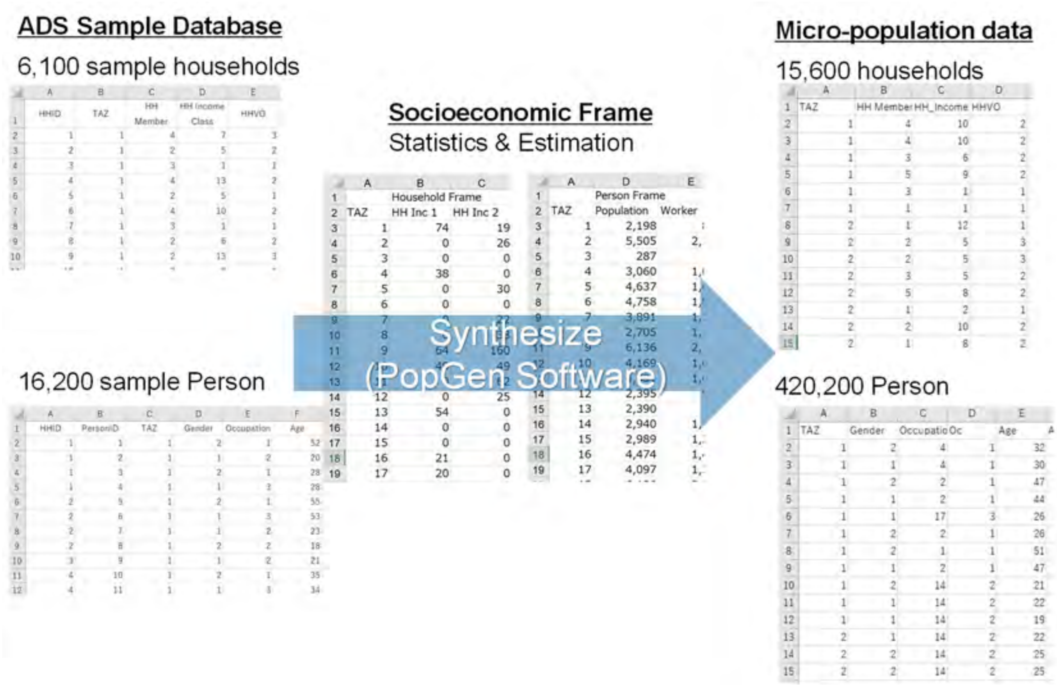
As a result, 420,000 individual data with household information were created.

Table 3.2.3 List of Control Variables of Population Synthesis Models

Type	Attribute	Category
Household	Monthly household income	1.Under 450 BAM 2.BAM 450 - BAM 749 3.BAM 750 - BAM 1,049 4.BAM 1,050 - BAM 1,349 5.BAM 1,350 - BAM 1,649 6.BAM 1,650 – BAM 1,949 7.BAM 1,950 - BAM 2,249 8.BAM 2,250 - BAM 2,549 9.BAM 2,550 - BAM 2,849 10.BAM 2,850 - BAM 3,149 11.BAM 3,150 - BAM 3,449 12.BAM 3,450 - BAM 3,749 13.Over BAM 3,750
Household	No. of household members	1.1 Person 2.2 Persons 3.3 Persons 4.4 Persons 5.5 Persons and more
Person	Gender	1.Male 2.Female
Person	Age group	1. 0-14 years 2.15- 64 years 3.65 years and more
Person	Social status	1.Worker 2.Student 3.Other

Note: BAM stands for Bosnia-Herzegovina Convertible Mark and used in KM
Source: JICA Expert Team

For household and person samples, the result of the ADS was utilized as it contains fundamental household and personal attributes, which affect the estimation of travel behavior.



Source: JICA Expert Team

Figure 3.2.8 Synthesized Person Database

5) Vehicle Ownership Model (VOM)

(1) Model Structure

A household vehicle ownership model is developed as a discrete choice model using household samples of the ADS. The model divides households into three groups: "NCO" households not owning any car, "CO1" households owning one car, and "CO2+" households owning two or more cars.

The utility function of the model is formulated with the Alternative Specific Constant (ASC) and household income as variables, as shown in Table 3.2.4. The representative values are used as variables. The choice probability of each alternative is calculated by the following formula using the utility function.

$$\mathrm{P}_i = \frac{\exp(V_i)}{\sum_i \exp\,(V_i)}$$

P_i : Probability of choosing vehicle ownership *i*
V_i : Utility function of vehicle ownership *i*

Table 3.2.4 Utility Function of Vehicle Ownership Model

Name	Specification
NCO	V_NCO = B_X1 * HHInc
CO1	V_CO1 = ASC_2 * one
CO2+	V_CO2+ = ASC_3 * one + B_X3 * HHInc

Note: B_X1, ASC_2, ASC_3, B_X3: Estimated parameters, HHInc: Household Income
Source: JICA Expert Team

Table 3.2.5 Household Monthly Income Group

ID	Group	Typical
1	under 450 BAM	225
2	BAM 450 - BAM 749	600

ID	Group	Typical
3	BAM 750 KM - BAM 1,049	900
4	BAM 1,050 KM - BAM 1,349	1,200
5	BAM 1,350 - BAM 1,649	1,500
6	BAM 1,650 - BAM 1,949	1,800
7	BAM 1,950 - BAM 2,249	2,100
8	BAM 2,250 - BAM 2,549	2,400
9	BAM 2,550 - BAM 2,849	2,700
10	BAM 2,850 - BAM 3,149	3,000
11	BAM 3,150 - BAM 3,449	3,300
12	BAM 3,450 - BAM 3,749	3,600
13	over BAM 3,750	3,900

Source: JICA Expert Team

(2) Parameter Estimation Results

The estimated parameter is shown in Table 3.2.6.

Table 3.2.6 Estimated Parameter of Vehicle Ownership Model

Name	Value	Std err	t-test	p-value
ASC_2	0	fixed		0
ASC_3	-3.47	0.124	-28.06	0
B_X1	-0.000642	1.71E-05	-37.54	0
B_X3	0.000878	4.36E-05	20.13	0

Source: JICA Expert Team

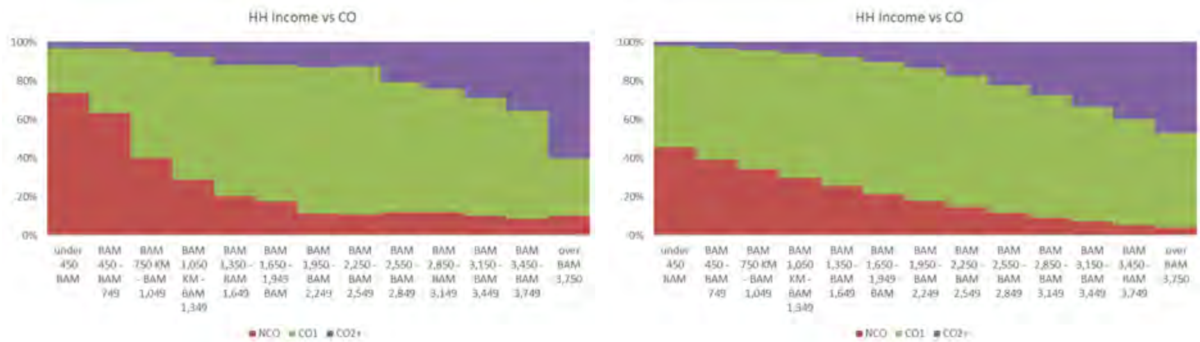
(3) Model Validation

Table 3.2.7 compares the ADS samples with the estimated number of households for each vehicle ownership group based on the developed model. The difference in the number of households is 1.9 % maximum. Figure 3.2.9 shows the ratio of vehicle ownership groups by income group.

Table 3.2.7 Comparison of ADS and Model Estimation Results

	NCO	CO1	CO2+
A. ADS Result [*1]	1,080	3,911	1,156
B. Estimated Result	1,072	3,920	1,154
Relative Error (B-A)/A	-0.7%	0.2%	-0.2%

Unit: Households, *1: Before Expansion Source: JICA Expert Team



ADS Result Estimated Result

Source: JICA Expert Team

Figure 3.2.9 Model Validation by Household Monthly Income Level

6) Trip Frequency Model (TFM)

(1) Model Structure

A trip frequency model is developed for four trip purposes using samples from the ADS. As shown in Table 3.2.8, more than 99% of the samples for all purposes fall within the range of 0 to 2 trip frequencies, so a discrete selection model that selects 0, 1, and 2 trip frequencies for each purpose was employed. Samples that made three or more trips for the same purpose were grouped into the trip frequency 2 group and used for parameter estimation. The explanatory variables for the trip frequency model were gender, occupation, and household income, as shown in Table 3.2.9. The selection probability of each option is calculated by the following formula using the utility function.

$$\mathrm{P}_i = \frac{\exp(V_i)}{\sum_i \exp\,(V_i)}$$

P_i : Probability of choosing option *i*
V_i : Utility function of option *i*

Table 3.2.8 Trip Frequency by Trip Purpose in PT Survey

Frequency	HBW	HBS	HBO	NHB	Total
0	30%	85%	66%	91%	68%
1	16%	6%	13%	8%	11%
2	53%	9%	19%	1%	21%
3	0%	0%	1%	0%	0%
4	0%	0%	1%	0%	0%
5 and more	0%	0%	0%	0%	0%

Note: HBW = home-based Work trip (home-to-work and work-to-home trip)
HBS = home-based School trip (home-to-school and school-to-home trip)
HBO = home-based Other trip (home-to-other and other-to-home trip)
NHB = non-home-based trip
Source: JICA Expert Team

Table 3.2.9 Explanatory Variables of Trip Frequency Model

Name	Specification
Wrkr	Dummy variable for workers as his/her attribute. 1 if he/she is worker.
Stdt	Dummy variable for students as his/her attribute. 1 if he/she is student.
Othr	Dummy variable for others as his/her attribute. 1 if he/she is not worker nor student.
Female	Dummy variable for female. 1 if he/she is female.
HHIncome	Household monthly income in BAM.
Age_Mid	Dummy variable for middle-aged person. 1 if he/she is 15-64 years old.

Source: JICA Expert Team

(2) Parameter Estimation Results

The utility function's structure and the parameter estimation results are shown in the following.

(a) Home-based work (HBW)

Table 3.2.10 Utility Function of Trip Frequency Model (HBW)

Alternative	Utility Function
0	V_0 = ASC_0 * one
1	V_1 = ASC_1 * one + B_Worker * Worker
2	V_2 = ASC_2 * one + B_HHInc * HHIncome + B_Worker * Worker

Source: JICA Expert Team

Table 3.2.11 Estimated Parameter of Trip Frequency Model (HBW)

Name	Value	Std err	t-test	p-value
ASC_0	0	fixed		
ASC_1	-3.12	0.0965	-32.34	0
ASC_2	-2.24	0.13	-17.19	0
B_HHInc	0.000127	4.21E-05	3.01	0
B_Worker	3.49	0.104	33.57	0

Source: JICA Expert Team

(b) Home-based school (HBS)

Table 3.2.12 Utility Function of Trip Frequency Model (HBS)

Alternative	Utility Function
0	V_0 = ASC_0 * one
1	V_1 = ASC_1 * one + B_Student * Student
2	V_2 = ASC_2 * one + B_Student * Student

Source: JICA Expert Team

Table 3.2.13 Estimated Parameter of Trip Frequency Model (HBS)

Name	Value	Std err	t-test	p-value
ASC_0	0	fixed		
ASC_1	-4.41	0.112	-39.28	0
ASC_2	-3.96	0.106	-37.57	0
B_Student	4.41	0.13	33.92	0

Source: JICA Expert Team

(c) Home-based others (HBO)

Table 3.2.14 Utility Function of Trip Frequency Model (HBO)

Alternative	Utility Function
0	V_0 = ASC_0 * one + B_Female * Female
1	V_1 = ASC_1 * one + B_Other * Other
2	V_2 = ASC_2 * one + B_Other * Other

Source: JICA Expert Team

Table 3.2.15 Estimated Parameter of Trip Frequency Model (HBO)

Name	Value	Std err	t-test	p-value
ASC_0	0	fixed		
ASC_1	-1.82	0.0676	-26.9	0
ASC_2	-1.44	0.0631	-22.79	0
B_Female	-0.232	0.0716	-3.25	0
B_Other	1.05	0.149	7.07	0

Source: JICA Expert Team

(d) Non-Home Based (NHB)

Table 3.2.16 Utility Function of Trip Frequency Model (NHB)

Alternative	Utility Function
0	V_0 = ASC_0 * one
1	V_1 = B_HHInc * HHInc
2	V_2 = B_Age_Mid * Age_Mid

Source: JICA Expert Team

Table 3.2.17 Estimated Parameter of Trip Frequency Model (NHB)

Name	Value	Std err	t-test	p-value
ASC_0	2.79	0.164	17.04	0
B_Age_Mid	-1.14	0.135	-8.43	0
B_HHInc	0.000153	6.45E-05	2.38	0.02

Source: JICA Expert Team

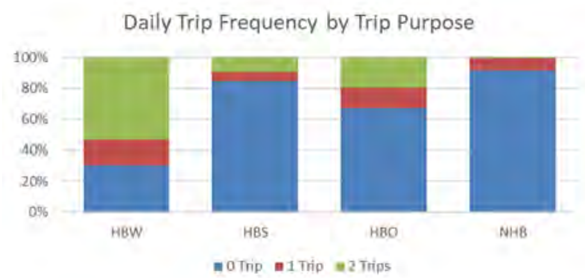
(3) Model Validation

The following table and figures show the number of persons by daily trip frequency and purpose observed in the ADS samples and developed model estimation results. It is confirmed that the distribution of trip frequency is similar.

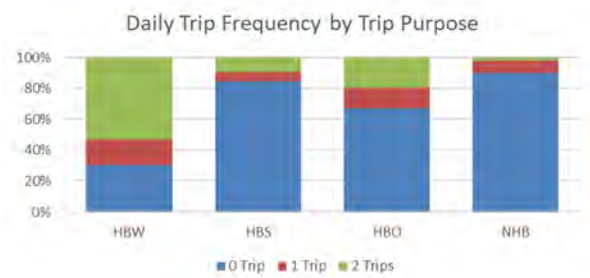
Table 3.2.18 Comparison of ADS and Model Estimation Results

Trip Purpose	HBW			HBS		
Trip Frequency	0	1	2	0	1	2
A. ADS Result *1	1,232	675	2,182	3,478	245	382
B. Estimated Result	1,232	674	2,183	3,477	244	383
Relative Error (B-A)/A	0.00%	-0.18%	0.05%	-0.02%	-0.26%	0.32%
Trip Purpose	**HBO**			**NHB**		
Trip Frequency	0	1	2	0	1	2
A. ADS Result *1	2,710	542	792	3,749	332	25
B. Estimated Result	2,711	541	791	3,697	325	85
Relative Error (B-A)/A	0.05%	-0.15%	-0.08%	-1.40%	-2.20%	239%

Unit: Households, *1: Before Expansion
Source: JICA Expert Team



ADS Result



Estimated Result

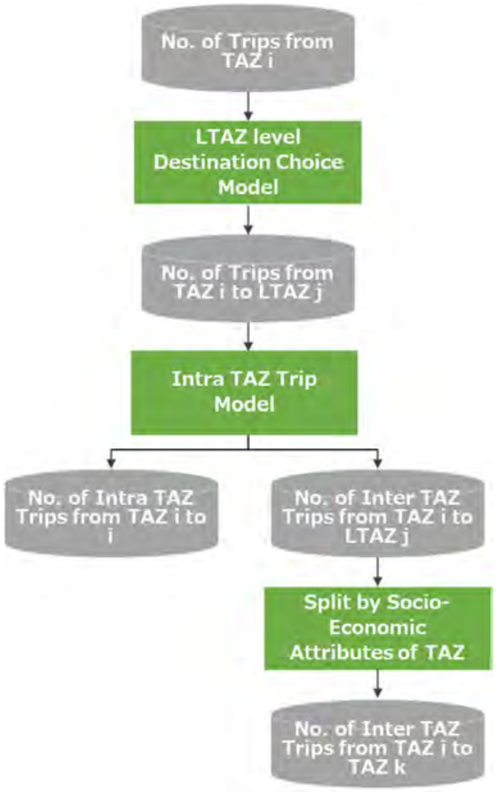
Source: JICA Expert Team

Figure 3.2.10 Model Validation by Trip Purpose

7) Destination Choice Model (DCM)

(1) Model Structure

After several trials, the three-step destination choice model, which consists of the LTAZ level destination model, Intra TAZ trip model, and split by socio-economic attributes, is shown in Figure 3.2.11. Firstly, the LTAZ level destination model, a multinomial choice model, selects a destination from nine LTAZs. Secondly, the Intra TAZ trip model, a binomial choice model, splits Intra TAZ trips and Inter TAZ trips if the LTAZ of an origin and a destination are the same. Lastly, the Inter TAZ trips are split by the socio-economic attributes of TAZ.



Source: JICA Expert Team

Figure 3.2.11 Flow of Destination Choice Model

(2) Parameter Estimation Results (LTAZ Destination Choice)

The utility functions and parameter estimation results for the LTAZ destination choice model by trip purpose are described in the following pages.

Table 3.2.19 Explanatory Variables of LTAZ Destination Choice Model

Name	Specification
Wrk_WrkP_X	Number of workers at workplace in destination alternative LTAZ X.
Std_X	Number of students in destination alternative LTAZ X.
ImpX	Average impedance km between origin LTAZ and destination alternative LTAZ X.
LnImpX	Average natural log of impedance km between origin LTAZ and destination alternative LTAZ X.

Source: JICA Expert Team

Table 3.2.20 Utility Function of LTAZ Destination Choice Model for HBW

Alternative	Utility Function
LTAZ01	V_01 = B_Imp * Imp1 + B_Wrkr * Wrk_WrkP_1
LTAZ02	V_02 = B_Imp * Imp2 + B_Wrkr * Wrk_WrkP_2
LTAZ03	V_03 = B_Imp * Imp3 + B_Wrkr * Wrk_WrkP_3
LTAZ04	V_04 = B_Imp * Imp4 + B_Wrkr * Wrk_WrkP_4
LTAZ05	V_05 = B_Imp * Imp5 + B_Wrkr * Wrk_WrkP_5
LTAZ06	V_06 = B_Imp * Imp6 + B_Wrkr * Wrk_WrkP_6
LTAZ07	V_07 = B_Imp * Imp7 + B_Wrkr * Wrk_WrkP_7
LTAZ08	V_08 = B_Imp * Imp8 + B_Wrkr * Wrk_WrkP_8
LTAZ09	V_09 = B_Imp * Imp9 + B_Wrkr * Wrk_WrkP_9

Source: JICA Expert Team

Table 3.2.21 Utility Function of LTAZ Destination Choice Model for HBS

Alternative	Utility Function
LTAZ01	V_01 = B_LnImp * LnImp1 + B_Std * Std_1
LTAZ02	V_02 = B_LnImp * LnImp2 + B_Std * Std_2
LTAZ03	V_03 = B_LnImp * LnImp3 + B_Std * Std_3
LTAZ04	V_04 = B_LnImp * LnImp4 + B_Std * Std_4
LTAZ05	V_05 = B_LnImp * LnImp5 + B_Std * Std_5
LTAZ06	V_06 = B_LnImp * LnImp6 + B_Std * Std_6
LTAZ07	V_07 = B_LnImp * LnImp7 + B_Std * Std_7
LTAZ08	V_08 = B_LnImp * LnImp8 + B_Std * Std_8
LTAZ09	V_09 = B_LnImp * LnImp9 + B_Std * Std_9

Source: JICA Expert Team

Table 3.2.22 Utility Function of LTAZ Destination Choice Model for HBO

Alternative	Utility Function
LTAZ01	V_01 = B_Imp * Imp1 + B_Wrkr * Wrk_WrkP_1
LTAZ02	V_02 = B_Imp * Imp2 + B_Wrkr * Wrk_WrkP_2
LTAZ03	V_03 = B_Imp * Imp3 + B_Wrkr * Wrk_WrkP_3
LTAZ04	V_04 = B_Imp * Imp4 + B_Wrkr * Wrk_WrkP_4
LTAZ05	V_05 = B_Imp * Imp5 + B_Wrkr * Wrk_WrkP_5
LTAZ06	V_06 = B_Imp * Imp6 + B_Wrkr * Wrk_WrkP_6
LTAZ07	V_07 = B_Imp * Imp7 + B_Wrkr * Wrk_WrkP_7
LTAZ08	V_08 = B_Imp * Imp8 + B_Wrkr * Wrk_WrkP_8
LTAZ09	V_09 = B_Imp * Imp9 + B_Wrkr * Wrk_WrkP_9

Source: JICA Expert Team

Table 3.2.23 Utility Function of LTAZ Destination Choice Model for NHB

Alternative	Utility Function
LTAZ01	V_01 = B_LnImp * LnImp1 + B_Wrkr * Wrk_WrkP_1
LTAZ02	V_02 = B_LnImp * LnImp2 + B_Wrkr * Wrk_WrkP_2
LTAZ03	V_03 = B_LnImp * LnImp3 + B_Wrkr * Wrk_WrkP_3
LTAZ04	V_04 = B_LnImp * LnImp4 + B_Wrkr * Wrk_WrkP_4
LTAZ05	V_05 = B_LnImp * LnImp5 + B_Wrkr * Wrk_WrkP_5
LTAZ06	V_06 = B_LnImp * LnImp6 + B_Wrkr * Wrk_WrkP_6
LTAZ07	V_07 = B_LnImp * LnImp7 + B_Wrkr * Wrk_WrkP_7
LTAZ08	V_08 = B_LnImp * LnImp8 + B_Wrkr * Wrk_WrkP_8
LTAZ09	V_09 = B_LnImp * LnImp9 + B_Wrkr * Wrk_WrkP_9

Source: JICA Expert Team

Table 3.2.24 Estimated Parameters of LTAZ Destination Choice Model

Model	Name	Value	Std err	t-test	p-value
HBW	B_Imp	-0.131	0.0039	-33.55	0
	B_Wrkr	4.79E-05	1.76E-06	27.27	0
HBS	B_LnImp	-1.51	0.0662	-22.74	0
	B_Std	2.42E-05	9.39E-06	2.58	0.01
HBO	B_Imp	-0.157	0.00664	-23.65	0
	B_Wrkr	4.19E-05	2.75E-06	15.22	0
NHB	B_LnImp	-1.25	0.118	-10.6	0
	B_Wrkr	5.53E-05	7.48E-06	7.39	0

Source: JICA Expert Team

(3) Parameter Estimation Results (Intra TAZ Destination Choice)

The utility functions and the parameter estimation results for the Intra TAZ destination choice model are described in the following pages.

Table 3.2.25 Explanatory Variables of Intra TAZ Destination Choice Model

Name	Specification
HBW	Dummy variable for Home-based Work (HBW) trip. 1 if the trip purpose is HBW.
HTS	Dummy variable for Home-based School (HBS) trip. 1 if the trip purpose is HBS.

Source: JICA Expert Team

Table 3.2.26 Utility Function of Intra TAZ Destination Choice Model

Alternative	Utility Function
InterTAZ	V_0 = ASC_0 * one + B_HBS * HBS
IntraTAZ	V_1 =ASC_1 * one + B_HBW * HBW

Source: JICA Expert Team

Table 3.2.27 Estimated Parameter of Intra TAZ Destination Choice Model

Name	Value	Std err	t-test	p-value
ASC_0	2.63	0.0772	34.14	0
ASC_1	0	fixed		
B_HBS	0.657	0.184	3.56	0
B_HBW	-0.273	0.1	-2.73	0.01

Source: JICA Expert Team

(4) Split by Socio-economic Attributes of TAZ

Trips of which destination LTAZ is not the same as the origin LTAZ and of which destination LTAZ is same as origin LTAZ but split into Inter TAZ trip were split by socio-economic attributes of TAZ. The socio-economic attributes are used as an explanatory variable of the LTAZ destination choice model.

8) Modal Choice Model (MCM)

(1) Model Structure

After several trials, the MCM was developed with the Revealed Preference (RP) data, actual modal choice data, collected in the ADS. Considering the available transportation mode in Sarajevo, a three-item choice model was employed, namely non-motorized transport (NMT), private vehicle (PV), and public transport (PuT). Model parameters for HBW and HBS trips were estimated separately for households with car ownership (HHVO=2,3) and without car ownership (HHVO=1). The explanatory variables of the model are the total travel time and total travel cost of each mode, as well as constants for each choice. PuT trip will be divided into tram, bus, and trolleybus users through the next assignment process.

Table 3.2.28 Utility Functions of Modal Choice Model

Alternative	Utility Function
A1_NMT	V1 = ASC_NMT * one + B_TIME * T_NMT + B_COST * C_NMT
A2_PV	V2 = ASC_PV * one + B_TIME * T_Car + B_COST * C_Car
A3_PuT	V3 = ASC_PuT * one + B_TIME * T_PuT + B_COST * C_PuT

Source: JICA Expert Team

Table 3.2.29 Explanatory Variables for Modal Choice Model

Name	Specification
T_X	Total travel time in minutes when travelling by travel mode X
C_X	Total travel cost in BAM when travelling by travel mode X

Source: JICA Expert Team

(2) Parameter Estimation Results

The parameter estimation results by trip purpose by vehicle ownership are described in the following pages.

Table 3.2.30 Estimated Parameters for Modal Choice Model

HBW HHVO=1

Name	Value	Std err	t-test	p-value
ASC_Car	-1.55	0.087	-17.87	0
ASC_NMT	-0.511	0.0934	-5.47	0
ASC_PuT	0	fixed		
B_COST	-0.443	0.0445	-9.97	0
B_TIME	-0.049	0.00252	-19.48	0

HBW HHVO=2,3

Name	Value	Std err	t-test	p-value
ASC_Car	0	fixed		
ASC_NMT	-0.735	0.14	-5.25	0
ASC_PuT	0	fixed		
B_COST	-0.474	0.0678	-7	0
B_TIME	-0.0465	0.00112	-41.61	0

HBS HHVO=1

Name	Value	Std err	t-test	p-value
ASC_Car	-4.18	0.191	-21.84	0
ASC_NMT	0	fixed		
ASC_PuT	0	fixed		
B_COST	-0.666	0.0852	-7.81	0
B_TIME	-0.0569	0.00391	-14.56	0

HBS HHVO=2,3

Name	Value	Std err	t-test	p-value
ASC_Car	-2.62	0.158	-16.62	0
ASC_NMT	0	fixed		
ASC_PuT	0.276	0.0906	3.04	0
B_COST	-0.589	0.0432	-13.63	0
B_TIME	-0.0652	0.00267	-24.44	0

HBO HHVO=1,2,3

Name	Value	Std err	t-test	p-value
ASC_Car	1.34	0.0296	45.38	0
ASC_NMT	0	fixed		
ASC_PuT	0	fixed		
B_COST	-0.0904	0.0202	-4.48	0
B_TIME	-0.00501	0.000534	-9.38	0

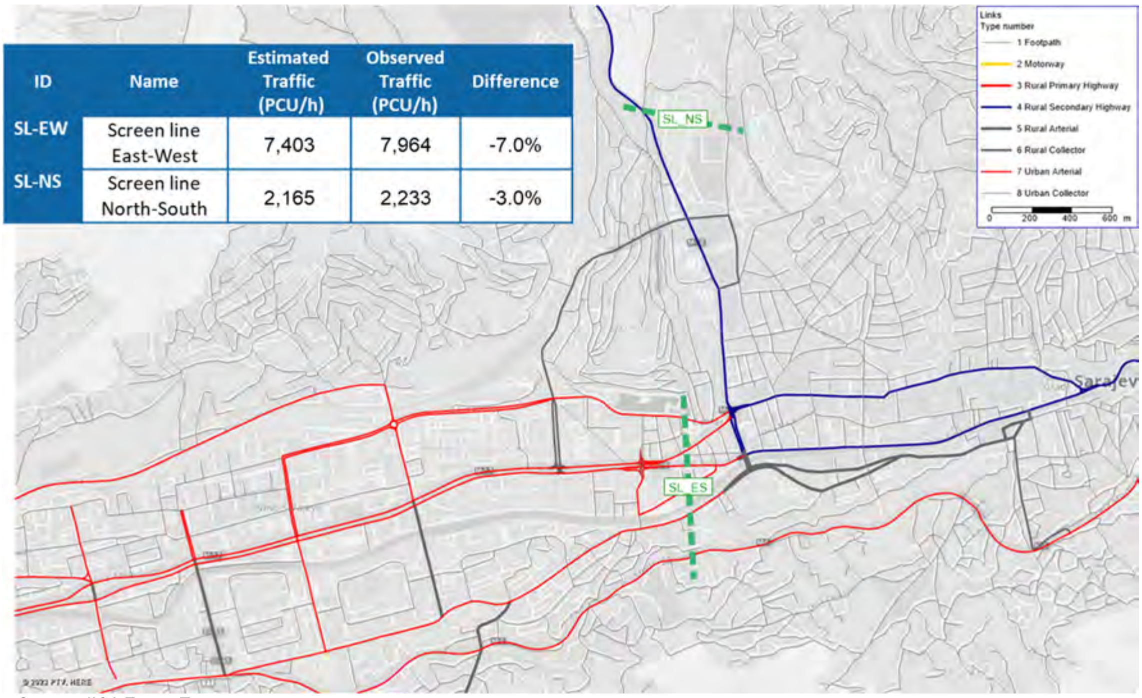
NHB HHVO=1,2,3

Name	Value	Std err	t-test	p-value
ASC_Car	1.25	0.0822	15.19	0
ASC_NMT	0	fixed		
ASC_PuT	0	fixed		
B_COST	-0.339	0.0545	-6.22	0
B_TIME	-0.0183	0.00202	-9.05	0

Source: JICA Expert Team

9) Validation and Calibration

The screen line survey results validated the estimated traffic volume of private vehicles. As shown in the table in the figure below, the difference between the estimated traffic volume and observed traffic volume in AM Peak Hour is less than 7%, and the whole demand forecast model has been validated.



ID	Name	Estimated Traffic (PCU/h)	Observed Traffic (PCU/h)	Difference
SL-EW	Screen line East-West	7,403	7,964	-7.0%
SL-NS	Screen line North-South	2,165	2,233	-3.0%

Source: JICA Expert Team

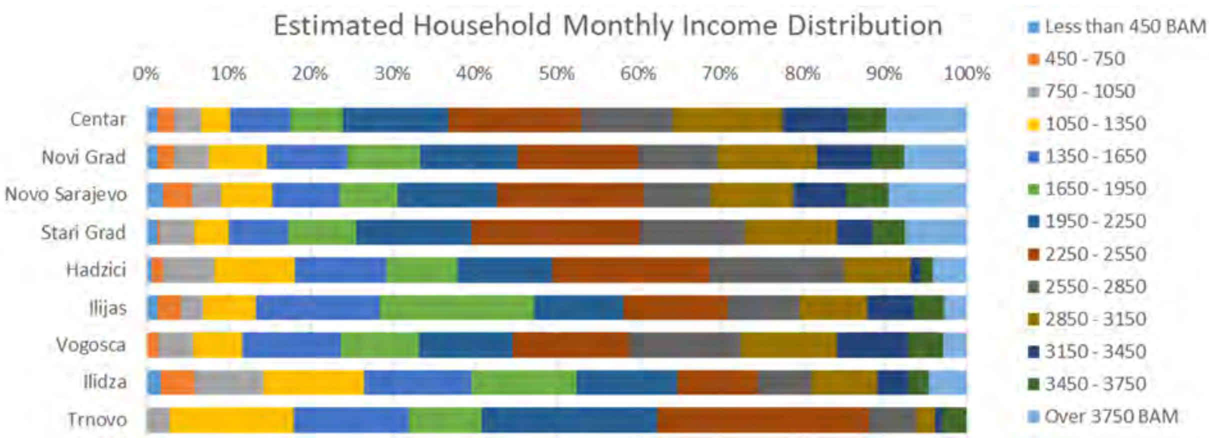
Figure 3.2.12 Mode Share Comparison

3.3 Demand Forecasting

The existing traffic demand is estimated with the abovementioned travel demand forecast model. This sub-chapter describes the result of traffic demand estimation.

1) Household Income Distribution

The following figure shows the distribution of household income by municipality based on the synthesized population data. As shown, the share of high-income households in the central area are more extensive than in suburban municipalities.



Source: JICA Expert Team

Figure 3.3.1 Estimated Household Monthly Income Distribution by Municipality

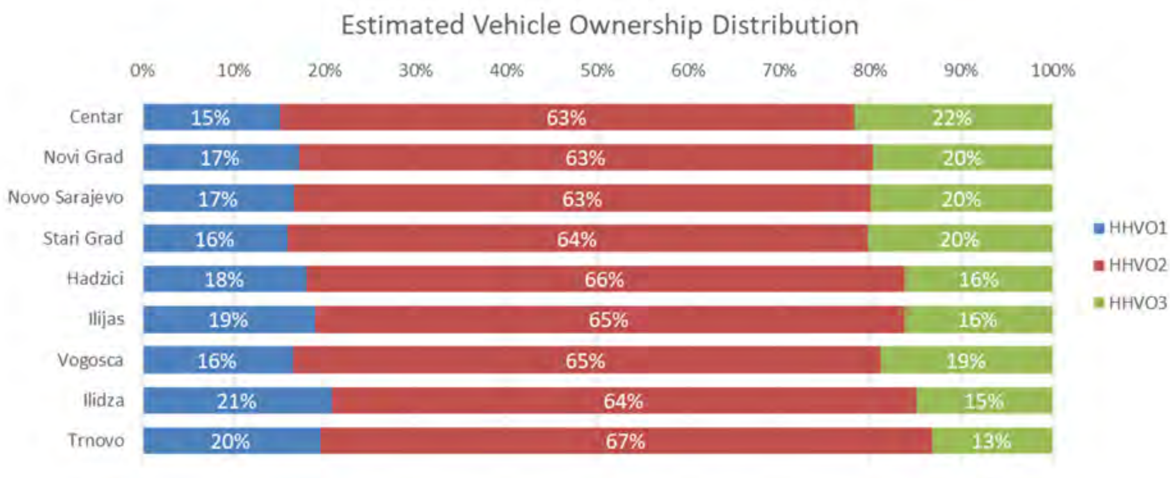
2) Vehicle Ownership Estimation

Vehicle ownership is estimated with the abovementioned vehicle ownership model (VOM) and household income distribution by TAZ. It is estimated that among 124,000 households, 83% of all households own one or more cars.

Table 3.3.1 Estimated Vehicle Ownership

HHVO Code	Type	'000 Household	'000 Population
HHVO1	Households not owning any car	26	72
HHVO2	Households owning one car	96	268
HHVO3	Households owning two or more cars	28	80
	Total	151	420

Source: JICA Expert Team



Source: JICA Expert Team

Figure 3.3.2 Estimated Vehicle Ownership by Municipality

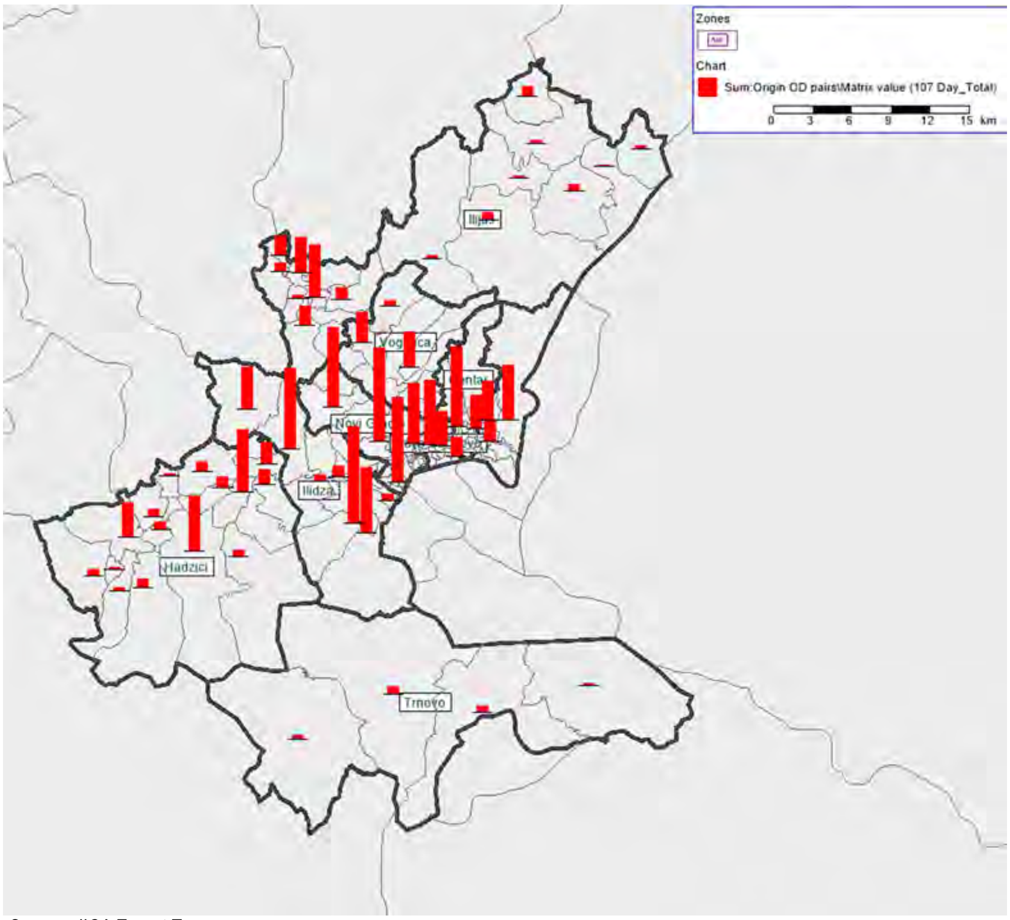
3) Trip Estimation

The following table shows the estimated total number of daily trips by purpose in Canton of Sarajevo. The highest is HBW trip, followed by HBO, HBS, and NHB. In total, 736,000 trips are generated from Canton of Sarajevo, meaning the gross trip rate is 1.75 trips per day per person. Trips are generated mainly from Novo Sarajevo, Novi Grad, Ilidza, and Stari Grad.

Table 3.3.2 Estimated Daily Trip by Purpose

Purpose	000 Trip/day	Share
HBW	293	40%
HBS	98	13%
HBO	288	39%
NHB	57	8%
Total	**736**	**100%**

Source: JICA Expert Team

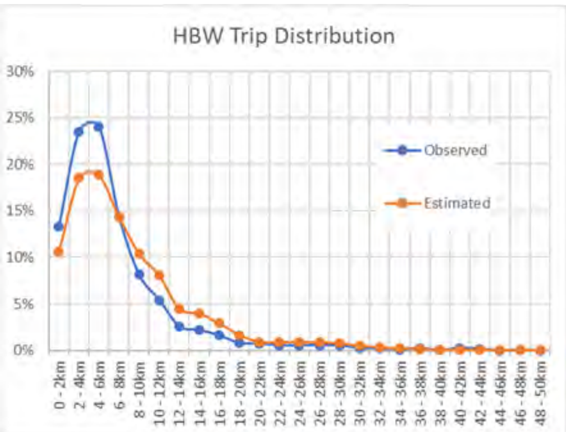


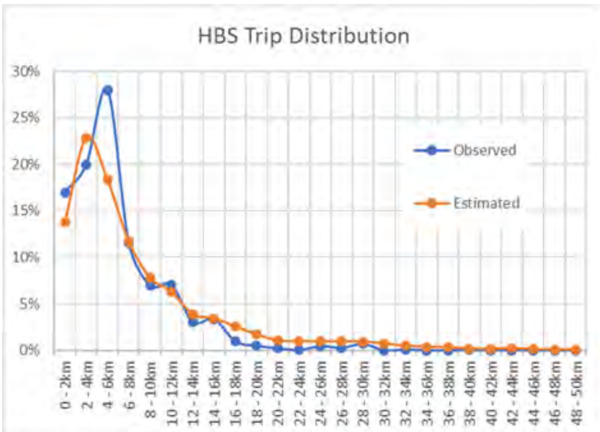
Source: JICA Expert Team

Figure 3.3.3 Estimated Trip Generation by TAZ

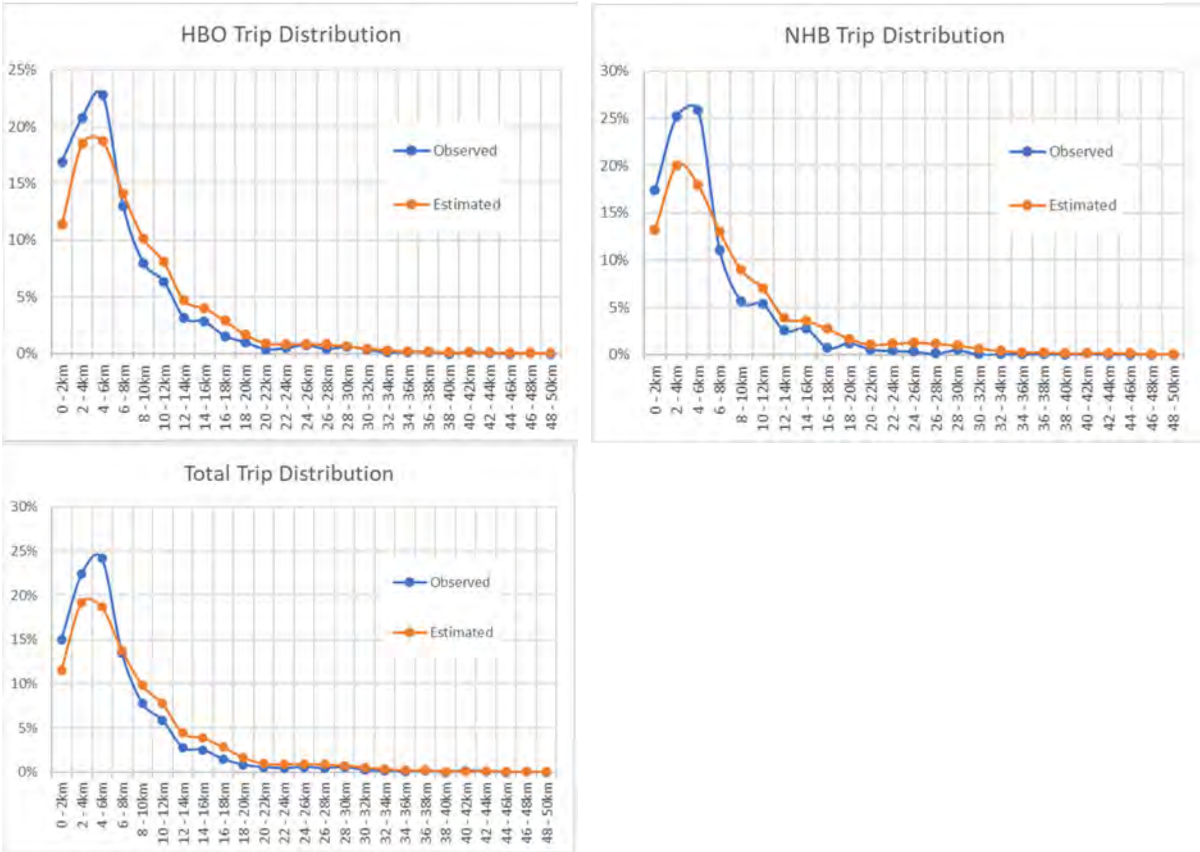
4) Trip Destination Estimation

The following figures show the estimated/observed distribution of trip length by trip purpose. The median, or 50th percentile, of total trips is estimated at 4.08 km, excluding intra-TAZ trips[5].





[5] The demand forecast model assumes that all trips within a TAZ originate from the zone centroid (one point), and travel distance within the TAZ cannot be estimated. Therefore, intra-TAZ trips were excluded.



Source: JICA Expert Team

Figure 3.3.4 Daily OD by LTAZ for All Purposes

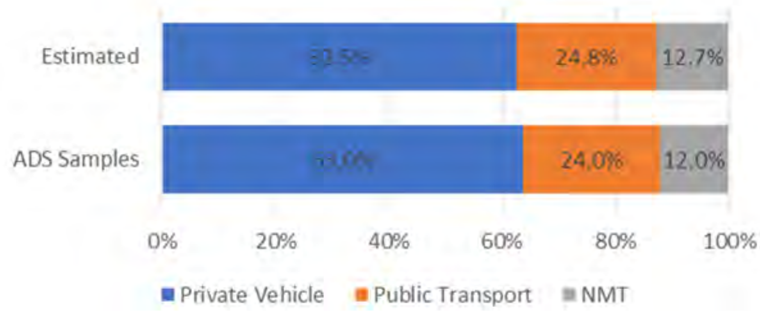
The following figure shows the estimated LTAZ desired line. It should be noted that the centroid of each LTAZ means the geographical center, not the center of the trip generation point. Also, it can't compare equally since the size and shape of each TAZ is unique.

Source: JICA Expert Team

Figure 3.3.5 Daily OD by LTAZ for Base Year

5) Modal Share Estimation

The following figure shows the estimated modal share in Canton of Sarajevo in AM Peak Hour and observed modal share in ADS sample. The modal share of public transport in all trips is estimated at 24.8%.



Source: JICA Expert Team

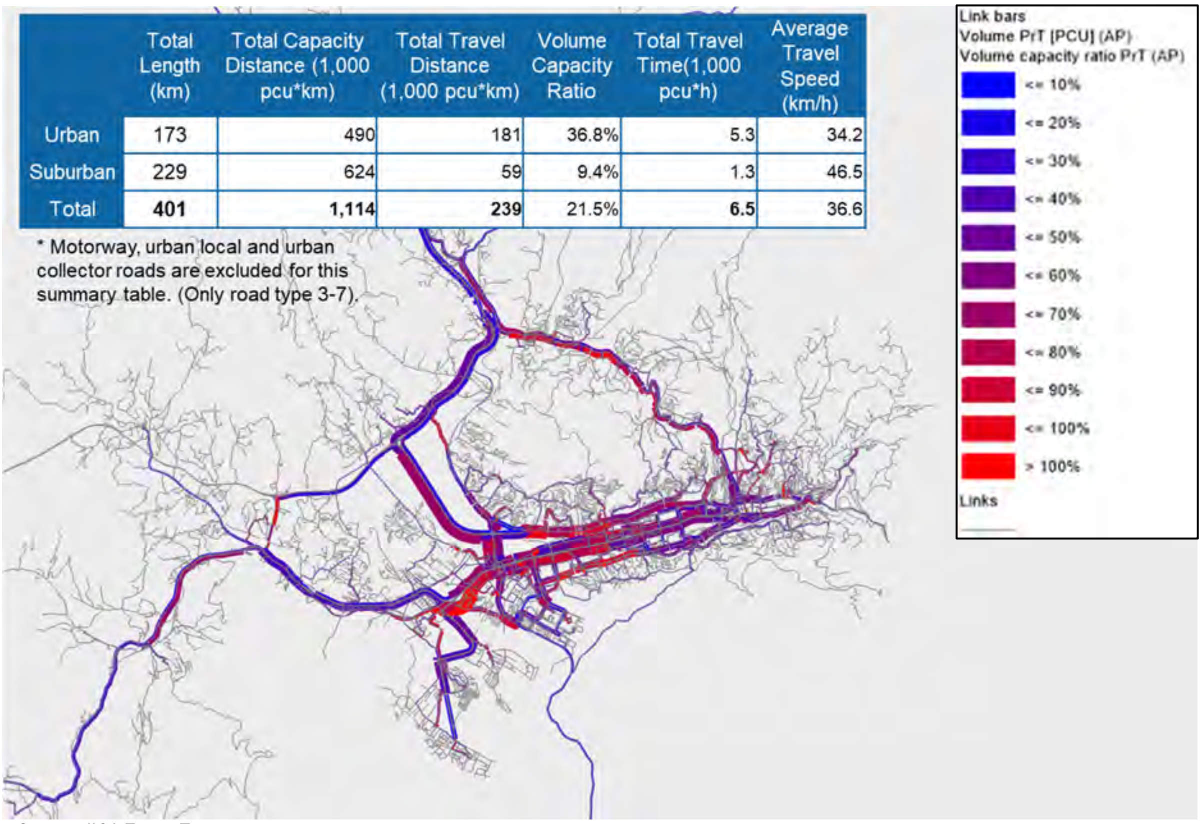
Figure 3.3.6 Mode Share Comparison

6) Traffic Demand Forecasting

The following figures show the assignment results for private vehicles and public transport. The table in Figure 3.3.8 describes the performance index of the road network in AM Peak Hour in the study area. “Urban” in the table represents road links within the urban area in the urban plan. The estimated V/C (volume/capacity) ratio in the urban area is 36.8%, and the suburban area is 9.4%. Comparing these V/Cs indicates that the congestion is severe in urban areas.

Source: JICA Expert Team

Figure 3.3.7 Assignment Results for Private Vehicle in the AM Peak Hour (7–8 AM)



	Total Length (km)	Total Capacity Distance (1,000 pcu*km)	Total Travel Distance (1,000 pcu*km)	Volume Capacity Ratio	Total Travel Time(1,000 pcu*h)	Average Travel Speed (km/h)
Urban	173	490	181	36.8%	5.3	34.2
Suburban	229	624	59	9.4%	1.3	46.5
Total	401	1,114	239	21.5%	6.5	36.6

Source: JICA Expert Team

Figure 3.3.8 Assignment Results for Private Vehicle in AM Peak Hour (V/C Ratio)

Source: JICA Expert Team

Figure 3.3.9 Assignment Results for Public Transport Passenger in AM Peak Hour (7–8 AM)

3.4 Database Handover

Upon completion of this project, the database has been shared with the counterpart. Contents of the database are the prime data, which is collected and produced throughout the project period. The majority of the tabular-style data is provided in the format of

Microsoft Excel or Microsoft Access, formats and other files to be opened by the specific softwaredepending on the used. Below is the list of data to hand over. Terms of reference of surveys conducted are also given to the counterpart for better understanding and knowledge transferability. After the Project, professors from the University of Sarajevo will take over the use and maintenance of the data and models.

Table 3.4.1 Database Handover

Item	Data Title	Data Remarks	Data Format
Screenline Survey	• Terms of reference • Survey form • Database	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Traffic count and occupancy results	• PDF • PDF • Excel
Cordon Line Survey (Bus)	• Terms of reference • Survey form • Database	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Bus passenger interview and occupancy results	• PDF • PDF • Excel
Cordon Line Survey (Airport)	• Terms of reference • Survey form • Database	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Air passenger interview and occupancy results	• PDF • PDF • Excel
Cordon Line Survey (Road)	• Terms of reference • Survey form • Database	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Road user interview and occupancy results	• PDF • PDF • Excel
Cordon Line Survey (Railway)	• Terms of reference • Survey form • Database	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Railway user interview and occupancy results	• PDF • PDF • Excel
Public Transport Corridor Survey	• Terms of reference • Survey form • Database	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Boarding/alighting passenger, time-distance attributes	• PDF • PDF • Excel
Large-scale Establishment Survey	• Terms of reference • Survey form • Database	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Person count and visitor interviews	• PDF • PDF • Excel
Activity Diary Survey	• Terms of reference • Survey form • Database • Other references	• Location, sample, methodology, and field survey • Questionnaire in both English and Bosnian • Demographic and trip diary information (OD included) • Coding, GPS data converter and OD finder	• PDF • PDF • Access • Excel
Demand Model (Present: 2022, Future: 2036)	• Present network • Population • GRDP • Synth. population • Future network • Training materials	• Present network with complete attributes • Present and future population • Present and future GRDP • Synthesized population based on input variables • Future network with confirmed projects • Both database and demand model training materials	• VISUM • Excel • Excel • YAML, csv (input & output files) • VISUM • PPT

Source: JICA Expert Team

4 Overall Public Transport Operation Plan

4.1 Service Specifications of Public Transport Modes

1) Outputs from Survey and Demand Model

Following the work outlined in Chapter 3: Travel Demand Forecast, the public transport network in the model was studied to extract headways for every line as the basis to review the service specifications of public transport modes.

From the screen line traffic count survey results, the 1-hour periods of 7:00 AM–8:00 AM and 11:00 AM–12:00 PM were chosen representatives of the AM peak and off-peak periods of the day for the purpose of specifying average headways for these periods as part of the service specifications of public transport lines.

The following model outputs were used:

- Distance and average speed of the links from the network assignment result to derive journey time of the public transport lines.
- Computed journey time plus rest time to derive turnaround time
- Rest time is assumed to be 5% or 5 min (whichever is more) for AM peak and 8% or 8 min (whichever is more) for off-peak.
- Number of departures to derive headway.
- Turnaround and headway to compute the number of vehicles for both the AM peak and off-peak periods

2) Scenarios Tested

The following scenarios were examined and first discussed with the counterparts on 14 July 2023 and refined over subsequent discussions between 29 September 2023 and 16 October 2023 to develop a recommended operations plan:

- Full-service (base) case – Based on registered public transport timetables provided.
- Hypothetical (oversupply) case – Based on headways suitable to make public transport more attractive.
- Optimal (recommended) case – Based on the ideal case with selected service improvements and network rationalization to reach near the Full-service case.

(1) Full-service case

The model run for the Full-service case was based on this information in the modeled network:

- Public transport routes, stops, and timetables of GRAS are developed from the GTFS data provided by MOT.
- Public transport network and timetable of CENTROTRANS are digitized from the information in the “CentroCard App.”

This resulted in the following vehicle requirements for each mode, which were then calibrated to the actual number of vehicles according to the registered timetable provided by MOT on 29 September 2023.

Table 4.1.1 Vehicle Requirements for the Full-Service Case

Mode	Peak Vehicle Requirement	Off-Peak Vehicle Requirement
Tram (GRAS)	47	45
Trolleybus (GRAS)	31	27
Bus (GRAS+CENTROTRANS)	86	86
Minibus (GRAS+CENTROTRANS)	38	28
Total	**202**	**186**

Source: JICA Expert Team

Line-level details are attached in Appendix 3.4.

However, the registered timetables were never implemented, and the above vehicle requirements are more than the known number of vehicles currently in operations as follows.

Table 4.1.2 Current Operational Fleet

Mode	Registered Timetable Fleet	Current Operational Fleet
Tram (GRAS)	47	38
Trolleybus (GRAS)	31	19
Bus (GRAS & CENTROTRANS)	95	87
Minibus (GRAS & CENTROTRANS)	45	34
Total	**218**	**178**

Source: JICA Expert Team

Differences between Peak Vehicle Requirement (Full-Service Case) in Table 4.1.1 and Registered Timetable Fleet in Table 4.1.2 are due to some bus and minibus lines that are not scheduled to operate during the peak periods.

(2) Hypothetical service case

This attempts to examine a scenario using policy-based maximum headway tiered by mode, as follows, based on the demand characteristics of public transport in Sarajevo:

- Tram: Peak 8 min, off-peak 10 min
- Trolleybus: Peak 10 min, off-peak 12 min
- Bus: Peak 15 min, off-peak 30 min
- Minibus: Peak 30 min, off-peak 60 min
- Lines with better headways than above per the Full-service case are kept the same.

This is also in line with how major developed cities worldwide structure their frequent public transport network such that most citizens do not have to plan their trips around a timetable at least during the peak (better still, all day).

This results in the following vehicle requirements for each mode.

Table 4.1.3 Vehicle Requirements for the Hypothetical Service Case

Mode	Peak Vehicle Requirement	Off-Peak Vehicle Requirement
Tram (GRAS)	60	51
Trolleybus (GRAS)	55	42
Bus (GRAS+CENTROTRANS)	193	113
Minibus (GRAS+CENTROTRANS)	62	32
Total	370	238

Source: JICA Expert Team

Line-level details are attached in Appendix 3.4.

It is to be qualified that this will create an oversupply of services to induce demand for public transport, provided that the city is able to afford it and its infrastructure is able to support it. It will also take significant increase in commercial speeds for trams/trolleybuses through better transit priority measures and as well as major upgrades of depot infrastructure to accommodate this fleet size. It is also understood from discussions with GRAS engineering team that the tram infrastructure can only support a maximum fleet of up to 45 without severe reduction in operational speed since most tram lines have to operate along the same stretch of the tram track along a single file with no overtaking. GRAS also previously tried to put 65 vehicles in operation and with 44 stops it was impossible to run.

Therefore, it will take great political will and several decades to materialize given the operators' current operating and financial conditions, and can only serve as a distant target for a long-term transport master plan. Such a master plan is just as important as a means for the city to commit to improving access to public transport, such that, over time residents and businesses could make informed decisions about where to locate that would gradually reorganize the city so that people who valued transit were close to good transit, thus making better use of the transit system's finite resources.

With the population of Canton Sarajevo at 413,593 as of the 2013 census, the Hypothetical scenario's peak vehicle requirement of 370 will provide 895 vehicles per million inhabitants, which is still below par with major developed cities with well-established public transportation as follows:

Table 4.1.4 Comparison of Number of Public Transport Vehicles per Million Inhabitants among Major Cities

City	Number of Public Transport Vehicles per million inhabitants
London	1,105
Singapore	1,248
Sydney	1,806
Hong Kong	1,767
Vienna	1,203
Canton Sarajevo (Hypothetical)	895

Source: https://citytransit.uitp.org

Given the current financial situation with GRAS and the fleet increase that the city could realistically afford within this decade, this case is impossible to achieve under current conditions.

(3) Optimal service (recommended) case

This scenario attempts to adjust frequencies of selected tram/trolleybus/bus routes, as well as to set service frequencies of the minibuses routes from a social perspective of a “civil minimum” (citizens’ minimum standards).

<u>Trams</u>

- From the model assignment, Lines 2, 5 & 6 that directly duplicate Line 3 have relatively low occupancy which can be absorbed by Line 3. Therefore, it is possible to reduce the peak tram requirement by scaling down the directly duplicating Lines 2, 5 & 6 to about half their fleet, achieving net reduction of 12 trams, from 55 in the Full-service case to 43 in the Optimal case.
- A target average occupancy of 70% per vehicle during the AM peak was used as the upper limit in the capacity optimization process.
- Lines 1 and 4 were not adjusted due to their unique links to the Railway Station.
- The changes in fleet and justification are explained in the below table.

Table 4.1.5 Tram Occupancy and Peak Vehicle Requirement

Line Number	AM Peak Max Load Point Occupancy	No of vehicles (Full-Service case)	No of vehicles (Optimal case)
1	14%	3	3
2	6%	6	4
3	50%	19	19
4	22%	3	3
5	11%	8	6
6	42%	8	7
		47	**42**

Source: JICA Expert Team

Source: JICA Expert Team

Figure 4.1.1 Public Transports Network (Tram)

<u>Trolleybuses</u>

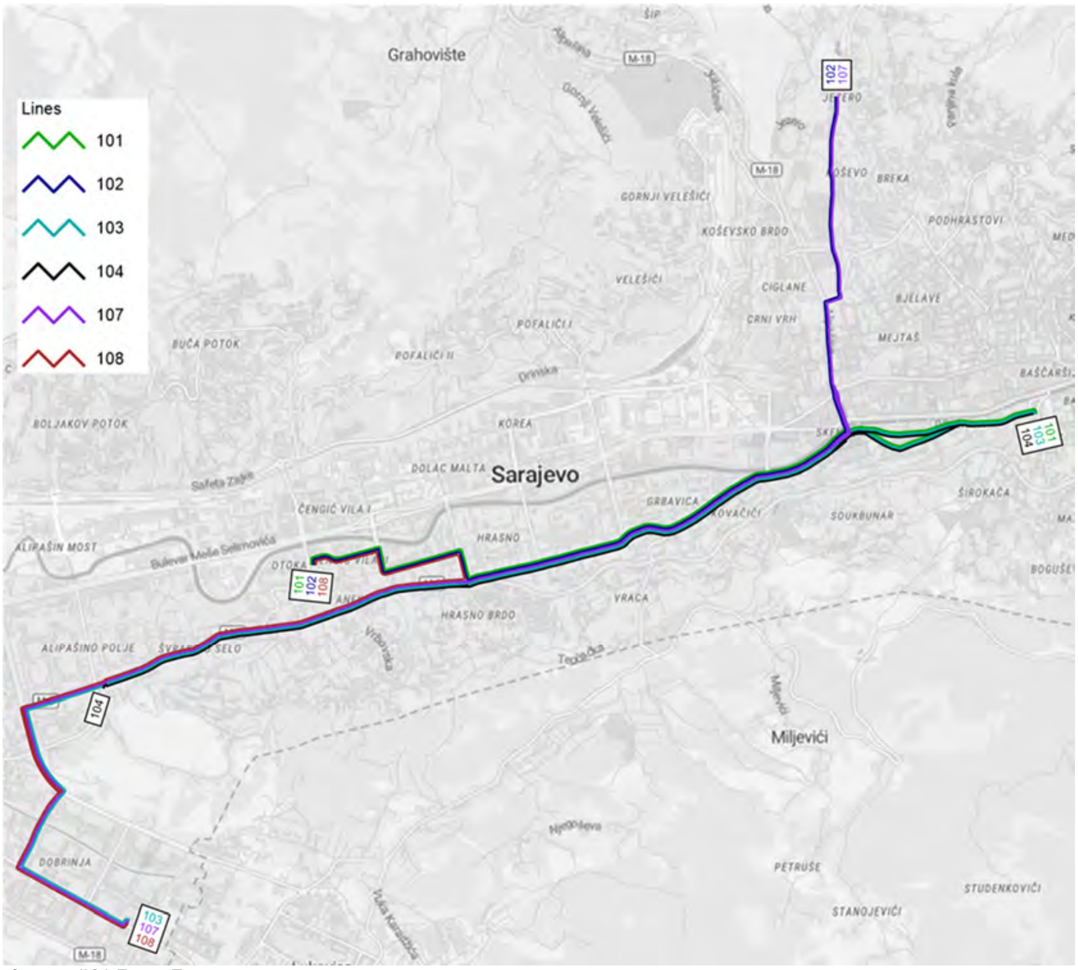
- For the Full-service case, average vehicle occupancies at the heaviest points of each trolleybus route from the model assignment were reviewed.
- A target average occupancy of 70% per vehicle during the AM peak was used as the upper limit in the capacity optimization process.

Therefore, it was found possible to adjust the fleet requirements as follows:

Table 4.1.6 Trolleybus Occupancy and Peak Vehicle Requirement

Line Number	AM Peak Max Load Point Occupancy	No of vehicles (Full-Service case)	No of vehicles (Optimal case)
101	6%	12	10
102	91%	2	3
103	75%	3	5
104	34%	5	3
107	96%	2	4
108	24%	7	7
		31	**32**

Source: JICA Expert Team



Source: JICA Expert Team

Figure 4.1.2 Public Transports Network (Trolleybus)

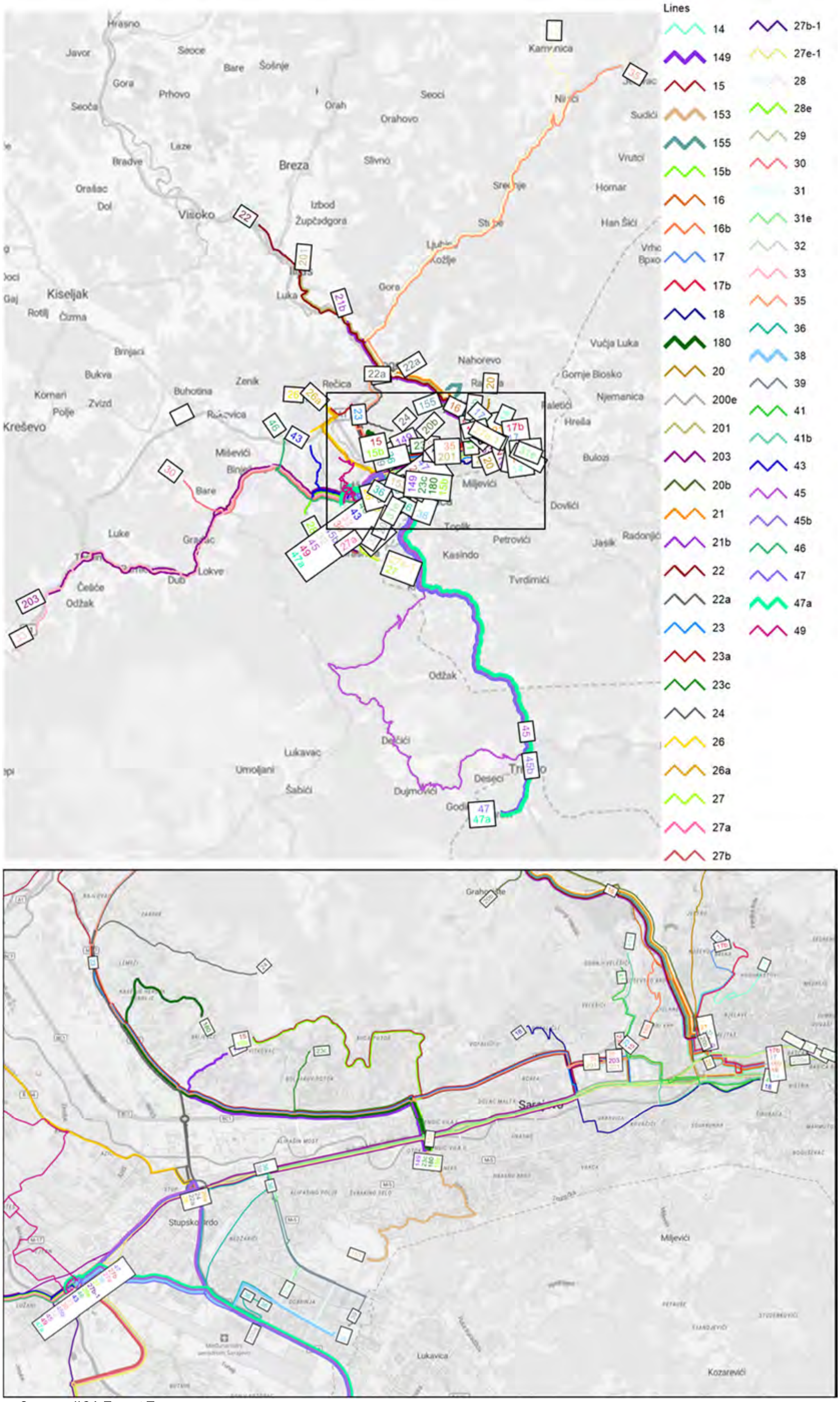
Buses

- Using a similar demand-driven approach in trams and trolleybuses where routes above 70% occupancy during the AM peak from the model assignment are improved to this target. They are not changed from the Full-Service case for off-peak.
- This results in 17 routes requiring an additional 20 buses as follows:

Table 4.1.7 List of Bus Routes to Improve Bus Capacity

S/N	Line Number	AM Peak Max Load Point Occupancy	No of vehicles (Full-Service case)	No of vehicles (Optimal case)	Change in No. of Vehicles
1.	16b	74%	2	3	+1
2.	21	86%	5	6	+1
3.	21b	105%	1	2	+1
4.	22a	125%	2	3	+1
5.	23a	133%	2	3	+1
6.	24	77%	1	2	+1
7.	26	132%	1	3	+2
8.	26a	177%	1	3	+2
9.	27	92%	4	5	+1
10.	27b	83%	1	2	+1
11.	28	96%	2	3	+1
12.	31e	91%	12	13	+1
13.	32	76%	2	3	+1
14.	33	135%	5	7	+2
15.	38	195%	1	2	+1
16.	39	132%	1	2	+1
17.	43	79%	2	3	+1
				Total	**+20**

Source: JICA Expert Team



Source: JICA Expert Team

Figure 4.1.3 Public Transports Network (Bus)

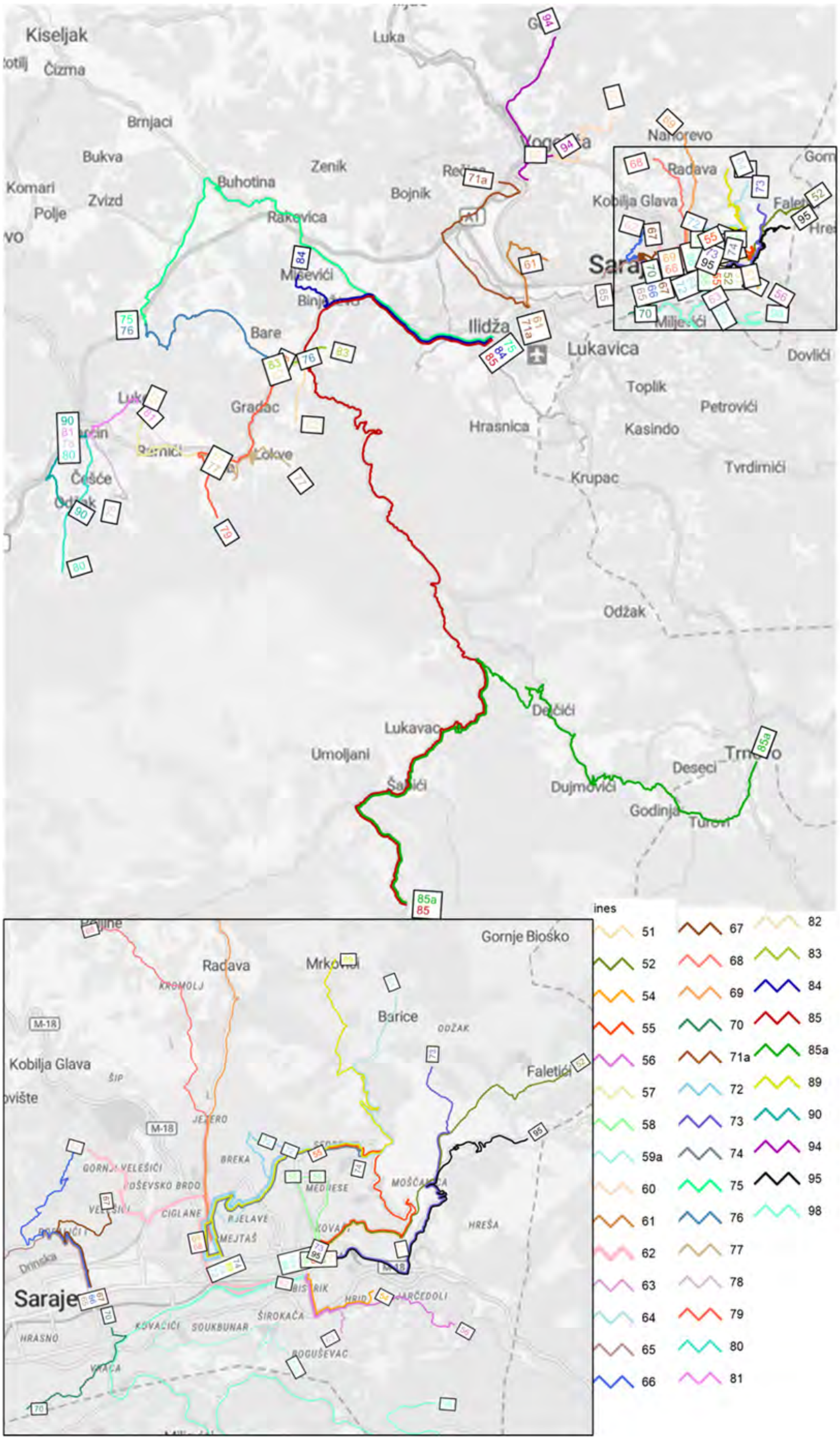
Minibuses

- 11 low-demand routes (54, 57, 63, 68, 72, 78, 79, 80, 82, 83, 84 & 85) have been identified to be streamlined with other routes at the same or nearest terminals.
- These routes may be combined through merging of timetables such that a single bus may switch to another route either at fixed times or at pre-determined intervals (e.g., every 2nd or 3rd trip).

Table 4.1.8 List of Minibus Routes to be Streamlined

S/N	Line Number	Coverage	AM Peak Ridership	No of vehicles (Full-Service case)	No of vehicles (Optimal case)	Change in No. of Vehicles	Remarks / Recommendation
1.	54	Latinska ćuprija - Hošin brijeg–	21	0	0	0	Currently combined with Line Number 56
2.	56	Latinska ćuprija - Popov gaj	109	1	1	0	Currently combined with Line Number 54
3.	63	Latinska ćuprija - Mahmutovac	19	1	0	-1	Combine with Line Number 54 & 56
4.	68	Sutjeska – Poljine	8	1	0	-1	Combine with Line Number 69
5.	69	Sutjeska - Nahorevo	140	1	1	0	Combine with Line Number 68
6.	72	Park terminal - Panjina kula	69	1	0	-1	Combine with Line Number 74
7.	74	Park - Sedrenik Rogina	325	2	2	0	Combine with Line Number 72
8.	57	Pazarić - Osenik	4	1	0	-1	Combine with Line Number 79
9.	79	Dupovci A - Ljubovčići	10	1	0	-1	Combine with Line Number 57
10.	78	Tarčin terminal - Budmolići	15	1	1	0	Combine with Line Number 80
11.	80	Korča - Škola H.E.Šarić A	5	1	0	-1	Combine with Line Number 78
12.	82	Hadžići B - Kasatići okretnica	19	1	1	0	Combine with Line Number 83
13.	83	Hadžići B - Ušivak I B	19	1	0	-1	Combine with Line Number 82
14.	84	Ilidža - Miševići	3	1	1	0	Combine with Line Number 85
15.	85	Ilidža - Sinanovići	13	1	0	-1	Combine with Line Number 84
			Total	**15**	**7**	-8	

Source: JICA Expert Team



Source: JICA Expert Team

Figure 4.1.4 Public Transports Network (Minibus)

- Therefore, a total of 15 routes could be operated by 7 vehicles, resulting in a peak vehicle requirement of 30 minibuses and off-peak vehicle requirement of 22 minibuses.
- Besides the merging of timetables, suburban routes should be further studied for feasibility of on-demand operations that have been successfully implemented in many rural areas worldwide.

Taking all the optimization processes and policy constraints into account, the resultant vehicle requirements are:

Table 4.1.9 Vehicle Requirements for the Optimal Service Case

Mode	Peak Vehicle Requirement	Off-Peak Vehicle Requirement
Tram (GRAS)	42	36
Trolleybus (GRAS)	32	26
Bus (GRAS+CENTROTRANS)	106	86
Minibus (GRAS+CENTROTRANS)	45	37
Total	**225**	**185**

Source: JICA Expert Team

Line-level details are attached in Appendix 3.4.

Detailed calculation steps to arrive at the required number of vehicles for the Optimal service case are outlined in Appendix 3.1.4, Operation Plan to Vehicle & Personnel Allocation - Steps to Calculate Vehicle Requirement for a Service Route. Comparison of peak vehicle requirement against the Current and Full-Service cases is as follows:

Table 4.1.10 Peak Vehicles for Current, Optimal, and Full-Service Cases

Mode	Current Operations	Optimal Service Case	Full Service Case
Tram (GRAS)	38	42	47
Trolleybus (GRAS)	19	32	31
Bus (GRAS+CENTROTRANS)	87	106	86
Minibus (GRAS+CENTROTRANS)	34	45	38
Total	**178**	**225**	**202**

Source: JICA Expert Team

These vehicle requirements are consistent with fleet renewal program described in volume 2, chapter 3.3, Direction of Fleet and Track Renewal. Specific details of route changes may be studied concurrently if better passenger data could be made available with integrated fare systems (to be discussed in volume 2, chapter 3.1 Fare and Ticket Management), as well as the improved capabilities of the MOT to undertake a data-driven central planning of public transport service requirements.

The pros and cons of each scenario are examined to validate the adoption of the Optimal service case:

Table 4.1.11 Peak Vehicles for Full-Service, Hypothetical Service and Optimal Service Cases

Case	Pros	Cons
Full-Service Case	- High level of service - Shorter waiting time - Less crowded vehicles	- Difficult to fulfill full vehicle requirements. - Existing tramline design can only accommodate up to 45 trams along a single file without severely reducing operational speed, due to

Case	Pros	Cons
		spacing of vehicles becoming too close. - Upgrade of tram lines and system required to accommodate proposed tram fleet resulting in high cost.
Hypothetical Service Case	- Highest level of service comparable with major cities in the world - Shortest waiting time - Least crowded vehicles	- Current tram and trolleybus infrastructure is unable to support the vehicle requirements due to all tram and trolleybus lines having to share a single track on their respective networks, which limits the number of vehicles that can be operated without reducing operating speed. - Major changes to infrastructure (depots, tram rails, signaling system upgrades, etc.) required, resulting in the highest cost. - New trams/trolleybuses in the pipeline of current sponsorship are not enough to meet the requirements of this scenario
Optimal Service Case	- Achievable with existing infrastructure with less investments hence lower cost. - Consistent with upcoming fleet renewal program. - Services calibrated to meet demand along various routes and neighborhoods and can be further fine-tuned as better passenger data are made available with new ticket payment systems in future. - No congestion or slowdown in tramway operation due to the oversupply of tram vehicles is expected to occur.	- City will experience an improvement in service level from the current service case but not as good as major cities worldwide.

Source: JICA Expert Team

Meanwhile, the Optimal case shall serve as the basis to determine driver requirements to be discussed in volume 2, chapter 2.1, Vehicle and Personnel Requirements from Operation Plan.

4.2 Operations Planning and Management Processes

1) Current Situation

Good data for public transportation management and examination of operation efficiency does not appear to be available in Canton Sarajevo due to the predominantly manual paper-based ticketing system and limited use of smart card fare systems, though CENTROTRANS issues electronic tickets (which will be discussed in detail under 3.3 Fare and Ticket Management). GRAS is also the body that is currently determining the service levels and timetables even with their limited capability.

It is also unknown what quantitative indicators MOT uses to assess the operational performance of the operators. It is even more apparent that, although the MOT oversees by law (on public transport of passengers) the activity of GRAS, the ministry is powerless to regulate GRAS and holds the operator accountable for operational performance; therefore, the need to introduce private operators like CENTROTRANS to fill up the service gaps left by GRAS. Moreover, there is currently no contract between the Government and operators for bus and minibus traffic, though the MOT is working towards it. This is discussed further in chapter 6.1 Organization of the Public Transport Regulator.

It is understood that MOT currently defines the timetables for bus routes tendered to new operators rather than defining service levels for the operator to prepare the timetables as practiced in bus contracts in major cities like London, Sydney, and Singapore worldwide.

Also not enough is understood about the criteria used to establish service levels for each line, apart from local knowledge and requests from the respective municipalities.

Nevertheless, it is believed that MOT needs to build up its capability in determining public transport service specifications to be in a credible position to administer bus service contracts with operators, which are described in further detail under Chapter 6.3.4 Remuneration scheme.

Besides vehicles, public transport infrastructure, a capital-intensive component of the public transport network, must also be optimized to make access and connectivity between public transport modes attractive for its usage. Chapter 1.3.1. Organization of the New Company mentioned that the tram line is currently 10 km long with an average distance of 350 m between stops, which is nearer than the typical spacing of at least 400 m for an equivalent primary mode designed for a commercial speed of at least 20 km/h.

Transfer connectivity between the primary modes of tram/trolleybus and secondary modes of bus/minibus are of mixed standards across the city. Locations with problematic transfers include Sutjeska, where the distance between the bus terminal and the tram or trolleybus stop is at least 400 m (or about a five-minute walk) when it should ideally be much less or even a same-stop transfer. Other locations where transfers are not conducive include Trg Austrije, Bašćarsija, Vijećnica, Latinska Ćuprija, Otoka, Pofalići and Nedžarići, which had similar observations from the JICA Study of 2019. On the other hand, the Ilidža terminal is one of the best examples of transfer points in Sarajevo.

2) Recommendations to improve

Observing the current situation into account, the Manual on Public Transport Operation Planning and Monitoring, as part of the appendices, attempts to impart the following topics to improve the Operations Planning and Management Processes:

- Route Planning
    - General Conditions of Routes
    - Service Specifications
    - Structuring the Public Transport Network
- Route Management
    - Establishment of operation standards
    - Policy of setting bus stops
    - Environment for transfers
    - Installation of facilities
    - Policy of route modifications / introducing new routes

The Route Planning chapter of the manual attempts to impart the typical format and information required for each public transport route to be tendered to operators, such as General Conditions of Routes and Service Specifications, adapting from the practice of public bus contracts in major cities worldwide. Besides route-level specifications, another exercise on Structuring the Public Transport Network is laid out to assess at the city level whether the relative service specifications for each mode or tier of public transport services effectively contribute to the attractiveness of the entire public transport.

The Route Management chapter of the manual recommends some indicators the MOT, being the regulator, could develop as a basis for measuring operators' performances under future bus contracts. With MOT also taking the role of a central planner of the public transport network and its infrastructure, the policy of setting up bus stops, improving the environment for transfers, and setting up public transport facilities are important considerations, along with guidelines to make modifications to the network.

4.3 Monitoring Framework to Improve Public Transport Operations

1) Current Situation

As discussed in the preceding Chapter 3.1 Operations Planning and Management Processes, it is also unknown what quantitative indicators MOT uses to assess the operational performance of the operators. Neither has MOT sufficient powers nor sufficient staff to regulate the operators such as GRAS. While these issues are discussed in more detail in Chapter 6.1, Organization of the Public Transport Regulator, this chapter outlines the data types required to implement a monitoring framework.

It is observed that an operations monitoring center for public transport has been established with a locally developed system. This can serve as a starting point for the using big data to monitor public transport performance.

Besides the absence of meaningful indicators to regulate public transport operators' operational performance, there also appears to be a lack of a systematic process to monitor customer feedback and satisfaction, which is another important dimension in assessing the effectiveness of public transport. Current known customer feedback channels from GRAS and CENTROTRANS are limited to just an open-ended email form and a phone number, making the classification and dissemination of feedback to the relevant departments (if done at all) a labor-intensive process, although CENTROTRANS conducts a procedure related to measuring the satisfaction of service users in accordance with the implemented ISO 9001 quality management system. Even so, not enough customer feedback and satisfaction information from ground up can be considered in the operations planning process. Thus, requests from municipality representatives appear to remain the primary source of feedback to fine-tune public transport operations.

2) Recommendations to improve

As outlined in Chapter 3.3.1, Priority to Public Transport, the operator must play an important role in identifying the improvements to be carried out by regularly analyzing and monitoring travel times on its lines. The MOT must also build up similar capability to have an oversight of the operator's capabilities as well as take the lead in driving service improvement and optimization in collaboration with the operator. Similarly, Chapter 3.3.2 Offer optimization emphasizes the necessity of having good and detailed data to account for daily changes in travel demand to keep the public transport network relevant and cost-effective.

Taking the above review into account, the Manual on Public Transport Operation Planning and Monitoring, as part of the Appendices, attempts to impart the following topics to Improve

Public Transport Operations:

- Monitoring Method for Operations of Public Transport
  - Data collection method: analysis of operation records
  - Monitoring of operators' performance
- Customer Survey & Relations
  - Questionnaire survey
  - Users' interview by class
  - Feedback via the internet or mobile channels
  - Extraction of operational issues and directions for solution

The Monitoring Method for Operations of Public Transport chapter of the manual suggests the basic building blocks of operational performance indicators: the time stamps at every stop used to calculate headway, reliability, and revenue kilometers. An array of operational reports can be developed around these indicators to suit the needs of both the regulator and the operators. Following up on these indicators is a framework for regulators to monitor the operators' performance and for operators to improve when necessary.

The Customer Survey & Relations chapter of the manual imparts the survey methods used in this project for future regular updating of the demand forecasting model, which also applies to future improvements of the public transport network and operations. As these methods are labor-intensive and suitable to implement annually, feedback via the Internet or mobile channels is recommended for daily operations through well-designed forms and QR codes that automate the classification and routing process to the relevant departments. This follows with a process to extract operational issues to identify root causes and trends in public transport satisfaction to facilitate the development of appropriate actions and solutions.

5 Public Transport Policy Analysis

5.1 Base Case with Ongoing Projects

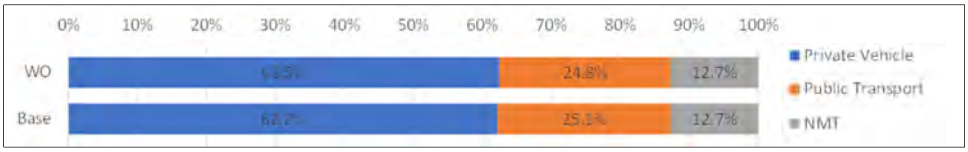
A base scenario has been set for policy analyses using the travel demand forecast model by including the following three ongoing projects in the present case. Those are all explained in Section 3.3 of Volume 2. The target year is assumed to be 2025, when all the three projects are completed.

- Renewal of 25 trolleybus vehicles (to be completed in 2023)
- Renewal of 15 sets of tram vehicles (to be completed in 2024)
- Reconstruction of the tram tracks (completed in 2023)

Assignment result for public transport passengers in a peak hour (7-8AM) in the base scenario is shown in Figure 5.1.1. Comparison of modal shares between “Without” scenario and the base scenario is presented in Figure 5.1.2. While the fleet renewal is challenging to incorporate into the network except for increased service frequency, a 20% increase in the operation speed of the trams was assumed after the reconstruction works of the tram tracks were completed. Though the number of tram passengers will increase by shifting from bus and trolleybus, the increase of the modal share of public transport is as little as 0.3% (from 24.8% to 25.1%). It implies a great modal shift to public transport from other private modes cannot be expected even though the tramway tracks are drastically renovated.

Source: JICA Expert Team

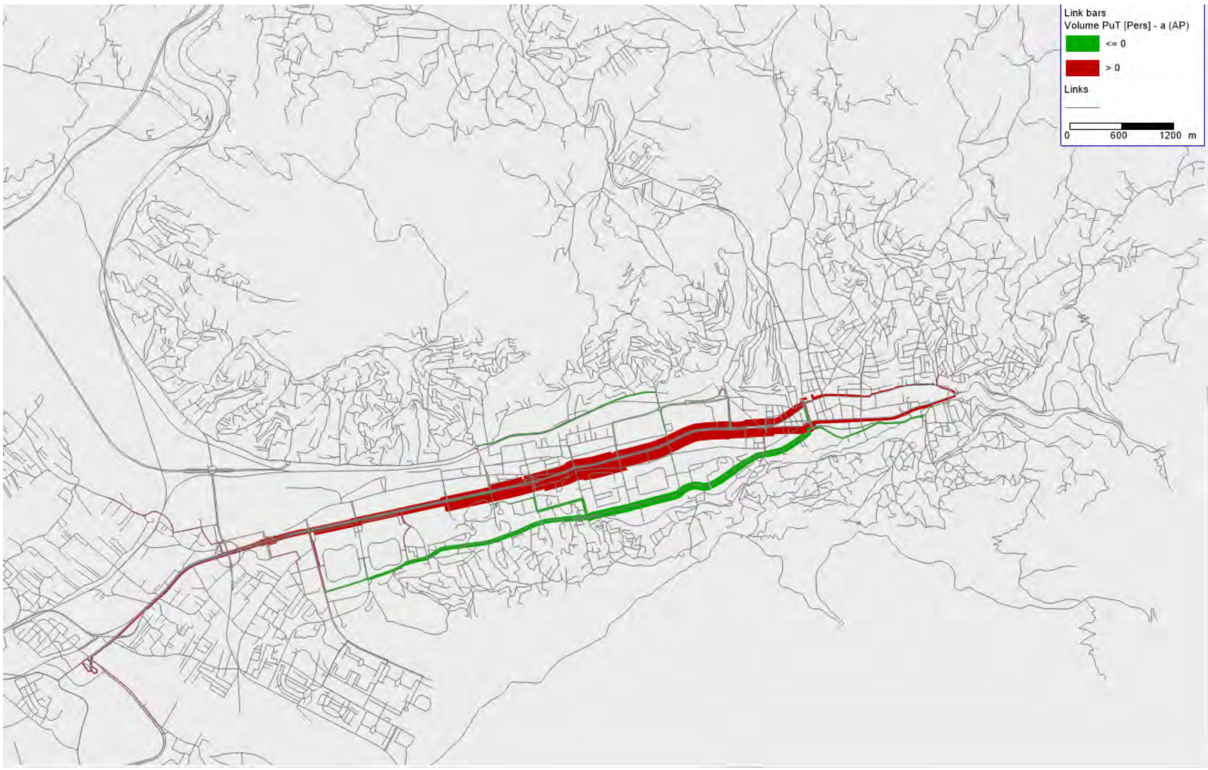
Figure 5.1.1 Assignment Result for Public Transport Passenger in Peak Hour (7-8AM: Base Scenario)



Note: NMT stands for non-motorized transport
Source: JICA Expert Team

Figure 5.1.2 Comparison of Modal Shares between “Without” Scenario and Base Scenario

The following figure shows the difference in the volume of public transport users on each link between the "Without” scenario and the base scenario. Red links mean the link where the number of public transport users increases. Green links show the decreased links. As shown, the number of tram users has increased. On the contrary, the trolleybus and bus passengers have decreased and shifted to tram.



Source: JICA Expert Team

Figure 5.1.3 Difference of Link Passenger Volume in AM Peak (Base Scenario – “Without” Scenario)

5.2 Demand Analysis of Public Transport Improvement Plans

1) Scenario Setting

In order to compare the demand forecast results with this base scenario, each of the following six public transport improvement policies has been added to the base scenario to make a new scenario, as agreed with the Sarajevo side.

i. **Revision of the tariff system 1 (introduction of transfer discount [50%])**

ii. **Revision of the tariff system 2 (distance-proportional fare system: 0.8 + 0.27 BAM/km)**

Policy analysis of revising the public transport tariff system is mentioned in the Work Plan.

There is an ongoing study, "Public Service Contract and Tariff System Reform," funded by EBRD, where various tariff systems from European cities are currently studied. Scenarios 1 and 2 are typical public transport tariff systems.

iii. **Introduction of a Low Emission Zone (LEZ)**

While there is no discussion on introducing the environmental tax, the Cantonal Ministry of Utilities, Infrastructure, Spatial Planning, Construction and Environmental Protection conducted an air pollution mitigation project for citizens' protection. The traffic-related part (i.e., LEZ) was very small, and the survey results indicated that traffic pollution is not the only one nor the biggest air pollutant during the winter period. However, based on the Swedish study, MOT took over the ministry's idea and considered LEZ as a traffic demand management measure to proclaim the protection of traffic zones called red zones, as described in Section 2.3 of Volume 3.

An LEZ is a geographical area within a city where a certain type of vehicle is prohibited entry based on emissions. For heavy and light-duty vehicles, access is denied for emissions above a specific limit, excluding the most polluting vehicles and, thus, improving air quality. Emission control technologies improve over time, and the design of the zone is therefore based on the exclusion of vehicles that do not comply with the highest, current Euro-emission standards.[6] At the initial stage of the proposed LEZ, restricted vehicles are up to Euro3 vehicles, which mean an exclusion of approximately 15% to 20% of the total passenger cars. 18% has been tentatively set in this scenario.

iv. **Enhancement of minibus services (minibus service frequencies to be doubled)**

v. **Drastic rationalization of minibus services (deleting low-frequency minibus lines)**

Regarding the improvement of the minibus services, it has already reached the optimum ensuring socially minimum access for mobility; hence, no more discussions on improvement are necessary, according to the Sarajevo side. These two changes in the minibus services (i.e., doubling minibus service frequencies and deleting low-frequency minibus lines) are tested for their information.

vi. **Improved operation plan proposed by TRAMODE**

This is an overall public transport operation plan proposed by the JICA Expert Team (Optimal Service Case), as explained in Chapter 4.

Thus, a total of six scenarios have been set, as presented in the table below. The modal share of public transport is mainly estimated for the following six scenarios to evaluate the impact of public transport policies.

Table 5.2.1 Scenario Setting

Ongoing Projects and Improvement Policies	Scenario							
	WO*	Base	1	2	3	4	5	6
Tram Track Reconstruction		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Renewal of Trolleybus Vehicles		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Renewal of Tram Rolling Stocks		Yes	Yes	Yes	Yes	Yes	Yes	Yes
i. Transfer Discount (50% discount)			Yes					

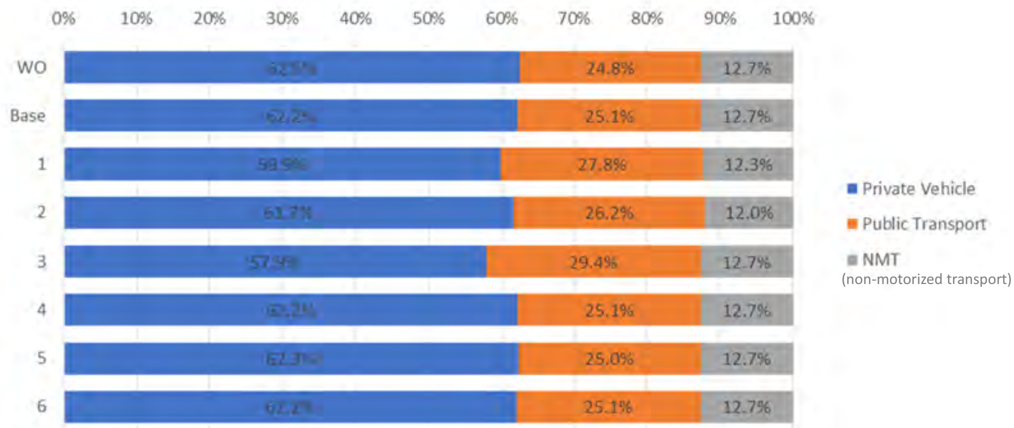
[6] IVL Swedish Environmental Research Institute, 2022, Report C 728 - Low Emission Zone in Sarajevo – Development and implementation, December.

Ongoing Projects and Improvement Policies	Scenario							
	WO*	Base	1	2	3	4	5	6
ii. Distance Based Fare (0.8 + 0.27 BAM/km)				Yes				
iii. Low Emission Zone (Car trip in LEZ reduction by 18%)					Yes			
iv. Minibus High Frequency (Double frequency)						Yes		
v. Minibus Limited-Service (Deleting low frequency route)							Yes	
vi. Improved Operation Plan proposed by TRAMODE								Yes

*WO: Without any improvement
Source: JICA Expert Team

2) Result of Scenario Analysis

The following figure shows a comparison of the modal share among the six scenarios as well as "Without" and base scenarios. As shown below, Scenario 3, introducing a low-emission zone, brings the largest impact on the modal share of public transport. Scenarios 1 and 2 also bring the second and third largest impact, respectively. On the other hand, the impact of Scenario 4 and Scenario 5, namely, scenarios related to the minibus, is limited. Elasticity to shift to/from private vehicles may be low due to the changes in minibus services, implying that the service standards should rather be set from a social perspective of a "civil minimum" (citizens' minimum standards). Also, the impact of Scenario 6, the improved operation plan, is limited since there is no additional service line or tariff change. In other words, as far as overall modal shares are concerned, no negative impact is expected from the improved operation plan proposed for better cost efficiency.



Source: JICA Expert Team

Figure 5.2.1 Estimated Modal Share by Scenario in AM Peak Hour

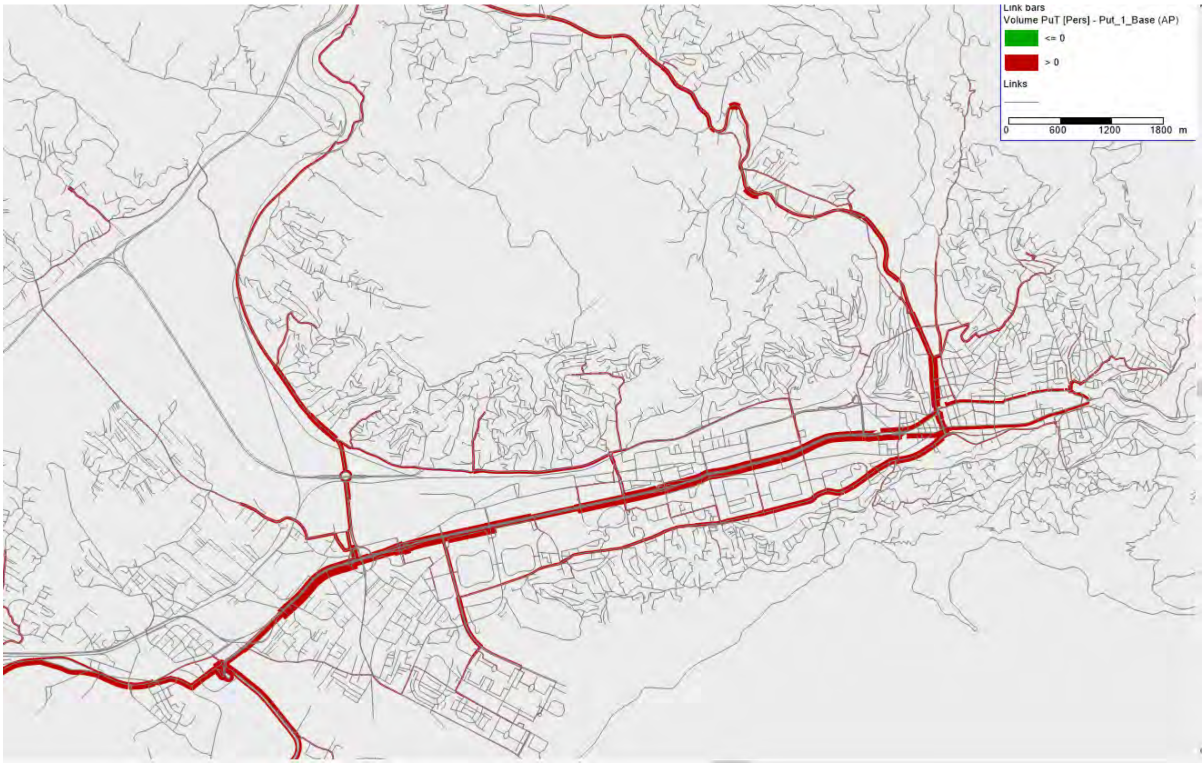
The next table compares the performance indicators in the morning peak hour among the six scenarios as well as "Without" and base scenarios. The lowest PCU-km, total travel distance by private vehicle, is estimated for Scenario 3, Low Emission Zone scenario. Consequently, the highest fare-box revenue for public transport is estimated for Scenario 3. Compared with the base scenario, higher fare-box revenue is estimated for the minibus high-frequency scenario (Scenario 4) and improved operation plan scenario (Scenario 6) because of the enhanced public transport services. However, the operation distance of public transport is also increased in those scenarios. In Scenarios 1, 2, and 5, a decrease in the fare-box revenue is estimated. While the degree of this decrease is about the same in Scenarios 1 and 2, there is a clear difference in the modal share, and introduction of a 50% transfer discount (Scenario 1) may be more effective in increasing the public transport mode share than the distance-proportional fare system (Scenario 2).

Table 5.2.2 Comparison of Performance Indicators in AM Peak Hour

	Private Vehicle	Public Transport			
	PCU*-km (1000)	No. of Passengers (1000: Unlinked**)	Passenger-km (1000)	Fare Revenue (1000 BAM)	Vehicle-km (1000)
WO	241.0	21.1	81.9	36.7	3.6
Base	240.3	21.3	83.2	37.1	3.6
1	231.1	24.7	97.7	35.2	3.6
2	242.4	22.2	80.4	35.2	3.6
3	227.6	23.2	97.8	39.7	3.6
4	240.1	21.5	83.8	37.3	4.1
5	240.8	21.1	82.1	36.7	3.4
6	239.8	21.6	84.2	37.4	4.1

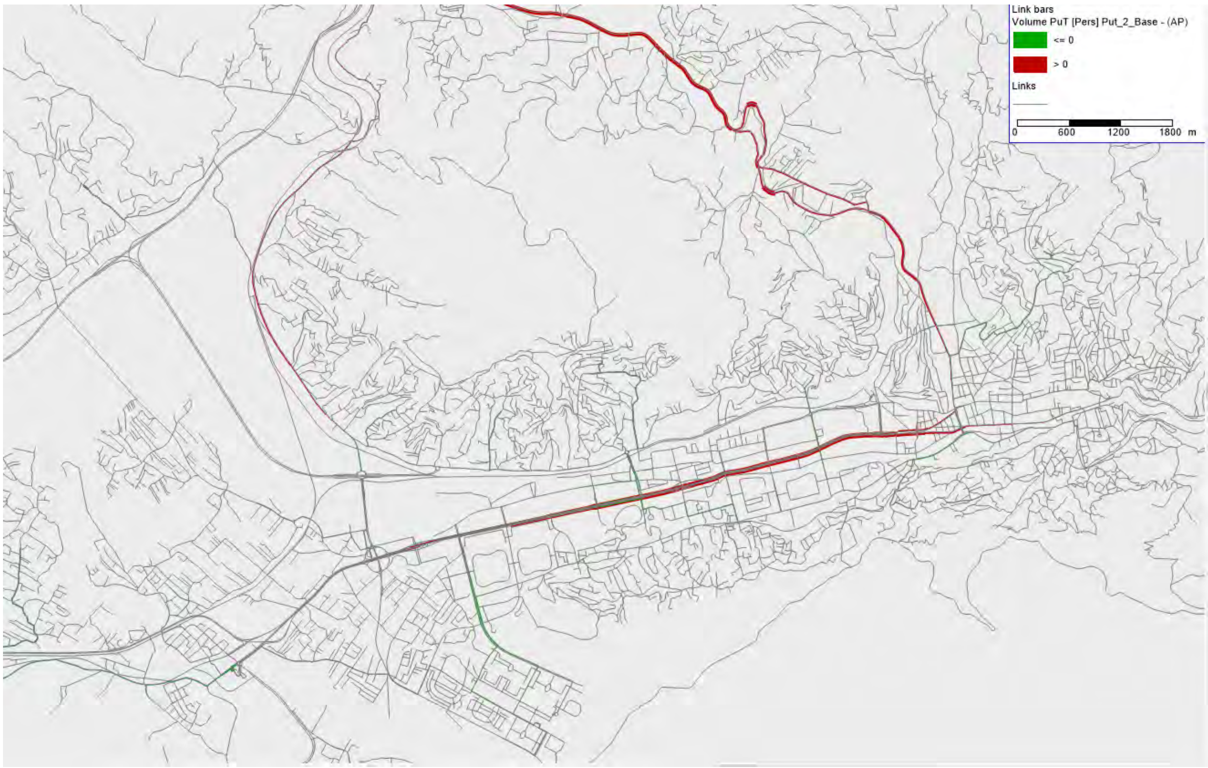
*PCU: Passenger Car Unit
**Unlinked means that the passenger who transferred public transport is counted as separate passengers.

As in the comparison between the "Without" scenario and the base scenario, the following figures show the difference in the volume of public transport users on each link between the base scenario and other scenarios. As mentioned above, Scenario 3 brings the largest impact. On the other hand, the impact on Scenarios 4 and 5, namely, scenarios related to the minibus, is limited. Especially, it is estimated that some passengers are shifted to another bus route in scenario 5, minibus limited-service scenario. Service level of minibus should be considered according not to traffic impact but to social impact.



Source: JICA Expert Team

Figure 5.2.2 Difference of Link Passenger Volume in AM Peak (Scenario 1 – Base Scenario)

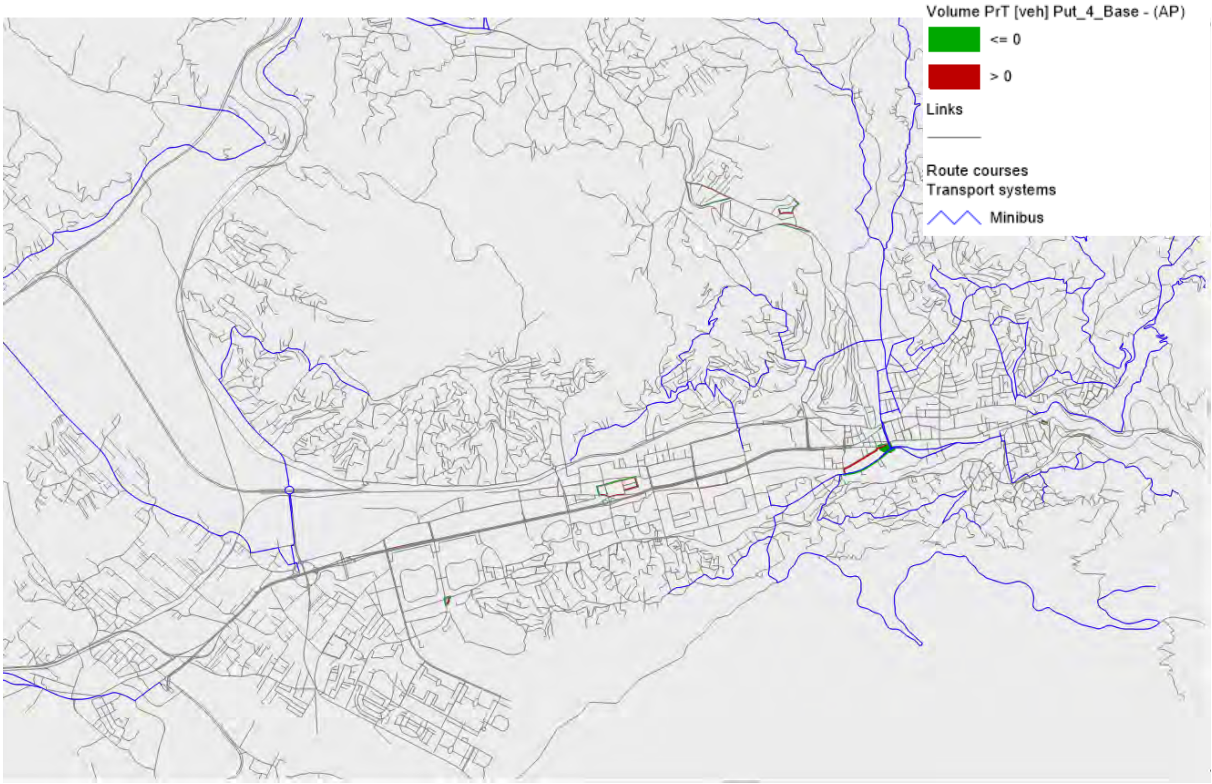


Source: JICA Expert Team

Figure 5.2.3 Difference of Link Passenger Volume in AM Peak (Scenario 2 – Base Scenario)

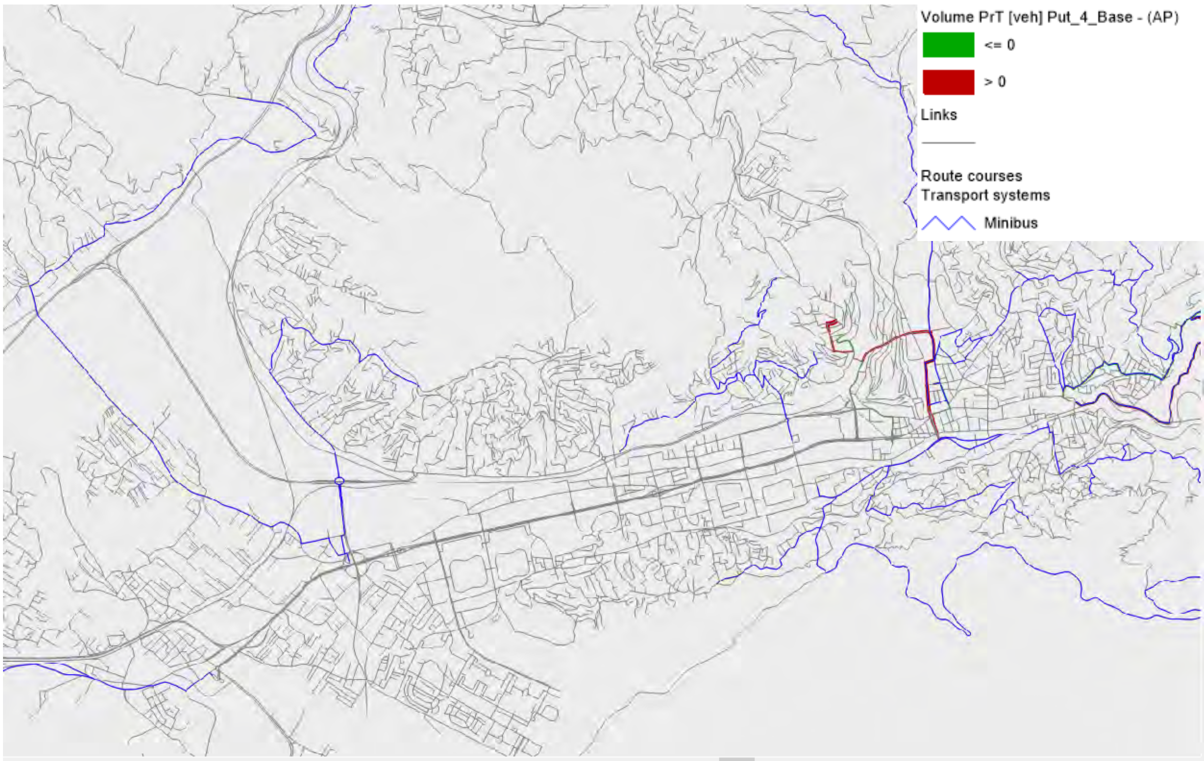
Source: JICA Expert Team

Figure 5.2.4 Difference of Link Passenger Volume in AM Peak (Scenario 3 – Base Scenario)



Source: JICA Expert Team

Figure 5.2.5 Difference of Link Passenger Volume in AM Peak (Scenario 4 – Base Scenario)



Source: JICA Expert Team

Figure 5.2.6 Difference of Link Passenger Volume in AM Peak (Scenario 5 – Base Scenario)

The next figure shows the difference in the volume of public transport users on each link between the base scenario and Scenario 6. Compared with the base scenario, this improves the service frequency and does not change the service area or tariff system. Therefore, even if some passengers are shifted to high-frequency lines, the impact on modal share is limited.

Source: JICA Expert Team

Figure 5.2.7 Difference of Link Passenger Volume in AM Peak (Scenario 6 – Base Scenario)

3) Conclusion

Out of the public transport improvement policies tested in the demand forecast, an LEZ policy for regulation of car use in specific areas seems to be the most effective to increase the public transport ridership or modal share, which makes sense as it directly works on private vehicle users. The proposed target area for vehicle restriction (called a red zone) is large enough to benefit the whole of Sarajevo. However, it should be noted that LEZ also has disadvantages, especially negative impact on business and a difficulty in obtaining public acceptance for implementation, as described in Section 2.3 of Volume III. Further analysis may include testing various target areas for LEZ as well as target vehicles for its actual implementation.

Change in the tariff system may also impact the travel behavior of the citizens in Sarajevo. Of the two scenarios tested, the introduction of transfer discount of 50% was forecasted to increase the public transport modal share more than the policy of a distance-proportional fare system of a formula (0.8 + 0.27 BAM/km), which was assumed to be the same fare as the one based on the average travel distance on public transport. While the former seems to bring a natural benefit because about 40% of public transport users make a transfer, according to ADS, switching to a distance-proportional fare system is expected to increase the public transport modal share even though the total fare revenue will stay almost the same. Needless to say, further analysis of other scenarios with various transfer discounts and distance-proportional fare formulae shall be necessary for further study as several proposed fare systems are soon to be made by the EBRD study.

As for the enhancement and rationalization of minibus services, their impact on the modal share was limited. An increase or reduction of minibus services did not change the network assignment results. The elasticity between public transport and private vehicles of the citizens living along the minibus lines seems to be low. The negative impact of deleting minibus lines that are minimally maintained for social equity was not observed, probably due to the small number of passengers. Present minibus services may already be socially optimum.

Likewise, the operation improvement plan proposed by the JICA Expert Team (optimal service case) is forecasted to have little impact on the modal share. At the same time, some passengers may shift to higher-frequency lines. The network assignment result also shows that links with increased and decreased passengers are even. While the improved operation plan is proposed for better cost efficiency, no negative impact is foreseen. Hence, the proposed operation improvement plan, which attempts to combine the full-service case scenario by adjusting frequencies of selected tram/trolleybus/bus routes, as well as streamlining minibuses routes with low demand, is considered appropriate.

5.3 Future Base Case with Confirmed Projects

The JICA Expert Team also analyzed the future (medium- to long-term) demand of public transport development options envisaged by Canton Sarajevo.

1) Population Forecast

(1) Urban Plan

During the 3rd JCC in May 2022, it was confirmed that “Urban Plan 2016-2036”, drafted by ZPRKS, would be referred for the future socio-economic framework, and the target year would be set at 2036 in line with the Urban Plan.

When analyzing the contents of the Urban Plan, it was found that the geographical boundary of the Urban Plan only covers the urban area of each municipality, while the Project area is equivalent to the size of Canton Sarajevo, composed of the nine municipalities.

In the Urban Plan, the two options were shown in terms of the population projection. The outlines of each option are as follows:

<u>Option 1</u>

(a) The number of inhabitants will increase considering the capacity of the space from 366,551 in 2013 to 620,000 in 2036.

(b) Pronounced increase in the population in Novi Grad, Ilidža, and Vogošća with housing and commercial development.

(c) Immigration to the City of Sarajevo will continue.

(d) The share of the young population will gradually increase (Age 0-14: 15.1% in 2013 to 16.9% in 2036).

(e) The population aging process will slow down (Age 65+: 14.3% in 2013 to 12.7% in 2036).

(f) The number of households will increase (133,569 in 2013 to 205,240 in 2036).

<u>Option 2</u>

(a) Better utilization of existing housing capacities and infrastructure systems, especially in Stari Grad, Centar, and Novo Sarajevo urban areas.

(b) A more intensive increase in the number of inhabitants is planned in Novi Grad, Vogošća, and Ilidža; therefore, in some local communities, Option 2 allocates a higher population than Option 1.

Table 5.3.1 Population Projection of Urban Plan (Option 1&2)

	2013		2036 (Option 1)			2036 (Option 2)		
	Number	%	Number	%	CAGR *	Number	%	CAGR *
Stari Grad	36,605	10.0%	49,000	7.9%	1.28%	49,500	9.6%	1.32%
Centar	54,580	14.9%	74,000	11.9%	1.33%	74,800	14.5%	1.38%
Novo Sarajevo	64,814	17.7%	84,000	13.5%	1.13%	83,600	16.2%	1.11%
Novi Grad	118,553	32.3%	181,000	29.2%	1.86%	150,300	29.1%	1.04%
Ilidža	66,559	18.2%	190,000	30.6%	4.67%	118,000	22.9%	2.52%
Vogošća	25,440	6.9%	42,000	6.8%	2.20%	39,800	7.7%	1.96%
Urban Sarajevo	366,551		620,000		2.31%	516,000		1.50%

*CAGR: Compound Annual Growth Rate
Source: JICA Expert Team summarized from Urban Plan 2016-2036, ZPRKS

It was found that a pronounced increase in the population in Ilidža, Hadžići, Ilijaš, and Trnovo is expected without specific housing, commercial, and business development plans (narrative descriptions were found, but no quantitative figures).

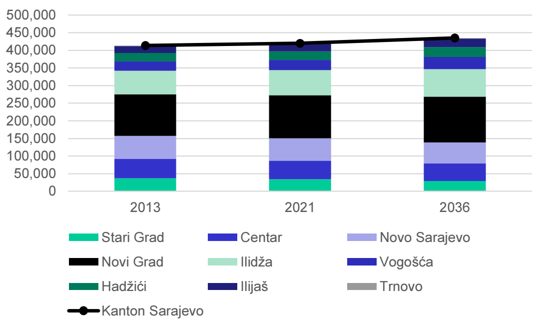
After the consultation with MOT and ZPRKS, it was concluded that the population forecast developed in the Urban Plan is too optimistic considering the recent trends of declining population growth in City of Sarajevo: -0.11% between 2014 and 2021 as well as the neighboring cities like Zagreb and Belgrade. These cities, which serve as regional centers with wider gravitational area, have minimal population growth or a decrease. Thus, the population forecast was decided to be developed by the JICA Expert Team in consultation with the stakeholders.

(2) Own population forecast

Three scenarios were developed to forecast the population of Canton Sarajevo up to 2036.

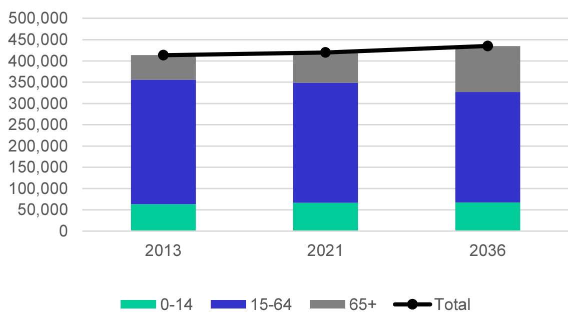
<u>Scenario 1: Trend base scenario</u>

The preconditions are that the population growth trend between 2013 and 2021 is applied to estimate the figure in 2036, and the additional development is not expected.



Source: JICA Expert Team

Figure 5.3.1 Population by Municipality (Scenario 1)



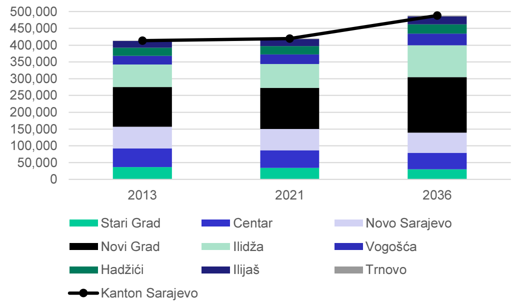
Source: JICA Expert Team

Figure 5.3.2 Population by Age Category (Scenario 1)

The result showed that the total population is expected to be 435,081 in 2036, a 5% increase from 2013, Compound Annual Growth Rate (CAGR) of 0.2%. A negative growth would be expected in Stari Grad, Centar, and Novo Sarajevo, but a positive growth in other Municipalities. The aging population (+65 years old) would be 14% of the 2013 total population to 25% in 2036.

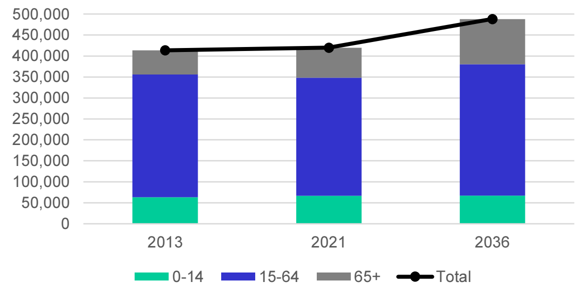
<u>Scenario 2: High growth scenario</u>

The preconditions are that the population growth trend between 2013 and 2021 is applied to estimate the figure in 2036, except for Novi Grad and Ilidža, where additional residential/commercial development is expected. A higher growth of the working-age population (15-64) is expected in these Municipalities, CAGR of 2.0% from 2021 to 2036.



Source: JICA Expert Team

Figure 5.3.3 Population by Municipality (Scenario 2)



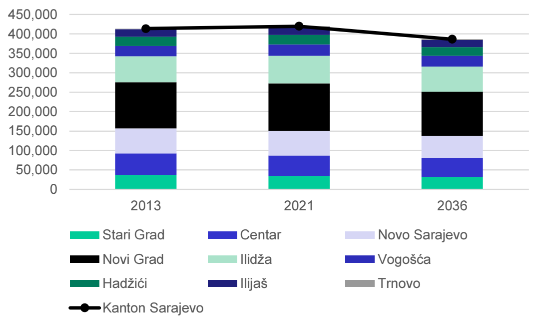
Source: JICA Expert Team

Figure 5.3.4 Population by Age Category (Scenario 2)

The results showed that the total population is expected to be 488,170 in 2036, an 18% increase from 2013, with a CAGR of 0.7%. The aging population (+65 years old) would be estimated at 14% of the total population in 2013 to 22% in 2036.

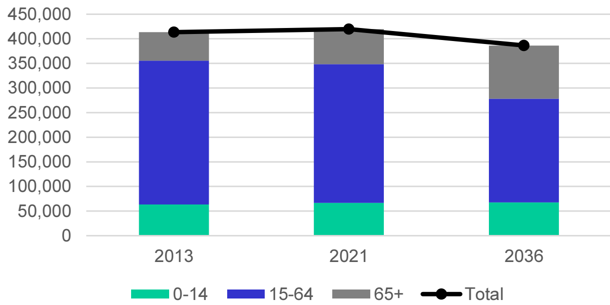
<u>Scenario 3: Pessimistic scenario</u>

The preconditions are that the population growth trend between 2013 and 2021 is applied to estimate the figure in 2036, except for the working-age population (15-64), estimating faster migration outflow. The CAGR of -1.8% is applied to the working-age population following the trend of Stari Grad between 2013 and 2021.



Source: JICA Expert Team

Figure 5.3.5 Population by Municipality (Scenario 3)



Source: JICA Expert Team

Figure 5.3.6 Population by Age Category (Scenario 3)

The results showed that the total population is expected to be 386,336 in 2036, a 7% decrease from 2013, CAGR of -0.3%. The aging population (+65 years old) would be accelerated; 14% of the total population in 2013 to 28% in 2036.

<u>Conclusion</u>

After the discussion of the above three scenarios with ZPRKS, MOT, Agency for Statistics of BiH, and Institute of Statistics of Canton Sarajevo on 10 March 2023, it was concluded that the population projection scenario (1): Trend base scenario was selected for the Project.

2) GRDP Forecast

The data on gross value added by economic activity in BiH and Canton Sarajevo, the current price, of 2013 and 2021 was obtained from the Federal Institute of Statistics. The GRDP per capita in Canton Sarajevo for 2036 was estimated with the following steps:

(a) The GDP deflator of BiH was applied to estimate the constant price of Canton Sarajevo.

(b) Using the obtained data, the GRDP per capita of Canton Sarajevo in 2021 was estimated (current: 19,003 KM, constant: 18,128 KM).

(c) Following the trend base scenario applied in the population projection, the GRDP per capita growth rate of current is 4.62% and constant is 3.94% was utilized to project the GRDP per capita in Canton Sarajevo in 2036.

(d) The estimated GRDP per capita in Canton Sarajevo for 2036 is 37,394 KM for current and 32,364 KM for constant.

Table 5.3.2 Gross Value Added by Economic Activities in BiH and Canton Sarajevo, current & constant price (2013, 2021, 2036) (Unit: '000KM)

	BiH		Canton Sarajevo		
	2013	2021	2013	2021	2036
Total of activities	**14,944,873**	**21,851,250**	**4,699,530**	**6,855,302**	**13,977,192**
FISIM (-)	515,036	566,639	140,986	205,659	419,316
Gross value added, basic prices	**14,429,837**	**21,284,611**	**4,558,544**	**6,649,643**	**13,557,876**
Taxes on products less	2,948,943	3,945,154	911,709	1,329,929	2,711,575
Gross domestic product (GDP)	**17,378,780**	**25,229,765**	**5,470,253**	**7,979,572**	**16,269,452**
Population, mid-year estimate	**2,219,131**	**2,168,602**	**413,034**	**419,918**	**435,081**
Gross domestic product per capita, KM (current prices)	**7.831**	**11.634**	**13.244**	**19.003**	**37.394**
Gross domestic product per capita, KM (constant prices)	**7.869**	**11.099**	**13.308**	**18.128**	**32.364**

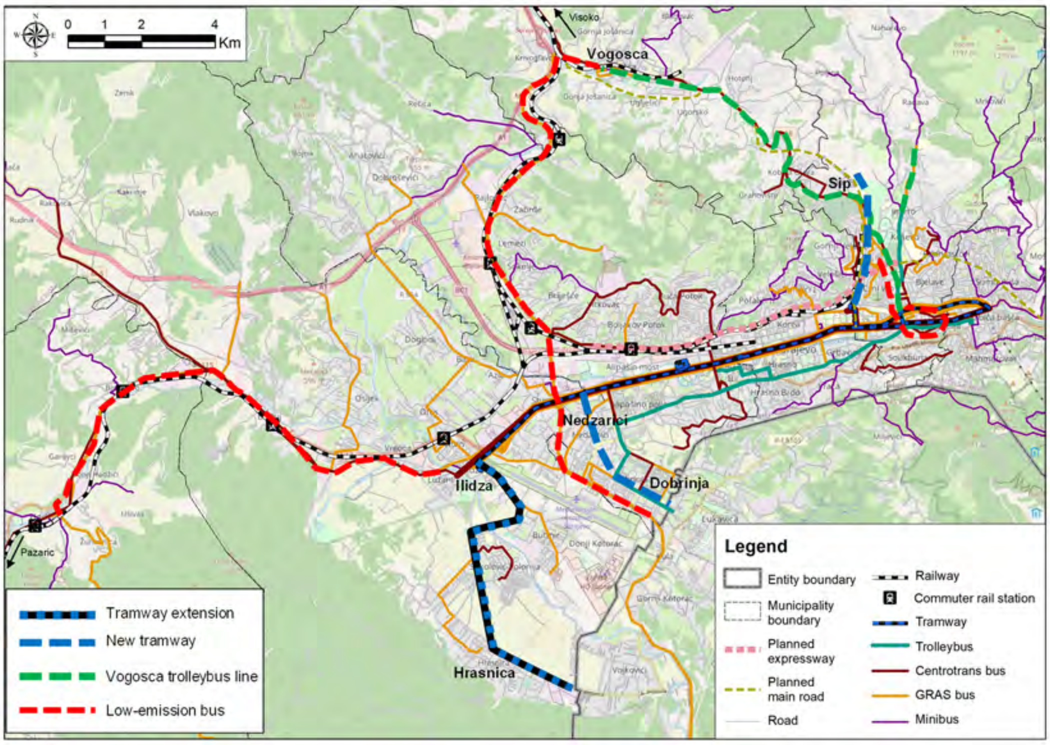
Source: Federal Institute of Statistics and JICA Expert Team

3) Future Base Case

The future base case network has been set by adding the following confirmed (committed or nearly committed) projects to the present base network:

- Extension of the tram lines (Ilidza–Hrasnica),
- Development of a new tram line (Nedzarici–Dobrinja, Sarajevo station–Sip),
- Operation of low-emission bus services, and
- Reconstruction of Vogosca trolleybus line.

For the future public transport network, as presented in Figure 5.3.9, extension of the tramway from Ilidza to Hrasnica, construction of new tramway lines from Nedzarici to Dobrinja and from Main station to Sip, and reconstruction of the trolleybus line to Vogosca are considered as additional projects that are most likely to be realized. Several low-emission bus lines, including electric buses, will also be operated with high probability, and transport capacity and service quality are expected to be improved. Moreover, further improvement and rationalization of the conventional bus and minibus network are included. Such future public transport network is tested in the demand forecast as a future base case.



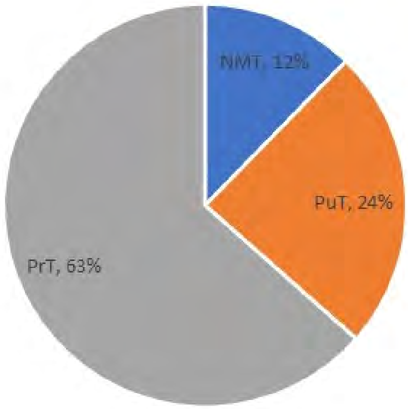
Source: JICA Expert Team

Figure 5.3.7 Future Base Case Network

The following figure shows the volume of public transport users on each link because of the network assignment of the future base case. Modal share is presented in the subsequent figure.

Source: JICA Expert Team

Figure 5.3.8 Assignment Result for Public Transport Passenger in Peak Hour (7-8AM: Future Base Case)



Note: PrT is private transport, PuT is public transport,
NMT is non-motorized transport
Source: JICA Expert Team

Figure 5.3.9 Estimated Modal Share in Future Base Case

Extension and expansion of existing public transport network are considered future development of public transport. However, the forecasted passenger demand along these “new” lines is a lower number than that of the existing ones. In other words, current lines shall still impeccably affect and contribute to the future passenger movement. Several reasons and the background behind this future occurrence may be related to:

- The areas to which the tram extension line connects are not generating/attracting many passengers (in Stup and Hrasnica). Derived passenger demand after the realization of these lines may occur in parallel with further area development in those areas.
- The new branch tram from Nedzarici to Dobrinja and new trolleybuses lines may have strong competition with the existing bus and trolleybus lines. This would cause passenger demand to be shared over multiple public transport lines that serve similar corridors. Depending on how the future policies must be applied, public transport line rationalization may be needed in such corridors such as abolishment of the existing bus lines and modification of the trolleybus line toward the airport.

5.4 Demand Analysis of Future Public Transport Development Options

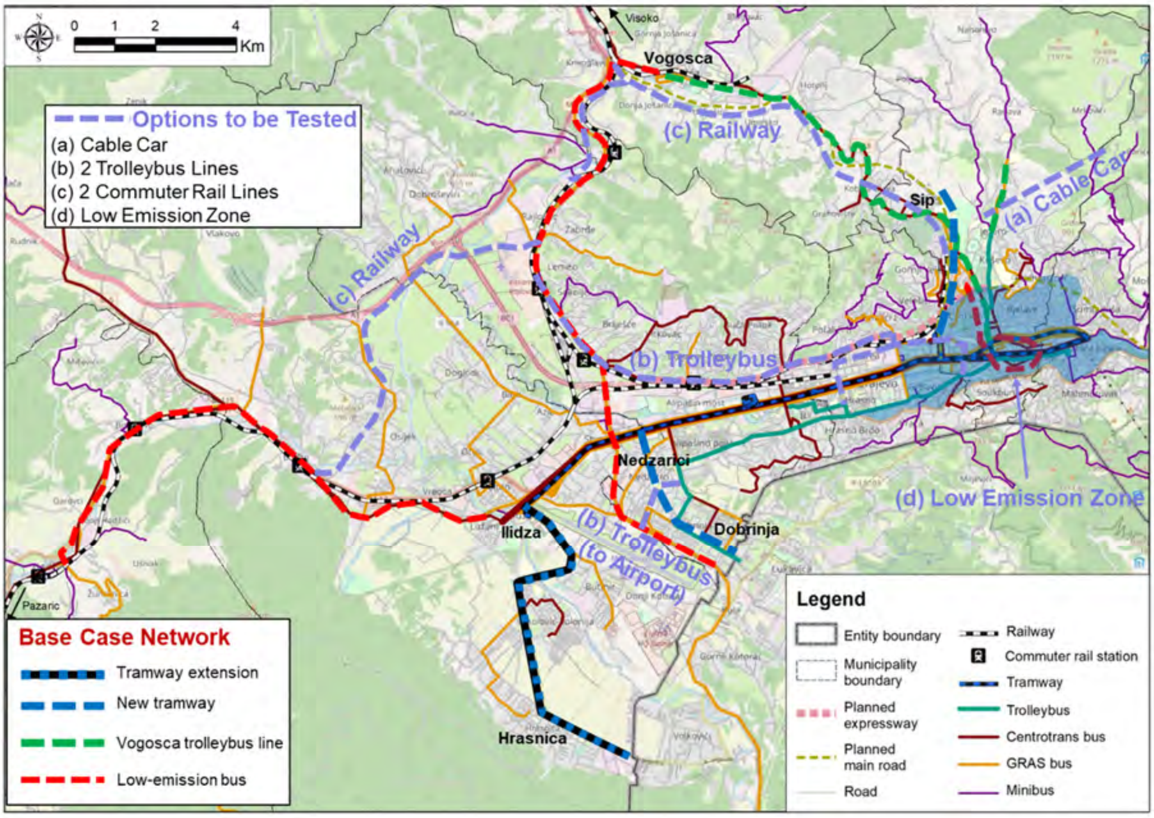
Canton Sarajevo has several options for public transportation development. Those which are tested in the demand forecast are listed below.

(a) Cable car (telepherique) for commuters (Pionirska Dolina– Barice)

(b) New trolleybus lines (Airport Line, Safeta Zajke–Drinska)

(c) New commuter rail lines

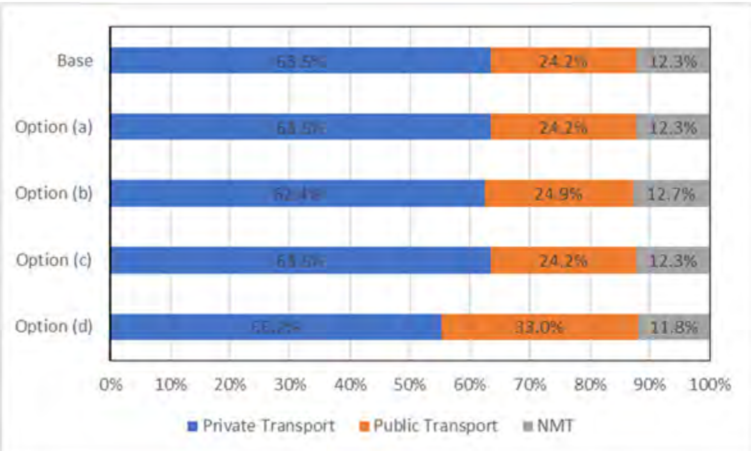
(d) Further implementation of a Low Emission Zone (LEZ) (regulation up to Euro5 vehicles)



Source: JICA Expert Team

Figure 5.4.1 Public Transport Options to be Tested in the Future Demand Forecast

The demand forecast result of each public transport development idea is shown as a change in the mode share from that of the future base case. Particularly for (a)-(c), the forecasted number of users, as well as the assumed fare, are presented.



Source: JICA Expert Team

Figure 5.4.2 Forecasted Modal Share of Future Public Transport Development Options

Table 5.4.1 Forecasted Number of Users for Future Options (a)–(c)

Option	Year 2036		
	Number (7–8 AM)	Fare (KM)	Annual Fare Revenue (million KM)
(a)	10	4	0.15
(b)	444	1.6	2.66
(c)	20	1.6	0.12

Note: Fare and revenue are based on the present value and peak-hour ratio of 8%. Subsidized fare is not considered.
Source: JICA Expert Team

The above table reflects the number of projected or forecasted passengers for the three options. The number of passengers in the morning peak hour can be seen as the highest along the future development of trolleybus lines (option (b)) and subsequently would receive the highest revenue among the three options. Notably, one of the plans in option (b) is the new trolleybus to the airport. Despite the number of passengers during peak hour is lower than the tram, the functionality of this line itself is arguably beneficial.

The new cable car, option (a), is shown to have the lowest number of passengers. It may be considered more for a touristic purpose than for daily or commuting use. Such kind of passenger demand is hard to be reflected in this model.

The areas to which the new commuter railway, option (c), connects are not generating/ attracting many passengers. After the realization of these lines, the derived passenger demand should occur in parallel with further area development in those areas.

5.5 Further Possibilities of Public Transport Policy Analysis

As mentioned above, several transport policies were analyzed with the travel demand forecast model, developed in this Project. There is a possibility that the model can be used further for the following objectives in the future.

1) Impact analysis on changing transport policy

This Project analyzed the impact of introducing the Low Emission Zone and changing the tariff system. In addition, the model can be used for other transport policies, such as introducing a road pricing system.

2) Feasibility study on developing new public transport line

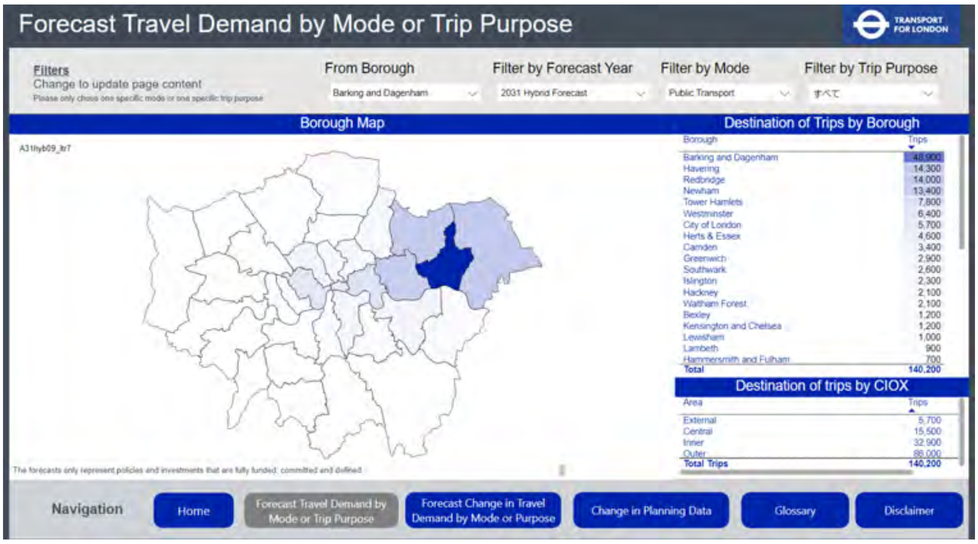
The model can forecast the traffic demand on new public transport such as Mass Rapid Transport (MRT). The estimated passenger demand can be used to estimate the fare-box revenue and assess the Project's financial feasibility together with cost estimation.

3) Traffic impact analysis on urban development

New urban developments such as large resident areas and shopping malls change the traffic movement in the city. The model can assess the impact on traffic. It is also used to select mitigation measures to minimize the traffic impact.

4) Promoting citizens' understanding of transportation policies (Mobility Management)

It should be noted that many cities, such as London and Tokyo, own a transport model and have updated it. The modal can be a common tool among stakeholders, including citizens, to discuss future transport policy numerically. For example, the Greater London Authority (GLA) provides a transport dashboard to promote citizens' understanding of transportation policy (Figure 5.5.1).



Source: Greater London Authority

Figure 5.5.1 Transport Dashboard with Forecasted Travel Demand in London

6 Organizational and Institutional Arrangements

6.1 Organization of the Public Transport Regulation Functions: Resources, Scheme and Agenda

1) Organization and Functions of the MOT

The MOT is the main line agency regulating public transport in the Canton of Sarajevo. This prerogative was re-affirmed in the recent Law on Public Transport of Passengers (2022). This law, submitted by the Cantonal government and enacted by the Cantonal Assembly, will be referred to as "LPTP" in this chapter.

(1) Organization

MOT missions are regulated by State, Federal, and Cantonal laws, detailed by rules (or rulebooks) prepared and amended regularly by the ministry, and approved by the SCG (signed by the Prime Minister). The last rulebook is dated January 2020 (amended in September). It introduces the Ministry's functions and, for each staff member, the position name, the general tasks assigned, and the qualifications required. The total number of staff planned was 63 for the whole ministry (Rulebook, January 2020).

The MOT comprises five entities: three organizational sectors (or units), each headed by an Assistant Minister, one non-organizational unit, and one considered as a semi-enterprise (road directorate) with specific revenues, all under the authority of the Minister of Traffic. Table 6.1.1 presents a summarized organization, and the organization chart of the ministry is inserted in Appendix 4.1.

Table 6.1.1 Organization of the MOT

Name	Functions
Economic Affairs, Development Planning and Projects Implementation and Financial Sector	Assumes planning functions (transport needed by the economic development), finance and accounting, as well as large projects management and implementation.[7] It collaborates with the non-organizational unit regarding procurement. The staff number of the sector was estimated at two in April 2022.
Transport Sector (3 departments)	Oversees various regular transport services: buses, trams, trolleybuses, cable cars, elevators, taxis, private and irregular transport of passengers, and freight transport. Under the sector, a regular Department of Passenger Public Transport (DPPT) was recently established (with an estimated six staff). Under the transport sector are also the Department for Taxis, Irregular Transport of Passengers and Private Passengers Transport, and the Department for Freight Transport and Public Transport Stops.
Safety Technical Regulation of Traffic and Parking Sector (2 departments)	Manages traffic control system, including the traffic signals for trams and ITS aspects. The staff number effectively "at work" in this sector was estimated at four in 2022, excluding the Traffic Control Center, and will increase with the development of the Traffic Control Center.
Non-organizational Unit (Equivalent to General Affairs Unit)	Specific functions not assumed by the three sectors or the Road Directorate, such as, legal, procurement, and financial functions. It ensures the link between initiatives prepared/proposed by the sectors and the directorate and political and regulatory agendas.[8]
Road Directorate	In charge of cantonal road construction and maintenance and road safety. In accordance with Article 12 of the Cantonal Law on Road Safety (2022), the directorate will be transformed into a public enterprise wholly owned by the SCG.[9] The estimated number of staff is 12.

Source: JICA Expert Team

[7] For example, those currently financed by the EBRD or EIB. Aside from the permanent staff, only some non-permanent staff funded by projects are employed.
[8] Staff: secretary of the MOT; one expert advisor for economic and financial affairs; expert associate dedicated to project implementation; three senior officers for IT, economic affairs, and administrative and technical affairs; and one driver.
[9] The EBRD recommended this initiative to ensure the allocation of resources collected by the Road Directorate (ringfencing).

Although by far the main line administration for transport in Sarajevo, the MOT cooperates with ministries such as the Ministry in charge of Environment (low emission zones, etc.),[10] the Ministry of Finance, the Ministry of Interior (in charge of traffic police, vehicles registration and delivery of driving licenses) and various bodies with dedicated functions also concerned with transportation:

- Several laws potentially important for the transport service, such as the Law on Concessions or the Law on Public-Private Partnership (PPP), require the establishment of specific commissions aside from the line ministry to advise the procurement process, oversee the progress of implementation, etc.
- The LPTP (Art. 10), in accordance with the Law on Road Transport of the FBiH (2006; Art. 7), mandates the MOT to establish a consultative commission[11] for network lines and timetables creation and modifications[12].
- Public procurement regulation requires ministries to establish tendering committees.
- The Cantonal Administration for Cantonal Inspection Affairs, independent from other ministries, is composed of inspectorates; the Inspectorate for Traffic and Roads controls the effective implementation of cantonal laws and regulations in these two fields. The cantonal administration does not interfere with passenger misconducts (such as free riders, etc.). According to the LPTP, its inspectors check the provision of the public transport service (delays, service interruptions, etc.) and their findings are recorded in minutes and reported to the MOT which supposedly should act as the main entity in charge of the implementation of the LPTP (as stated in Art. 58).
- LPTP, the public transport operator (limited company), which is regulated by three mains federal laws: the Law on Public Enterprises, the Company Law, and the Law on Principles of Local Self-Government (plus laws on accounting and auditing and on procurement). It should also comply with Cantonal laws such as the LPTP, the Law on Communal Activities (2004, amended up to 2019), and the Law on Public Services (2016).[13].

Notably, the GRAS financial crisis, worsened from the mid-2010s, has significantly mobilized the MOT (payments due by the operator, reform of the public transport organization, procurement of vehicles, etc.).

(2) Functions

MOT's responsibilities, clarified and updated, are summarized in Table 6.1.2. The MOT is also the main interlocutor of the railway company to ensure the integration of the train service in the global urban transportation scheme.

[10] Ministry of Communal Utility Economy, Infrastructure, Spatial Planning, Construction & Environmental Protection

[11] Members: "Ministry, the Canton Sarajevo Planning Institute, operators / carriers, municipalities upon whose request the line is modified and other institutions that the Minister considers should be members of the Commission" (Art. 10)

[12] Timetables for public transport of passengers are regulated by the Federal MOTC Regulation on Method, Criteria and Procedure for Harmonisation, Verification and Registration of Timetables as well as on Register's Content and Maintenance (number 1/06-02-2-1554/13 dated 2 October 2013) and amended in 2014 and 2015.

[13] The status of the company, approved by its general assembly, adapts from time to time (e.g., in November 2005 and August 2013) to the amendments of the federal regulation on public enterprises through decisions of the Cantonal Assembly (as in 2005) or its general assembly (as in 2013).

Table 6.1.2 Current Responsibilities of the MOT in Brief

Main functions	Regular public transport	Traffic control, regulation, and safety	Parking	Other motorized vehicles (taxis, trucks, etc.)	NMT modes	Cantonal roads
Policy/strategy preparation	Yes	Yes	Yes	Yes	Yes	Yes
Preparation of regulation	Yes	Yes	Yes	Yes	Yes	Yes
Planning of capital investments and fund raising	Yes*	Yes*	Yes*	Irrelevant	No (or limited)	Yes
Project management	Yes*	Yes*	Yes*	Irrelevant	No (or limited)	Yes
Fares/fees	Yes	Irrelevant	Yes	Yes	No	Irrelevant (no toll roads)
Operation performance oversight	Yes	Yes	Yes	Irrelevant	Irrelevant	Yes
PT licenses	Yes	Irrelevant	Irrelevant	Yes	Irrelevant	Irrelevant

Note: *Cantonal projects
Source: JICA Expert Team

2) Assessment

(1) Main strengths

The six main strengths of the MOT are: 1) A much committed Minister, very actively involved in projects and regulatory initiatives before, during and after the pandemic; 2) The cohesion of the team, supervised by experienced assistant ministers cooperating regularly and closely with each other; 3) A globally clear regulation regarding overall ministry's tasks and duties; strengthened by laws sometimes recently promulgated or amended;[14] 4) A simple decision process within the MOT and a relatively easy access of its Minister to the SCG Cabinet; 5) The interest of the ministry's staff for innovative solutions and absence of "conservative mindset"; its technical background and experience makes the staff receptive to further knowledge acquisition and assimilation;[15] and 6) Accumulated experience of the ministry regarding public transport organization and management issues, namely:

- About one decade of experience trying to try to solve public transport issues linked to GRAS's financial difficulties, including disputes settled by courts,
- Experience in large capital investment projects (EBRD and EIB),
- Ongoing implementation of the traffic control center (about 20 staff to be recruited),
- Working experience with international experts gained during technical assistances financed by JICA, EBRD, United Kingdom, Switzerland, Sweden, Spain, etc., and
- Familiarization with public transport experiences abroad (study tours) and exchanges with foreign experts assigned to projects in Sarajevo.

[14] The LPTP states relatively clearly the MOT role regarding public transport, and other transport modes (except railways). This is an asset from the perspective of public transport performance strengthening and sustainable urban mobility development (inter-modality and multimodality).
[15] The Baseline Survey conducted in September 2021 under TRAMODE collected responses of 9 selected transport experts from Sarajevo – including 3 from the MOT. However, this survey only provided an insight since questions i) were related to individual capacities (not to capacities of their organization) ii) focused rather on topics of interest than on assessment of individual skills.

(2) Main Weakness

The main weakness of the MOT is its limited staff compared with its assigned tasks. The Transport Sector is an outstanding example. Compared with the 15 staff planned, the number of effective positions filled is low.[16]

Table 6.1.3 Staffing of the MOT Transport Sector

Departments (short naming)	Planned in the Rulebook 2020 (Sept.)	Staff (excl. Assistant Minister)	Recruitments Expected
Taxi	15	1	2 additional staffs to be recruited soon
Freight transport + stops		2	
Regular Public Transport of Passengers		2	
Total	15 (+ 1 Assistant Minister)	5 (+ 1 Assistant Minister)	2

Source: JICA Expert Team

From the organization chart provided by the September 2020's version of the rulebook on the ministry's organization, the total number of positions planned for the Transport Sector was 16 (Assistant Minister included) and 6 for the DPPT (1 person per position); plus, the Assistant Minister, part-time dedicated to public transport), namely:

- 1 Assistant Minister
- 1 (Head of the department) for regular public transport of passengers
- 1 Expert advisor for regular public transport of passengers
- 1 expert for network of lines and timetables
- 1 senior expert for legal affairs and administrative settlements
- 1 expert associate for tariff systems
- 1 expert associate for monitoring of regular transport lines

In practice, the effective staff for the DPPT as of 2022 was 2 (excluding the Assistant Minister). The workload combined with the limited staff number obliges each civil servant to develop polyvalence. Although polyvalence is to some extent positive, this understaffing is not consistent with the importance of the current challenges of public transport. These challenges are required to make sure that those who are not in a senior management position keep a significant level of specialization.

In the Department for Freight Transport and Public Transport Stops (same Transport Sector), a maximum of 4 positions is probably dedicated (and only 1 full-time) to public transport stops affairs (plus the Assistant Minister):

- 1 Assistant Minister
- 1 Head of department
- 1 Expert associate for monitoring transport stops
- 1 Expert associate for legal affairs and administrative settlements

[16] The regulation on employment of civil servants is constraining. For instance, candidates must have a minimum of 1 year of professional experience (3 years if the function to be assumed is categorized as technical advisory). The regulation makes MOT apprehensive to recruit talented, new graduate (for instance, master's or PhD in the case of a transport demand modeler).

- 1 Senior officer for operational technical affairs

The same rulebook mentions 14 positions (incl. the Assistant Minister) for the Safety Technical Regulation of Traffic and Parking Sector. One can tentatively assume that 40-45% of these positions relate totally or partially to public transport (around six positions).

In this rulebook, positions for the economic affairs, development planning and projects implementation, and financial sector (9 in total), mostly involved in public transport and traffic-related projects, were indicated as below:

- 1 Assistant minister
- 1 Expert advisor for economic affairs
- 1 Expert advisor for projects
- 1 Senior expert associate for finance accounting affairs
- 2 Senior experts associate for strategic planning and development preparation of projects and utilization of funds program.
- 1 Expert associate for implementation of projects and international programs
- 1 Expert associate for finance accounting affairs
- 1 Senior officer for economic and administrative affairs

Overall, excluding the Road Directorate, and including Secretary and Assistant Ministers, the estimated total official positions planned in September 2022 for the MOT was 47. Among these 47 positions[17], several do not relate to public transport of passengers (e. g., freight taxi or irregular transport of passengers, a large part of the Non-organizational Unit, etc.).

(3) International Comparison

A brief comparison with other transport authorities confirms this understaffing (Table 6.1.4), although figures must be regarded cautiously (geographical perimeter is sometimes very large [e.g., Australia], since the scope of responsibilities may vary significantly [some authorities are also operators], etc.). At the same time, the effective number of MOT staff is below the officially stated (rulebook), and the ministry does not only oversee public transport affairs.

Table 6.1.4 Staffing of Selected Transport Authorities

Urban Area (Main City)	Organizations	Total Staff (A)	Service Areas Rough Population (B)	Staff/000, habitant (A)/(B)	Public Transport Modes
Sarajevo	Ministry of Traffic	47	438,000	0.11	Tram, Trolleybus, bus, taxi, freight, traffic
Zagreb	City Office for Physical Planning, Construction of the City, Utility Services and Transport	652	806,000	0.81	Tram, bus
London	Transport for London** (under GLA)	28,000	9,000,000	3.1	Subway, tram, LRT, bus

[17] The total number of staff for positions listed is 70, or around 70. In addition to these 47 staffs, and from the last MOT organization chart available, 23 staff were identified by the JICA Expert Team for the Road Directorate. This does not include the staff of the Traffic Control Center, (expectedly 18 persons), essentially dedicated to the public transport traffic regulation and control.

Urban Area (Main City)	Organizations	Total Staff (A)	Service Areas Rough Population (B)	Staff/000, habitant (A)/(B)	Public Transport Modes
Singapore	Land Transport Authority	3,073	5.454.000	0.56	Subway/MRT, bus
Munich	Verkehrs- und Tarifverbund München GmbH	6,260	3,000,000	2.08	Local trains, subway, tram, bus
Perth	Public Transport Authority of Western Australia*	1,420	2,700,000	0.52	Bus, ferries, train
Stuttgart (incl. Ludwigsburg, Böblingen, Essli ngen, and Rems-Murr)	1) Division of Policy Planning and Sustainable Mobility (DPPSM) 2) Verkehrs- und Tarifverbund Stuttgart GmbH (VVS) 3) Ministry of Transport of Baden Wurttemberg (MOT)	DPPSM: N/A VVS: 83 MOT: 400	1,991,000	0.24	Train, subway (U-Bahn), bus, trolleybus, train
Lyon	SYTRAL Mobilités	140	1,420,000	0.10	Subway, tram, trolleybus, bus, cable car
Belgrade	Secretariat of Transport	81	1,400,000	0.05	Subway, tram, bus
Oslo	Ruter AS	50 (regulation only)	1,000,000	0.05	Metro, tram, bus, ferry
Grenoble	SMAAG	100	443,000	0.23	Tram, bus, cable car

Note: * Also an operator. Urban and regional transport (bus, ferries, rails, etc.)
** Also a subway operator
Source: JICA Expert Team

3) Opportunity to Specify MOT Regulatory Functions as Public Transport Service Regulator

(1) Regulation Context

Appendix of Volume 1 provides a list of regulations relevant to this chapter 6. The cantonal regulation in Sarajevo must fit with existing federal and national regulations of which modification is difficult for political reasons. The list shows that Canton Sarajevo initiated many regulatory changes since mid-2010, the enactment of three key laws in early 2022, including the LPTP, the first law dedicated specifically to public transport of passengers. Besides laws, Government, Assembly and Minister's Decisions and Rulebooks have more specific targets, for instance the organization of the MOT[18] or the cantonal subsidies allocated to specific categories of passengers.

The LPTP clearly designates the MOT as the main line agency for traffic and public transport in the canton. Appendix 4.2 provides a tentative list of regulations relevant to the urban public transportation sector organization. Cantonal laws and regulations commonly provide more details than federal and national laws). Cantons develop the same laws but increasingly reflect in their regulation their particularities and own policies.[19] In Sarajevo, besides the LPTP, some other laws refer to the MOT. The Law on Ministries and Other Bodies of Administration of the Canton (2021, 2022) defines its mandate in very general terms. In contrast, the Law on Concessions describes in detail its role in the cases of public transport-related concession agreements (see 6.3).

[18] The main basis of the current situation is the detailed rulebook published in January 2020
[19] Vasiljevic Z., 2017, The Legal Regime of Utility Services and Public-Private Partnership in Bosnia and Herzegovina, Network Industries Quarterly, April.

According to the Law on Communal Activities (2004 and amended up to 2019), the price users pay should be consistent with the service quality. It should cover operation costs, including depreciation. The Cantonal budget can bridge the gap between revenues collected and costs.

The LPTP encourages more competition for the bus service. One key objective is to alleviate the weight of the public transport service cost on the cantonal budget. The MOT, also encouraged by the EBRD, is considering developing a contract-based system to ensure this service. The LPTP also required establishing a specific entity dedicated to public transport: planning, oversight of lines management, tariff system, etc. (Art. 3). The DPPT was effectively established in 2022. The law does not explicitly mention the term "regulatory functions" but implicitly empowers the MOT to assume these functions. In 2019, a joint study by PWC and ITP[20] proposed establishing a specific public transport authority; however, there are not many details regarding the arrangements and functions of this authority, like in many cities around the world.

(2) Demarcation between the MOT, operators and other organizations

According to the regulatory framework, particularly the LPTP, the demarcation of responsibilities between MOT, operators, and other organizations is straightforward (see Table 6.1.5). The regulation separates 1) the policy, organization supervision, and control of the public transport service and ii) the implementation of the service by operators. The current financial situation of GRAS has resulted in derogations regarding assets ownership.

- The physical assets used to operate the service are clearly owned by operators and, accordingly, recorded in their accounts. One case is the trolleybus and tram financed by EBRD/EIB. Upon the decision of the cantonal government, the ownership of vehicles purchased will be transferred for free to GRAS (mechanisms to transfer them under the future tram/trolleybus company are not yet defined).
- The MOT has a central role in defining the characteristics of the service (lines and timetables). Therefore, MOT's decisions weigh substantially on operators' operation/renewal and investment constraints. The current system is much more prescriptive.
- The MOT establishes timetables for each line (LPTP, Art. 3) and registers them in a Register of Timetables. Registration is necessary to start the operation of a line. Operators must comply with these timetables. Operators and municipalities can propose to the MOT the creation or the modification of timetables (art. 11 of the LPTP), by following a procedure defined by the MOT.
- The LPTP requests different commissions with advisory roles (public invitation, fares, lines). The commission for public invitation should be established by the MOT (and the LPTP does not explicitly exclude the membership of public operators, for instance, the expected tram/trolleybus operator).
- The LPTP provides limited details regarding the relation between the MOT and other cantonal administrations and municipalities regulated by other laws. In

[20] Price Waterhouse Cooper, Institute of Transport Policy, 2019, Public Transport Strategy for Canton Sarajevo; Public Transport Strategy & Network Analysis, November. Financed by the British Embassy, UKAID, the Good Governance Fund and UK | BiH, Reform Assistance to Bosnia Herzegovina.

practice, the MOT consults with other ministries, such as the MOF and the Ministry of Economy (also in charge of environment, public utilities, and urban development). Collaborations with concerned municipalities are required by the LPTP in the case of lines and network planning. Municipalities can also gather requests from their residents and conduct diligent inspections.

- Fare modification (named price of the transport service in the regulation) is considered by the MOT with the support of a Commission for Regular Service comprising five members, including three MOT senior officers and two external experts from public institutions.[21] The MOT proposes and justifies fare modifications to the SCG that the Cantonal Assembly approved (or rejected). Overall, fare increases were limited in the last 15 years.
- Although the LPTP mentions contracts with bus and mini-bus operators, contractual arrangements are not currently in place (see Section 6.3)
- The tariff system, subject to SCG's approval, is proposed by the MOT. Its components (zoning, link with train service, card, etc.) apply to all registered timetables listed in Art. 54 of the LPTP.
- The MOT is substantially involved in project management in substitution to GRAS (impeached by its bankruptcy status) through acquiring vehicles and other procedures (e.g., obtention of the construction permit for the reconstruction of the tram line) related to loans from international development partners.

The LPTP provides limited details regarding the coordination between the MOT and other cantonal administrations and municipalities. In practice, the MOT consults many other ministries such as the MOF and the Ministry of Communal Utility Economy, Infrastructure, Spatial Planning, Construction and Environmental Protection. The LPTP requires collaborations with concerned municipalities for lines, network planning – and these later can also relay residents' requests and diligent inspections relating to the effectiveness of the service within their administrative boundaries.

Table 6.1.5 Demarcation of Functions between the MOT, Operators, and other Organizations

Responsibilities	MOT	Operators	Other organizations	Comments
Preparation of PT planning in the Canton	Responsible	Consulted by MOT	ZPRKS, other ministries concerned, municipalities	-
Organization of the PT sector	Responsible	-	Proposed to the SCG and Assembly	Presumably also other ministries concerned consulted (MOF in particular)
Preparation of the PT service regulation	Responsible	Consulted by MOT	Laws: SCG approves / enacted by Cantonal Assembly	SCG or MOT only in the case of several decisions or rules
PT operators licensing	Responsible	-	-	Federal regulation
Selection of bus/minibus operators (case of letter of Invitation followed by public calls)	Responsible (coordination)	-	LPTP: Commission for public invitation/public call (to be formed by the MOT)	Experimented for 8 bus lines and 1 microbus line in August 2023 of
Network planning, Definition of PT lines and their characteristics	Responsible	Consulted by MOT (through the Advisory Commission)	Advisory commission for lines. Members: MOT, Planning Institute, operators, municipalities concerned, other institutions	Number of lines, types of lines (bus, tramway, minibus, etc.), routes, names, etc., number, type of vehicles required on each line,

[21] Currently from IPSA and the University of Economics of Sarajevo. See JICA, 2020, Data Collection Survey in Canton Sarajevo, Bosnia Herzegovina, p. 156

Responsibilities	MOT	Operators	Other organizations	Comments
			deemed relevant by the MOT.	terminals, stations, bus stops
Registration, modification, maintenance and deletion of PT lines				Possibility for operators to propose modification of lines under certain conditions.
Registration, modification, maintenance and deletion of timetables	Responsible	Consulted by MOT	Advisory commission for lines?	Role of formal committee to be clarified in the Final Report
Fares policy and level	Responsible	Can propose to MOT	SCG and finally the Cantonal Assembly approve the fares. Commission for Regular Service as advisory body to the MOT	MOT proposes fares to SCG
Monitoring and control of the effectiveness of PT operation: compliance with service on lines and with timetables	Responsible	-	Inspectorate for Traffic and Roads of the Cantonal Administration for Cantonal Inspection Affairs. The LPTP also mentions municipal inspectors	Notifications submitted to the MOT for action/decision
Assets ownership (fleet)	-	Owners	Public operators: Any deregistration of assets is decided finally by the Cantonal Assembly. Deregistration can be proposed by the MOT to the SCG The Law on Communal Activities (2016) highlights SCG's role in the financing and acquisition of fixed assets	Trolleybus purchased under EBRD loan, and registered in the inventory of MOT's assets, made available to GRAS without financial counterpart
Assets ownership (depots)	-	Owners		-
Assets ownership (tracks and catenaries, sub-stations)	Owner (temporarily?)	Owners		Deregistration decided in 2021 to be confirmed by the court. Declared Common Good and Natural Wealth in 2021 by the Cantonal Assembly
Maintenance and repair of PT facilities	-	Responsible	-	-
PT business and financial planning and implementation	-	Responsible	Public operator: Ministry of Finance oversees cantonal companies. Audit through the Audit Committee (appointed by the supervisory board of the public operator)	Strong commitment of SCG regarding the GRAS issue. The Cantonal Assembly is the governing body of cantonal (public) companies
Delivery of PT service (operation)	-	Responsible	-	-
Individual authorizations to controllers (of passengers)	Responsible	-	-	Authorization regulated by cantonal law (2014)
Organization and management of controllers of passengers	-	Responsible	-	-
Revenue collection	-	Responsible	MOT for subsidies to operators for some categories of users	-
Monitoring of users' satisfaction	-	Responsible	Municipalities can also relay to the MOT requests from residents/users and also diligent inspectors	-

Source: JICA Expert Team

(3) The Case of MOT in Sarajevo Enlightened by Foreign Experiences of Public Transport Authorities

From the late 70s, economic regulatory functions were justified by the liberalization of the large-scale infrastructure-based services markets (railway, air, energy, telecommunications) followed later by urban public services, including public transport, water supply, solid waste, etc. In this context, regulatory functions (not to be confused with regulation) became increasingly viewed as needed to ensure fair competition, regulate tariffs, and protect users' interests, in addition to more "traditional" aspects such as safety and environment protection. Although regulation functions initially targeted the private sector and national public monopoles, they became increasingly regarded at the local level as a tool to balance the domination of city-owned operators with market entry facilitation to stimulate competition and lower costs. This approach was mainly developed in all post-socialist economies in Europe and Asia (and this concern is reflected in the FBiH Law on Public Enterprises).

Transport authorities worldwide differ in their relation to the governmental and political system. In Northern America, the United Kingdom, or Australia, relatively autonomous authorities (e.g., headed by appointed independent commissioners) have often been established. In continental Europe, transport authorities are more often placed directly under sub-national governments' control (regional [Italy, Spain], metropoles [France, Spain], or association of neighboring local governments [Germany, France]). In the third "model," common in Asia (including Japan) and in Southeastern Europe, the transport authority's regulatory functions are assumed by an administrative department of the local government. At least in OECD countries, transport authorities perform relatively similar activities when regulatory functions are concerned.

Several functions commonly assumed by urban public transport authorities in OECD countries are still limited (or not) assumed by the MOT of Canton Sarajevo, for instance, regarding contract management, financial aspects, or some aspects relating to service quality monitoring. Table 6.1.6 adapts to the MOT case a nomenclature of regulatory functions proposed by the Transport System Research Group of the Aristotle University of Thessaloniki in 2012.[22] It mentions other key stakeholders are understood as key entities as well.

Table 6.1.6 MOT: Assessment of the Regulatory Functions as Assumed in 2022[23]

Main Functions Potentially Assumed by Urban Transport Authorities in Europe	MOT's Commitment	MOKE	MOT's Commitment in 2022: Overall Assessment
Responsibility of modes (urban buses, tram, trolleybuses)	Effective	PTO	**Planning: Effective and currently strengthening.**
Special transport services (transport service for workers, disabled, schools)	Limited	PTO	
Determination of service attributes	Effective/Timetables	PTO	
Coordinating transport services	Effective	PTO	
Network design	Effective	MUN/PTO	
Planning and operation of bus lanes	Effective/Timetables	PTO	
Award and/or conduct studies and projects	Effective	Financers/OCA	
Design of transport infrastructure	Effective	MUN/OCA	

[22] Naniopoulos A., Genitsaris N., Balampekou I. 2012, The Metropolitan Transport Authority in Europe. Towards a Methodology for Defining Objectives, Responsibilities and Tasks, Transport Research Arena, Procedia - Social and Behavioral Sciences 48, pp. 2804–2815.
[23] MOKE: Main Other Key Entities; MUN: Municipalities; OCA: Other Cantonal Administrations; PTO: Public Transport Operators.

Main Functions Potentially Assumed by Urban Transport Authorities in Europe	MOT's Commitment	MOKE	MOT's Commitment in 2022: Overall Assessment
Management of urban haulage	Not attested yet	Enterprises	
Research and Innovation	Limited	Universities, research institutes.	
General transport and mobility plans	Emerging	MUN	**Transport and Traffic Management: Effective and currently strengthening.**
Approval of the location of stops, stations, parking places	Effective	MUN	
Consultation with users (direct or indirect)	Limited	MUN	
Information provision	Limited	PTO	
Marketing	Not attested	PTO	
Demand, traffic and incident management	Effective	MUN/OCA	
Monitoring the indicators and road safety	Effective	Traffic Police?	
Audit of the adequacy of signs	Effective	Traffic Police?	
Mobility management (accessibility, walking/cycling, car/bike sharing, parking policy)	Effective/Emerging	MUN	
Design of contract and awarding of transport services	Effective/Emerging for contracts	OCA	**Contract Management: Partial (timetables); to be developed.**
Monitoring of compliance with contract's terms	Emerging	OCA	
Quality management, evaluation of level of services and users' satisfaction	Level of service essentially	PTO/OCA	
Standards definition: stock, rolling stock, stations	Limited	PTO	
Fare policy	Effective	OCA	**Financial tasks: Partial and to be developed.**
Ticket sales	No	PTO	
Fare revenue management	No	PTO	
Subsidy allocation management	Effective	OCA	
Investment in infrastructure, rolling stock and systems	Effective (pub. assets)	PTO/OCA	
Local transport tax: interaction with traffic limitation measures	Not attested	OCA	
Pricing strategies (I. e. congestion charging): interaction with traffic limitation	Limited	OCA	
Tax for the added value due to new infrastructure (see utility tax)	Not attested	OCA	
Infrastructure (stops, terminal Sat., depots, fleets…)	Limited	PTO/MUN	**Ownership: Limited (except acquisitions under current foreign loans)**
Ownership of systems (telematics, ticketing, information boards)	Limited	PTO	
Land use issues	Limited	OCA	**Land Use, Environment and Development: Limited but emerging**
Environmental (air pollution, noise, energy consumption, etc.) and development issues	Limited	OCA	

Source: JICA Expert Team

According to Table 6.1.6, the MOT performs effective planning and transport and traffic management tasks. Obligations of operators are defined through timetables. However, since contracts with operators have not been established yet,[24] the contact management-related functions are identified as “to be developed” (see Section 6.3).

The MOT is indirectly in charge of managing the assets mentioned, unless in the case of

[24] Only one contract was signed with CENTROTRANS to assume the bus service (one line) during tramway infrastructure construction work (line 2 (Cengic vila- Bascarsija).

cantonal roads and through the Road Directorate (see Sub-section 6.2). So far, there is no evidence that the MOT deals much with land use issues aside from its participation in the preparation of the urban plan 2036 and in specific construction works (parking, etc.). The environmental aspects linked to traffic and public transport are a growing concern. Besides procurement of low emission vehicles and coordination with the cantonal ministry in charge of the environment to develop more sustainable mobility, the MOT considers developing low-emission zones with the support of Spain.

Third-country training (TCT) in Lyon and Grenoble enabled learning about the detailed practices of two public transport authorities, the SYTRAL Mobilités (Lyon) and the SMMAG (Grenoble).[25] Compared with Grenoble, the staff of SMMAG is more than triple that of MOT staff (the size of the two cities is comparable), which explains its capacity to develop a wider scope of tasks. Also, both SYTRAL and SMMAG represent being the owner of the assets, while in Sarajevo, the MOT does not.

The LPTP relatively clearly defines the functions of the MOT. However, there is no explicit mention of the "regulatory functions" of the ministry. Clear but limited consideration is given to aspects such as the public transport operation market, competition, etc., taking into account the existing regulation for public-owned enterprises and the EU regulation of public services. In the LPTP, the reference to the Law on Concession is eventually very appropriate, but the link between this and the LPTP could be more developed through a specific rulebook, for instance, regarding monitoring of concession contracts aspects as part of the regulatory functions of the MOT.

After several years of difficulties for GRAS to assume its service, it is urgent to recover the residents' confidence in the public transport system by providing a reliable and performing service. From this perspective, the MOT has a leading role in developing specific regulatory functions as the public transport authority, which requires staff increase and acquisition of new skills.

4) Orientations for the MOT

(1) The Approach

The most critical and short-term priority for the MOT could be the solution to the GRAS financial crisis. Because of the limited public budgets and skilled human resources, the development of regulatory functions within the MOT should be progressive. This development should align with the spirit of the LPTP, which clarifies MOT prerogatives. There is no evidence today that radical changes (such as shifting to another scheme for regulatory functions as the four possible options indicated in Table 6.1.10) would improve public transport's performance. Several options (involvement of the municipalities, creation of an independent body, etc.) might face institutional and political obstacles. Progressivity means 1) strengthening the regulatory functions from the existing relatively stable and performing scheme represented by MOT's exclusive oversight of cantonal public transport (except railways) and the net cost contract system, and from this, 2) consolidating during the coming decade more perennial bidding processes (for bus/microbus services) and contractual arrangements with operators. Orientations provided by recently enacted regulations represent a framework that largely fits the need to improve public transport

[25] SYTRAL: Syndicat des Transports de l'Agglomération Lyonnaise ; SMMAG: Syndicat Mixte des Mobilités de l'Aire Grenobloise.

organizations.

A first series of initiatives (see below) could target 2024–2025 (approval time) up to 2030 (start of implementation) without a change in MOT's institutional framework. The internal organization in three main sectors seems suitable to the arrangements proposed in this chapter if the close collaboration between sectors perdures and intensifies between the three key dimensions they represent: public transport operation, traffic management, and long-term planning (capital investment planning in particular). The current Transport Sector and, particularly, the DPPT (regarding operation specifically and contract implementation) should be the main entity concerned with public transport regulatory functions. But the other two sectors also develop skills and experience in areas of competence often well developed in other public transport authorities abroad, particularly in the EU, as mentioned above.

One crucial aspect is developing a bidding procedure to select operators. The LPTP develops a general scheme for the procedure that should fit with the regulation, whatever the option is (see section 6.3). This law also defines some conditions for bidding that virtually exclude small operators (Chapter 4). Although the MOT recently got significant experience in procurement for large projects (including international competitive bidding), selecting service providers at a large scale is another matter, and the MOT has no previous experience. Perhaps the MOT could approach the EMTA[26] to speed up the transfer of experience process. The important points are:

- The technical and ethical quality of selection committees: For instance, in the case of a non-concessionary scheme[27] in the LPTP, regarding members of the Commission for Public Invitation (see Table 6.1.5) and the functioning of this Commission.
- The financial capacity of the operator and its financial resilience to unexpected lower revenues generated by the service and its capacity to manage its own human resources, particularly, drivers and maintenance staff.
- The need to organize tenders for enough lines due to the heaviness of the procedure to comply with bidders.
- Possibly the need to mix as subjects of the tendering process presumed profitable and non-profitable lines to ensure that these latter (minibus in particular) will get an operator.

Internal re-organization of the MOT is not a priority today. Yet, the LPTP could adjust by mandating a Public Transport Regulatory Committee, chaired by the Minister of Traffic and composed of the three assistant ministers with the DPPT Head as secretary, to streamline the contribution of each sector to the implementation of the regulatory functions, and the creation of a specific budget line for these functions.

As a general principle, strengthening the capacities of MOT should be well understood and supported by the main stakeholders[28] of public transport and, firstly, the operators.

[26] European Metropolitan Transport Authorities (34 members, including SYTRAL and the Secretariat for Public Transport of Belgrade). See: https://www.emta.com/
[27] For Concessions, the establishment of a Concession for Commission is also described in the Concession Law (art. 13)
[28] Including other cantonal ministries, for instance, through a data sharing platform (assets, traffic volumes, survey results, etc.).

Inevitably, developing regulatory functions will also represent additional burdens but benefits to the performance of the entire public transport system. The cooperation of operators is critical, for instance, regarding information costs of any project embarking on fleets of MOT and monitoring equipment for data collection purposes.

(2) Proposed Initiative by 2024–2025

In many respects, a large part of the detailed arrangements to implement the regulatory functions will depend on the decisions to be taken regarding the future of GRAS and the status of the new public operator(s) as a canton-owned company.

In the next 2-3 years, and through regulatory (e.g., rulebook), budgetary (permanent staff recruitments), and organizational initiatives, the SCG can officially confirm MOT's regulatory functions, tentatively formulated in Table 6.1.7.

A policy document on public transport development approved by both SCG and the Cantonal Assembly can explain the rationale and objectives of public transport regulatory functions in the context of organizational strengthening through contracts with operators. This document can lead to amending the LPTP to explicitly mention the regulatory functions (Section 6.2) to secure their yearly financing legally by the canton (payrolls, external expertise, software and hardware, vocational training) through a specific budget heading.

Table 6.1.7 Proposed Regulatory Functions of the MOT by 2024–2025

No	Functions
1	Oversight of the management of land transport modes in Canton (railways excluded), traffic and parking, transport/mobility planning
2	Administer delivery/suspension/revocation of licenses to operators, develop a certification system for lines and companies, etc.
3	Administer the bidding process to select operators
4	Preparation and implementation of public transport operation contracts with both private and public service providers (see 6.3) and in line with the regulation (in particular, timetables)
5	Regular monitoring and evaluation of fare revenue collection & management scheme, proposal of fares setting modifications (including zoning and fares subsidies), and regular reviews/analysis of the public transport service (full) costs;
6	Prepare and manage fare revision mechanisms (to be approved by the SCG) considering expected operation cost increases
7	Formulate service performance indicators/metrics and KPIs (see box) and develop a benchmarking-oriented framework
8	Methodological guidance regarding reporting mandated by operators (indicators, user satisfaction survey methods, etc.).
9	Monitoring of users' satisfaction and level of service; Arbitration of occasional disputes (disputes between operators, users) with conciliation mechanisms made available to the public;
10	Prospective studies in line with strategic planning, for instance, studies on specific taxes to finance public transport or employer incentives to encourage it as a joint with the MOF and the Ministry of Economy
11	Oversight of transport assets declared public goods in 2021 if confirmed by the court: tracks and contact network/catenaries
12	External communication, public relations, and encouragement to operators to develop customer charters (as in Oslo or Ireland)

Source: JICA Expert Team

Performing well these regulatory functions requires staff. Indeed, the SCG currently makes efforts in this direction. However, many new positions in the amended rulebook (September 2022) concerned the Road Directorate (legal affairs, procurement, advisor for cadaster, GIS). As mentioned earlier, this rulebook considers a substantial number of positions, several of which are at the core of regulatory functions, e.g., monitoring of timetables, tariff system, or project management. As considered in Sections 6.2 and 6.3, several areas of operational competencies (staff to be recruited in accordance with the rulebook or further recruitments) are likely needed by 2030 to strengthen MOT's functions as a public transport authority:

- Area 1: Public transport operation cost control and public transport assets management;
- Area 2: Legal affairs in relation with contractual matters linked to public transport operation (see section 6.2);
- Area 3: Transport economics, in particular in relation with land use and environmental aspects;
- Area 4: Information and communication technologies systems and digitalization (not only public transport of passengers but also development of MaaS-related applications);
- Area 5: Public relation and potentially grievance redress mechanisms; and
- Area 6: Transport demand modelling and microsimulation.

In the short term, there is a clear need expressed by the MOT for Areas 4 and 6. But, in addition, and from a regulatory function strengthening perspective, Area 1 and Area 2 are considered by the JICA Expert Team as essential. For Area 2, external legal experts should support the MOT at the contract elaboration stage, but internal skills will be required to monitor the contract implementation, not excluding external outsourcing of legal expertise to confirm discrepancies between the effective operation of the service and the terms of the contract).

All these areas may not require high senior staff, but previous professional experiences will be a great plus. Further recruitment, in addition to those indicated in the rulebook, seem inevitable. As highlighted relevantly by the MOT, along with discussions with the JICA Expert Team, they should be gradual and correspond to prioritized needs. In the next 2–3 years, Areas 1 and 2, together with Areas 4 and 6, are eventually priorities. Enhancing MOT capacities also requires methodological knowledge transfers through the assistance of external consultants.

Developing the functions listed above will have a cost: direct recruitment by the MOT, specific surveys and studies (sub-contracted), management software, embarked monitoring systems, legal expertise, training, and external communication (publications, events, etc.). The Cantonal budget should finance the costs. Specific financing mechanisms could also cover some of these costs (part of the mobility tax if such is established, concession fees paid by operators, etc.).

Regarding the recommended establishment of a transport authority, PWC and ITP (2019), it was estimated two years is necessary time for preparation and three years for implementation. The JICA Expert Team suggests an alternative timeline.

- There is no urgent need to establish a specific transport authority if the MOT is mandated to assume regulatory functions. Time to spend on institutional arrangements shall be saved.
- One to two years could be necessary to develop contractual arrangements. This

period is also needed to complete ongoing structural transformations[29] and to take policy and regulation initiative if their need is confirmed.[30]

- The process of strengthening regulatory functions should be gradual. After a tenth of the year, contractual and compliance monitoring arrangements for these functions can be adapted further (see Table 6.1.8 as an illustrative example of service performance indicators used in another city).

Table 6.1.8 Illustration from TCT in Lyon: The 9 Categories of Service Performance Indicators Used by SYTRAL Mobilités (2022)

These indicators, monitored regularly, go together with an annual system of bonus/malus to benefit or penalize financially the operator. 1. Service regularity/punctuality 2. Information to passengers 3. Cleanliness 4. Relation with customers 5. Comfort 6. Accessibility to the network 7. Fraud 8. Rate stamping of travel ticket/pass (bus) 9. Rate stamping of travel ticket/pass (metro/tram)

Source: SYTRAL Mobilités, 2022

(3) Recommended Scheme to Perform Regulatory Functions

Overall, a pragmatic approach is recommended: the scheme only consists in developing the regulatory functions without changing the current organizational framework in prioritizing the MOT capacities strengthening and systematic contractualization of the public transport service. Current arrangements as per the LPTP are overall very relevant, and the development of regulatory functions should not mean an institutional concern in addition to the other impending concerns, first of all, the future of GRAS. The pros and cons of these recommended options are presented in Table 6.1.9.

Table 6.1.9 Pro and Cons of the Recommended Overall Scheme in the Next 8-10 years

Options	Advantages and Opportunities	Objections, risks or difficulties
Recommended scheme (RS) for the next 10 years A - To keep the arrangement as existing (regulatory functions under MOT, in particular, DPPT - exclusively)	- No major organizational change or modification of the MOT internal chain of command - Existing MOT team experienced and working in a collaborative spirit - Regulatory functions not disconnected from other functions of the MOT (e.g., preparation of policies and regulations) - Affirms the oversight of the public transport by the MOT - Limits transaction costs (to achieve consensus between local governments))	- MOT staff remains committed to other tasks than regulatory functions. This may slow down the development of regulatory functions unless additional staff is provided. - Unlike in the case of independent regulators, regulatory functions through MOT remain essential tools in SCG's hand and, therefore, subject to excessive political interferences - Lack of resources allocated to MOT to assume regulatory functions

Source: JICA Expert Team

(4) Longer-term Organizational Schemes to Perform Regulatory Functions

Later, the decision to adopt the scheme recommended for the next 10 years should result from regular evaluations.[31] This may lead to reconsidering the recommended scheme after 10 years. Several options are possible, as reflected by foreign experiences. Whatever the

[29] Current investments in fleets and infrastructure, tariff system reform, GRAS problem conclusion, users' satisfaction, and willingness to pay higher fares.
[30] Public transport policy statement, amendments to existing laws, and MOT rulebook (required for creating new positions within the ministry according to Art. 10 of the Law on Civil Servants in Canton Sarajevo, etc.
[31] This would possibly include external evaluation mandated by the MOT as transport authority and inspections made by the Inspectorate for Traffic and Roads of the Cantonal Administration for Cantonal Inspection Affairs

option, it should suit the particularities of the public transport/mobility sector in Sarajevo at that time.[32] Table 6.1.10 presents the pros and cons of four of these options from the understanding of the present context. Options were ranked according to their decreasing feasibility and relevance as they can be estimated today. This ranking is tentative.

The long-term evolution of the organizational scheme should be guided by the necessity to perform the regulatory functions under the development strategy of Sarajevo and with the evolution of the general governance-related context (such as a stronger involvement of municipalities in the mobility policy; see possible option PO 3 in the table).

Table 6.1.10 Brief Considerations about Long-term Options for Regulatory Functions Scheme

Options	Advantages and Opportunities	Objections, risks or difficulties
RS for the next 10 years A - To keep the arrangement as existing (regulatory functions under MOT- in particular DPPT - exclusively)	As in Table 6.1.9	As in Table 6.1.9
Possible option after 10 years (PO1) To establish a semi-autonomous Transport Regulatory Unit under direct MOT's supervision JICA Expert Team general comment: To be considered only after recommended scenario is successfully implemented. JICA Expert Team general comment: Option 1 is interesting only if it facilitates further professionalization of the regulatory functions (and fare collection by the authority in the future?)	- Facilitate the delineation of regulatory functions, their cost, and their evaluation - Staff more efficient because exclusively dedicated to these functions - Represent a gradual evolution of Short-term Recommended Scheme above	- Same as above, plus: - Possibly the semi-autonomy will remain virtual, for instance, in terms of recruitment policy and effective influence on fare setting - Functional difficulty to separate the DPPT and the regulatory unit.
Possible option after 10 years (PO2) To establish a separate regulatory body for public services tariffs only under the joint-oversight of three Ministries of 1) Budget, 2) Traffic 3) Utilities – JICA Expert Team general comment: Not recommended today (in particular because of the risks of disconnection between technical and financial aspects)	- Comprehensive vision of the tariffs (and therefore costs) of the different utilities and development of a coherent approach of tariffs for all utilities as defined in the Law on Communal Activities - Stimulate among ministries a shared understanding of the use of public cantonal assets (performance of services, maintenance costs, etc.)	- Requires a total reform of public tariffs in all sectors - Risk of disconnection between technical and financial aspects - The coherence of tariff policies seems not a priority today for public transport
Possible option after 10 years (PO3) 3 - To establish a Transport/Mobility authority with MOT and Municipalities involved in its governance (appointed representative members of the board of the authority) JICA Expert Team general comment: Option 3 fits with progress in local governance and with principle to share the financial burden with municipal budgets; but challenging if all municipalities excessively politicize PT-related issues	- SCG, represented by the MOT, can keep a large number of shares and be granted veto power on several subjects - Makes possible the contribution of municipalities to the financing of regulatory functions - Fits more with the principles of local governance as followed by many EU countries - Participation of municipalities may represent a driving force to give more importance to transport users and residents in the regulatory process - Regulatory functions more "visible" to residents	- This option seems not consistent with the current cantonal regulation or even the constitution as existing - Requires a well-designed scheme effectively inclusive of the various interests of the 9 municipalities to avoid excessive "capture" by the MOT or conversely, impossible decisions due to conflicts with / between municipalities (risk of politization of the regulatory function affecting its action)
Possible option after 10 years (PO4) To establish a separate cantonal PT	- Same as PO1, plus: - The entity is encouraged to be more cost	- The entity must be empowered by a cantonal law, which may be

[32] These options do not consider structuring the public transport sector, which may have some incidence on the regulatory scheme. For instance, it might be decided in the future to separate public assets ownership from operation by establishing a separate body in charge of regulatory functions and public transport assets management.

Options	Advantages and Opportunities	Objections, risks or difficulties
regulatory board entity under a Board of appointed independent Commissioners, following the ROŽBIH model for railways at national level. Option 4 should not fit with national and entity laws. JICA Expert Team general comment: No evidence that ROŽBIH model is relevant to Canton Sarajevo. Risk of disconnection with other cantonal prerogatives (urban planning, environment, utilities, etc.)	effective - Clearer identification of regulatory functions costs - Opportunity to recruit staff with managerial/business culture - Affirms the desire to grant more autonomy to the regulator vs excessive political and administrative interferences - Regulatory functions are eventually more "visible" to residents	difficult to get promulgated - This may lead to change the status of MOT staff transferred under this entity (resistance from MOT staff and from the MOT itself) - The experience of the ROŽBIH may not be so positive (more inquiries needed)

Source: JICA Expert Team

6.2 Division of Roles between the Public Transport Regulator and Operators for Fleet and Infrastructure Management

1) Procurement, Ownership and Heavy Maintenance

(1) General Considerations

This sub-section is not limited to the project cycle and encompasses financing, payments of suppliers, and O&M aspects. The arrangements proposed comply with the principle of managerial independence of all enterprises ensuring public transport operation, including in the case of canton-owned enterprises. Political and administrative interferences in the management of fleets and infrastructure should be avoided, and the obligations of operators should be defined contractually (alternatively, through a regulated competition model as developed in Japan; see Section 6.3).

Notably, the current model of public enterprises in Bosnia-Herzegovina is affected by structural financial weaknesses.[33] The model might be reformed or adapted in the future through regulation measures to improve their financial situation, including the urban public transport sector, for instance, facilitating recapitalization through increased equitization of these companies or developing joint ventures as done in Republic Srpska or attempted in Canton Tuzla. In the case of Sarajevo's public transport, these aspects are currently considered by the consultant Deloitte under EBRD financing.

In addition to the arrangements described below, evaluations should be conducted by the MOT[34] at least when public initiatives and projects are concerned (e.g., purchase of vehicles financed by loan contracted by the SCG).

However, the decision to renew the fleet should remain under the operator rather than the MOT's discretion, especially if the ministry assumes parallel regulatory functions as defined in Section 6.1.

In the next five tables (6.2.1 to 6.2.5):

- It is assumed that a specific new public company, named KJKP JPS below, or Sarajevo Public Transport Company (SPTC) will be established by the Canton Sarajevo to own and operate the tramways and trolleybus and related infrastructure and depot and to be delegated the ownership by the Canton of those infrastructure

[33] See Cegar B., Parodi F. J, 2019, State-owned Enterprises in Bosnia and Herzegovina: Assessing Performance and Oversight, International Monetary Fund Working Paper WP/19/201.
[34] By commissioning external and independent evaluators and following the public procurement process

which were declared as public goods in 2021. This establishment is not yet confirmed.

- Consultation, as understood in the tables, may have various purposes: to get approval, non-objection, or just opinions. A more detailed review of laws and complex regulations would be needed to map all organizations concerned exhaustively and specify the expectations from them (approval, non-objection, general or specific opinion, etc.). As indicated in the tables, consultation aims to stimulate constructive collaboration between operators and SCG administrations, particularly the MOT, in the interest of the overall public transport performance and satisfaction of users.
- "Consultant" refers to various sources of expertise. Besides consulting firms, the term designates also academic expertise, experts from other public institutions (national or foreign), individual experts, etc.

(2) Tracks and Catenaries

Tracks and catenaries are located on public spaces, namely roads. The Law on Traffic Regulation in the Area of Canton Sarajevo (2022) clearly states the cantonal ownership of these facilities and the responsibility of the tram/trolleybus operator to maintain these facilities (Art. 90).[35] Up to the Cantonal decision to proclaim these assets as common good and natural wealth (June 2021), these assets were recorded as ownership of GRAS in its accounts. If the Court confirms their new status of these assets, their use could be subject to a concession contract as defined by the Eponym Law, with payment of fees by the concessionaire (KJKP JPS) to the SCG. The company would ensure the extension, renewal, and maintenance of the assets.

The Law on Traffic Regulation in the Area of Sarajevo gives provision regarding the definition of land areas along the tracks: 6 meters on each side. These areas are not in the tramway operator's ownership, but the delivery of any building permits for other purposes than the tram service is subject to the operator's approval.

Article 37 of the Law on Communal Activities (2016) highlights SCG role in the financing and acquisition of fixed assets – and this includes tracks and catenaries of which fungibility is very limited (catenaries) or quasi-nil (tracks).

Table 6.2.1 Tracks and Catenaries

Roles	Responsibility	Consulted Organizations	External technical assistance when necessitated
1. Assets ownership	CS (through MOT)	MOF/KJKP JPS	Consultant (technical / financial / legal)
2. Maintenance and renewal planning	KJKP JPS	MOT, other relevant ministries, municipalities concerned,	Consultant (technical)
3. Heavy maintenance/renewal	KJKP JPS	MOT	Consultant (technical)
4. Service operation and maintenance in routine	KJKP JPS Considered in public service contract (with	MOT, other operators, Municipalities, electricity supplier	Consultant (technical / financial / legal)

[35] See also Sarajevo Institute of Economics, 2021, Study on Socio-Economic Justification of the Establishment of a New KJKP for the Provision of Tram and Trolleybus Public Transport Services.

Roles	Responsibility	Consulted Organizations	External technical assistance when necessitated
	SCG) monitored by MOT		
5. Financing of renewal (and loan repayment)	KJKP JPS or SCG (on-lending to KJKP JPS	MOT, MOF, federal & national governments, external financers when relevant (development aid)	Consultant (technical/financial)
6. Payment of renewal suppliers and contractors	KJKP JPS	-	-
7. Extension: Design (basic + detailed)	KJKP JPS (in accordance with spatial and urban plans approved by the Canton)	MOT / incl Road Directorate - JP Cesta Cantona Sarajevo	Consultant (technical)
8. Extension: Identification of suppliers/ Contractors and preparation of tendering documents	KJKP JPS	MOT Other: relevant ministries / Municipalities	Consultant (technical)
9. Extension: Selection of suppliers or contractors	KJKP JPS / SCG Specific Tendering Committee (Secretariat: MOT)[36]	MOF/Inspectorate of Traffic and Road Inspection	Consultant (procurement)
10. Extension: Supervision of works / Inspection / Certificate of Satisfactory Completion	KJKP JPS	MOT	Consultant (technical)

Source: JICA Expert Team

(3) Trams and Trolleybuses Fleets and Relating Depots

Table 6.2.1 indicates the arrangement recommended. It does not concern the current EBRD financing scheme where SCG directly procures the vehicles financed by an EBRD loan.[37] According to the regulation, the fleet should be under the ownership of the operator. KJKP JPS should assume the responsibility to purchase and renew or modernize/extend (depots). This responsibility requires close consultation with other entities, particularly the MOT.

When the acquisition of vehicles or the extension/renewal of facilities is financed through governmental borrowing, the public operator should assume their reimbursement following an on-lending scheme. The on-lending conditions should consider two opposite aspects. On the other hand, the evidence that tram and trolleybus lines are the most profitable in Sarajevo justifies minimizing preferential on-lending conditions. On the other hand, preferential on-lending conditions would encourage the development of specific types of vehicles (e.g., low emission). Whatever, the current financial crisis of GRAS made experts [38] and SCG considering rather positively the mere donation of these purchased trams and trolleybuses to the (new) public operator.

Table 6.2.2 assumes that the KJKP JPS is established. In its business plans and corporate development plan, the operator should consider the development of a CCMS, and if possible, a comprehensive AMS in close relation with the MOT.

[36] Per the Law on Public Procurement of Bosnia and Herzegovina ("Official Gazette of BiH," No. 49/04, 19/05, 52/05, 94/05, 8/06, 24/06 and 70/06)
[37] Probably under an on-lending scheme with national and federal governments: to be confirmed.
[38] See, Kesetovic I., Advic A., 2021, Study for Adoption and Plan of Financial Restructuring of KJKP "GRAS" doo Sarajevo.

Table 6.2.2 Trams and Trolleybuses Fleet

Roles	Responsibility	Consulted Organizations	External technical assistance when necessitated
1. Assets ownership	KJKP JPS	MOF/MOT	Consultant (financial/legal)
2. Maintenance and renewal planning	KJKP JPS	MOT	Consultant (technical)
3. Heavy maintenance/renewal and financing	KJKP JPS	Suppliers, MOT, Feedback from transport users	Consultant (technical/CMMS)
4. Service operation and maintenance in routine	KJKP JPS	MOT, other operators, municipalities, power supplier	Consultant (technical/management)
5. Financing of renewal (and loan repayment)	KJKP JPS (on-lending of part of loans contracted by SCG)	SCG (MOT/MOF), FBiH and BiH Ministries of Finance	Consultant (technical/financial)
6. Payment of renewal/extension suppliers and contractors	KJKP JPS	Commercial banks, SCG through MOT and MOF when needed	-
7. Acquisition/extension: Design (basic + detailed)	KJKP JPS	MOT, possibly consultation of other public transport operators (GRAS, ZFBiH)	Consultant (technical)
8. Acquisition/extension: Identification of suppliers/ Contractors and preparation of tendering documents	KJKP JPS	MOT	Consultant (technical)
9. Acquisition/extension: Selection of supplier or contractor	KJKP JPS. Specific tendering committee (public procurement)	SCG (MOT/MOF/internal inspection and auditing)	Consultant (procurement)
10. Acquisition/extension: Supervision of works / Inspection / Certificate of Satisfactory Completion	KJKP JPS	Relevant cantonal administration	Consultant (technical)

Source: JICA Expert Team

(4) Buses and Minibuses Fleets and Depots

Currently, vehicle acquisition can only be financed by the SCG or possibly donated (to the SCG) by other cities. By law, public transport vehicles should be under the ownership of the public operator established by the government to provide the service. For now, GRAS is unable (and forbidden) to purchase any vehicle. But whatever the outcome of the GRAS crisis, a public company should continue operating part of the bus and minibus service. The general arrangement for bus and minibus fleets and depots will be like the case of tramways/trolleybus above considered.

In the coming decade, public fleet renewals will be necessary, and the SCG will likely continue to finance them. SCG, as a stakeholder and financer, plays a key role in the purchasing process for fleet renewal and extension and vehicle/depot maintenance planning and implementation. From the operational/practical viewpoint, MOT should be vested in this role as a public transport authority. The ministry should develop the capacity to assist (methods/tools, guidance) and control (costs) and avoid interfering with the daily management of the operator and its business plans.

Before several years, it is difficult to consider the financial support of SCG to the public bus operator as biasing the competition, especially if the public bus company is obliged to operate many of the non-profitable lines. To ensure its financial sustainability, this operator might be authorized to develop non-regular public transport or non-transport-related activities. Eventually, the accounts relating to regular public transport should be separated, and a specific subsidiary company should be established to ensure standard public transport service (see Section 6.3).

Of course, the public bus company will benefit from a competitive advantage over a private competitor(s) if the government can easily access external financing to acquire vehicles requiring less O&M costs. This could possibly be corrected through appropriate on-lending mechanisms.[39]

Table 6.2.3 Bus Minibus Fleets and Depots - Public Operator

Roles	Responsibility	Consulted Organizations	External technical assistance when necessitated
1. Assets ownership	Public operator	Selling or leasing company	-
2. Maintenance and renewal planning	Public operator	MOT (strong involvement)	Consultant (technical)
3. Heavy maintenance/renewal	Public operator	MOT (lighter involvement)	-
4. Service operation and maintenance in routine	Public operator	-	-
5. Financing of renewal (and loan repayment)	Currently SCG or donations public operator in the future	Commercial banks, shareholders	Consultant (technical/financial)
6. Payment of renewal/extension suppliers and contractors	Likely SCG (on-lending?)	Commercial banks	-
7. Acquisition/extension: Design (basic + detailed)	Public operator	MOT	Consultant (technical/financial)
8. Acquisition/extension: Identification of suppliers/	Public operator. Specific tendering committee (public procurement)	-	Consultant (technical/financial)
9. Acquisition/extension: Selection of supplier or contractor	Public operator. Specific tendering committee (public procurement)	-	-
10. Acquisition/extension of depots and workshops: Supervision of works / Inspection / Certificate of Satisfactory Completion	Public operator	-	-

Source: JICA Expert Team

The case of private operators is simpler. A key condition of a successful development of the service provided by a private is its managerial independence, in particular, because it assumes most of the industrial risk (investments and O&M costs). Table 6.2.4 provides the overall picture for private transport operators in Sarajevo if these operators self-finance their fleet renewal or mobilize commercial bank loans for this purpose. The consultation with the MOT is important at the planning stage (for 3. and 4.) for the ministry to fully understand maintenance and renewal needs—and their cost.

Table 6.2.4 Bus Minibus Fleets and Depots - Private Operators

Roles	Responsibility	Consulted Organizations	External technical assistance when necessitated
1. Assets ownership	Private operator	Selling or leasing company	-
2. Maintenance and renewal planning	Private operator	MOT	Consultant (technical)
3. Heavy maintenance/renewal	Private operator	MOT	-
4. Service operation and maintenance in routine	Private operator	-	-
5. Financing of renewal (and loan repayment)	Private operator	Commercial banks,	Consultant

[39] As per Art. 2a, point c of the Law of Public Enterprises of the Federation.

Roles	Responsibility	Consulted Organizations	External technical assistance when necessitated
		shareholders	(technical/financial)
6. Payment of renewal/extension suppliers and contractors	Private operator	Commercial banks	-
7. Acquisition/extension: Design (basic + detailed)	Private operator	MOT	Consultant (technical/financial)
8. Acquisition/extension: Identification of suppliers/	Private operator. No public procurement	-	Consultant (technical/financial)
9. Acquisition/extension: Selection of supplier or contractor	Private operator. No public procurement	-	-
10. Acquisition/extension of depots and workshops: Supervision of works / Inspection / Certificate of Satisfactory Completion	Private operator	-	-

Source: JICA Expert Team

2) Physical Assets Management

Since the 1990s, an increasing number of local governments and transport authorities have developed tools to manage their assets, particularly in Northern America and Oceania. In Europe, among other examples, advanced assets management systems (AMS) were designed for railways in Stockholm or tramways in Gothenburg. Compatible with CMMS, the AMS is a decision tool combining an extensive range of dimensions (Table 6.2.5).

Table 6.2.5 Dimensions of AMS

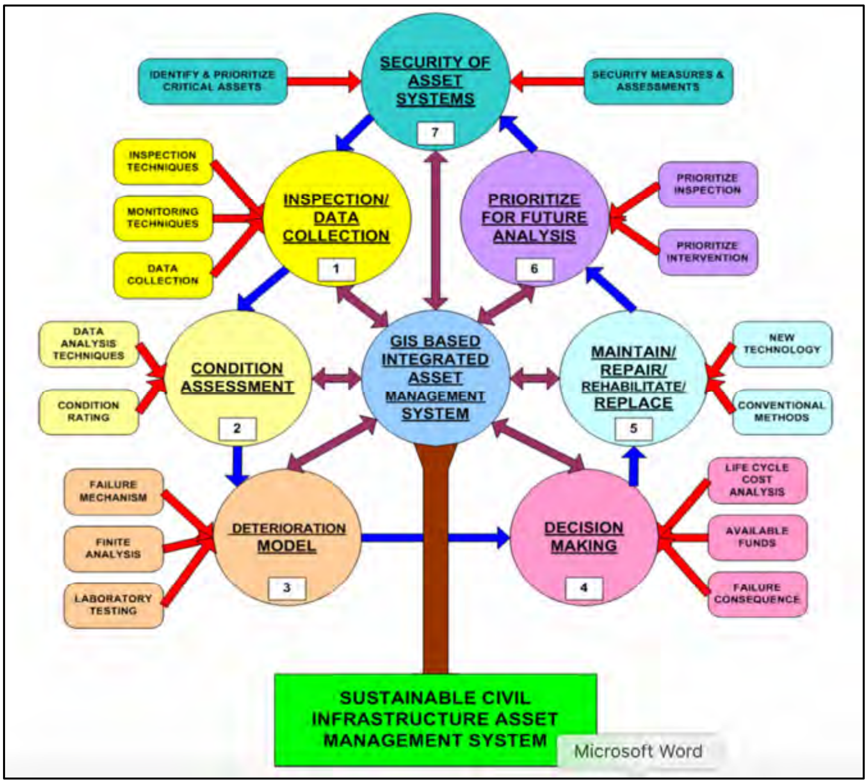
No	Management-related Dimensions
1	Policy, strategy of a city or company, and the regulation framework
2	Assets identification, registration and valuation
3	Life cycle of assets, including their final disposal or recycling
4	In depth assets costs analysis
5	Criteria of service performance and security
6	Gaps analysis, including cost effective methods to identify problems affecting the condition of assets
7	Improvement of the capital planning process through investment scenarios to maintain the targeted level of performance
8	Purchase of spare parts and consumables optimization
9	Inclusion of adaptation to technological innovation in the investment decision process
10	Coordination between human resources (enhancement of skills), technical (equipment), financial and managerial (financial, long-term development plan, business plans)
11	Internal organization (data sharing, operation procedures, decisions, etc.) and external (e.g., supply chain, external financing
12	Etc.

Source: JICA Expert Team

Digital technologies enable now local governments to considerably refine the processing and visualization of public assets-related information (detailed design, valuation, geospatial data, photos, maintenance reports, report on incidents, etc.) and facilitate decisions regarding asset management options.

Compared with a CMMS, the assets management approach is more comprehensive. It focuses more on the use and quality of service as a whole, and, of course, it helps to plan and implement repair, maintenance, renewal, and extension of physical assets. Developing an AMS requires close collaboration between stakeholders concerned through (but not only) a data-sharing system and operational collaborative platforms in the case of public transport in Sarajevo, public operators and MOT in Sarajevo.

Figure 6.2.1 represents the assets management chain in the case of municipal assets, as proposed in 2006 by scholars from the University of Pennsylvania for water facilities.[40] The figure helps to visualize the high level of integration between tasks required.



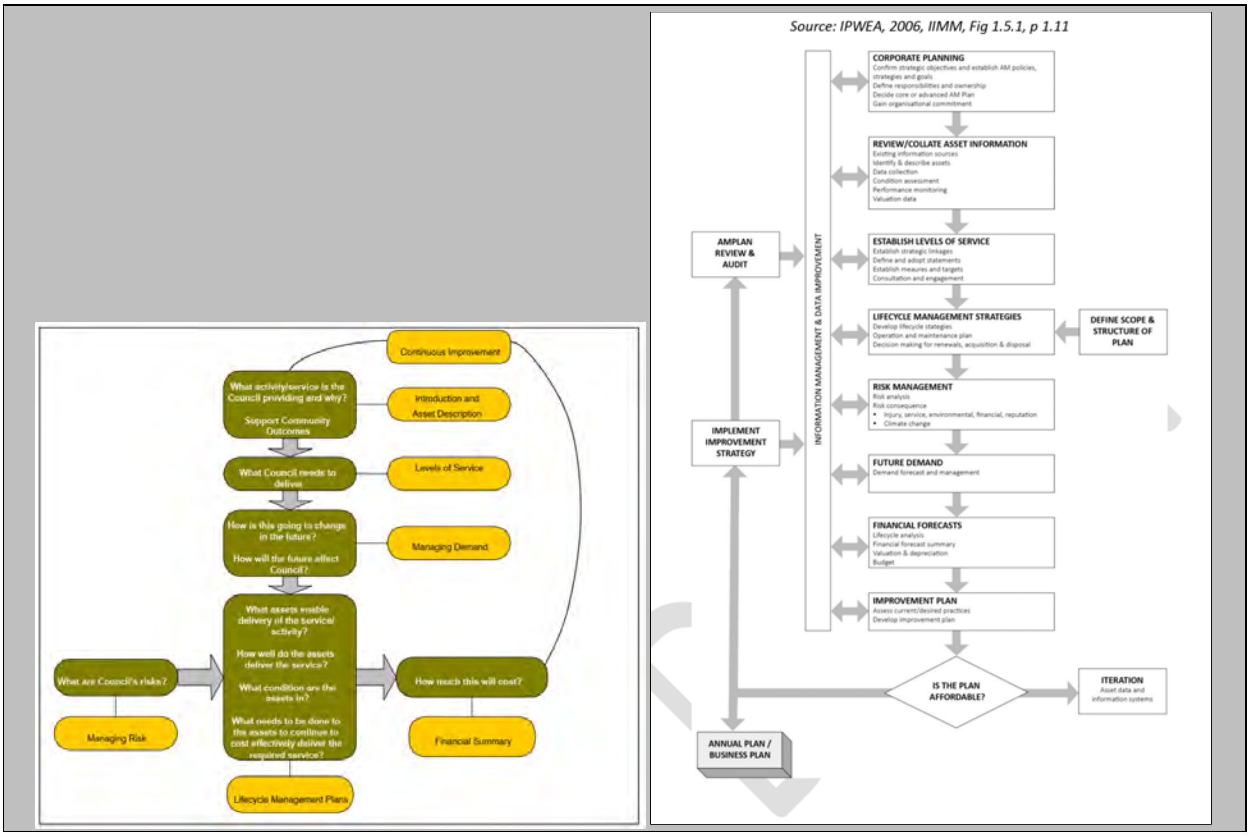
Source: Sinha, Eslambochi, 2006

Figure 6.2.1 Municipal Assets Management Chain

Implementing an assets management approach requires many years, and an AMS cannot be installed and implemented overnight. Time is needed to provide the system with information, coordinate the information sharing between the main entities concerned by the ownership and operators of the assets, agree on analysis and diagnosis methods, and coordinate with the decision chain. Developing assets management often disturbs pre-existing internal organization schemes or procedures and sometimes generates internal opposition.

Assets management requires a strategy and plan. Figure 6.2.2 represents the assets management planning process for the public transport service developed by the New Zealand City of Wellington (around 230,000 inhabitants) and the Australian city of Adelaide (around 1.4 million inhabitants).[41] It is unrelated to vehicles but the physical infrastructure. The figure illustrates how approaches and tools originated from business management can be adapted to the needs of local governments. Assets management requires the capacity to centralize a large number of existing data relating to assets (technical and financial, in particular) to define the level of service, develop assets according to a lifecycle approach (from a sustainability perspective, this should include the disposal of assets when unusable anymore), and conduct in-depth financial analysis.

[40] Sinha K. S., Eslambolchi S. S., 2006, Municipal Water & Wastewater Infrastructure Asset Management, in Bridging the Gap: An Educational Primer on Sustainable Water Infrastructure Assets Management, University of Pennsylvania, 37 p.
[41] i) Wellington City Council, 2009, Transport Assets Management Summary 2010/11 2019/20; ii) City of Adelaide, 2016, Transportation Assets Management Plan, 166 p.



Sources: Wellington City Council (2010); Adelaide Plain Council (2020)

Figure 6.2.2 Municipal Transport Assets Management Planning Processes in 1) Left: Wellington and 2) Right: Adelaide

AMS is an information system and decision support tool which enables a more optimal allocation of resources to routine maintenance, replacement, heavy maintenance, new acquisition, etc. It is directly guided by the key principles of the corporate development plan of its owner, whether company or public institution (e.g., improvement of the quality of service). Planning assets management development is particularly relevant when important recent capital investments are made (currently in Sarajevo, e.g., the new Belkommunmash trolleybuses). In the case of Sarajevo's canton-owned operators of public transport, targeting a too complex AMS is not recommended.[42]

Whatever the organization, the successful development of the assets management process necessitates a high degree of collaboration between departments: in particular technical, financial and also human resources. Public transport assets could represent the first stage of a process to develop assets management approach for all Canton-owned assets.

Regarding canton-owned public transport infrastructure and fleet, and once the decisions relating to GRAS and the new tram/trolleybus operator will be taken by the SCG, the MOT (possibly jointly with the Ministry of Finance) could:

- Stage 1 By end of Q2/2024, develop a concept paper on assets management to be submitted to the SCG. This paper would be useful to consider the internal organization of the public operators.
- Stage 2. Q4/2024-Q4/2025. Technical assistance (business management firm + IT

[42] In Lyon Metropole for instance, the operator Keolis has developed independently along the years its own (complex) AMS that the transport authority regards now as a "black box"

firm) to support public operators i) to prepare assets management strategy and plan complemented ii) to develop AMS feasibility study hosted by public operators and a monitoring framework (for MOT) iii) to prepare a tender to recruit a technical assistance for stage 3 and iv) to provide training on assets management. Possibly a grant from international agencies or foreign technical cooperation could be mobilized to provide expertise.

- Stage 3 Q2/2026-Q2/2027. Software acquisition for AMS hosted by public operators and initial development of the tool (by IT firm + software provider), comparable to detailed design in the construction sector, to tailor the needs of the operators[43].
- Stage 4 Q3/2027-Onwards. Development and full implementation of the AMS by public operators. The MOT is regularly informed about the implementation and provides comments to operators.

6.3 Private Sector Involvement in Public Transport and Public Service Contract

1) Overall Arrangement

(1) Context

This context is mainly characterized by the GRAS financial crisis and the resulting erosion of the quality of its service. However, the increasing role of the performing CENTROTRANS is a breach in the historical monopoly of GRAS on the regular urban bus service. This increasing role of the private operator combined with GRAS difficulties represents an opportunity for Canton to consider the re-organization of the service of regular transport of passengers.

The Law on Communal Activities (2004; rev. 2016) requires the price of the service[44] to cover all costs. Cost effectiveness, control and cost minimization shall be the backbone of a financially sustainable operation scheme to come, for both public and private operators. Good practices developed by CENTROTRANS, for instance regarding daily cost analysis and failures in the service line by line, could be mandated from each operator in the future, whether public or private.

The LPTP[45] defines the obligations of the operator (and the conditions to become an operator) in particular through their compliance with timetables (Section E, in particular from Art. 13). The validity of the timetable is 3 years but extensible (Art. 9). Competing for public calls requires the operator a certain number of conditions, for instance regarding the number of vehicles owned (Art.32).

Importantly, the LPTP also introduces the notion of contracts by referring to the Law on

[43] Many software tools are available on the market at a licensing cost ranging from 20,000 to 30,000 EUR. But adjusting these tools to the particular data sources and to the local needs remains time consuming at the stage.
[44] Price of utilities does not mean tariff paid by users.
[45] Article 5 Performing Public Scheduled Passenger Transportation: "*Public scheduled passenger transportation in the territory of the Canton, as a communal activity of special interest to the Canton, established by the Law on Communal Activities (...), is performed by a public company whose founder is the Canton and other legal entities registered to perform this activity, in accordance with this law*". Chapter III also details the process to select operators. Indeed, these aspects were already considered in the Rulebook (prepared in 2009 by the MOT) "on the Conditions, Manner and Specificity of the Organization of Public Regular Passenger Transport in Canton Sarajevo".

Concession. This later, which targets the transport of passengers among other activities, includes the municipally owned companies as potential concessionaires (the law mentions exceptions, but public transport is not concerned) [46].). The law also designates the MOT as the line ministry for transport of passengers (Art. 6) and the ministry should assume the control of the concessionaire's compliance with its concession contract (Art. 32).

Developing contractual arrangements was discussed several times by the JICA Expert Team, the MOT and operators; The subject was also considered during TCTs, in particular in France (Lyon and Grenoble, October 2022). Contract arrangements were already mentioned in the PWC-ITP study (2019). Both MOT officers and operators expressed a similar interest in the principle of contractualization.

(2) Toward Contractual Arrangements

The world counts many examples of public transport services provided without contract, also named "regulated competition model". Japan, where the performance of this service is uncontested, provides many of these examples. Yet, having or not contracts is largely a matter of local culture of the economic/business relation combined with local governance considerations. To this respect, Japan is specific compared with European countries. In the case of public transport in Sarajevo, the JICA Expert Team supports a contract-based system[47], and for the reasons listed in Table 6.3.1.

Table 6.3.1 Expected Advantages of a Contract-based Operation Scheme

No	Expected advantages
1	Contractual terms comply with the regulation. Modifications of the regulation may lead to revise the contract, depending on the case[48]. This is named regulatory risk and contracts can include clauses to manage this risk.
2	A signed contract attests that the parties share the same understanding of the existing regulation at the time of contract signature. This helps preventing some disputes, if misunderstandings are well clarified before this signature.
3	A contractual approach enables some flexibility along contact implementation: In general, it is easier to amend a contract than a regulation. If the regulation is constraining (e.g., timetable), the operator and the authority can agree about arrangements introducing some flexibility in the operation without derogating to this regulation.
4	A contract can include obligations not/limitedly considered by the regulation or can define obligations more precisely than the regulation (e. g.., requirements concerning sub-contractors). After some years, lessons from the contract implementation can also motivate the government to adjust/clarify this regulation.
5	A contract, through reporting and obligations of means, helps to develop a more transparent remuneration scheme taking into account service costs (operation and capital investments), and performance expected (bonus and penalties, etc.)
6	Developing similar contracts with different operators facilitates the comparison of their performance (yardstick competition)
7	Contractual arrangements can be accessible to the public (upon request; as a public document), at least its general clauses. For a public service like bus or tram/trolleybus transport, his would comply with sound local governance principles
8	A contract-based system for regular bus transport service, if successfully implemented, should generate more interest from a larger number of potential operators for the bus/minibus service in Sarajevo.
9	Contractual arrangements for public services like regular public service fit with the European regulation in particular Regulation 1370/2007.

Source: JICA Expert Team

[46] The establishment of a Commission for Concession is also mandated by the Concession Law (art. 13)
[47] Although important from an inter-modality perspective, contractualization between Canton Sarajevo or its public transport operator(s) and the ZFBiH is not considered in this section.
[48] The situation differs, depending if the operator is a domestic company or a foreign one. In the first case, it will have like to accept adjustment of the contract to national/local regulation modifications. In the second case, the parties may, in some cases, be protected international treaties against regulatory changes.

Based on the principles described above, operators should be contracted by the SCG. In principle, no difference should be made between public and private companies in the contracting process: the public transport regulator, should define the content of an operation contract and a fair competition should be organized between all potential operators.

Contracts can also concern public operators, as confirmed by the cantonal Law on Concessions. In Europe, an increasing number of governmental entities contract with their public operators, for instance in Grenoble Metropole (new arrangement) or in Berlin[49]; The Law on Public Enterprises of the Federation of Bosnia and Herzegovina does not prohibit contractual arrangements with public entities.

Contracts do not have only advantages. Developing and managing contracts is time-consuming and requires external expertise. As mentioned below, the regulation commonly requires a relatively fastidious procedure, presumably more costly than the public call procedure. It may demotivate some potential tenderers and result in costs for the authority (expertise to assist contract preparation, control of the contract, etc.) or damaging results on the service (delay in the commencement). One notorious risk for authority along the life of the contract is linked to the asymmetry of information accessible to both parties (in particular, regarding technical aspects).

(3) Important Aspects of the Contract

(a) Applicability of Existing Laws

Both the LPTP, the Law on Concessions and the Law on Communal Activities combined represent a favorable legal environment to make applicable contractual solutions for regular public transport of passengers[50]. In the LPTP, reference made to the Law on Concessions, and concessions as an alternative to public call for the service of bus lines (public procurement regulation) was likely purposely.

Alternative legal solutions could have been:

- To use the cantonal Law on Public Private Partnership as a legal framework for a PPP contract. This makes possible contracts from 5 to 30 years. But, unlike the Law on Concession, this law can only concern private entities (as private parties) and municipally owned companies are considered as public parties. Therefore, this law does not fit to the cases of tram/trolleybus and bus public operators. This may lead to substantial difference between contracts arranged with, respectively, public and private operators and make difficult to adopt a benchmarking approach.
- To proceed according to the existing regulation of public procurement, which includes public transport service. However, the Law on Public Procurement of Bosnia and Herzegovina (2014; 2022), excludes this service when another operator provides the same type of service in the same area (Art. 81)[51]. The mention of the procedure of public call (*javni poziv*) described in the LPTP was eventually justified

[49] The operator is the municipally-owned Berliner Verkehrsbetriebe (BVG)
[50] Article 3 of this law (2002) defines the concession as “the right granted by a conceding party to provide the construction of infrastructure and/or services and to exploit natural resources under terms and conditions agreed on by Conceding Party and Concessionaire”.
[51] Interestingly, this law mentions of framework agreements, a concept possibly relevant for operation of multiple bus and microbus lines, but these agreements should not exceed more than 4 years (Art. 32).

by the specific context of incapacity of GRAS to operate the lines tendered.

Overall, and to develop a similar comparable contractual framework for the public and the private bus and microbus operators seems the concession scheme as defined by the Law on Concession and, if possible, for both public and private bus operators.

This being said, the Law on Concession is likely not the panacea. Firstly, it remains relatively general[52] and its requirements are demanding[53]; and a concession must be approved not only by the SCG but also by the Cantonal Assembly. Secondly, the staff of public operator(s) may consider a concession contract as a virtual privatization and oppose to it. Thirdly, the requirements of this law should generate an intensive workload for both parties (preparation of concession agreement and its monitoring). In other words, it may not be appropriate to develop concessional schemes for a handful of small lines only. This law cannot be applied for only a few lines and/or from time to time. Some aspects, such as the status of staff of the public operators under the concession regime, require further consideration in the contracts.

Moreover, the concession scheme means that the bus/minibus operator is financially strong enough to assume the required responsibility. Presumably this condition is satisfied in the case of the private (CENTROTRANS today), not for the public operator (GRAS today). A solution to ensure fist minimum of financial sustainability of bus operation under public operator should be found first (addressing the GRAS debt problem). In the meanwhile, the resort to public calls to allocate lines is eventually the only temporary solution before developing concessions scheme simultaneously with the public and the private.

The tram/trolleybus is a different case. The KJKP JPS will keep the monopoly of the service and the LPTP makes competition impossible. The tendering procedure mandated by the Law of Concessions is irrelevant to the case of the KJKP JPS. Yet, it could be relevant to develop a long-term contractual arrangement with SCG similar to those developed for bus operators.

(b) Contract Content

The Law of Concessions defines the content of concession contracts (Art. 21). This includes a draft contract agreement (as one of the tendering documents).

The content of the contract implemented in Grenoble Alpes Metropole between 2013 and 2021, slightly adapted to the context of Sarajevo is proposed in Appendix 4.3. Although the assets ownership regime differs in the two cities (and the remuneration of the operator is of a gross cost contract-type in Grenoble), it is proposed for Sarajevo that the contractor regularly reports to the contracting authority (SCG through the MOT) heavy maintenance activities and renewal planning and achievements, as it does in Grenoble Alpes Metropole. One also notes that Art. 30 relates to the company specifically established to operate the service.

(c) Instruction Process and Contract Holders

For each contract, the parties should be the SCG on one side and the bus transport operator

[52] To get an extensive view of the aspects encompassed by a concession in the EU, one can refer to the Directive of the European Parliament and of the Council 2014/23/EU on the Award of Concession Contracts, dated 26 Feb. 2014.

[53] The MOT, as other ministries, must prepare a three-year and annual concession plan for granting concessions; they must also justify the need of concession.

on the other side. This is very clearly stated in the case of a concession contract. Contracts should be prepared by the MOT with the support of external consultants and reviewed by a commission[54], approved by the Cantonal Assembly and signed by the Prime Minister.

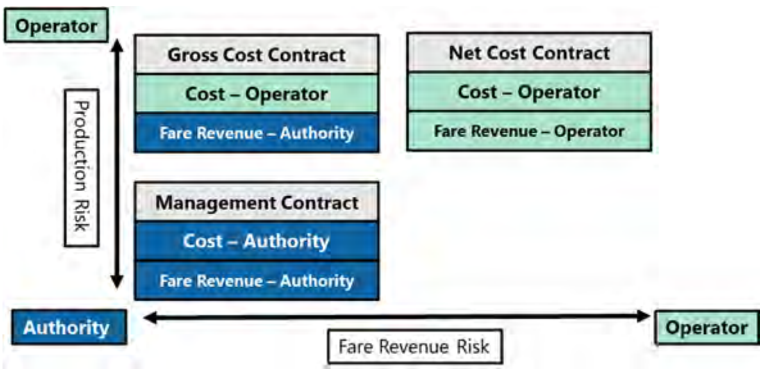
(d) Ringfencing and dedicated operating companies.

It is essential to ringfence the accounts relating to the urban and regular bus transport of passengers in order to develop a viable concession fee scheme. Concessionaires, as companies, should also be able to develop separate business lines more profitable than the public transport public service. This double concern is reflected by the LPTP through the requirement of separated account (Art. 33). But controlling the effectiveness of separated accounts might be complicated in practice. A more radical solution (heavier to develop but more "secured" from a control/auditing viewpoint) is to require from all bus operators, private but also public[55], to establish a specific entity to operate the service subject of the concession contract.

(e) Remuneration of the Operator

The current system is of a "net cost" type: operators collect fare revenues and apply monthly for transfers from the SCG of amounts of fares relating to categories of officially subsidized passengers. In the next 8-10 years, maintaining the "net cost" arrangements is recommended because simpler to manage and also suitable to the regulation on concessions. After this period, spent to develop further MOT's capacities and a financial solution to ensure a minimum financial viability of the bus public operator(s), a shift toward a gross cost contract-based scheme could be considered.

Figure 6.3.1 illustrates the difference between the two schemes in terms of risk sharing, the operator assuming higher risks (production and fare revenue) in a net cost contract.



Source: JICA Expert Team

Figure 6.3.1 Gross Cost and Net Cost Contracts

Table 6.3.2 presents a summary of the pros and cons of the two contractual mechanisms.

[54] Commissions are required by both the Law of Concession, the Law on PPP and, as mentioned in section 6.1, the LPTP, but differ in their organization

[55] In the long-term however, a diversification of the business lines of the public operator(s) is probably desirable (e. g. gains from advertising, cross cantonal transport, etc.) and, to a certain extent, for financial reasons. Actually, in its status, GRAS can develop a series of activities not limited to public transport of passengers.

Table 6.3.2 Net Cost and Gross Cost Contracts: Pro and Cons in Brief

Pro/Cons	Net Cost Contract		Gross Cost Contract	
	Authority	Operator	Authority	Operator
Pros	Authorities can leverage the knowledge of operators (market development, service design, etc.)	More opportunities for innovation and new ideas can be introduced	Changes to the services can be made easily	Lower impact of external shocks and revenue risk
Cons	Less involvement in operators' performance Risks of cutting less profitable lines	Revenue and cost risks caused by external shocks	Need a constant monitoring work of operators. Risks of lower fare revenue collection and service deficiencies	Less innovational opportunities Difficult to change parameters related to the contract

Source: JICA Expert Team

A net cost contract, where the operator keeps the ticket sales income and therefore takes traffic risk, will incentivize the operator to propose adjustments of the operating plans to actual demand.

Operators currently invest in buses. For this reason, it is recommended that contracts last 8 to 10 years (example, the original contractual period in Grenoble was 7 years up to 2021 and 6 years in Lyon, 5 years in London, and 10 years maximum in Stockholm[56]) and to allow the operation of used buses (ranging from 6 to 8 years at the beginning of bus operation to maximum 20 years), which can easily be available from countries like Germany or the Netherlands, after a first operation cycle. This reproduces what CENTROTRANS is currently doing and is economically optimal for the Canton.

Because of commercial speed fluctuations, gross cost remuneration should not be based on a price per kilometer. It is of course always possible to divide the total cost of a transport offer by the total number of kilometers run (whether commercial kilometers, i.e., with passengers inside the vehicle, or total kilometers, i.e., including empty kilometers like distances driven between depot and terminal station, or for maintenance or any other reason). But the resulting ratio can vary significantly according to the transport offer.

Operator remuneration should therefore be based on the following cost split:

- Kilometer costs
    - Fuel
    - Oil and consumables
    - Maintenance
- Driving costs
    - Number of drivers x cost of a driver
- Amortization costs
    - Number of buses x cost of a bus.
- General expenses and profit.

[56] In several cases and usually in practice, the duration of the original contracts was extended by a few years in the recent past (e.g., Lyon, Grenoble) or is permitted by the regulation (Stockholm; not more than 50% of the original duration). For Lyon and Grenoble, see Table A5.1.3 in Appendix of this Volume; For London and Stockholm, see (p. 20 and p. 59, respectively): Global Green Growth Institute, 2018, Comparative Analysis of Bust Public Transport Concession Models, full report, 205 p.

If presented according to this split, the commercial offers of the operators can easily be checked, the main technical difficulty being checking the number of buses and drivers required to perform a given transport offer.

Fuel consumption per kilometer is well documented, as well as the corresponding costs. The same goes for all other costs proportional to kilometers, including maintenance. Likewise, orders of magnitudes of driver costs can easily be calculated based on salaries and charges. Costs of fleet investment also are easily available. Although less easy to calculate, general expenses should not represent more than 10% of total costs and will be justified by each candidate.

After an offer is accepted and turned into a contract, it is easy to check if the number of drivers and buses matches those announced in the commercial offer. In addition, actual operating costs can be checked through financial audits of the accounts of the operators that need to be allowed by their contracts. Contracts can also provide for a cap on profits and readjustment of prices in case audits demonstrate some costs have changed considerably since the commercial offer.

When an Operating Plan evolves during a contract because demand evolves, all unit prices are already set and can easily be reused to remunerate the new offer. The only technical difficulty remaining here is the evaluation of the number of drivers and buses to be mobilized for the revised transport offer.

Finally, checking the relevance of a public transport operation price ends in being able to calculate the number of buses and drivers required to operate a given Operating Plan. This calculation is non-trivial, and most transport authorities are not equipped to perform it. It is worth having a clear view of the attached stakes because operators are often mistaken too in such calculations. This is why authorities should not rely on competition to address the issue. All the more, it is likely that competition might be very limited in Sarajevo.

Performing this calculation is called rostering or scheduling: given an Operating Plan, it consists of determining car and driver services and allocating each driver service to a specific driver. This calculation is a complex optimization problem. Relying on built-in automatic calculations in software, such as Hastus, is dangerous because the parametrization of such software is a complex operation, not very often mastered by operators. In practice, sub-optimal operators can often need 10 to 20% more production factors (buses and drivers) than optimal operators to produce the same offer.

We advise the authority to regularly (at least before a tender is launched and preferably every couple of years) use the services of a specialized consultant to calculate the production means required to produce a given Operating Plan and compare it with the actual proposals or performance of the operator.

If such regular checks are not possible, the authority will have to rely on the performance and ability to optimize the use of production factors of its operators.

(f) Subsidies (bus/microbus)

Subsidies from the cantonal budget will be inevitable in the contract, until now in arrangements with GRAS and CENTROTRANS. These subsidies relate essentially to public transport users such as veterans, war victims or heroes, vulnerable groups, and students. To make financially viable proposals, bus/microbus bidding operators need to fully understand in advance the mechanisms regulating the access of the operator to subsidies.

In addition, and to generate the interest of more bidders, mechanisms to subsidize non-profitable lines should be considered by the SCG and regulated relevantly. That may take time to be approved. The objective would not be to maintain the bus/microbus service artificially everywhere but to ensure a minimum of service where it is needed by residents (even if those residents are already “subsidized” because students or elderly) and in areas strategic to the long-term development of Sarajevo. The principle to subsidize specific lines is not in place in the current regulations, but the JICA Expert Team could not find evidence that such a principle could conflict with the existing regulation.

(g) Contracts Duration: Discussion and Recommendation

Regarding bus and minibuses, international practices show that public transport operation contracts have a relatively limited term (3 or 7 years), particularly in the EU. EU Regulation EC 1370/2007 on Public Passengers Transport Services by Rail or by Road limits to 10 years the contracts for operation considered as a public service (see the EU concept of public service obligation).[57]

Table 6.3.3 Contract Terms (Buses and Minibuses Service): Respective Pros

Pros for Long-term contracts (10 years or above)	Pros for Short or Medium-term Contracts (3-7 years)
Term of contract should correspond to the periods of assets utilization and financing (e.g., long-term loans), around 12–15 years in the case of vehicles, up to 30 years for tramways and trolleybus is well-maintained, and much longer for immovable assets (tracks, depots) Fares are low, making the minimum period longer to get a positive financial return on investment in movable assets.	In the case of public operators’ capital investments, and for a foreseeable period, and particularly fleet renewal, the cantonal budget will be the financer, not the operator.
A long duration of the contract increases the visibility of the operator as an investor, which also assumes fully commercial risks regarding the future (e.g., fleet future renewal financing)	The public transport sector is currently in transition. Many changes should happen in the next 10 years, for instance, regarding transport regulation, public bus operators’ future, tariff system, and compliance with EU regulations and requests (adhesion process).
In a low-fare context, competition between operators is eventually not a short-term priority in Sarajevo. The argument that short-term contracts ensure fairer competition is limitedly relevant there.	Short-term contracts stimulate competition for the market (tendering process) between potential operators.
Operators assume the risk of non-reconduction of their contract after a short period. In addition, operators employ their own permanent staff. If the duration of the contract is too limited, the continuity of employment (especially for drivers and maintenance workers) must be secured by specific mechanisms.	Foreign experiences (England or France for inter-city local transports) show that short-term contracts for operation are compatible with the bus fleet ownership by operators. Modalities to transfer this ownership and employment contracts from a former to a new operator can be considered (e.g., in the case of urban public transport in France).
Long-term contract signals citizens and workers’ unions that public transport service is stabilized. Short-term contracts represent a higher administrative burden and higher preparation/management costs for the Canton.	In the case of buses, most of the recently acquired vehicles are secondhand. Unless active maintenance is provided, their expected remaining life is more limited.

Source: JICA Expert Team

According to exchanges with the MOT and CENTROTRANS, contracts less than 5 years or even 10 years are inappropriate due to the existing regulation (presumably the Law on Concession) and the operator’s financial constraints. In order to comply with the EU

[57] Contracts durations were shortened for rail transport by Regulation (EU) 2016/2338 of the European Parliament and of the Council of 14 December 2016

regulation, a maximum of 8 or 10 years could be the contract duration for bus operation, with possible extension to 2-3 years. In fact, CENTROTRANS will likely be able to keep its strong position as a bus operator for 8 to10 years. Then, longer (or shorter) contracts can be arranged. Currently, this 8 or 10-year period is also the time likely needed to shift toward a gross cost scheme if such a scheme is the SCG's long-term objective.

The case of the KJKP JPS again differs. Would a concession-type contract be established with the company and the SCG (not under the umbrella of the Law on Concessions), its duration could be aligned on the lifespan of tramway and trolleybus significantly longer than for buses. A 20–25-year contract could be considered.

(4) Summary and General "Mindset" Proposed for the Contracts

The tentative scheme proposed in the sub-section is summarized in Table 6.3.4.

Table 6.3.4 Overall Arrangement Proposed for Public Transport

<table>
<tr><th>Modes</th><th>Main Laws Applicable</th><th>Tendering Process</th><th>Contract</th><th>Duration</th><th>Type</th></tr>
<tr><td>Tramway/Trolleybus/Depots – public operator</td><td>LPTP/Law on Public Companies</td><td>No</td><td>Yes</td><td>25–30 years</td><td rowspan="3">Net Cost</td></tr>
<tr><td>Bus – public operator</td><td>LPTP/Law on Concessions/Law on Public Companies/Law on Communal Activities</td><td rowspan="2">Yes, following public invitation as per LPTP in the next 10 years, possibly under the Law on Concession after 10 years</td><td rowspan="2">Yes</td><td rowspan="2">8–10 years</td></tr>
<tr><td>Bus – private operator</td><td>LPTP/ Law on Concessions/ Law on Communal Activities</td></tr>
</table>

Source: JICA Expert Team

In the next 8–10 years, improving the overall service performance of many lines should be prioritized. During this period, objectives such as ensuring fair competition between bus operators were a second priority in Sarajevo, although regulations in Bosnia-Herzegovina are keen to prevent distortion of competition.[58] Along with discussions with the JICA Expert Team, the interest of potential operators from other cantons and municipalities (Tuzla, Banja Luka…) for the bus service in Sarajevo was mentioned by the MOT. Considering the initiatives taken in several cantons regarding public enterprises (more market-oriented, joint venture, etc.), such interest would not be surprising in the future. Whatever, considering the present situation of the service in Sarajevo, concerns relating to fair competition between operators to enter the market can probably wait for some years.[59]

An important aspect of a contractual arrangement is its capacity to add flexibility to a constraining regulatory context. Constraints represented by compliance with timetables should not exclude the approval of operators' initiative to provide the service to better adapt to the demand or to innovate in the organization of the service. Suppose the principle of a 10-year contract is approved. In that case, such permission to derogate against the initial requirements of timetables must be accepted by the MOT for the operator and the authority to adjust the service in a positive manner in the interest of public transport users and the

[58] See, for instance, the Article 2a of the Law on Public Enterprises in the Federation of Bosnia and Herzegovina

[59] Available literature on contracts sometimes insists on competition aspects, in particular, the competition so-called "in the market". These analyses refer to theoretical grounds of the economics of utilities developed in the 1970s, but also, in the case of development banks like the World Bank, to the concrete need to encourage the provision of urban services in very large and fast-growing metropolis like Metro Manila, Mexico City or Lagos. In the case of large EU cities, real competition between candidate private service providers can be expected. These characteristics eventually do not correspond to the situation of public transport in Sarajevo today, and a transition period is necessary.

local public transport strategy and not only to comply with the existing regulation. The LPTP introduces some flexibility (Art. 29) but probably not in a very clear manner for potential operators—at least those not familiar with the Bosnian regulation.

The MOT should progressively affirm its regulatory functions, prioritizing performing its regulatory functions. The ministry and operators should work together as partners, particularly to i) fairly assess the cost of the service according to a shared understanding of the assessment method and ii) better reflect these costs and their expected evolution on fares if the service performance improvement increase the passengers' willingness to pay.

(5) Sarajevo market issues and main features of the contract

In an ideal world, a competitive process should be organized in order to select a single operator for the whole urban network. It is, however, not obvious that such a process will be able to attract another operator than CENTROTRANS:

- International operators like ARRIVA, TRANSDEV, or KEOLIS may not be very attracted by the size of the market and its perspectives. Usually, annual turnovers below 100 million EUR are not considered by these companies.
- GRAS is currently not in the position to seriously compete against CENTROTRANS.
- Other local interurban companies are too small and too weak compared to CENTROTRANS.
- Second tier international operators, like, for instance Gürsel, a Turkish company currently operating the Amman, Jordan network, or GoBus, an Egyptian company operating interurban lines in Egypt, might not be interested because of access difficulties and size of the market. Their added value to the Sarajevo market (i.e., the benefits they can bring vs. the extra cost linked to cultural and geographical distance) is arguable; even more, CENTROTRANS has state-of-the-art performance and organization.

Organizing a single competitive process to operate the Canton of Sarajevo urban bus network is recommended. As there is a high risk of having only one respondent, and as the Operating Plan will evolve according to demand fluctuations, the structure of the contract to be negotiated should include the following provisions:

- Establishment of a dedicated operating company dedicated to Canton Sarajevo
- Possibility for the public transport regulator to launch financial and technical audits of the dedicated operating company.
- Profit cap for dedicated operating company.
- Flexible remuneration to facilitate changes in Operating Plans.

2) Summary of Division of Tasks Proposed for the next 10 Years

(1) The MOT

Table 6.3.5 summarizes the main functions proposed to be assumed by the MOT in the context of contractualization with operators.

Table 6.3.5 Main Tasks to be Assumed by the MOT in the Next 10 Years

Tasks			
1. Implements the general transport policy of the level and substance of the public transport service all along the duration of operation contracts	4. Ensures the sound management of subsidies transferred to operators and bonus and malus relating to service and performance objectives	7. Provides arbitrage in unsolved disputes between operators and users or between operators. Records complaints from users or residents	Overall remark: Subject to public transport policy, tariffs, large investments, etc. Yearly reporting of activities as 1) public transport service regulator and 2) public transport assets manager (summarized reports available to the public)
2. Monitors and controls the implementation of contracts implementation, particularly the compliance of operators with timetables (with enough leeway for flexibility or adaptation)	5. Ensures the monitoring of the cost supported by operators for the public transport service	8. Mandates studies and research when relevant (inspections, planning, feasibility, strategies, etc.)	
3. Propose (to SCG) and implement the fare policy and reform of the tariff system all along the duration of operation contracts	6. Implement SCG ownership responsibilities regarding assets confirmed as public goods: construction or heavy maintenance of tracks / catenaries (tram/trolleybus infrastructure)	9. Maintains web portal dedicated to public transport regulatory functions and stimulates policy dialogue on public transport	

Source: JICA Expert Team

(2) Operators

Table 6.3.6 recapitulates operators' tasks. Operators assume the ownership of projects relating to fleets (plus depots, workshops, etc.) and the maintenance and renewal of these assets. Operators are vested with the tasks directly linked to operation (commercialization, revenue collection, etc.). They are required to report regularly to the MOT regarding the technical and financial data relating to the status of the fleet used.

Should the operator sub-contract part of the service temporarily to another operator (if permitted by law and with the approval of the MOT), the sub-contractor would provide its service according to the terms of the main contract between the operator and SCG.

Table 6.3.6 Main Tasks to be Assumed by Operators in the Next 10 Years

Tasks			
1. Production of the public transport service as defined in the contract	4. Commercialization and promotion of the lines/facilities it operates	7. Develop and maintain passengers' information system, communication Ensure security and safety of passengers	Overall remark Reporting and information to the MOT as required in the contract.
2. Assumes project ownership for purchase and heavy maintenance of tram/trolleybus/bus fleets	5. Fare revenue collection. Implementation of measures to reduce free ridership	8. Maintenance management (and cleaning) of physical assets	
3. Mandate studies and advisory services (technical, marketing), support in expertise to MOT to manage projects when needed	6. Customer management (individuals, schools, large employers, etc.)	9. Other services related to public transport (Management of P+R areas?)	

Source: JICA Expert Team

APPENDIX

A1 Technical Notes on Transport Surveys and Database

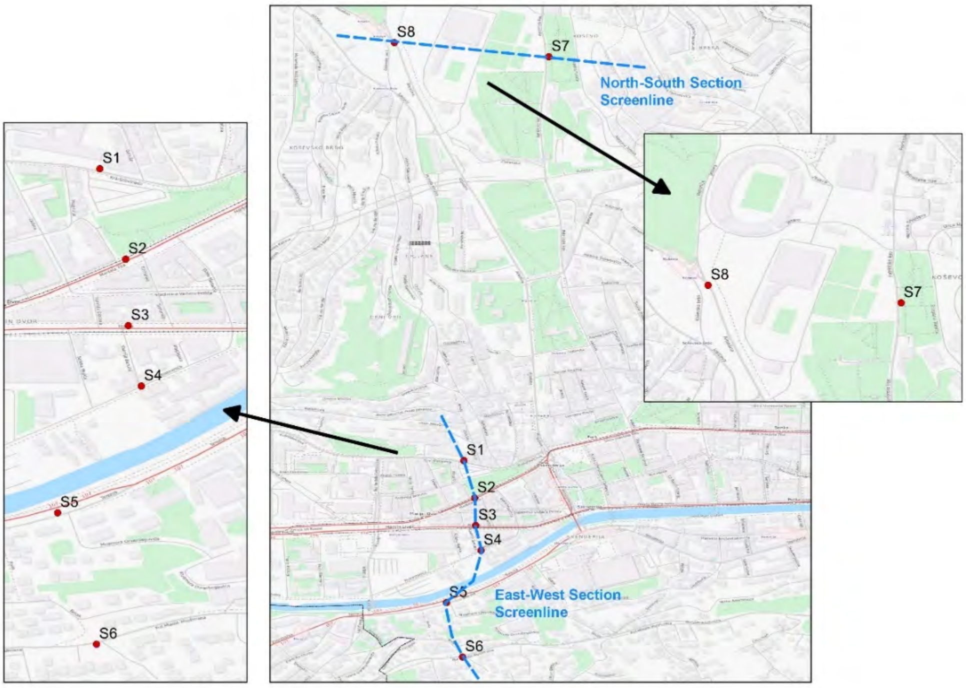
A1.1 Screenline Survey

1) Objective

The main objective of the survey is to obtain data on the current traffic situation along the imaginary lines of east-west and north-south that quarterly divides Canton of Sarajevo. Eventually, the data shall be useful for the calibration purpose of the model. The survey especially collects information on the quantity and occupancy of passing vehicles.

2) Survey Location

In the original plan of simplification of the traffic count update, utilizing traffic sensor data on four locations, which were previously surveyed in 2019 by JICA, was considered. However, the fact that the reliability of the sensor itself was rather questionable for multiple reasons was found during the factual investigation. Finally, the traffic count and vehicle occupancy were surveyed at eight locations within the city center and suburbs.



Sources: JICA Expert Team

Figure A1.1.1 Screenline Survey Location

3) Methodology

(1) Traffic count

Traffic count was done by onsite observation of a human surveyor with a tally counter by type of vehicle, direction, and input data every 15 minutes for as long as 16 hours (6 AM to 10 PM) on one typical weekday.

(2) Vehicle occupancy

The occupancy data by type of vehicle and direction was collected by observing and counting the number of passengers in private vehicles. For public transport and chartered buses, the counting was done by best estimating the percentage of passengers. The percentage of public transport passengers followed the scale of:

- empty to below 25% of the normal capacity,
- 25%,
- 50%, (half full of the normal capacity),
- 75%,
- 100%, (full, normal capacity),
- 125%,
- 150%,
- 175%, and
- 200% (crowded seating and standing capacities are fully occupied).

The occupancy data was collected simultaneously and during the traffic count for 16 hours. The data was collected for the first 20 minutes or the first 30 vehicles that passed through the survey location at each hour (whichever comes first).

4) Survey Item

This survey distinguished type of vehicle to be surveyed as follows:

[Private Vehicle]

- Motorcycle,
- car, sedan, minivan, van,
- taxi,
- pick-up, a light-duty truck with cargo bed at the back (with and without roof),
- small truck (a 2-axle truck),
- medium truck (a 3-axle truck),
- large truck (a 4-axle truck and more),
- chartered minibus,
- chartered medium bus, and
- chartered large bus.

[Public Transport]

- Minibus
- regular bus and trolleybus, and
- tram

Furthermore, the following items at each survey location were recorded:

- date of the survey,
- road name,
- direction of traffic,

- 15-minute segmented data of traffic count, and
- Vehicle occupancy data

5) Survey Forms

The survey forms used are shown in the following pages.:

(1) Traffic count

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan

Screenline - Traffic Count

Location Code	:	**Road Name**	:
Date	:	**Direction Code**	:
Day	:	**Direction from & to**	:

Hour Begins	TYPE OF VEHICLES													**Total**
	1	2	3	4	5	6	7	8	9	10	11	12	13	
	Motorcycle	Car, sedan, minivan, van	Taxi	Pick up	Small Truck 2-Axle Truck	Medium Truck 3-Axle Truck	Large Truck ≥4-Axle Truck	Chartered Minibus	Chartered Medium Bus	Chartered Large Bus	Minibus	Bus, Trolley	Tram	
06:00														
07:00														
08:00														
09:00														
10:00														
11:00														
12:00														
13:00														
14:00														
15:00														
16:00														
17:00														
18:00														
19:00														
20:00														
21:00														
22:00														
Total Number of Vehicle														
16.hrs														

Sources: JICA Expert Team

Figure A1.1.2 Traffic Count Form

(2) Vehicle occupancy

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan

Screenline - Vehicle Occupancy

Location Code :
Date :
Day :

Road Name :
Direction Code :
Direction from & to :

No	TYPE OF VEHICLES												
	1	2	3	4	5	6	7	8	9	10	11	12	13
	Motorcycle	Car	Taxi	Pick up	Small Truck 2-Axle Truck	Medium Truck 3-Axle Truck	Large Truck ≥4-Axle Truck	Chartered Minibus	Chartered Medium Bus	Chartered Large Bus	Minibus	Bus, Trolley	Tram
1													
2													
3													
4													
5													
6													
7													
8													
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20													
21													
22													
23													

Sources: JICA Expert Team

Figure A1.1.3 Vehicle Occupancy Form

6) Survey Result and Finding

(1) Traffic count

The traffic count results in each location and direction is shown in the table below. A high number of vehicles compared to the number of public transport vehicles can be seen.

Table A1.1.1 Traffic Count Result by Location and Direction

Location Name		Motor cycle	Private Car	Taxi	Pick Up, Box	Small Truck	Medium Truck	Large Truck	Chartered Minibus	Chartered Medium Bus	Chartered Large Bus	PT Minibus	PT Bus, Trolleybus	PT Tram
S1	A	50	5,470	608	428	27	6	1	6	1	1	6	0	0
	B	14	1,883	142	100	14	18	6	2	0	0	2	0	0
S2	A	220	21,297	2,122	1,452	64	41	5	18	95	208	18	208	95
S3	A	134	22,801	2,884	918	95	8	7	12	81	257	12	257	80
S4	A	46	4,420	237	277	9	2	0	4	1	2	4	2	0
S5	A	60	7,859	538	240	51	23	5	32	35	36	32	105	0
	B	58	8,130	679	421	51	10	3	36	42	45	36	105	0
S6	A	19	4486	85	256	77	40	169	20	11	6	20	105	0
	B	22	4,248	70	279	44	30	182	24	5	10	24	105	0
S7	A	23	4,041	272	313	26	12	10	49	26	41	49	105	0
	B	32	5,482	254	157	36	4	2	82	0	37	82	105	0
S8	A	0	9,585	1	363	71	57	29	0	133	41	0	105	0
	B	0	7,562	22	270	81	66	74	0	123	42	0	105	0

Source: JICA Expert Team

The composition of the transport mode percentage can be seen in the table below. Private cars have the biggest percentage, while public transport consisting of minibuses and medium and large buses is low.

Table A1.1.2 Composition of the Transport Mode Percentage

Mode	Percentage (%)
Motorcycle	0.2
Private Car	81.8
Taxi	6.0
Pick Up, Box	4.2
Small Truck	0.6
Medium Truck	0.4
Large Truck	0.9
Chartered Minibus	0.3
Chartered Medium Bus	0.8
Chartered Large Bus	1.4
Public Transport Minibus	0.3
Public Transport Medium Bus	2.5
Public Transport Tram	0.5

Source: JICA Expert Team

(2) Vehicle occupancy

The occupancy unit is person. Private vehicle occupancy may be considered low.

Table A1.1.3 Vehicle Occupancy

Location Name	Motor cycle	Private Car	Taxi	Pick Up, Box	Small Truck	Medium Truck	Large Truck	Chartered Minibus	Chartered Medium Bus	Chartered Large Bus	PT Minibus	PT Bus, Trolleybus	PT Tram
S1	1.10	1.45	1.60	1.47	1.55	1.00	1.00	25.00		25.00	25.00		
S2	1.11	1.44	1.39	1.34	1.24	1.46	1.00	31.25	71.00	75.61	31.25	75.71	80.73
S3	1.04	1.42	1.45	1.69	1.65	1.00	1.00	25.00	38.64	74.52	25.00	74.52	74.32
S4	1.08	1.35	1.74	1.32	1.60			50.00			50.00	50.00	
S5	1.15	1.44	1.54	1.44	1.38	1.20	1.00	55.21	34.26	49.81	55.21	83.97	
S6	1.00	1.48	1.52	1.45	1.46	1.25	1.10	65.00	55.00	43.75	65.00	43.75	
S7	1.16	1.37	1.55	1.36	1.47	1.00	1.00	54.82	42.00	48.96	54.82	48.96	
S8	1.00	1.56	1.68	1.42	1.19	1.23	1.23		74.42	77.50		77.50	

Source: JICA Expert Team

(3) Comparison of traffic count over the years

Considering the COVID-19 pandemic, one may argue if the survey is worth doing or not, considering the bias the pandemic may cause. Therefore, time-series traffic count data over four years (2019–2022) must be analyzed. Such data collection is enabled by utilizing the result of traffic sensor system that are spread across the city. The system overlaps with the survey locations at three locations. Despite the yearly traffic count result gaps, the conclusion that the traffic in 2022 is no longer affected by the pandemic can be observed.

Table A1.1.4 Comparison of Traffic Count Over Years

One Typical Weekday in (unit: in vehicle)	S2	S5	S8
2019	22,818	19,431	17,598
2020	25,964	18,738	17,096
2021	24,177	18,792	14,654
2022	25,610	18,627	18,520

Source: JICA Expert Team

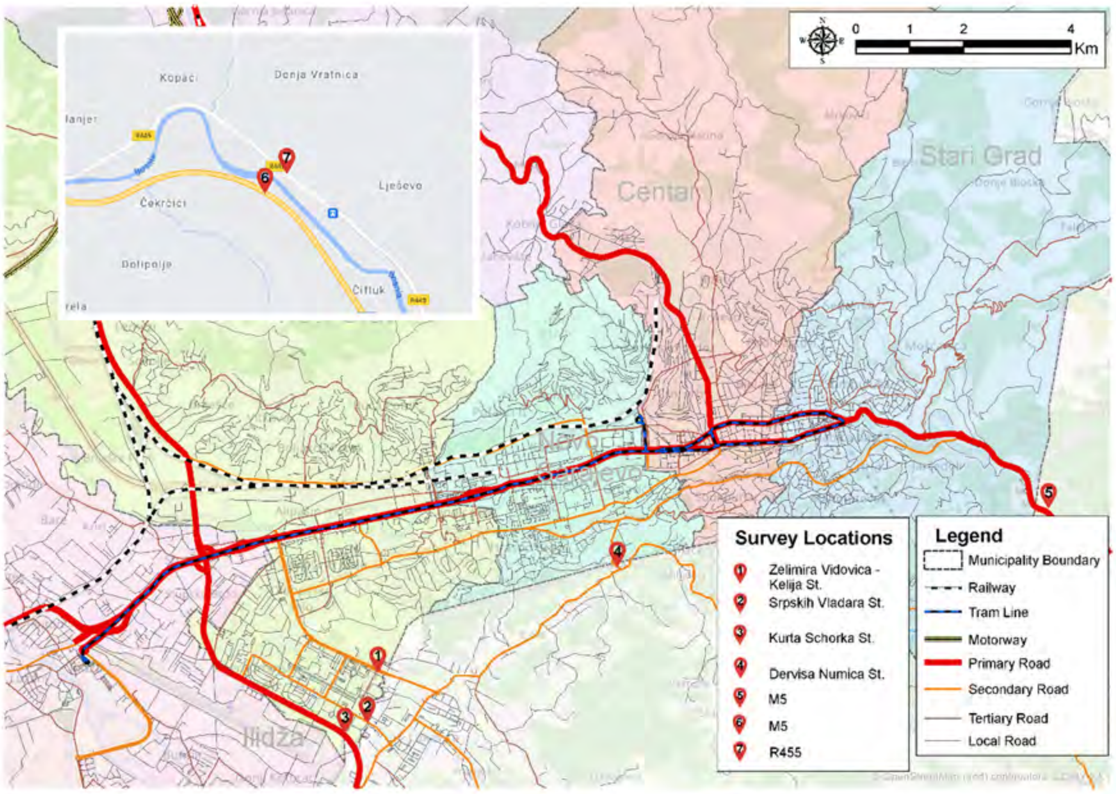
A1.2 Cordon Line Survey – Roadside Origin–Destination Interview

1) Objective

The main objective of the survey is to obtain data on the current origin–destination (OD) of private vehicle users crossing the boundary of Canton of Sarajevo or the so-called external OD trips. Eventually, the data is used for the model calibration.

2) Survey Location

The direction of commuting trips to/from Canton of Sarajevo is along the main road corridors that connect to both Visoko and Republic Srpska bounds. Therefore, survey locations are set to be within this corridor and close to the boundary. Below is the map of seven survey locations.



Sources: JICA Expert Team

Figure A1.2.1 Cordon Line Survey – Roadside OD Interview Location

3) Methodology

The survey was done on a typical weekday for 24 hours. Details of the survey methodology are elaborated below:

(1) OD interview survey

This survey was carried out for directions of inbound and outbound of Canton Sarajevo. The interview targeted one sample from each vehicle, including a chartered bus, that makes the main trip (i.e., the chauffeur can be a respondent if driving alone). This interview survey did not apply to public transport.

This interview was conducted at the roadside with assistance from related authorities to pull the target vehicles over to the roadside. The target interview sample was 20% of the of traffic count or a maximum of 600 samples at each location and each direction.

Considering the space constraints of the roadside and traffic flow on Srpskih Vladara Street (also known as Bulevar Mimara Sinana Street), the interview sample size was set to 10% out of the total traffic count.

(2) Traffic count

Traffic count was done by onsite observation of human surveyor with tally counter by type of vehicle, direction, and input data of every 15 minutes.

(3) Vehicle occupancy

The occupancy data by vehicle type and direction was collected by observing and counting the number of passengers of private vehicles. For public transport, the counting was done by best estimating the percentage of passengers. The percentage of public transport passengers followed the scale of:

- empty to below 25% of the normal capacity
- 25%,
- 50%, half full of the normal capacity
- 75%,
- 100%, full, the normal capacity
- 125%,
- 150%,
- 175%, and
- 200%, crowded, seating, and standing capacities are fully occupied.

The occupancy data collection is done for the first 20 minutes or the first 30 vehicles that passed through the survey location of each hour of survey (whichever comes first)

4) Survey Item

This survey distinguished type of vehicle to be surveyed as follows:

[Private Vehicle]

- motorcycle,
- car, sedan, minivan, van,
- taxi,
- pick up (light-duty truck with cargo bed at the back [with and without roof)],
- small truck (2-axle truck),
- medium truck (3-axle truck),
- large truck (4-axle truck and more),

[Public Transport]

- minibus, and
- regular bus and trolleybus.

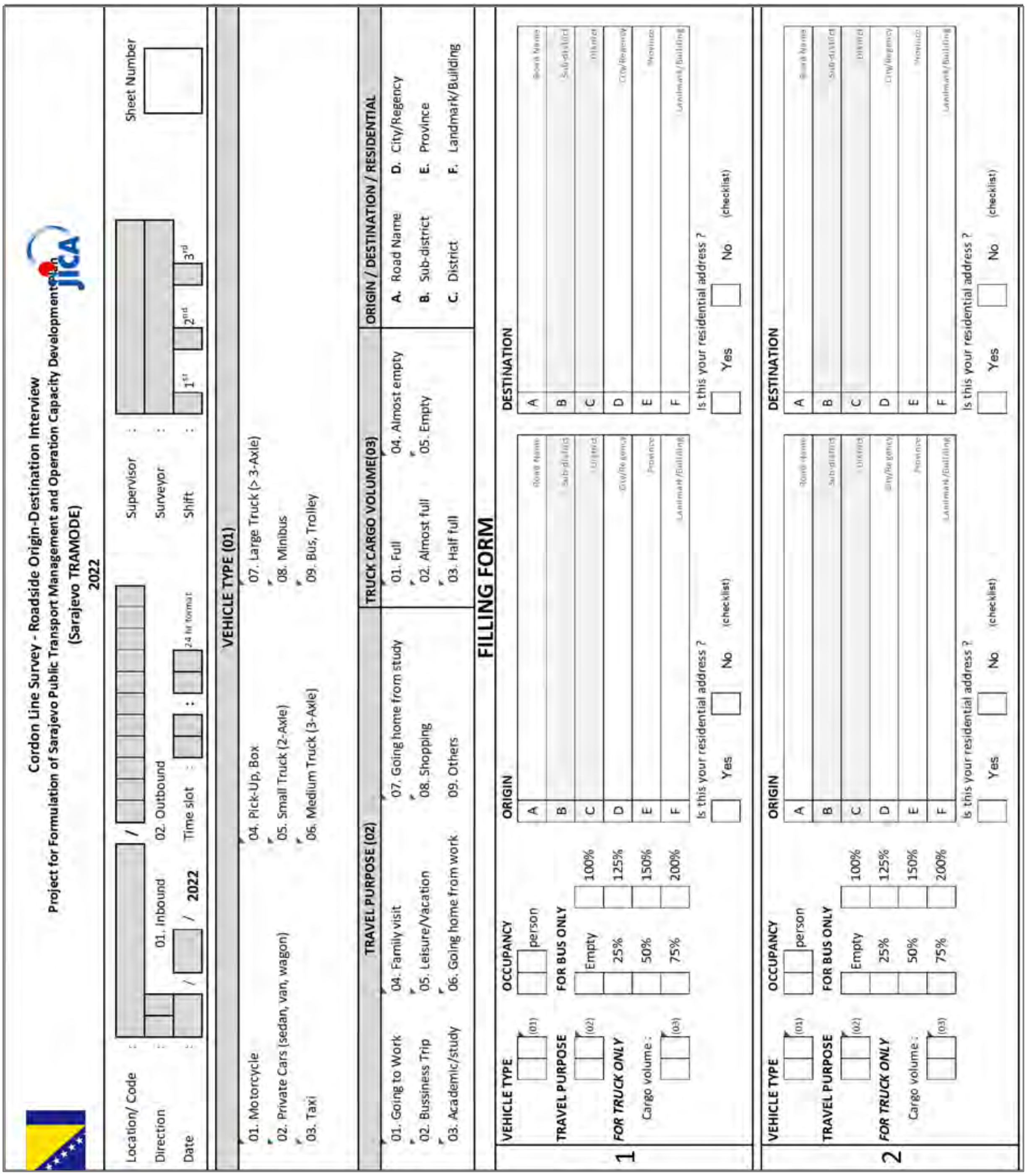
Furthermore, the following items at each survey location were recorded:

- date of the survey,
- road name,
- direction of traffic,
- 15-minute segmented data of traffic count, and
- vehicle occupancy data.

5) Survey Form

The survey forms used are in the following pages:

(1) OD interview



Cordon Line Survey - Roadside Origin-Destination Interview
Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan
(Sarajevo TRAMODE)
2022

Location/ Code : /
Direction : 01. Inbound 02. Outbound
Date : / / 2022 Time slot : : 24 hr format
Supervisor :
Surveyor :
Shift : 1st 2nd 3rd
Sheet Number

VEHICLE TYPE (01)

01. Motorcycle
02. Private Cars (sedan, van, wagon)
03. Taxi
04. Pick-Up, Box
05. Small Truck (2-Axle)
06. Medium Truck (3-Axle)
07. Large Truck (> 3-Axle)
08. Minibus
09. Bus, Trolley

TRAVEL PURPOSE (02)

01. Going to Work
02. Bussiness Trip
03. Academic/study
04. Family visit
05. Leisure/Vacation
06. Going home from work
07. Going home from study
08. Shopping
09. Others

TRUCK CARGO VOLUME(03)

01. Full
02. Almost full
03. Half full
04. Almost empty
05. Empty

ORIGIN / DESTINATION / RESIDENTIAL

A. Road Name
B. Sub-district
C. District
D. City/Regency
E. Province
F. Landmark/Building

FILLING FORM

1
VEHICLE TYPE (01)
OCCUPANCY person
TRAVEL PURPOSE (02)
FOR BUS ONLY Empty 25% 50% 75% 100% 125% 150% 200%
FOR TRUCK ONLY
Cargo volume : (03)
ORIGIN A Road Name B Sub-district C District D City/Regency E Province F Landmark/Building
Is this your residential address ? Yes No (checklist)
DESTINATION A Road Name B Sub-district C District D City/Regency E Province F Landmark/Building
Is this your residential address ? Yes No (checklist)

2
VEHICLE TYPE (01)
OCCUPANCY person
TRAVEL PURPOSE (02)
FOR BUS ONLY Empty 25% 50% 75% 100% 125% 150% 200%
FOR TRUCK ONLY
Cargo volume : (03)
ORIGIN A Road Name B Sub-district C District D City/Regency E Province F Landmark/Building
Is this your residential address ? Yes No (checklist)
DESTINATION A Road Name B Sub-district C District D City/Regency E Province F Landmark/Building
Is this your residential address ? Yes No (checklist)

Sources: JICA Expert Team

Figure A1.2.2 OD Interview Form

(2) Traffic count

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan
Cordon Line Survey - Roadside Origin-Destination Interview
Traffic Count

Location Code		Direction Code	
Location Name		Direction From	
Date		Direction to	
Day		Weather	

Hour Begins	1 Motor Cycle	2 Private Passenger Car	3 Taxi	4 Pick Up, Box	5 Small Truck (2-Axle)	6 Medium Truck (3-Axle)	7 Large Truck (>3 Axle)	8 Minibus	9 Bus, Trolley
06:00 - 07:00									
07:00 - 08:00									
08:00 - 09:00									
09:00 - 10:00									
10:00 - 11:00									
11:00 - 12:00									
12:00 - 13:00									
13:00 - 14:00									
14:00 - 15:00									
15:00 - 16:00									
16:00 - 17:00									
17:00 - 18:00									
18:00 - 19:00									
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 00:00									
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
Total Number of Vehicle									
24 hrs	0	0	0	0	0	0	0	0	0

Sources: JICA Expert Team

Figure A1.2.3 Traffic Count Form

(3) Vehicle occupancy

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan
Cordon Line Survey - Roadside Origin-Destination Interview
Vehicle Occupancy Survey

Location Code	
Location Name	
Date	
Day	
Hour	

Direction Code	
Direction from	
Direction to	
Weather	

No.	Occupancy of Vehicle Type								
	Number of Passenger							Percentage of Passenger	
	Motor Cycle	Private Passenger Car	Taxi	Pick Up, Box	Small Truck (2-Axle)	Medium Truck (3-Axle)	Large Truck (>3 Axle)	Minibus	Bus, Trolley
	1	2	3	4	5	6	7	8	9
1									
2									
3									
4									
5									
6									
7									
8									
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26									
27									
28									
29									
30									

Sources: JICA Expert Team

Figure A1.2.4 Vehicle Occupancy Form

6) Survey result and finding

(1) Traffic count

The traffic count results for each location and direction are shown in the table below. A high number of vehicles compared to the number of public transport vehicles can be seen.

Table A1.2.1 Traffic Count by Location and Direction

Location Name		Motor cycle	Private Car	Taxi	Pick Up, Box	Small Truck	Medium Truck	Large Truck	Minibus	Bus, Trolleybus
L1	Inbound	18	4,457	69	301	20	4	7	4	
	Outbound	12	4,877	78	250	60	10	7		
L2	Inbound	3	1,984	105	161	13	1			
	Outbound	1	1,725	56	52	11				
L3	Inbound	16	4,702	35	588	112	84	216	17	31
	Outbound	14	4,680	46	611	152	114	225	15	31
L4	Inbound	28	6,193	89	192	33	30	45	30	23
	Outbound	29	5,697	73	128	18	22	31	21	14
L5	Inbound	1	4,054	20	312	112	54	197	48	58
	Outbound	10	4,245	18	429	100	64	171	36	35
L6	Inbound	8	6,947		439	374	106	258	596	97
	Outbound	14	6,831		362	406	101	254	641	92
L7	Inbound	4	2,324	6	323	35	10	21		33
	Outbound	7	2,376	4	273	52	8	10	20	28

Source: JICA Expert Team

(2) Vehicle occupancy

The occupancy unit is persons. Private vehicle occupancy may be considered low.

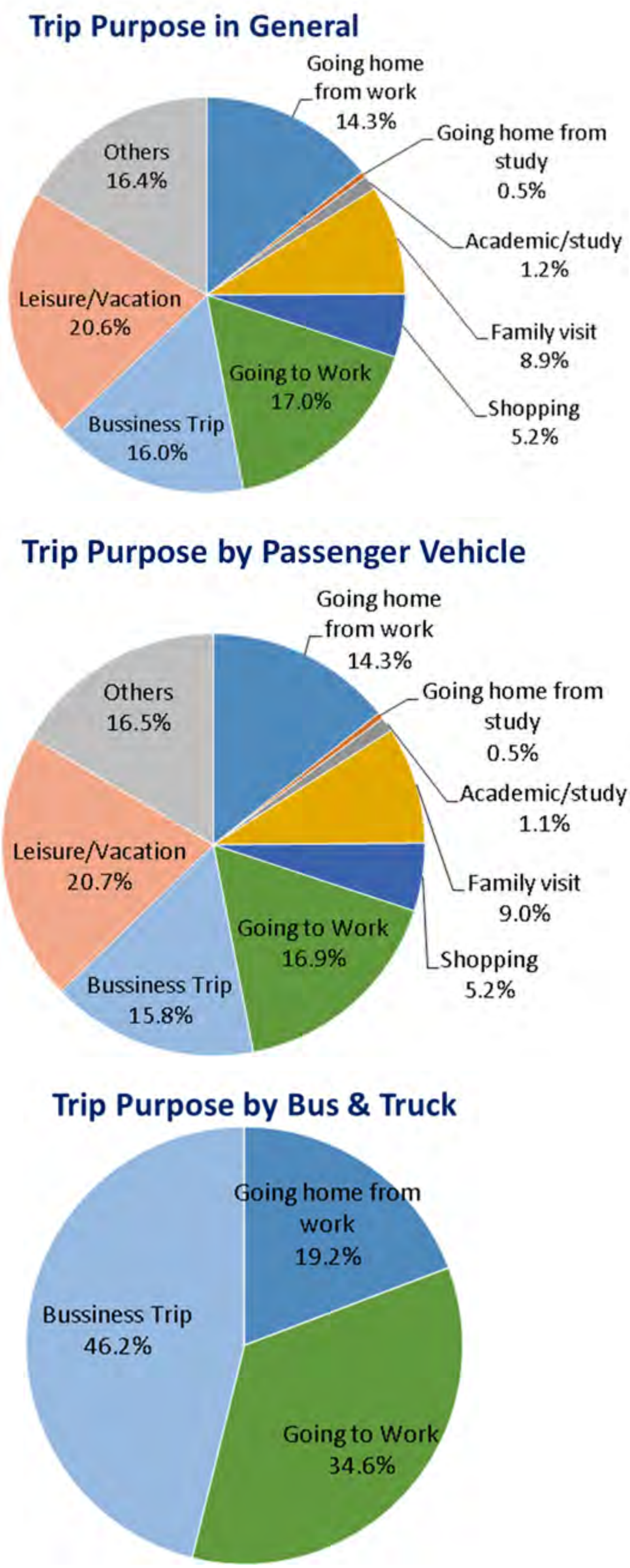
Table A1.2.2 Vehicle Occupancy

Location Name	Motor cycle	Private Car	Taxi	Pick Up, Box	Small Truck	Medium Truck	Large Truck	Minibus	Bus, Trolleybus
L1	1.13	1.41	1.74	1.39	1.19	1.20	1.00		
L2		1.44	1.40	1.28	1.33	1.00			
L3	1.18	1.48	1.72	1.47	1.41	1.08	1.07	13.75	33.75
L4	1.00	1.44	1.55	1.37	1.35	1.00	1.03	10.45	35.25
L5	1.00	1.54	1.46	1.39	1.29	1.10	1.04	13.00	39.00
L6	1.00	1.69		1.38	1.14	1.13	1.11	10.07	39.89
L7	1.00	1.49	1.33	1.50	1.11	1.17	1.00	20.00	25.06

Source: JICA Expert Team

(3) The interview

The characteristics of trips can be acknowledged from the survey.



Sources: JICA Expert Team

Figure A1.2.5 Trip Purpose by Mode

A1.3 Cordon Line Survey – In-Outbound Public Transport Passenger OD Interview

1) Objective

The main objective of the survey is to obtain data on the current inbound and outbound OD trips that cross the boundary of Canton of Sarajevo (external OD trips). For this purpose, the survey investigation was applied to the modes of bus, train, and airplane passengers. In-outbound public transport passenger was defined as the passengers of the mentioned modes who use the public transport services that connect Canton Sarajevo and outside. Outside here represents the buffer area within Bosnia and Herzegovina and internationally. Eventually, the data is used for transportation model calibration.

2) Survey Location

Considering passengers of multiple modes to be surveyed, as mentioned in the previous section, each location of the survey represents those modes.

- Sarajevo Bus Terminal

This is to capture the passengers of inter-cantonal and international bus services.

- Mojmilo II Bus Stop

Due to Sarajevo East Terminal's location outside the borderline of Canton Sarajevo, few city bus lines go over the boundary. Mojmilo II Bus Stop is recognized as the last bus stop before the borderline on Ante Babica Street, and it is passed by Lines 31, 31E, 39, 103, and 107).

- Dobrinja Bus Stop

Due to the typology of the boundary between Canton of Sarajevo and the Republic of Srpska that divides the area in Dobrinja into two, the survey is necessary here as it generates and attracts the cordon trips.

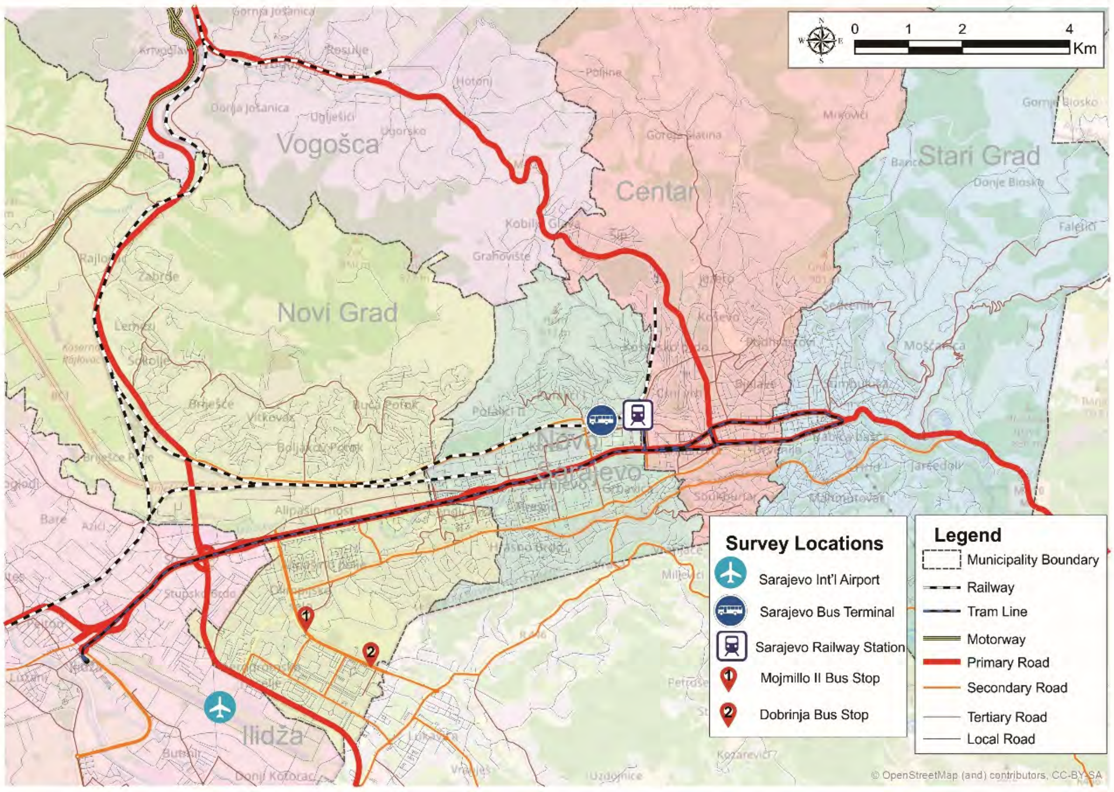
- Sarajevo Railway Station

This is to capture train passengers traveling only along the inter-cantonal corridors. There is no train service to international destinations.

- Sarajevo International Airport

This is to capture the air passengers flying to international destinations. There is no commercial airport in Bosnia and Herzegovina (no commercial domestic flight).

The next map shows the location of the surveys.



Sources: JICA Expert Team

Figure A1.3.1 Cordon Line Survey – In-Outbound Public Transport Passenger OD Interview

3) Methodology

The surveys at all locations were on a typical weekday that went as long as the service was in operation. The passengers in a group were represented by a representative leader of the group (for example, a family is represented by a parent, a group of students is represented by a teacher or the most senior student, and so on). Details of the survey methodology are elaborated below:

(1) Sarajevo Bus Terminal

- OD Interview

Passengers in the waiting areas of inter-cantonal and international departures were interviewed. The sample rate of the interview was 20% of the total passengers of each departing bus.

- Occupancy

The survey for occupancy involved indicating the actual number of passengers just before the bus is about to depart.

(2) Mojmilo II Bus Stop

- OD Interview

Arriving/getting off bus passengers at bus stops (of bus lines mentioned in the previous section of going outbound) were interviewed. The sample rate of the interview was 100% of all the passengers getting off at the bus stop. Inter-cantonal bus was excluded from the interview survey.

- Occupancy

The occupancy survey in all the named buses involved recording the actual number of passengers just before the bus is about to depart.

(3) Dobrinja Bus Stop

- OD Interview

Waiting inbound and outbound passengers were interviewed at the bus stop. The sample rate of the interview was 50% of the total waiting passengers.

- Occupancy

The survey for occupancy in all the stop-by buses involved recording the actual number of passengers just before the bus was about to depart.

(4) Sarajevo Railway Station

- OD Interview

Passengers at the waiting area of the departing inter-cantonal train were interviewed. The sample rate of the interview was 20% of the total passengers of each train.

- Occupancy

Occupancy was surveyed for all the named trains by indicating the actual number of the passengers just of the train.

(5) Sarajevo International Airport

- OD Interview

Passengers in the waiting area of departure gates were interviewed. The sample rate of the interview was at 20% of the total waiting passenger of each flight. Transit passengers were not interviewed.

- Occupancy

Occupancy, or the total passenger of each flight, was determined by asking airport authorities.

4) Survey Item

The survey items are as follows:

- OD information (address and type of building),
- access mode used to reach the survey location,
- trip purpose,
- plan to come back,
- preferred mode of transport during return, and
- occupancy of departing passengers.

5) Survey Form

The survey forms are attached in the following pages.

(1) Passenger OD interview at Bus Terminal

Sarajevo TRAMODE

Passenger OD Interview - at SARAJEVO BUS TERMINAL

Bus Terminal		Surveyor No.	
Interview Time	H H : M M 24 hours format	Supervisor No.	
Date/Month	D D / M M 2022	Sheet No.	

A Bus operator			
Bus destination			
Bus size	Medium / Large (Circle answer)	Medium / Large (Circle answer)	Medium / Large (Circle answer)
Direction	OUTBOUND ONLY	OUTBOUND ONLY	OUTBOUND ONLY
B Respondent No.	1	2	3
Total number of passenger (including respondent and passenger travelling with respondent ≥ 5 years old)			
C Origin address inside Sarajevo (Origin is a place just before going/coming to departing location)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)
D Type of origin - see Table T1 (if others please specify)	(......................)	(......................)	(......................)
Departure time from origin	H H : M M 24 hours format	H H : M M 24 hours format	H H : M M 24 hours format
E Access modes to departing location - see T2 (please mention in sequence from your origin to departing location)	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS
Travel time from Origin to the departing location	H H : M M	H H : M M	H H : M M
F Destination address	City/Regency Country Landmark (if location is not clear)	City/Regency Country Landmark (if location is not clear)	City/Regency Country Landmark (if location is not clear)
G Residence during weekdays	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton
H Trip purpose (if your residence during weekdays is 2, what is your trip purpose in Sarajevo Kanton)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)
I.1 Plan to comeback to Sarajevo Kanton or previous trip to Sarajevo Kanton (check on selected day)	1 2 3 4 5 6 7 / Mo Tu We Th Fr Sa Su; H H : M M *To explain that respondent will be back to Sarajevo again at anytime*; estimated time crossing boundary	1 2 3 4 5 6 7 / Mo Tu We Th Fr Sa Su; H H : M M *To explain that respondent will be back to Sarajevo again at anytime*; estimated time crossing boundary	1 2 3 4 5 6 7 / Mo Tu We Th Fr Sa Su; H H : M M *To explain that respondent will be back to Sarajevo again at anytime*; estimated time crossing boundary
I.2 Mode for trip above (I.1) - See Table T3	(......................)	(......................)	(......................)

T1 Type of origin	01 Hotel 02 Your residence 03 Private house other than your residence 04 Office	05 Restaurant 06 Shop/mall/market/tourist attraction 07 Private business place (Hospital, Bank, Religious Place, Police Station, etc.) 08 Other (specify)
T2 Mode choice for access	01 Walking, Bicycle, Romobil (Scooter) 02 Motorcycle 03 Car 04 Taxi 05 Tram 06 Mini Bus 07 Regular Bus	08 Articulated Bus (Trolley) 09 Chartered Bus (Company Bus, i.e.: Hotel Bus, etc.) 10 Train 11 Other (specify)
T3 Mode choice for plan trip	01 Long Haul Train 02 Long Haul Bus 03 Airplane	04 Private Car 05 Chartered Bus 06 Others (specify)

Sources: JICA Expert Team

Figure A1.3.2 Passenger OD Interview Form at the Bus Terminal

(2) Passenger OD interview at Mojmilo II and Dobrinja Bus Stops

Sarajevo TRAMODE
Passenger OD Interview - at Mojmilo+Dobrinja Bus Stop

Bus Stop	Dobrinja	Surveyor No.	
Interview Time	H H : M M 24 hours format	Supervisor No.	
Date/Month	D D / M M 2022	Sheet No.	

A Bus operator			
Bus destination			
Bus size	Minibus / Bus / Articulated (Trolley) (Circle answer)	Minibus / Bus / Articulated (Trolley) (Circle answer)	Minibus / Bus / Articulated (Trolley) (Circle answer)
Direction	OUTBOUND ONLY	OUTBOUND ONLY	OUTBOUND ONLY
B Respondent No.	1	2	3
Total number of passenger (including respondent and passenger travelling with respondent ≥5 years old)			
C.1 Origin address inside Sarajevo (Origin is a place just before going/coming to departing location)	Street Name Street No Municipality Name Sarajevo Kanton / Rep. Srpska (Circle answer) Landmark (if any)	Street Name Street No Municipality Name Sarajevo Kanton / Rep. Srpska (Circle answer) Landmark (if any)	Street Name Street No Municipality Name Sarajevo Kanton / Rep. Srpska (Circle answer) Landmark (if any)
D Type of origin - see Table T1 (if others please specify)	(........................)	(........................)	(........................)
Departure time from origin	H H : M M 24 hours format	H H : M M 24 hours format	H H : M M 24 hours format
E Access modes to departing location - see T2 (please mention in sequence from your origin to departing location)	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS
Travel time from Origin to Dobrinja	H H : M M	H H : M M	H H : M M
F Destination address	Street Name Street No Municipality Name Sarajevo Kanton / Rep. Srpska (Circle answer) Landmark (if any)	Street Name Street No Municipality Name Sarajevo Kanton / Rep. Srpska (Circle answer) Landmark (if any)	Street Name Street No Municipality Name Sarajevo Kanton / Rep. Srpska (Circle answer) Landmark (if any)
G Residence during weekdays	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton
H Trip purpose (if your residence during weekdays is 2, what is your trip purpose in Sarajevo Kanton)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)
I.1 Plan to comeback to Sarajevo Kanton or previous trip to Sarajevo Kanton (check on selected day)	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* estimated time crossing boundary	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* estimated time crossing boundary	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* estimated time crossing boundary
I.2 Mode for trip above (I.1) - See Table T3	(........................)	(........................)	(........................)

T1 Type of origin	01 Hotel 02 Your residence 03 Private house other than your residence 04 Office	05 Restaurant 06 Shop/mall/market/tourist attraction 07 Private business place (Hospital, Bank, Religious Place, Police Station, etc.) 08 Other (specify)
T2 Mode choice for access	01 Walking, Bicycle, Romobil (Scooter) 02 Motorcycle 03 Car 04 Taxi 05 Tram 06 Mini Bus 07 Regular Bus	08 Articulated Bus (Trolley) 09 Chartered Bus (Company Bus, i.e.: Hotel Bus, etc.) 10 Train 11 Other (specify)
T3 Mode choice for plan trip	01 Long Haul Train 02 Long Haul Bus 03 Airplane	04 Private Car 05 Chartered Bus 06 Others (specify)

Sources: JICA Expert Team

Figure A1.3.3 Passenger OD Interview Form at Mojmilo II and Dobrinja Bus Stops

(3) Passenger OD interview at Sarajevo Railway Station

Sarajevo TRAMODE

Passenger OD Interview - at Sarajevo Railway Station

Railway Station		Surveyor No.	
Interview Time	H H : M M 24 hours format	Supervisor No.	
Date/Month	D D / M M 2022	Sheet No.	

A Railway No Destination # Cars (Total) Direction	OUTBOUND ONLY	OUTBOUND ONLY	OUTBOUND ONLY
B Respondent No. Total number of passenger (including respondent and passenger travelling with respondent ≥ 5 years old)	1	2	3
C Origin address inside Sarajevo (Origin is a place just before going/coming to departing location)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)
D Type of origin - see Table T1 (if others please specify) Departure time from origin	(......................) H H : M M 24 hours format	(......................) H H : M M 24 hours format	(......................) H H : M M 24 hours format
E Access modes to departing location - see T2 (please mention in sequence from your origin to departing location) Travel time from Origin to the departing location	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS H H : M M	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS H H : M M	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS H H : M M
F Destination address	City/Regency Country Landmark (if location is not clear)	City/Regency Country Landmark (if location is not clear)	City/Regency Country Landmark (if location is not clear)
G Residence during weekdays	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton
H Trip purpose (if your residence during weekdays is 2, what is your trip purpose in Sarajevo Kanton)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (...)
I.1 Plan to comeback to Sarajevo Kanton or previous trip to Sarajevo Kanton (check on selected day)	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* / estimated time crossing boundary	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* / estimated time crossing boundary	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* / estimated time crossing boundary
I.2 Mode for trip above (I.1) - See Table T3	(......................)	(......................)	(......................)

T1 Type of origin	01 Hotel 02 Your residence 03 Private house other than your residence 04 Office	05 Restaurant 06 Shop/mall/market/tourist attraction 07 Private business place (Hospital, Bank, Religious Place, Police Station, etc.) 08 Other (specify)
T2 Mode choice for access	01 Walking, Bicycle, Romobil (Scooter) 02 Motorcycle 03 Car 04 Taxi 05 Tram 06 Mini Bus 07 Regular Bus	08 Articulated Bus (Trolley) 09 Chartered Bus (Company Bus, i.e.: Hotel Bus, etc.) 10 Train 11 Other (specify)
T3 Mode choice for plan trip	01 Long Haul Train 02 Long Haul Bus 03 Airplane	04 Private Car 05 Chartered Bus 06 Others (specify)

Sources: JICA Expert Team

Figure A1.3.4 Passenger OD Interview Form at Sarajevo Railway Station

(4) Passenger OD interview at Sarajevo International Airport

Sarajevo TRAMODE
Passenger OD Interview - at Sarajevo International Airport

Airport Terminal		Surveyor No.	
Interview Time	H H : M M *24 hours format*	Supervisor No.	
Date/Month	D D / M M 2022	Sheet No.	

A	Destination Flight ID Flight Number Direction	OUTBOUND ONLY	OUTBOUND ONLY	OUTBOUND ONLY
B	Respondent No. Total number of passenger (including respondent and passenger travelling with respondent ≥ 5 years old)	1	2	3
C	Origin address inside Sarajevo (Origin is a place just before going/coming to departing location)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)	Street Name Street No Municipality Name Federation or Country (if outside BiH) Landmark (if any)
D	Type of origin - see Table T1 (if others please specify) Departure time from origin	(……………………) H H : M M *24 hours format*	(……………………) H H : M M *24 hours format*	(……………………) H H : M M *24 hours format*
E	Access modes to departing location - see T2 (please mention in sequence from your origin to departing location) Travel time from Origin to the departing location	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS H H : M M	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS H H : M M	ORIGIN 1 → 2 → 3 → 4 INTERCITY BUS H H : M M
F	Destination address	City/Regency Country Landmark (if location is not clear)	City/Regency Country Landmark (if location is not clear)	City/Regency Country Landmark (if location is not clear)
G	Residence during weekdays	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton	1. Inside Sarajevo Kanton 2. Outside Sarajevo Kanton
H	Trip purpose (if your residence during weekdays is 2, what is your trip purpose in Sarajevo Kanton)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (…)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (…)	1. Working (work related) 2. Business (business related) 3. School (study related) 4. Private Business (undisclosed private matter) 5. Family Matters 6. Shopping/Leisure/Tourism 7. Others (…)
I.1	Plan to comeback to Sarajevo Kanton or previous trip to Sarajevo Kanton (check on selected day)	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* estimated time crossing boundary	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* estimated time crossing boundary	1 2 3 4 5 6 7 Mo Tu We Th Fr Sa Su H H : M M *To explain that respondent will be back to Sarajevo again at anytime* estimated time crossing boundary
I.2	Mode for trip above (I.1) - See Table T3	(……………………)	(……………………)	(……………………)

T1	Type of origin	01 Hotel 02 Your residence 03 Private house other than your residence 04 Office	05 Restaurant 06 Shop/mall/market/tourist attraction 07 Private business place (Hospital, Bank, Religious Place, Police Station, etc.) 08 Other (specify)
T2	Mode choice for access	01 Walking, Bicycle, Romobil (Scooter) 02 Motorcycle 03 Car 04 Taxi 05 Tram 06 Mini Bus 07 Regular Bus	08 Articulated Bus (Trolley) 09 Chartered Bus (Company Bus, i.e.: Hotel Bus, etc.) 10 Train 11 Other (specify)
T3	Mode choice for plan trip	01 Long Haul Train 02 Long Haul Bus 03 Airplane	04 Private Car 05 Chartered Bus 06 Others (specify)

Sources: JICA Expert Team

Figure A1.3.5 Passenger OD Interview Form at Sarajevo International Airport

(5) Occupancy survey at Bus Terminal

Sarajevo TRAMODE

Passenger Occupancy Survey Form - at SARAJEVO BUS TERMINAL

Bus Terminal : ______________________

Date/Month : __________ / __________

Surveyor ID : ______________________

Supervisor ID : ______________________

No.	Passenger Data	Time (24 hr) e.g. 12:59	Number of Pax	Remarks
1	Bus Operator : Bus Destination : __________(if applicable) Bus Size : Medium / Large (Circle your answer) Direction : OUTBOUND ONLY			
2	Bus Operator : Bus Number : __________(if applicable) Bus Size : Medium / Large (Circle your answer) Direction : OUTBOUND ONLY			
3	Bus Operator : Bus Number : __________(if applicable) Bus Size : Medium / Large (Circle your answer) Direction : OUTBOUND ONLY			
4	Bus Operator : Bus Number : __________(if applicable) Bus Size : Medium / Large (Circle your answer) Direction : OUTBOUND ONLY			
5	Bus Operator : Bus Number : __________(if applicable) Bus Size : Medium / Large (Circle your answer) Direction : OUTBOUND ONLY			
6	Bus Operator : Bus Number : __________(if applicable) Bus Size : Medium / Large (Circle your answer) Direction : OUTBOUND ONLY			

Sources: JICA Expert Team

Figure A1.3.6 Occupancy Survey Form at Bus Terminal

(6) Occupancy survey at Mojmilo II and Dobrinja Bus Stops

Sarajevo TRAMODE
Passenger Occupancy Survey Form - at BUS STOPS

Bus Stop Code : ______________________
Date/Month : __________ / __________
Surveyor ID : ______________________
Supervisor ID : ______________________

No.	Passenger Data	Time (24 hr) e.g. 12:59	Number of Pax	Flyer Distributoin Method (Circle your Answer)	Remarks
1	Bus Operator : GRAS / CentroTrans / Other:__________ (Circle your answer) Bus Number : ______________(if applicable) Bus Size : Minibus / Bus / Articulated (Trolley) (Circle your answer) Direction : OUTBOUND ONLY			1. Handed to every Passenger 2. Handed to Driver	
2	Bus Operator : GRAS / CentroTrans / Other:__________ (Circle your answer) Bus Number : ______________(if applicable) Bus Size : Minibus / Bus / Articulated (Trolley) (Circle your answer) Direction : OUTBOUND ONLY			1. Handed to every Passenger 2. Handed to Driver	
3	Bus Operator : GRAS / CentroTrans / Other:__________ (Circle your answer) Bus Number : ______________(if applicable) Bus Size : Minibus / Bus / Articulated (Trolley) (Circle your answer) Direction : OUTBOUND ONLY			1. Handed to every Passenger 2. Handed to Driver	
4	Bus Operator : GRAS / CentroTrans / Other:__________ (Circle your answer) Bus Number : ______________(if applicable) Bus Size : Minibus / Bus / Articulated (Trolley) (Circle your answer) Direction : OUTBOUND ONLY			1. Handed to every Passenger 2. Handed to Driver	
5	Bus Operator : GRAS / CentroTrans / Other:__________ (Circle your answer) Bus Number : ______________(if applicable) Bus Size : Minibus / Bus / Articulated (Trolley) (Circle your answer) Direction : OUTBOUND ONLY			1. Handed to every Passenger 2. Handed to Driver	
6	Bus Operator : GRAS / CentroTrans / Other:__________ (Circle your answer) Bus Number : ______________(if applicable) Bus Size : Minibus / Bus / Articulated (Trolley) (Circle your answer) Direction : OUTBOUND ONLY			1. Handed to every Passenger 2. Handed to Driver	

Sources: JICA Expert Team

Figure A1.3.7 Occupancy Survey Form at Mojmilo II and Dobrinja Bus Stops

(7) Occupancy survey at Sarajevo Railway Station

Sarajevo TRAMODE

Passenger Occupancy Survey Form - at Railway Station

Date/Month	: ____________ / ____________
Surveyor ID	: ________________________
Supervisor ID	: ________________________

No.	Passenger Data	Dep. Time (24 hr) e.g. 12:59	Number of Pax	Remarks
1	Destination : Train Number : #Cars (total) : Direction : OUTBOUND ONLY			
2	Destination : Train Number : #Cars (total) : Direction : OUTBOUND ONLY			
3	Destination : Train Number : #Cars (total) : Direction : OUTBOUND ONLY			
4	Destination : Train Number : #Cars (total) : Direction : OUTBOUND ONLY			
5	Destination : Train Number : #Cars (total) : Direction : OUTBOUND ONLY			
6	Destination : Train Number : #Cars (total) : Direction : OUTBOUND ONLY			

Sources: JICA Expert Team

Figure A1.3.8 Occupancy Survey Form at Sarajevo Railway Station

(8) Occupancy survey at Sarajevo International Airport

Sarajevo TRAMODE

Passenger Occupancy Survey Form - at Sarajevo International Airport

Date/Month : ______ / ______
Surveyor ID : ______
Supervisor ID : ______

No.	Passenger Data	Dep. Time (24 hr) e.g. 12:59	Number of Pax	Remarks
1	Destination : Flight Number : Flight ID : Direction : OUTBOUND ONLY			
2	Destination : Flight Number : Flight ID : Direction : OUTBOUND ONLY			
3	Destination : Flight Number : Flight ID : Direction : OUTBOUND ONLY			
4	Destination : Flight Number : Flight ID : Direction : OUTBOUND ONLY			
5	Destination : Flight Number : Flight ID : Direction : OUTBOUND ONLY			
6	Destination : Flight Number : Flight ID : Direction : OUTBOUND ONLY			

Sources: JICA Expert Team

Figure A1.3.9 Occupancy Survey Form at Sarajevo International Airport

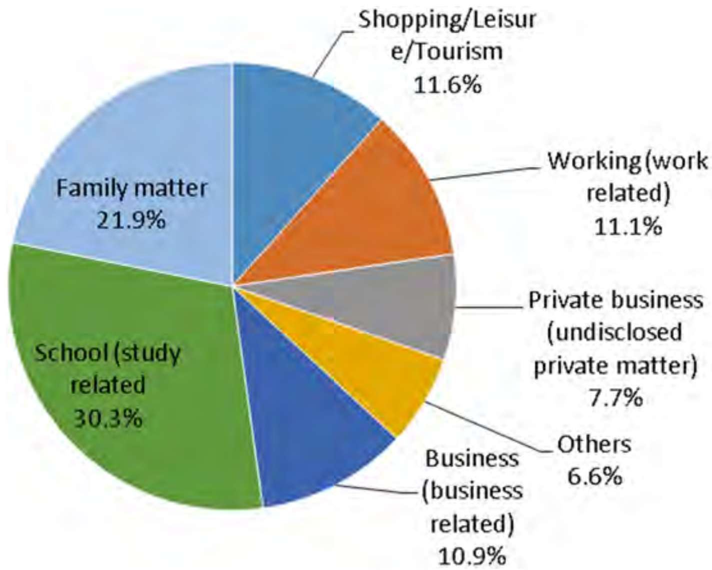
6) Survey Result and Finding

(1) Passenger OD Interview at Bus Terminal

Those on the inter-cantonal bus service dominate in the number of departing passengers than that of the international bus service. Ninety-three percent of the departing passengers traveled within Bosnia and Herzegovina, 4% traveled within the Balkan region, and only 3% traveled to western, central, and northern Europe. Major destinations within Bosnia and Herzegovina are Visoko, Zenica, Breza, Kakanj, Bihac, Tuzla, Banja Luka, and Mostar.

Without commercial domestic flights in the country, passengers have no other option but to use the inter-cantonal bus system (excluding those who own and have access to private vehicles). For the record, the travel time of an inter-cantonal bus varies between 2 to 5 hours, and the travel time of an international bus may reach multiple days.

The share of trip purposes can be seen in the figure below. Study-related and family matters are more than half of the trip purposes. Meanwhile, the rest of the options' share is distributed more or less evenly.



Sources: JICA Expert Team

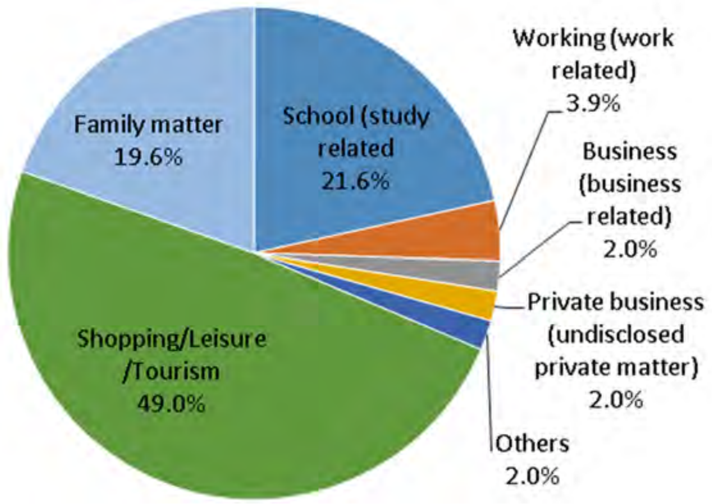
Figure A1.3.10 Share of Trip Purpose at Bus Terminal

The share of access modes used by the passengers to reach the bus terminal is non-motorized transport (NMT; 51%), regular bus (15%), tram (11%), private car (10%), taxi (10%), trolley bus (1%), minibus (1%), and motorcycle (1%). Most of the passengers would prefer to go back to Canton Sarajevo using the same bus service (93%), and small percentages would prefer using private car (5%), train (1%), and airplane (1%).

(2) Passenger OD Interview at Sarajevo Railway Station

The limitation of railway availability divided the railway passengers into two groups only: northbound (to Ilijas, Visoko, Kakanj, and Zenica) and southbound (to Konjic, Mostar, and Capljina). The share of departing northbound passengers is 36%, and southbound is 64%.

Different than those who used the inter-cantonal bus service, the trip purpose of departing passengers is 49% for shopping/leisure/tourism, 20% for family matters, 22% for study-related, 4% for work-related, 4% for business, and 1% for others. The highest share of the purpose may be caused by the fact that Mostar and Zenica are arguably the two most popular tourist sites in the country.



Sources: JICA Expert Team

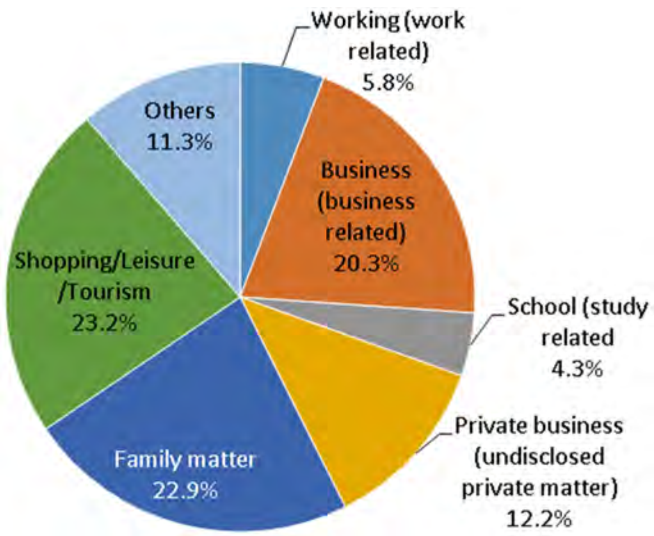
Figure A1.3.11 Share of Trip Purpose at Sarajevo Railway Station

The share of access modes used by passengers to reach the railway station is NMT (35%), private car (31%), taxi (13%), tram (12%), and regular bus (9%). Most of the passengers would prefer to go back to Canton Sarajevo using the same train service (90%), and a small percentage would prefer using a long-haul bus (8%) and private car (2%).

(3) Passenger OD Interview at Sarajevo International Airport

Destinations of the departing passengers are Turkey and the Middle East (35%), Western Europe (31%), Central Europe (23%), other Balkan countries (9%), the United Kingdom (1%), about Eastern and Northern Europe (about 2%), and North America, Australia, and other continents (about 2%).

The share of trip purposes can be seen in the figure below. Business is at 33%, shopping/leisure/tourism at 23%, family matters at 23%, work-related at 6%, study-related at 4%, and others at 11%.



Sources: JICA Expert Team

Figure A1.3.12 Share of Trip Purpose at Sarajevo International Airport

The share of access modes used by the passengers to reach the airport is 59% for private cars, 32% for taxis, 4% for regular buses, 1% for tram, 1% for chartered bus, 1% for trolleybus, 1% for minibus, and less than 1% for motorcycle and others. Most passengers would prefer to return to Canton of Sarajevo using the same air transport service (95%), and a small percentage would choose a long-haul bus (2%), private car (2%), and long-haul train (less than 1%).

A1.4 Public Transport Corridor Survey

1) Objective

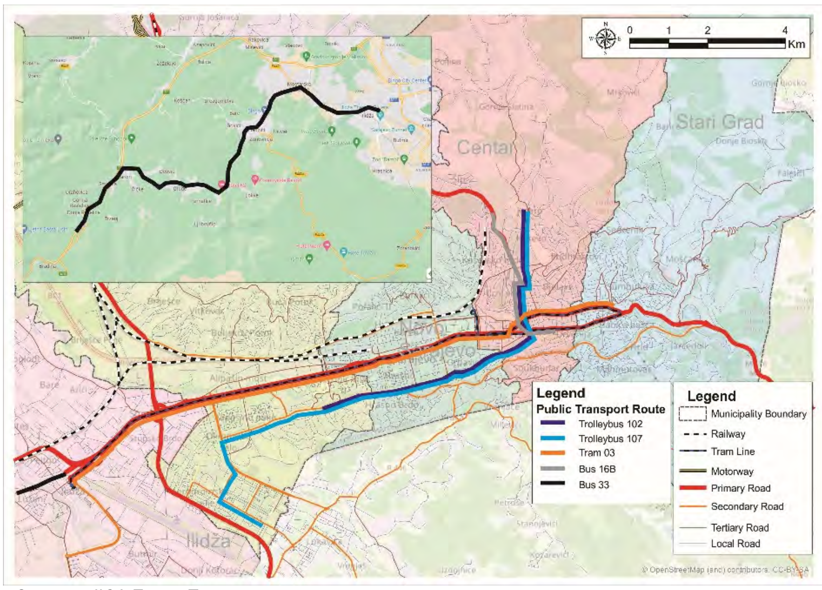
The main objective of the Public Transport Corridor Survey is to obtain data on sectional boarding/alighting passengers, dwelling time, and the speed of public transport in Canton of Sarajevo. For this purpose, the survey was applied to the representative fleets of tram, trolleybus, and bus. Eventually, the data shall be beneficial for the transportation model calibration.

2) Survey Location

The nature of this survey is corridor-based and seeks representation of urban and suburban lines. Therefore, observation took place along the corridors of the mentioned modes and sampled the transit lines of:

- Tram line 3 (Ilidza–Bascarsija) as the representation of the urban line.
- Trolleybus lines 102 (Otoka–Jezero) and 107 (Dobrinja–Jezero) as the representation of urban lines.
- Bus lines 16B (Dom Armije–Kosevsko Brdo) and 33 (Ilidza–Vukovici) as the representation of the suburban line.

The map below shows the location of the surveys.



Sources: JICA Expert Team

Figure A1.4.1 Public Transport Corridor Survey Locations

3) Methodology

The survey was done over an entire week for each corridor of the mentioned modes, and the data was recorded sectionally (by the stops). The onboard surveyor followed one probe fleet from the origin to the final terminus and back to the original terminus by following the next service departure. This iteration was done for the daily service hour of each line and throughout one week, enabling a profound analysis of public transport performance on weekdays and weekends.

(1) Boarding/Alighting passenger

The number of boarding and alighting passengers was recorded at every stop by the fleet at the stops or terminus.

(2) Dwelling time

The dwelling time was recorded once the door opened until it closed for boarding/alighting passengers.

(3) Fleet Speed

The speed of the fleet was calculated by directly collecting the following:

- Distance of one-stop to adjacent stop – and finally the terminus.
- Time duration between the departure from each stop until the fleet reached the following stops and terminus. This included the time when the fleet experienced traffic congestion or queued at the traffic light.

4) Survey Item

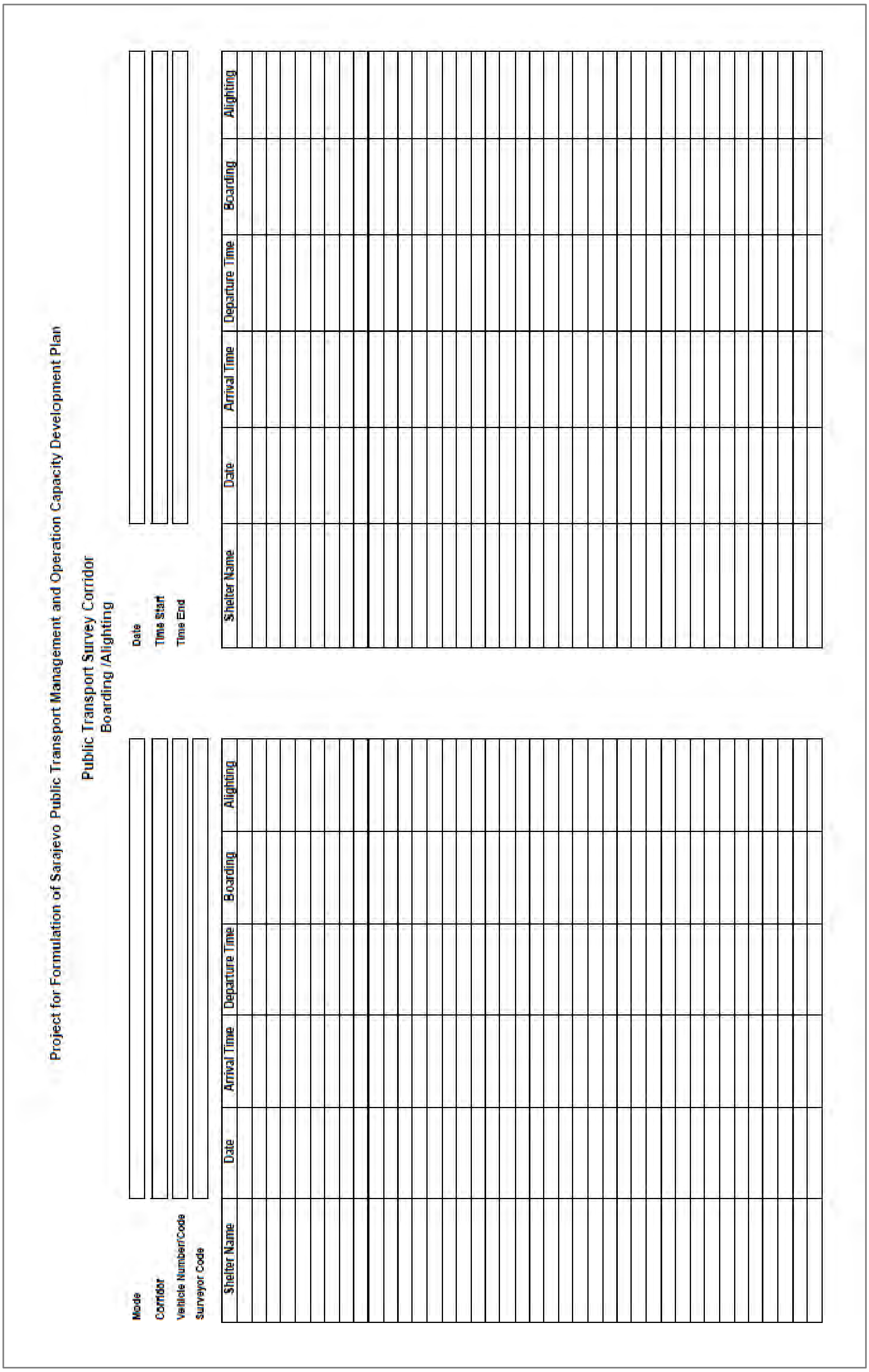
The survey items are as follows:

- identification of stops (naming and coding) and distance between stops,
- direction of fleet movement,
- stop-based arrival and departure times, and
- stop-based boarding and alighting passengers.

5) Survey Form

The survey forms are attached in the following pages.

(1) Boarding and alighting passengers survey form



Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan

Public Transport Survey Corridor
Boarding /Alighting

Mode
Corridor
Vehicle Number/Code
Surveyor Code

Date
Time Start
Time End

Shelter Name	Date	Arrival Time	Departure Time	Boarding	Alighting

Shelter Name	Date	Arrival Time	Departure Time	Boarding	Alighting

Sources: JICA Expert Team

Figure A1.4.2 Boarding and Alighting Passengers Survey Form

(2) Fleet speed survey form

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan

Travel Speed Survey
Public Transport Survey Corridor

Mode		Date	
Corridor		Direction	
Vehicle Number/Code		Surveyor Code	

Shelter Name (Start)	Shelter Name (End)	Start Time	End Time	Stop Time	Distance	Ave. Moving Speed

Sources: JICA Expert Team

Figure A1.4.3 Fleet Speed Survey Form

6) Survey Results and Findings

The results and findings mainly cover the number of boarding and alighting passengers, dwelling time, and the fleet speed. The summary of the daily and peak hour passengers can be seen in the table below. Note that the morning peak (AM Peak) is from 7 to 9 AM and afternoon peak (PM Peak) is from 3 to 5 PM.

Table A1.4.1 Summary of the Daily and Peak Hour Passengers

Line Name	Route	Daily	AM Peak	PM Peak
Tram 3	Ilidza–Bascarsija	67,851	15,141	18,375
Trolleybus 102	Otoka–Jezero	14,423	2,218	3,274
Trolleybus 107	Dobrinja–Jezero	12,571	2,960	3,583
Bus 33	Ilidza–Vukovici	3,384	796	592
Bus 16B	Dom Armije–Kosevsko Brdo	710	141	102

Source: JICA Expert Team

(1) Tram line 3 (Ilidza–Bascarsija, about 11-kilometer length)

During weekdays, the operation starts from 5 AM to 12 MN, and during weekends, from 5

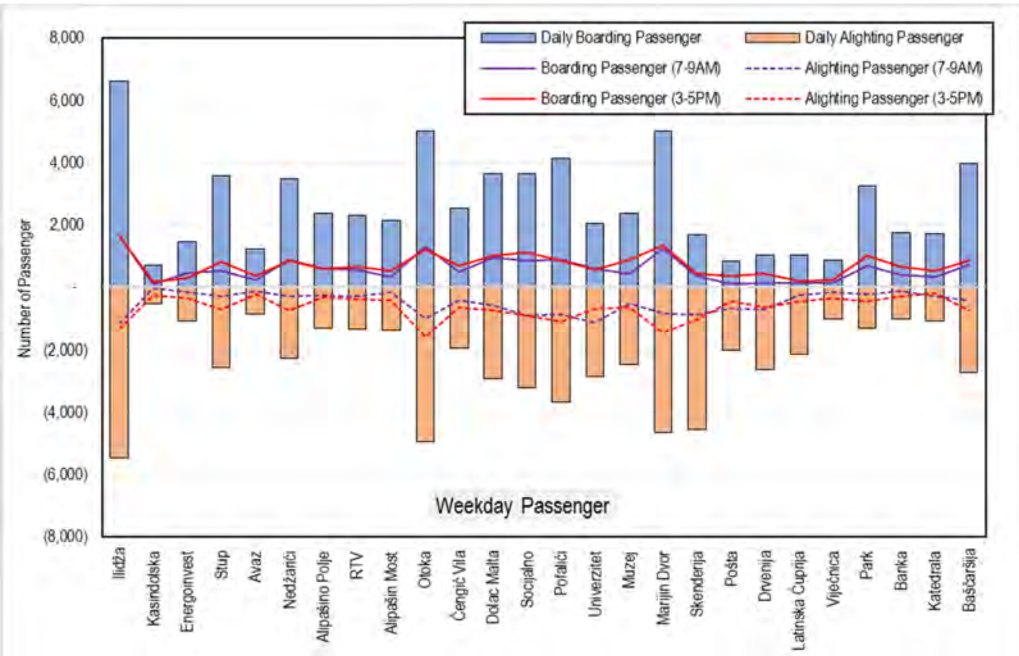
AM to around 11 PM. The line has 26 stops. The table below shows the lengths between stops.

Table A1.4.2 Lengths between Two Stops

Stop Name (Direction Ilidza–Bascarsija)		Length (meter)	Stop Name (Direction Bascarsija–Ilidza)		Length (meter)
Ilidža	Kasindolska	615	Baščaršija	Katedrala	466
Kasindolska	Energoinvest	613	Katedrala	Banka	467
Energoinvest	Stup	987	Banka	Park	529
Stup	Avaz	674	Park	Marijin Dvor	509
Avaz	Nedžarići	434	Marijin Dvor	Muzej	630
Nedžarići	Alipašino Polje	563	Muzej	Univerzitet	208
Alipašino Polje	RTV	534	Univerzitet	Pofalići	536
RTV	Alipašin Most	455	Pofalići	Socijalno	612
Alipašin Most	Otoka	1,067	Socijalno	Dolac Malta	523
Otoka	Čengić Vila	554	Dolac Malta	Čengić Vila	519
Čengić Vila	Dolac Malta	468	Čengić Vila	Otoka	507
Dolac Malta	Socijalno	518	Otoka	Alipašin Most	505
Socijalno	Pofalići	621	Alipašin Most	RTV	525
Pofalići	Univerzitet	383	RTV	Alipašino Polje	539
Univerzitet	Muzeji	366	Alipašino Polje	Nedžarići	565
Muzeji	Marijin Dvor	442	Nedžarići	Avaz	528
Marijin Dvor	Skenderija	500	Avaz	Stup	495
Skenderija	Pošta	517	Stup	Energoinvest	1,073
Pošta	Drvenija	289	Energoinvest	Kasindolska	589
Drvenija	Latinska Ćuprija	428	Kasindolska	Ilidža	436
Latinska Ćuprija	Vijećnica	420			
Vijećnica	Baščaršija	277			

Source: JICA Expert Team

Weekday passengers boarding and alighting during the day and peak hours (7–9 AM and 3–5 PM) are shown in the graph below.

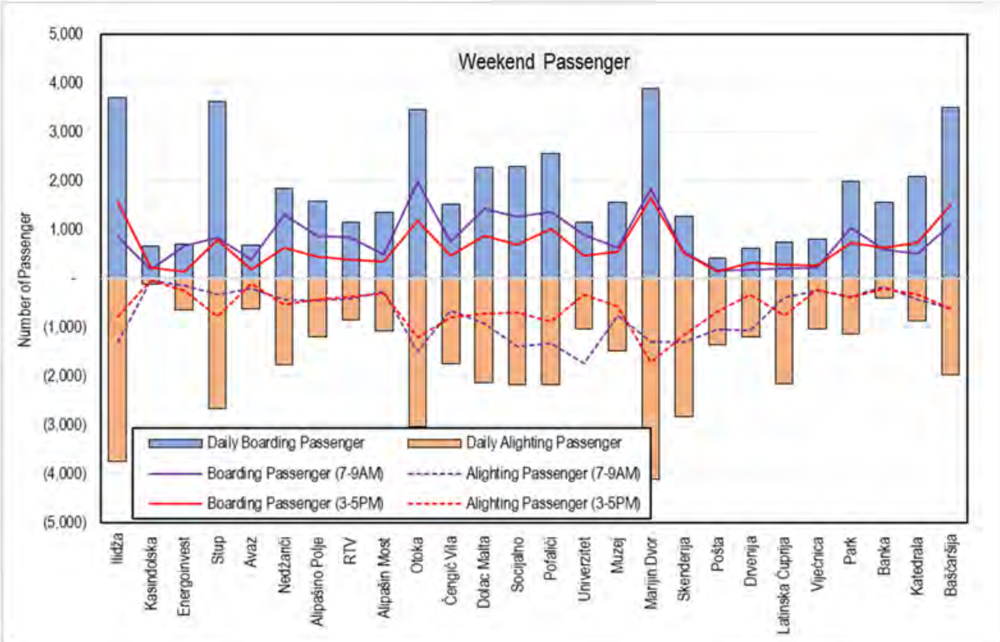


Sources: JICA Expert Team

Figure A1.4.4 Number of Boarding and Alighting Passengers of Tram 103: Daily and Peak Hours on Weekday

The high numbers of passenger flow by stops can be seen at the terminuses, Ilidza and Bascarsija, and along the corridor from Otoka to Skenderija. The corridor from Otoka to Skenderija is mostly populated by quite massive commercial and business development (i.e., offices, shops, educational facilities, etc.). Thus, it quite naturally attracts and generates demand from passengers. The same tendencies can be observed during AM and PM peak hours.

Weekend passengers boarding and alighting during the day and peak hours (7–9 AM and 3–5 PM) are shown in the graph below.

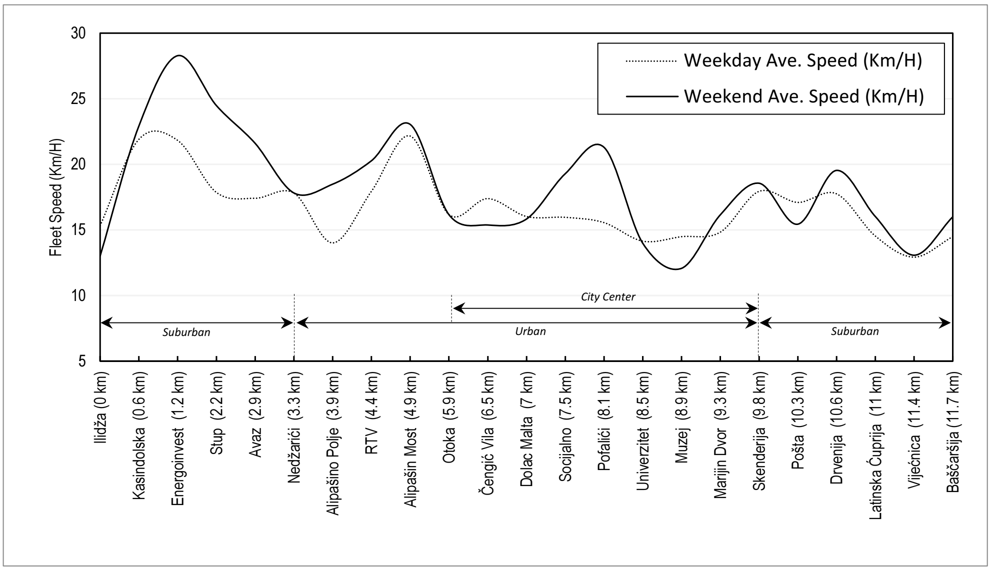


Sources: JICA Expert Team

Figure A1.4.5 Number of Boarding and Alighting Passengers of Tram 103: Daily and Peak Hours on Weekend

The high numbers of passenger flow by stops can be seen at the terminuses, Ilidza and Bascarsija, and the stops of Stup, Otoka, and Marijin Dvor. The stops of Stup, Otoka, and Marijin Dvor are directly connected to shopping malls: Bingo, Electronic Center Otoka, and Sarajevo City Center (SCC Shopping Center), respectively. Thus, they naturally highly attract and generate demand from passengers. The same tendencies can be observed during AM and PM peak hours.

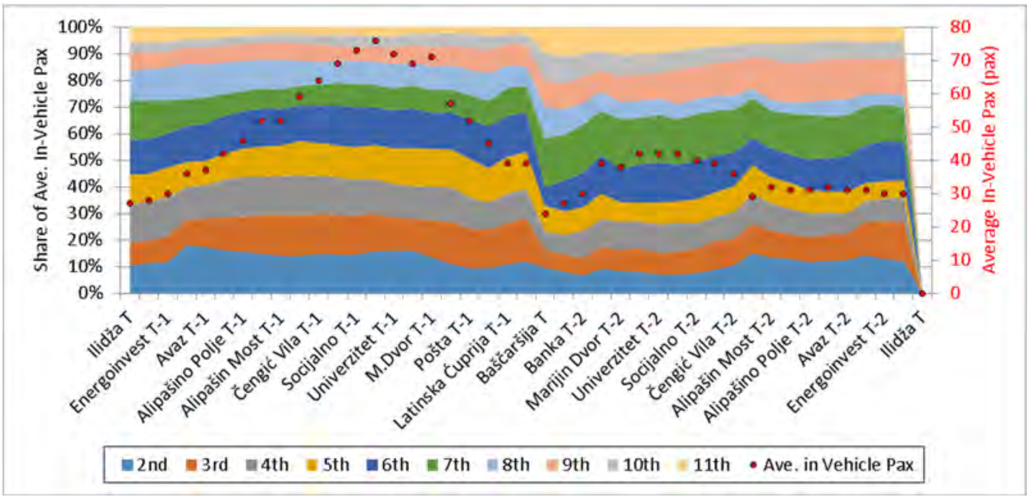
While the dwelling time at terminuses follows the timetable set up by the operator, dwelling time at stops is a passenger-derived parameter, meaning the tram conductor would open and close the tram doors once clearance is self-decided. Depending on the scale of the flow of boarding and alighting passengers at each stop, the dwelling time ranges from 15 to 40 seconds. At the above-mentioned stops, it ranges from 25 to 40 seconds. At some stops located before the mixed traffic intersections, the fleet dwelling time would sometimes be adjusted by the tram conductor based on the tram's red-light cycle. Such a condition is neither regulated nor prohibited but is rather upon the on-the-spot assessment of the tram conductor.



Sources: JICA Expert Team

Figure A1.4.6 Comparison of Speed of Tram 103 on Weekday and Weekend

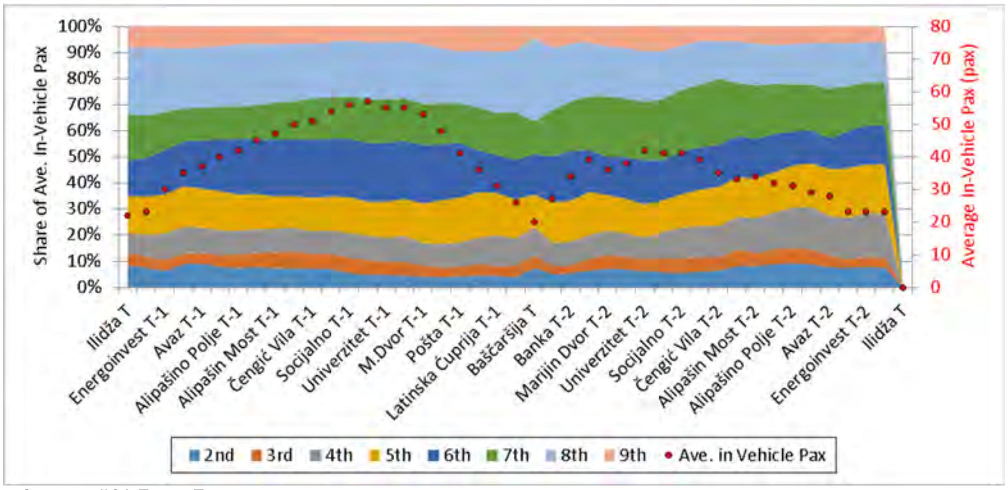
The average speed of this line on weekdays is 16 km/hour, and on weekends is 18 km/hour. The deviation of speed across the stops is depicted in the figure above—ranging from the lowest at 12 km/hour to the highest at 27 km/hour. The trend line of the speed indicates decreasing speed within the city center area and eventually is the lowest toward the terminus in Bascarsija.



Sources: JICA Expert Team

Figure A1.4.7 In-vehicle Passenger by Stop and Service Sequence of Tram 3 on Weekdays

The 1st and 12th services are not included in the figure because they can be considered an anomaly. The tendency is that tram passengers get stacked up from Ilidza to Universzitet (can be up to nearly full capacity) and get subsided towards Bascarsija. Again, the tram gets stacked up from Bascarsija to Marijin Dvor (can be up to half-full of capacity) and gets subsided along the way back to Ilidza. As for the share of in-vehicle passengers by service sequence, a higher percentage can be found during the 6th and 7th runs at around 5 PM.



Sources: JICA Expert Team

Figure A1.4.8 In-vehicle Passenger by Stop and Service Sequence of Tram 3 on Weekend

The tendency of the flow of the average in-vehicle passenger is similar to the weekdays, and the number is, in general, lower than that of weekdays. The share of in-vehicle passengers by service sequence is bigger from the 5th to 8th runs (about noon to about 5 PM). However, it may be worth mentioning that in-vehicle passengers during weekends are generally lower, except towards the attraction places (i.e., the shopping malls).

(2) Trolleybus line 102 (Otoka–Jezero, about 6.5-kilometer length)

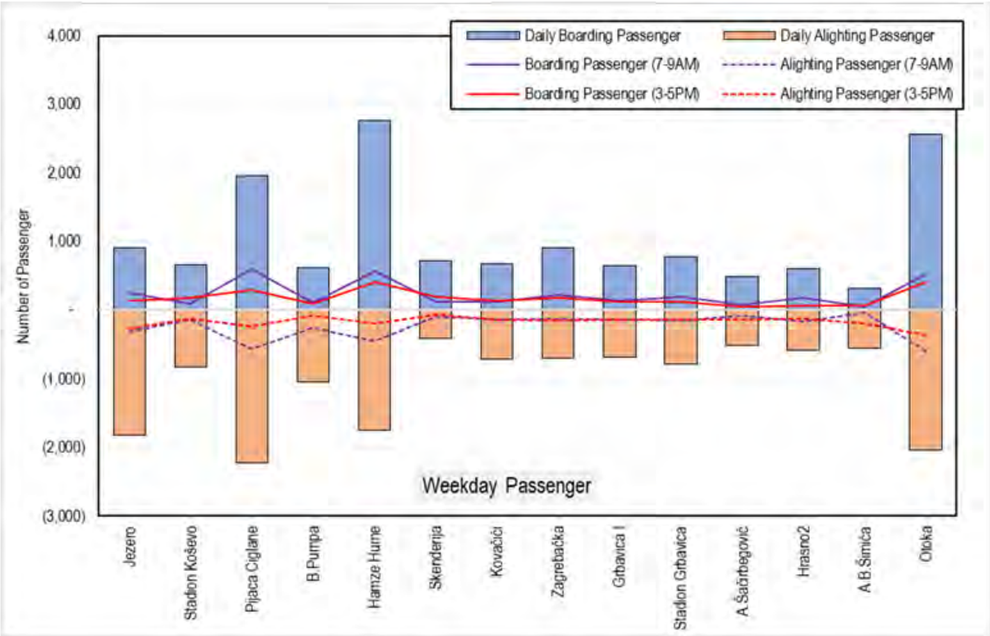
During weekdays and weekends, operations start from 6 AM to around 10 PM. Trolleybus has 14 stops along this line. The table below shows the lengths between two stops in sequence and for each direction.

Table A1.4.3 Lengths between Two Stops

Stop Name (Direction Jezeero–Otoka)		Length (meter)	Stop Name (Direction Otoka–Jezero)		Length (meter)
Jezero	Stadion Koševo	1,000	Otoka	A.B.Šimića	1,600
Stadion Koševo	Pijaca Ciglane	1,200	A.B.Šimića	Hrasno2	750
Pijaca Ciglane	B.Pumpa	900	Hrasno2	A.Šačirbegović	500
B.Pumpa	Hamze Hume	900	A.Šačirbegović	Sta. Grbavica	800
Hamze Hume	Skenderija	1,000	Sta. Grbavica	Grbavica I	800
Skenderija	Kovačići	950	Grbavica I	Zagrebačka	550
Kovačići	Zagrebačka	800	Zagrebačka	Kovačići	800
Zagrebačka	Grbavica I	550	Kovačići	Hamze Hume	950
Grbavica I	Sta. Grbavica	800	Hamze Hume	B.Pumpa	900
Sta. Grbavica	A.Šačirbegović	800	B.Pumpa	Pijaca Ciglane	900
A.Šačirbegović	Hrasno2	500	Pijaca Ciglane	Stadion Koševo	1,200
Hrasno2	A.B.Šimića	750	Stadion Koševo	Jezero	1,000
A.B.Šimića	Otoka	1,600			

Source: JICA Expert Team

On the weekday, the number of boarding and alighting passengers during the day and peak hours (7–9 AM and 3–5 PM) can be seen in the following graph.

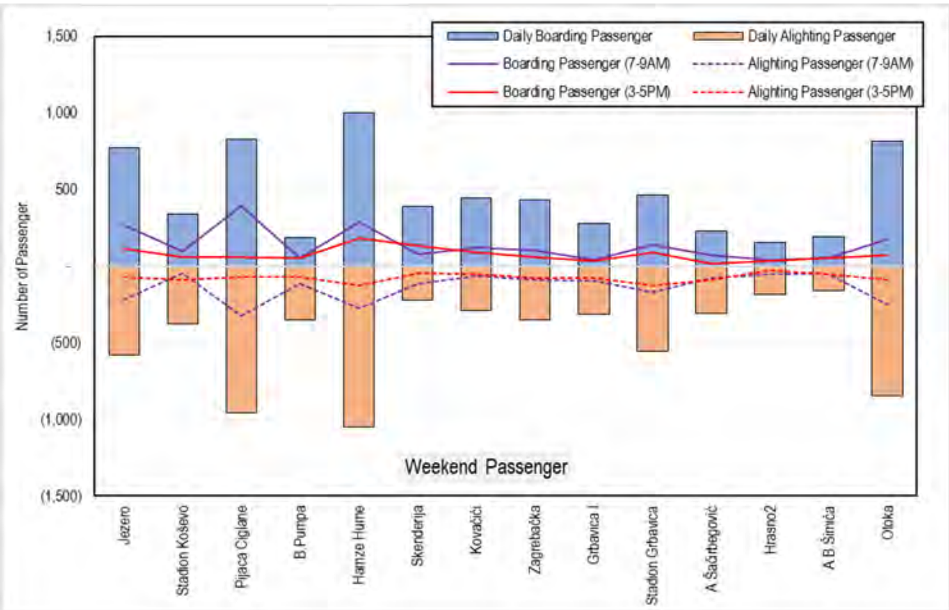


Sources: JICA Expert Team

Figure A1.4.9 Number of Boarding and Alighting Passenger of Trolley 102: Daily and Peak Hours on Weekday

The high numbers of passenger flow by stops can be seen at the terminuses, Jezero and Otoka, and the stops of Pijaca Ciglane and Hamze Hume. These two stops are considered major destinations for workers since this section is where the government and private sector offices are located. In addition, the two stops are the transfer points to/from other lines. Other than these mentioned stops, the daily passenger number is relatively low, and the same tendencies can be observed during AM and PM peak hours.

On the weekend, the number of boarding and alighting passengers during the day and peak hours (7–9 AM and 3–5 PM) can be seen in the graph below.

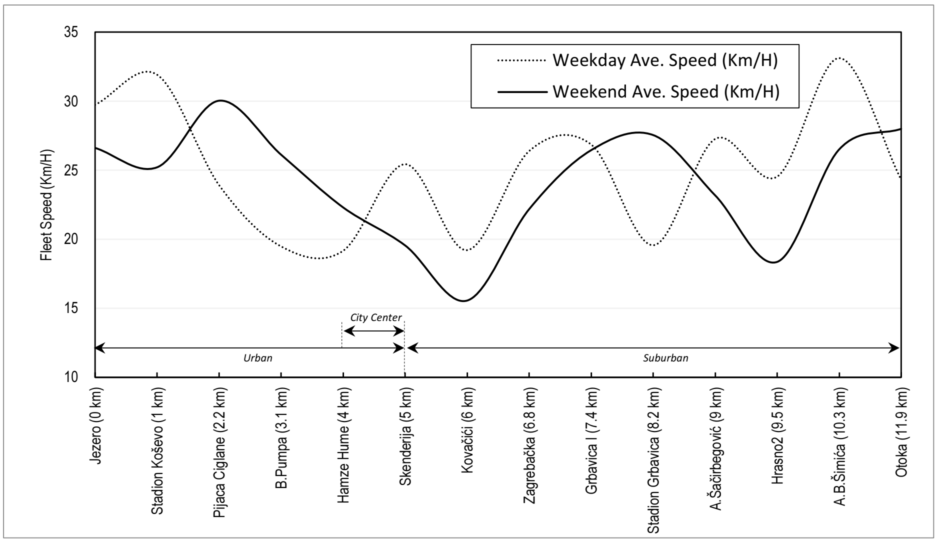


Sources: JICA Expert Team

Figure A1.4.10 Number of Boarding and Alighting Passenger of Trolley 102: Daily and Peak Hours on Weekend

Generally, the same pattern of boarding alighting passengers (daily and peak hours) during the weekend is the same as the weekdays despite the lower total number during the weekend. It may be safe to say that this line is relatively stable in terms of demand and throughout the operational days of service.

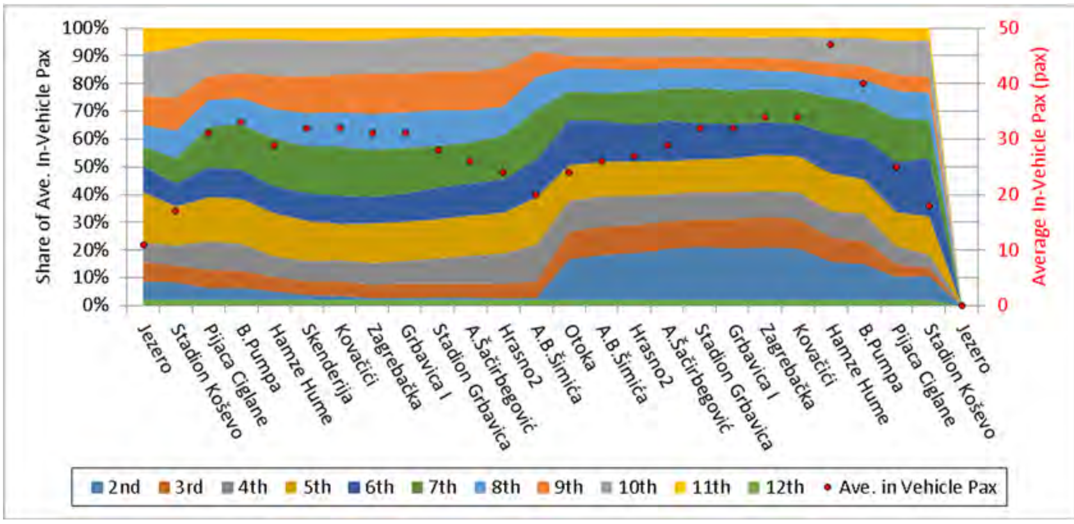
While the dwelling time condition is the same as the previous, depending on the scale of the flow of boarding and alighting passengers at each stop, the dwelling time ranges from 8 to 42 seconds, with 42 seconds dwelling time at Hamze Hume during weekdays. This may be a reflection of the combination time of the dwelling and the waiting time for the traffic light to turn green at the big intersection of Hamze Hume.



Sources: JICA Expert Team

Figure A1.4.11 Comparison of Speed of Trolley 102 on Weekday and Weekend

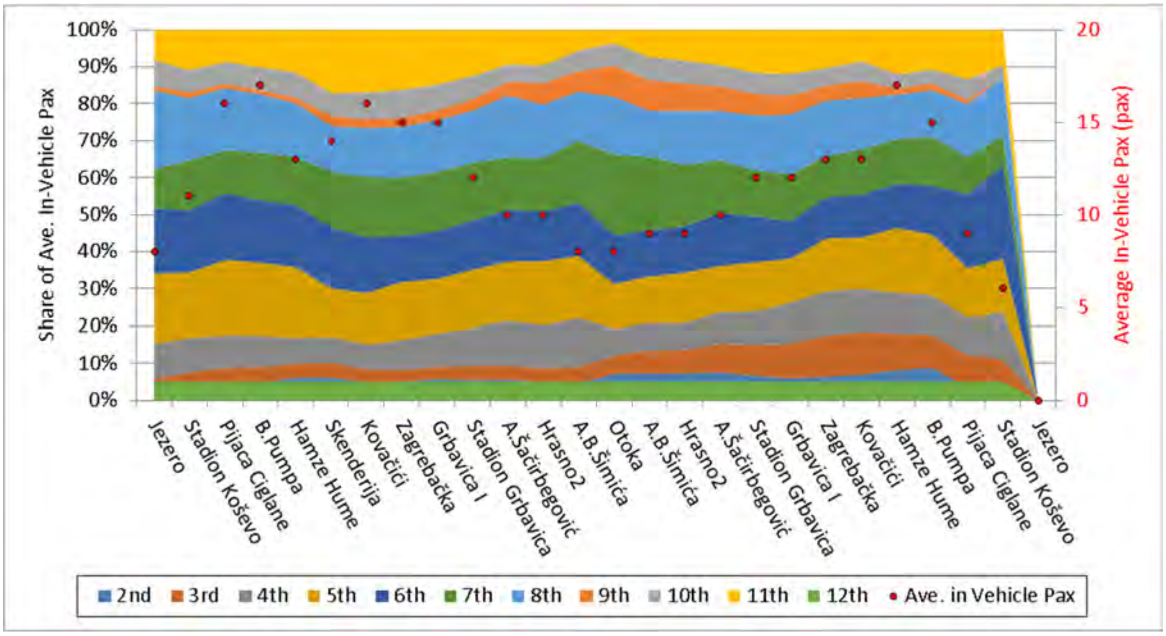
The average speed of this line is about 25 km/hour on both weekdays and weekends. The deviation of speed across the stops is depicted in the figure above, ranging from the lowest at 16 km/hour to the highest at 33 km/hour. The trend line of the speed indicates a slightly decreasing weekday speed within the city center area, eventually being the lowest toward the terminus in Otoka. During the weekend, the trend line of speed is relatively stable—a flat line.



Sources: JICA Expert Team

Figure A1.4.12 In-vehicle Passenger by Stop and Service Sequence of Trolley 102 on Weekday

The 1st and 13th services are not included because they can be considered anomalies. The tendency is that trolleybus in-vehicle passenger is quite similar throughout the stops except for the section of Hamze Hume. The share of in-vehicle passengers by service sequence is quite interesting to see. A higher percentage of the share during the 5th to 7th runs is around noon, indicating the urban line gets quite many passengers even during off-peak.



Sources: JICA Expert Team

Figure A1.4.13 In-vehicle Passenger by Stop and Service Sequence of Trolley 102 on Weekend

The tendency of the average in-vehicle passenger is the same as the weekdays. However, it may be worth mentioning that the average in-vehicle passenger during weekends is generally lower.

(3) Trolleybus line 107 (Dobrinja–Jezero, about 11.5-km length)

During weekdays and weekends, operations start from 6 AM to around 11 PM. Trolleybus has 23 stops along this line. The table below shows the lengths between two stops in sequence and for each direction.

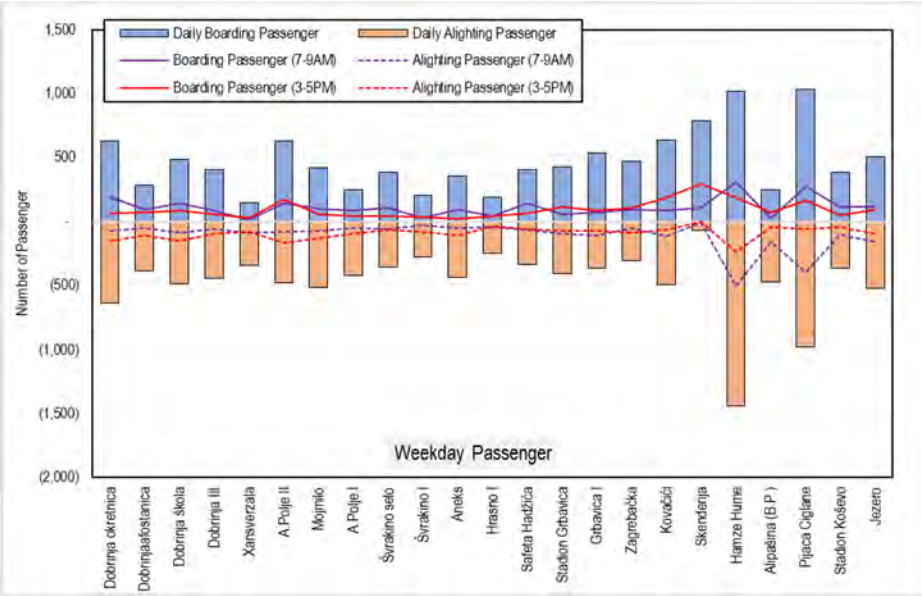
Table A1.4.4 Lengths between Two Stops

Stop Name (Direction Dobrinja–Jezero)		Length (meter)	Stop Name (Direction Jezero–Dobrinja)		Length (meter)
Dobrinja okretnica	Dobrinjaafostanica	170	Jezero	Stadion Koševo	450
Dobrinjaafostanica	Dobrinja škola	550	Stadion Koševo	Pijaca Ciglane	550
Dobrinja škola	Dobrinja III	600	Pijaca Ciglane	B.Pumpa	300
Dobrinja III	Xansverzala	200	B.Pumpa	Hamze Hume	600
Xansverzala	A.Polje II	300	Hamze Hume	Skenderija	210
A.Polje II	Mojmilo	280	Skenderija	Kovačići	750
Mojmilo	A.Polje I	550	Kovačići	Zagrebačka	450
A.Polje I	Švrakino selo	500	Zagrebačka	Grbavica I	500
Švrakino selo	Švrakino I	600	Grbavica I	Stadion Grbavica	650
Švrakino I	Aneks	550	Stadion Grbavica	Safeta Hadžića	700
Aneks	Hrasno I	600	Safeta Hadžića	Hrasno I	400
Hrasno I	Safeta Hadžića	300	Hrasno I	Aneks	350
Safeta Hadžića	Stadion Grbavica	600	Aneks	Švrakino I	600
Stadion Grbavica	Grbavica I	430	Švrakino I	Švrakino selo	500

Stop Name (Direction Dobrinja–Jezero)		Length (meter)	Stop Name (Direction Jezero–Dobrinja)		Length (meter)
Grbavica I	Zagrebačka	550	Švrakino selo	A.Polje I	240
Zagrebačka	Kovačići	500	A.Polje I	Mojmilo	550
Kovačići	Hamze Hume	1,000	Mojmilo	A.Polje II	400
Hamze Hume	Alipašina (B.P.)	700	A.Polje II	Xansverzala	450
Alipašina (B.P.)	Pijaca Ciglane	600	Xansverzala	Dobrinja III	350
Pijaca Ciglane	Stadion Koševo	600	Dobrinja III	Dobrinja škola	650
			Dobrinja škola	Dobrinjaafostanica	600
			Dobrinjaafostanica	Dobrinja okretnica	200

Source: JICA Expert Team

The number of daily passengers and the number of passengers during morning peak hours (7–9 AM) and afternoon (3–5 PM) can be seen in the graphic below.

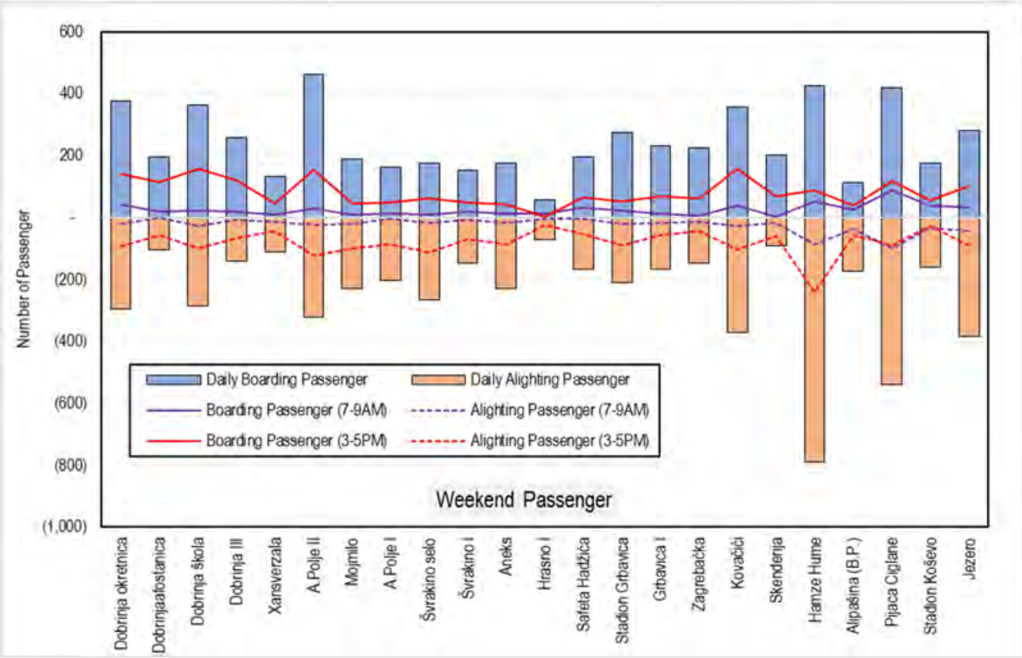


Sources: JICA Expert Team

Figure A1.4.14 Number of Boarding and Alighting Passenger of Trolley 107: Daily and Peak Hours on Weekday

The high numbers of passenger flow by stops can be seen at the terminuses, Jezero and Dobrinja, and the stops of Pijaca Ciglane and Hamze Hume. Similar explanation on Trolleybus line 102 is applied to these two stops. Other than these mentioned stops, the daily passenger number is moderately lower, and the same tendencies can be observed during AM and PM peak hours.

The weekend number of boarding and alighting passengers during the day and peak hours (7–9 AM and 3–5 PM) can be seen in the following graph.

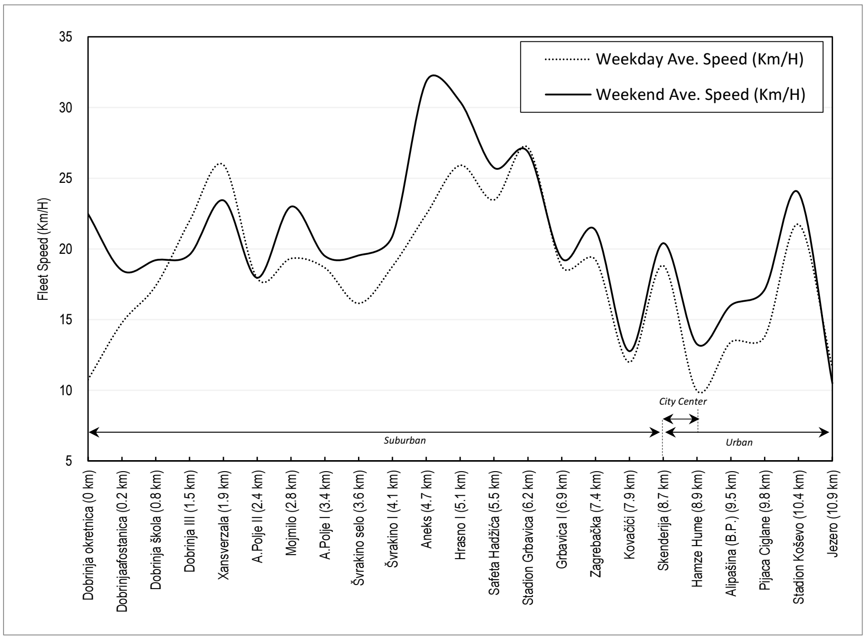


Sources: JICA Expert Team

Figure A1.4.15 Number of Boarding and Alighting Passenger of Trolley 107: Daily and Peak Hours on Weekend

Generally, the same pattern of boarding alighting passengers (daily and peak hours) during the weekend is the same as the weekdays despite the total number being lower on weekends. It may be safe to say that this line is rather stable in terms of demand and throughout operational days of service.

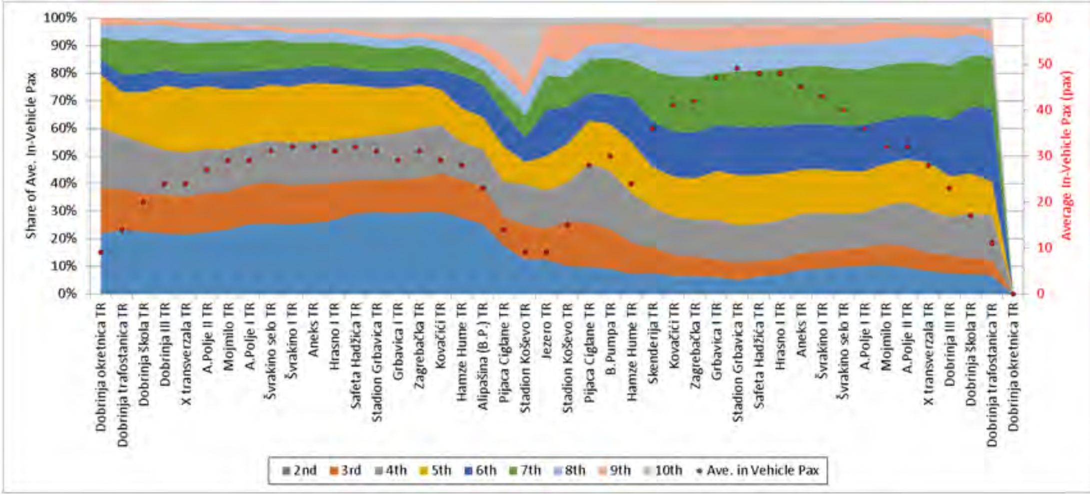
While the dwelling time condition is the same as the previous explanation, depending on the scale of the flow of boarding and alighting passengers at each stop, the range of dwelling time is between 7 to 44 seconds, with 44 seconds dwelling time at Hamze Hume during weekdays. This may be a reflection of the combined time of dwelling and waiting for the traffic light to turn green at the big intersection of Hamze Hume.



Sources: JICA Expert Team

Figure A1.4.16 Comparison of Speed of Trolley 107 on Weekday and Weekend

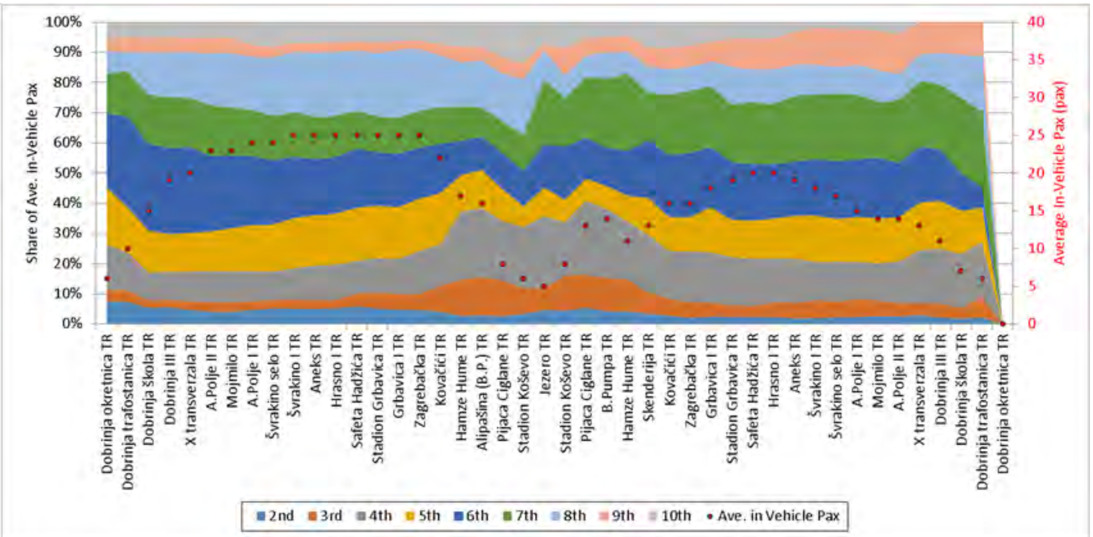
The average speed of this line is about 18 km/hour during weekdays and around 21 km/hour during weekends. The deviation of speed across the stops is depicted in the figure above, ranging from the lowest at 10 km/hour to the highest at 33 km/hour. The trend line of the weekend and weekday speeds indicate a moderate decreasing speed within the city center area, eventually being the lowest toward the terminus in Jezero.



Sources: JICA Expert Team

Figure A1.4.17 In-vehicle Passenger by Stop and Service Sequence of Trolley 107 on Weekday

The 1st and 10th services are not included because they can be considered anomalies. The tendency of trolley bus average in-vehicle passengers shows two peaks in a round trip service, which has the largest number halfway of the service route. The share of in-vehicle passengers by service sequence indicates a higher percentage of the share of the 1st and 4th to 7th runs from about 6 AM and 11 AM to around 4 PM. This may indicate that the urban line that connects the settlement area in Dobrinja gets busier during morning and afternoon peak hours.



Sources: JICA Expert Team

Figure A1.4.18 In-vehicle Passenger by Stop and Service Sequence of Trolley 107 on Weekend

The tendency of average in-vehicle passengers and share of in-vehicle passengers by service sequence is the same with the weekdays. However, it may be worth mentioning that the in-vehicle passenger rate during weekends is generally lower.

(4) Bus line 16B (Dom Armije–Kosevsko Brdo, about 4.5-kilometer length)

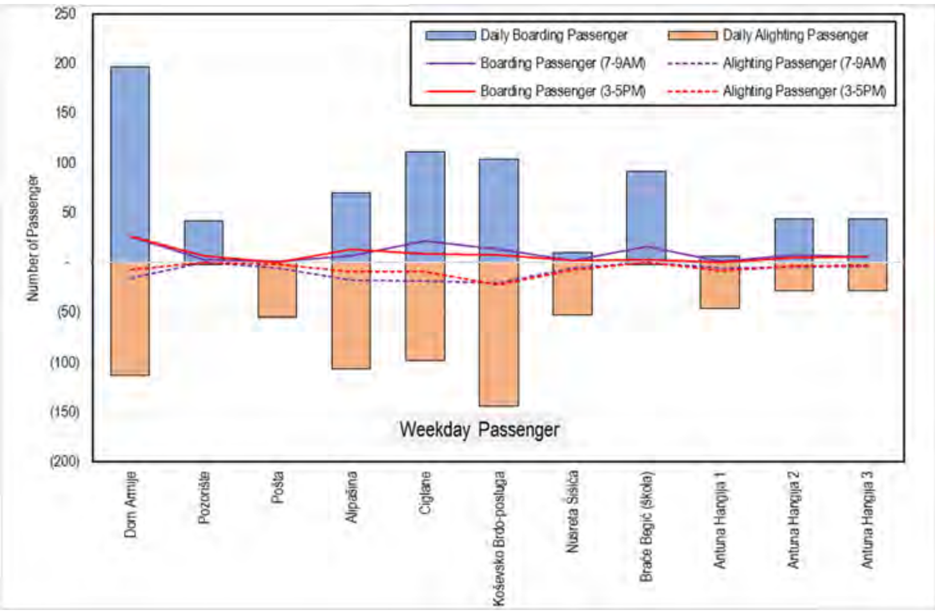
During weekdays, the operation starts from 6 AM to around 11 PM. During weekends, the operation starts from 6 AM to around 9 PM. The bus line has 9 stops. The table below shows the lengths between two stops in sequence and for each direction.

Table A1.4.5 Lengths between Two Stops

Stop Name (Direction Dom Armije–Kosevsko Brdo)		Length (meter)	Stop Name (Direction Kosevsko Brdo–Dom Armije)		Length (meter)
Dom Armije	Pozorište	350	Antuna Hangija 3	Antuna Hangija 2	250
Pozorište	Alipašina	1,200	Antuna Hangija 2	Braće Begić	500
Alipašina	Ciglane	750	Braće Begić	Koševsko Brdo-posluga	900
Ciglane	Koševsko Brdo-posluga	500	Koševsko Brdo-posluga	Ciglane	450
Koševsko Brdo-posluga	Nusreta Šišića	430	Ciglane	Alipašina	1,100
Nusreta Šišića	Antuna Hangija 1	450	Alipašina	Pošta	702
Antuna Hangija 1	Antuna Hangija 2	450	Pošta	Dom Armije	730
Antuna Hangija 2	Antuna Hangija 3	230			

Source: JICA Expert Team

The number of daily passengers and the number of passengers during morning peak hours (7–9 AM) and afternoon (3–5 PM) can be seen in the graph below.

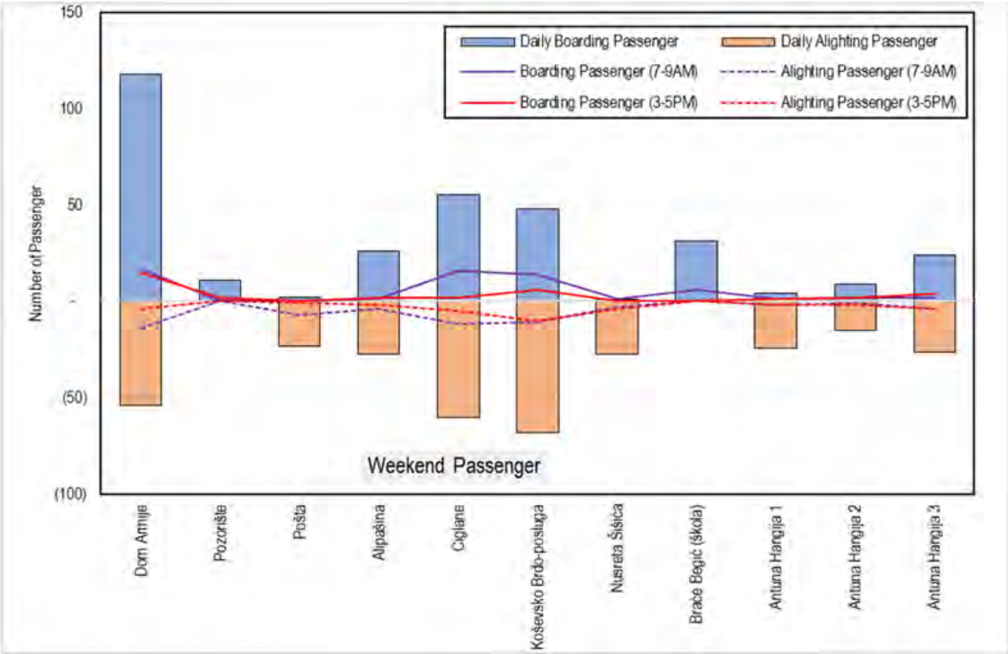


Sources: JICA Expert Team

Figure A1.4.19 Number of Boarding and Alighting Passenger of Bus 16B: Daily and Peak Hours on Weekday

Although the demand is moderately low in general, high numbers of passenger flow by stops can be seen at the Dom Armije and the stops of Ciglane and Kosevsko Brdo-posluga, being the location of offices. Other than these mentioned stops, the daily passenger number is even lower, and the same tendencies can be observed during AM and PM peak hours.

The weekend number of boarding and alighting passengers during the day and peak hours (7–9 AM and 3–5 PM) can be seen in the following graph.



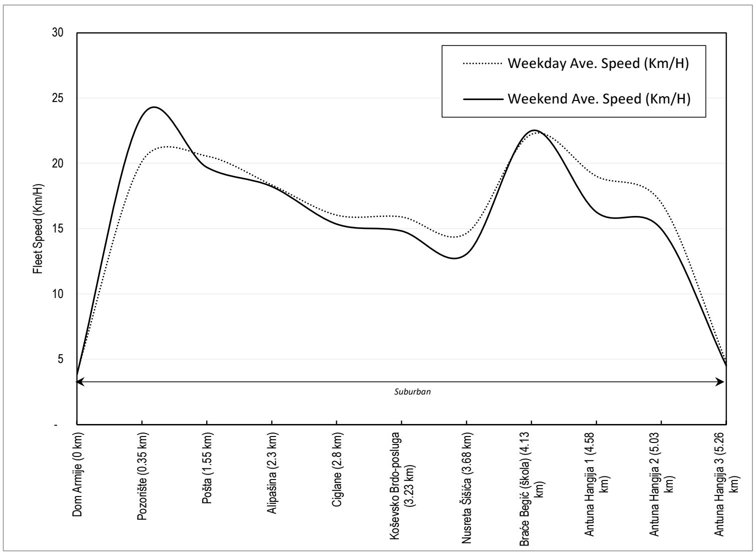
Sources: JICA Expert Team

Figure A1.4.20 Number of Boarding and Alighting Passenger of Bus 16B: Daily and Peak Hours on Weekend

Generally, the same pattern of boarding alighting passengers (daily and peak hours) during the weekend is the same as the weekdays despite the total number being lower on weekends.

It is worth noting that this line has just been recently activated (in October 2022), and the line is considerably short. In addition, the line overlaps with some other existing lines, making the competition of passenger demand exist.

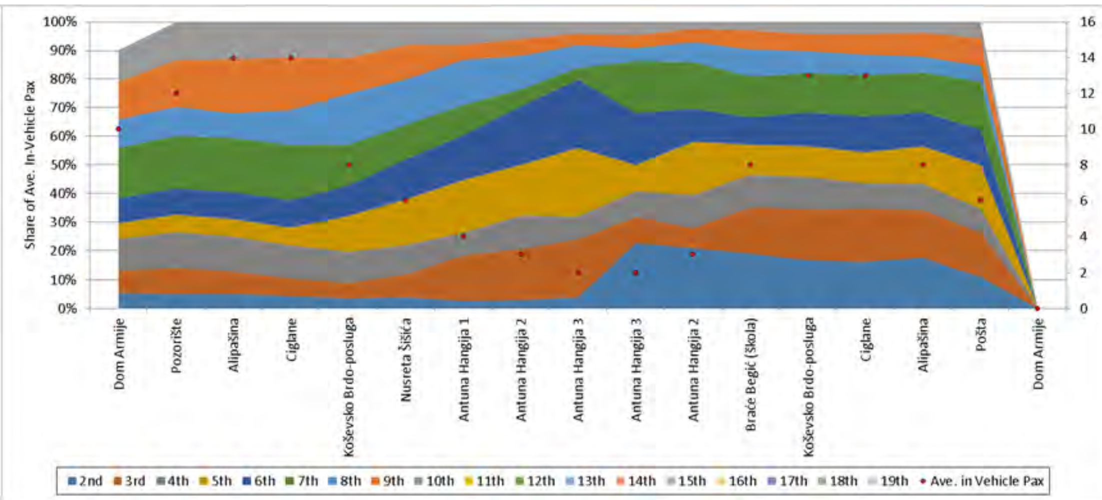
The range of dwelling time is between 3 to 26 seconds, with 26 seconds dwelling time at Alipasina during weekdays. The lower threshold of dwelling time of 3 seconds is the impact of the action of bus-stop-skipping operation. This situation is defined as the bus driver's discretion not to stop at certain stops when neither boarding nor alighting passengers are seen.



Sources: JICA Expert Team

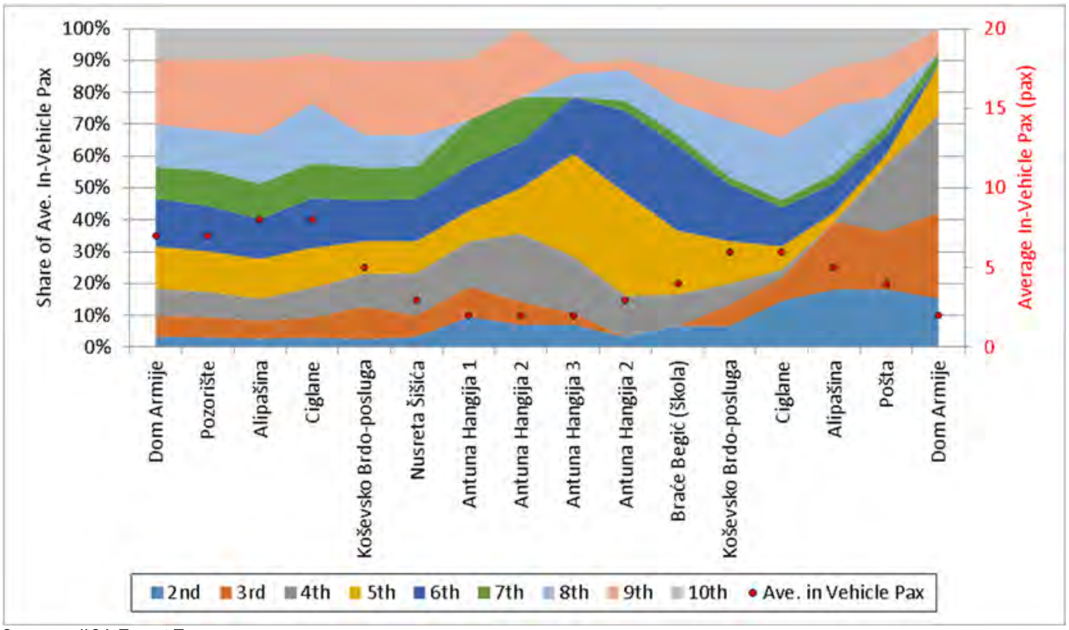
Figure A1.4.21 Comparison of Speed of Bus 16B on Weekday and Weekend

The average speed of this line is about 15 km/hour during weekdays and weekends. The deviation of speed across the stops is depicted in the figure above, ranging from the lowest at 4 km/hour to the highest at 24 km/hour. The trend line of the weekend and weekday speeds indicates a slight decrease as the service enters the dense area of Ciglane to Antuna Hangija. The exceptionally slow speed around the terminus locations is caused by the fact that this line does not really have the terminal infrastructure but only some sort of U-tur. Therefore, bus drivers tend to slow down to make up the time for the next departure as it is set in the formal timetable.



Sources: JICA Expert Team

Figure A1.4.22 In-vehicle Passenger by Stop and Service Sequence of Bus 16B on Weekday



Sources: JICA Expert Team

Figure A1.4.23 In-vehicle Passenger by Stop and Service Sequence of Bus 16B on Weekday

The tendency of average in-vehicle passengers and share of in-vehicle passengers by service sequence is the same with the weekdays. However, it may be worth mentioning that the in-vehicle passenger rate during weekends is generally lower.

(5) Bus line 33 (Ilidza–Vukovici, about 31.5-kilometer length)

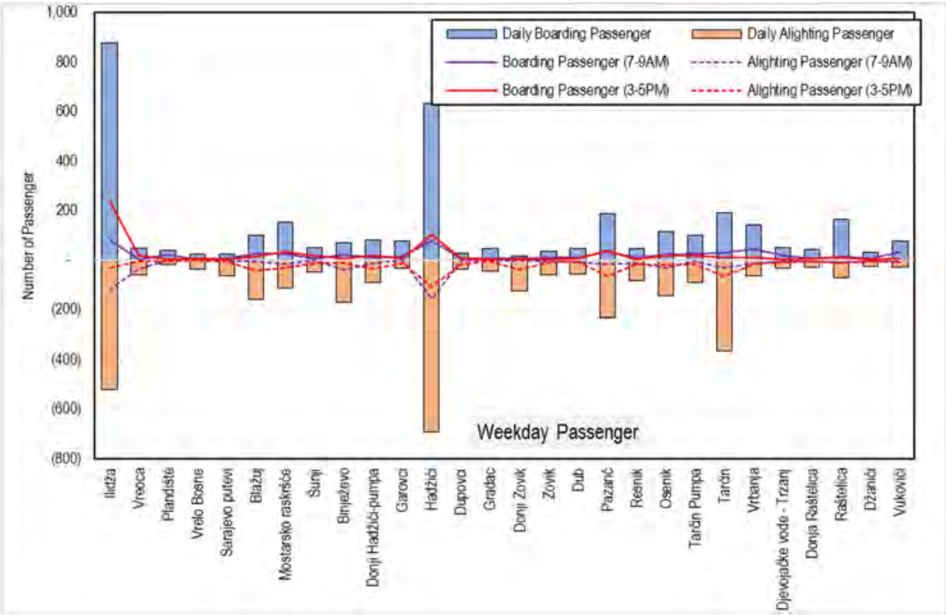
During weekdays, operations start from 6 AM to around 9 PM. During weekends, the operation starts from 6 AM to around 6 PM. The bus line consists of 28 stops. The table below shows the lengths between two stops in sequence and for each direction.

Table A1.4.6 Lengths between Two Stops

Stop Name (Direction Ilidza–Vukovici)		Length (meter)	Stop Name (Direction Vukovici–Ilidza)		Length (meter)
Ilidža	Vreoca	1,600	Vukovići	Džanići	450
Vreoca	Plandište	1,100	Džanići	Raštelica	2,200
Plandište	Vrelo Bosne	700	Raštelica	Donja Raštelica	900
Vrelo Bosne	Sarajevo putevi	600	Donja Raštelica	Djevojačke vode - Trzanj	300
Sarajevo putevi	Blažuj	550	Djevojačke vode - Trzanj	Vrbanja	1,700
Blažuj	Mostarsko raskršće	1,600	Vrbanja	Tarčin	1,000
Mostarsko raskršće	Šunji	1,000	Tarčin	Tarčin Pumpa	800
Šunji	Binježevo	1,200	Tarčin Pumpa	Osenik	1,900
Binježevo	Donji Hadžići-pumpa	1,200	Osenik	Resnik	2,000
Donji Hadžići-pumpa	Garovci	300	Resnik	Pazarić	1,100
Garovci	Hadžići	1,100	Pazarić	Dub	1,300
Hadžići	Dupovci	1,900	Dub	Zovik	1,300
Dupovci	Gradac	700	Zovik	Donji Zovik	900
Gradac	Donji Zovik	950	Donji Zovik	Gradac	950
Donji Zovik	Zovik	900	Gradac	Dupovci	700
Zovik	Dub	1,300	Dupovci	Hadžići	1,900
Dub	Pazarić	1,300	Hadžići	Garovci	1,100
Pazarić	Resnik	1,100	Garovci	Donji Hadžići-pumpa	300
Resnik	Osenik	2,000	Donji Hadžići-pumpa	Binježevo	1,200
Osenik	Tarčin Pumpa	1,900	Binježevo	Šunji	1,200
Tarčin Pumpa	Tarčin	800	Šunji	Mostarsko raskršće	1,000
Tarčin	Vrbanja	1,000	Mostarsko raskršće	Blažuj	1,600
Vrbanja	Djevojaćke Vode-Trzanj	1700	Blažuj	Sarajevo putevi	550
Djevojaćke Vode-Trzanj	Donja Raštelica	300	Sarajevo putevi	Vrelo Bosne	600
Donja Raštelica	Raštelica	900	Vrelo Bosne	Plandište	700
Raštelica	Džanići	2,200	Plandište	Vreoca	1,100
Džanići	Vukovići	1,600	Vreoca	Ilidža	1,600

Source: JICA Expert Team

The number of daily passengers and the number of passengers during morning peak hours (7–9 AM) and afternoon (3–5 PM) can be seen in the following graph.

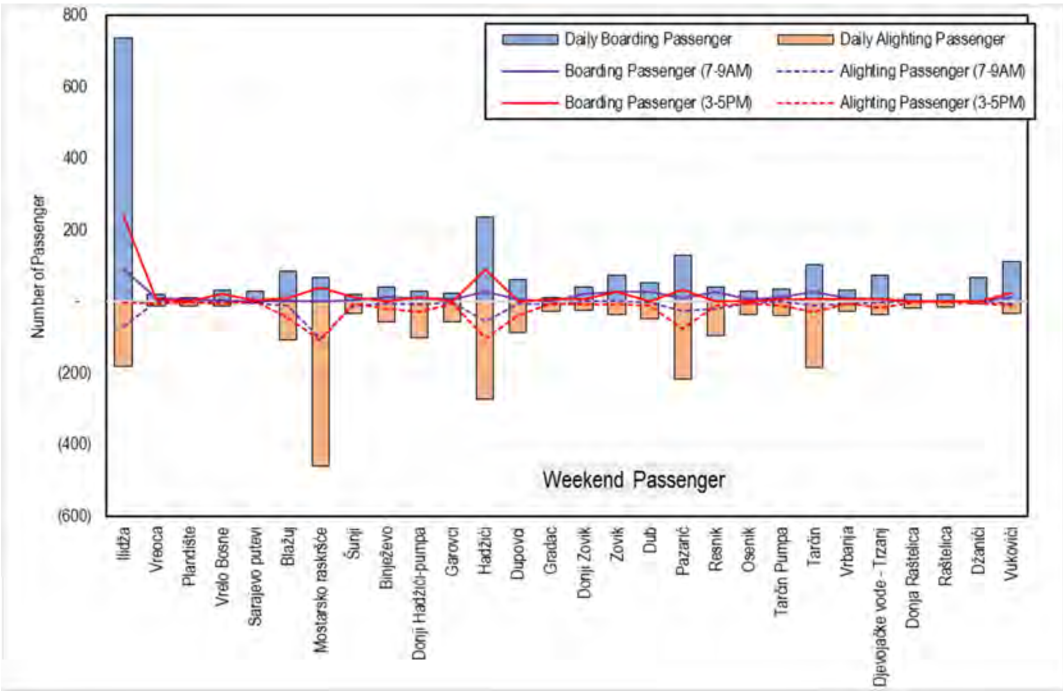


Sources: JICA Expert Team

Figure A1.4.24 Number of Boarding and Alighting Passenger of Bus 33: Daily and Peak Hours on Weekday

Extremely high numbers of passenger flow by stops can be seen at Ilidza and Hadzici. This line represents the connection between suburban and urban areas. Hadzici, Pazaric, and Tarcin, in this case, may be considered satellite cities in between. Other than these mentioned stops, the daily passenger number is even lower, and the same tendencies can be observed during AM and PM peak hours. It may be safe to say that this bus is an intra-cantonal bus service.

The weekend number of boarding and alighting passengers during the day and peak hours (7–9 AM and 3–5 PM) can be seen in the graph below.

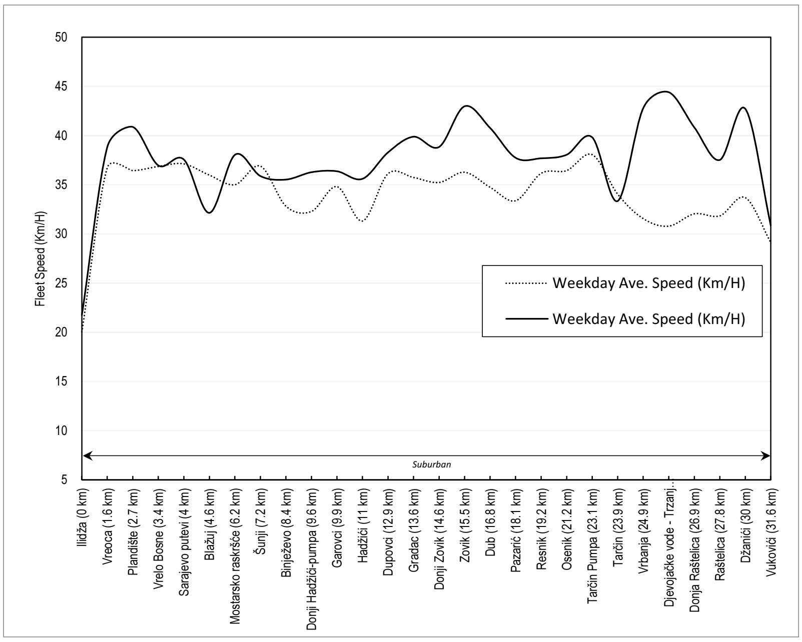


Sources: JICA Expert Team

Figure A1.4.25 Number of Boarding and Alighting Passenger of Bus 33: Daily and Peak Hours on Weekend

Generally, the same pattern of boarding alighting passengers (daily and peak hours) during the weekend is the same as the weekdays despite the total number being lower on weekends. In addition to Hadzici, Pazaric, and Tarcin, the alighting passengers during weekends is high at Mostarsko Raskisce.

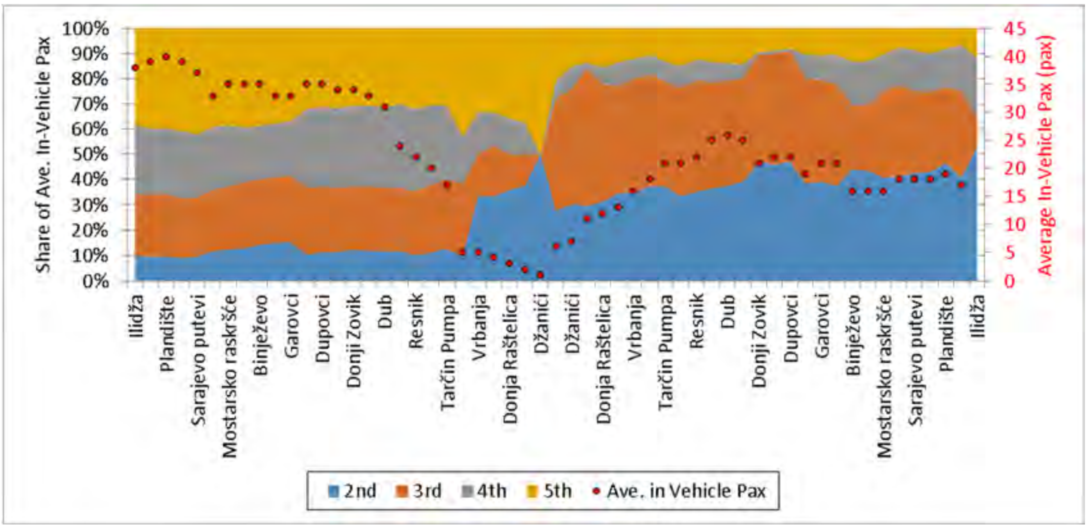
The range of dwelling time is between 11 to 32 seconds, with 32 seconds dwelling time at Hadzici during weekdays.



Sources: JICA Expert Team

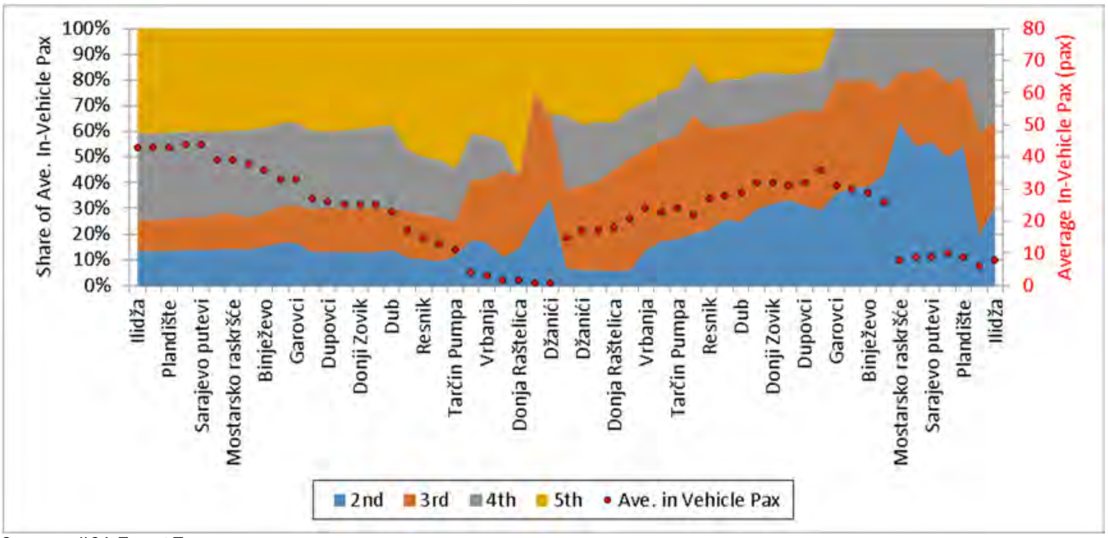
Figure A1.4.26 Comparison of Speed of Bus 33 on Weekday and Weekend

The average speed of this line is about 34 km/hour during weekdays and around 38 km/hour during weekends. The deviation of speed across the stops is depicted in the figure above, ranging from the lowest at 22 km/hour to the highest at 43 km/hour. The trend line of the weekend speeds indicates an increase towards the suburban areas, and weekday speeds indicate a slight decrease in speed within the same direction of suburban areas.



Sources: JICA Expert Team

Figure A1.4.27 In-vehicle Passenger by Stop and Service Sequence of Bus 33 on Weekday



Sources: JICA Expert Team

Figure A1.4.28 In-vehicle Passenger by Stop and Service Sequence of Bus 33 on Weekend

The tendency of average in-vehicle passengers and share of in-vehicle passengers by service sequence is the same with the weekdays. However, it may be worth mentioning that the in-vehicle passenger rate during weekends is generally lower.

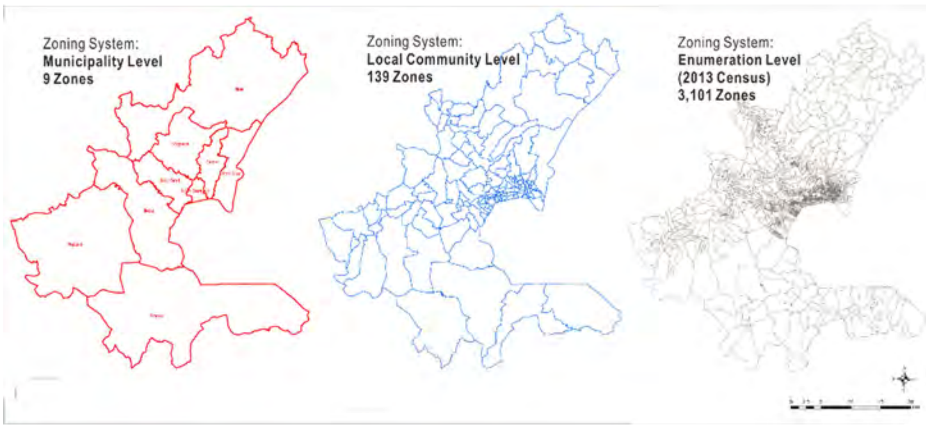
A1.5 Activity-Travel Diary Survey

1) Objective

The main objective of the Activity-Travel Diary Survey (ADS) is to obtain data on the daily activity-travel of Canton Sarajevo citizens, targeting mainly workers and students since they are the most active in traveling. In addition, the socioeconomic data for households and household members were collected.

2) Survey Location

In principle, the survey is to be applied to Canton of Sarajevo citizens of. The cantonal borderline is the limit.



Source: JICA Expert Team

Figure A1.5.1 Survey Zoning

There are three divisions of the zoning system for Canton of Sarajevo: (The following explanation is not sequential for storyline explanation.)

- The municipality level consists of 9 zones, also representing 9 municipalities. These are: Stari Grad, Centar, Novo Sarajevo, Novi Grad, Vogosca, Illjas, Ilidza, Hadzici, and Trnovo. This level of zone is clear and well-known to common Sarajevo citizens. The boundaries are clear, and most data categorization is based on this level.
- The enumeration level consists of 3,101 zones. This level of the zone was set up only for census data collection, and such a zone system has never been introduced to the public. Therefore, the public is not familiar with this kind of zone, and no other statistical data has been published with this kind of categorization. The division of these zones is basically based on the attempt to create an evenly distributed population density. This is why the zone area is small in the urban area and large in the suburban area, which is hilly/mountainous.
- The local community level consists of 139 zones. This zone level is factually applied in reality, with the existence of the semi-formal structure of community-based organizations. Such division might have been well-known by the old, if not ancient, generation of Bosnian, but not nowadays. Despite some census data analysis aggregated to this level of zone, the division itself has never really been used in public. Considering the adequacy of the zone number and the fact that this zone level is in between something too detailed (enumeration level) and something that is too coarse (municipality level), eventually, the traffic analysis zone (TAZ) of the survey and modeling work is based on this local community level zone.

3) Sampling

The target number of respondents was set up to 6,000 (workers and students) from 6,000 households, meaning one respondent represents one household. Initially and most ideally, the 2013 census data was aimed to be utilized as the basis of the sampling method—to assign the household surveyed in 2013 as the target respondent of this survey. However, the related stakeholders' strict and strong counterarguments regarding privacy and data breach issues canceled the idea. Eventually, the raw data of the 2013 census was inaccessible.

With minimum demographic and socioeconomic detail information as the fuel to sampling work, the sampling method was done by following these steps:

- Step 1: Considering the essence of why the enumeration level (3,101 zones) was created, to begin with, by evenly distributing the number of target samples to those 3,101 zones, each zone had to be represented by two respondents.
- Step 2: 2013 Census data also suggested that the ratio of worker to student in Canton Sarajevo is 1.65:1. Since there is no actual most recent demographic data, there is no significant increase (only 0.8%) in the 2022 population projected by the United Nations. The survey tried to keep the balance of the ratio between workers and students as the target sample.
- Step 3: The percentage of population data based on municipality from the 2013 census is utilized as the control of the total surveyed respondents by municipality.

Compiling all three steps of the sampling method, the survey set up the table of targeted diary survey respondents, as follows.

Table A1.5.1 Targeted Survey Respondents

Municipality	Total	Worker	Student
Centar	757	471	286
Hadzici	171	106	65
Ilidza	754	469	285
Ilijas	186	116	70
Novi Grad	2,199	1,369	830
Novo Sarajevo	1303	811	492
Stari Grad	387	241	146
Trnovo	54	34	20
Vogosca	223	139	84
Total	6,034	3,756	2,278

Source: JICA Expert Team

However, this table was an initial setup for the target respondents in the initial stage of the survey. The actual composition of worker and student respondents by municipality would refer to the actual composition of workers and students based on the socioeconomic survey of ADS. This process is a so-called adaptive sampling method that had to be done considering the lack of resources or obsolete secondary supporting data. The discussion of this is further elaborated in the Survey Results and Findings section.

4) Methodology and Field Survey Challenges

The methodology of the survey, in principle, is for the surveyor to come to the home of the respondent, conduct the on-the-spot survey of socioeconomic, opt for one household member to participate in the diary survey, and leave the diary survey form to be filled in by the target respondent for five consecutive days. In between the days of the diary survey, the surveyor would need to make frequent reminders so the respondent remains motivated. At the end of the fifth day, the surveyor would revisit the respondent and collect the completed diary survey form. The number of target respondents by municipality and main activity (worker and student) is controlled by the table shown previously.

Based on previous experience in other countries, applying this kind of survey requires committed respondents to complete the survey. Especially for the diary part, the survey context is huge and detailed, discouraging the respondent from completing the survey and rejecting any participation in the survey to begin with.

Below is the list of challenges of the survey in Sarajevo and how to overcome them.

(1) Privacy issue upholding

The privacy issue upholding is at different levels in many countries for various reasons (cultural, social, skepticism, and so on). Eventually, this matter always puts the participation rate at risk, which would subsequently lead to a prolonged survey period.

Some countermeasures taken to overcome this situation were a public announcement through the Ministry of Traffic’s website and a formal letter from the Ministry of Traffic that explains the survey and to be brought by the surveyor.

Finally, even with all the countermeasures, this matter still massively influenced the survey in Canton of Sarajevo, with a participation-to-rejection ratio of 1:10. Despite the assessment of the cause of this ratio not being recorded, the surveyors evaluated governmental-election-related skepticism was the leading cause.

(2) Halfway through participation

Even after the privacy issue was solved and respondents agreed to participate, the complexity and the length of the diary survey (five consecutive days) often led the respondents to halfway through participation. After the friendly reminder from the surveyor, some agreed to re-participate, but numerous simply gave up the survey.

Some countermeasures to overcome this situation were to involve the supposed head or the elders of the community so the respondents would feel more obligated to complete the survey. Another way of motivating the respondent is by providing an incentive system in the format of phone credit. However, the amount of 5KM phone credit was considered too small as an incentive by a significant portion of the respondents. Thus, the incentive system was not an option.

5) Survey Item

Forms 1 and 2 contain socioeconomic questions. Form 3 has a unique diary format to collect data on the respondents' travel behavior and daily activities for five consecutive days (e.g., Monday to Friday or Wednesday to Sunday). The survey forms contain the items as follows:

(1) Form 1: Household Information

- Survey zone code
- Household member composition with gender, age, status, etc.
- Household monthly income
- Vehicle ownership, etc.

(2) Form 2: Respondent's Information

- Address of work/school place
- Travel departure/arrival times
- Mode of transport
- Car/motorcycle availability
- Frequency
- Occupation
- Work type
- Weekday residence, etc.

(3) Form 3: Activity-Travel Diary (for five consecutive days)

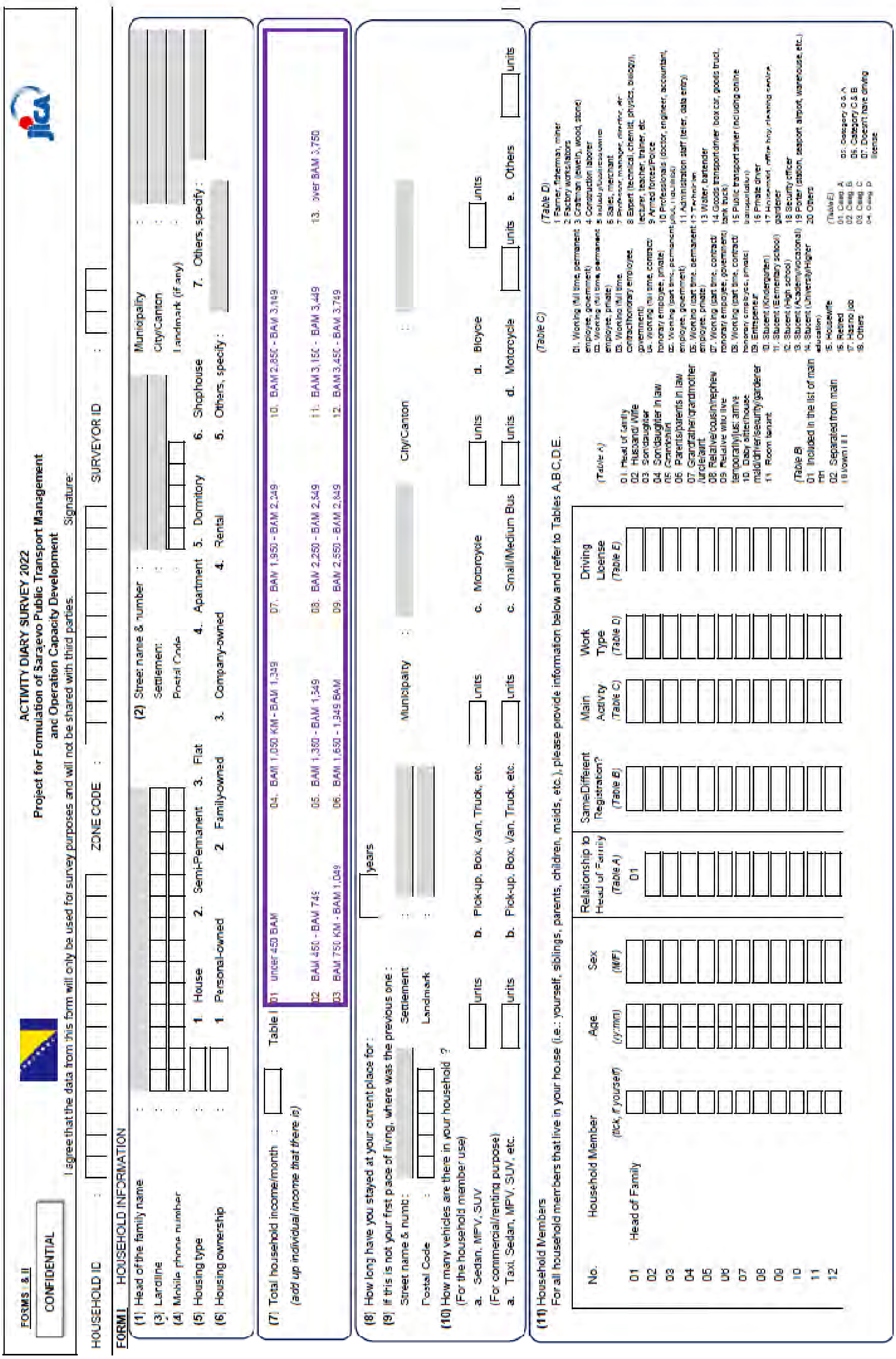
- Activities at home (for every 15 minutes)
- Activities outside the home (for every 15 minutes)
    - o Address of the activity location (addresses of major locations are listed on a separate page.)
- Transport mode used between activities at home and other places,
    - o Transport mode

    - Transport cost
- Characteristics of the day, for instance,
    - whether it was a usual weekday
    - whether it was a busy day or a calm day

6) Survey Forms

The survey forms used are attached to the next pages.

(1) Form 1: Household Information



FORMS I & II

CONFIDENTIAL

ACTIVITY DIARY SURVEY 2022
Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development

I agree that the data from this form will only be used for survey purposes and will not be shared with third parties. Signature:

HOUSEHOLD ID : ZONE CODE : SURVEYOR ID :

FORM I HOUSEHOLD INFORMATION

(1) Head of the family name :
(2) Street name & number : Municipality :
Settlement : City/Canton :
Postal Code : Landmark (if any) :
(3) Landline :
(4) Mobile phone number :
(5) Housing type : 1. House 2. Semi-Permanent 3. Flat 4. Apartment 5. Dormitory 6. Shophouse 7. Others, specify :
(6) Housing ownership : 1. Personal-owned 2. Family-owned 3. Company-owned 4. Rental 5. Others, specify :

(7) Total household income/month : (add up individual income that there is)

Table I
01. under 450 BAM
02. BAM 450 - BAM 749
03. BAM 750 KM - BAM 1,049
04. BAM 1,050 KM - BAM 1,349
05. BAM 1,350 - BAM 1,549
06. BAM 1,650 - 1,949 BAM
07. BAM 1,950 - BAM 2,249
08. BAM 2,250 - BAM 2,549
09. BAM 2,550 - BAM 2,849
10. BAM 2,850 - BAM 3,149
11. BAM 3,150 - BAM 3,449
12. BAM 3,450 - BAM 3,749
13. over BAM 3,750

(8) How long have you stayed at your current place for : years
(9) If this is not your first place of living, where was the previous one :
Street name & numb : Settlement : Municipality : City/Canton :
Postal Code : Landmark :
(10) How many vehicles are there in your household ?
(For the household member use)
a. Sedan, MPV, SUV units b. Pick-up, Box, Van, Truck, etc. units c. Motorcycle units d. Bicycle units
(For commercial/renting purpose)
a. Taxi, Sedan, MPV, SUV, etc. units b. Pick-up, Box, Van, Truck, etc. units c. Small/Medium Bus units d. Motorcycle units e. Others units

(11) Household Members
For all household members that live in your house (i.e.: yourself, siblings, parents, children, maids, etc.), please provide information below and refer to Tables A,B,C,D,E.

No.	Household Member	(tick, if yourself)	Age (yy:mm)	Sex (M/F)	Relationship to Head of Family (Table A)	Same/Different Registration? (Table B)	Main Activity (Table C)	Work Type (Table D)	Driving License (Table E)
01	Head of Family				01				
02									
03									
04									
05									
06									
07									
08									
09									
10									
11									
12									

(Table A)
01. Head of family
02. Husband/ Wife
03. Son/daughter
04. Son/daughter in law
05. Grandchild
06. Parents/parents in law
07. Grandfather/grandmother /uncle/aunt
08. Relative/cousin/nephew
09. Relative who live temporarily/just arrive
10. Baby sitter/house maid/driver/security/gardener
11. Room tenant

(Table B)
01. Included in the list of main HH
02. Separated from main HH

(Table C)
01. Working (full time, permanent employee, government)
02. Working (full time, permanent employee, private)
03. Working (full time, contract/honorary employee, government)
04. Working (full time, contract/ honorary employee, private)
05. Working (part time, permanent employee, government)
06. Working (part time, permanent employee, private)
07. Working (part time, contract/ honorary employee, government)
08. Working (part time, contract/ honorary employee, private)
09. Entrepeneur
10. Student (Kindergarten)
11. Student (Elementary school)
12. Student (High school)
13. Student (Academy/vocational)
14. Student (University/Higher education)
15. Housewife
16. Retired
17. Has no job
18. Others

(Table D)
1 Farmer, fisherman, miner
2 Factory works/labors
3 Craftman (jewelry, wood, stone)
4 Construction laborer
5 Industry/business owner
6 Sales, merchant
7 Professor, manager, director, etc
8 Expert (technical, chemist, physics, biology), lecturer, teacher, trainer, etc
9 Armed forces/Police
10 Professionals (doctor, engineer, accountant, pilot, nautical)
11 Administration staff (teller, data entry)
12 Technician
13 Waiter, bartender
14 Goods transport driver (box car, goods truck, tank truck)
15 Public transport driver (including online transportation)
16 Private driver
17 Housemaid, office boy, cleaning service, gardener
18 Security officer
19 Porter (station, seaport, airport, warehouse, etc.)
20 Others

(Table E)
01. Categ. A
02. Categ. B
03. Categ. C
04. Categ. D
05. Category C & A
06. Category C & B
07. Doesn't have driving license

Source: JICA Expert Team

Figure A1.5.2 Survey Form 1

(2) Form 2: Respondent Information

FORMS I & II

CONFIDENTIAL

ACTIVITY DIARY SURVEY 2022
Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development

I agree that the data from this form will only be used for survey purposes and will not be shared with third parties. Signature:

FORM II HOUSEHOLD MEMBER INFORMATION (to be filled by selected respondent that shall proceed to FORM III)

NAME OF RESPONDENT : MOBILE PHONE: EMAIL : HOUSEHOLD MEMBER CODE : from FORM I, (11), No.

If you reside at different address from the one that is stated in FORM I, please fill your domicile address
How many days in a week do you stay in this address ? days
Street name : Settlement : Postal Code : Municipality : City/Canton : Landmark :

A **WORKER RESPONDENT ONLY**
(1) Type of work field: see table G
(2) Are you working at home ? 1. YES (skip to question no. 12) 2. NO
(3) Is your workplace fixed during the survey ? 1. YES 2. NO (skip to question no. 6)
(4) Workplace address: Building Name : Street Name&N : Settlement : Postal Code : Municipality : City/Canton : Land Mark :
(5) WORK PLACE TYPE : see table F
(6) Departure time for work : (24 hrs format)
(7) Arrival time at workplace : (24 hrs format)
(8) Departure time for going back home : (24 hrs format)
(9) Arrival time at home : (24 hrs format)
(10) Is your commuting trip expense covered by allowance? 1. No 2. Yes, fully covered 3. Yes, partially covered BAM/ /month
(11) Days to go to work in a week : days a week If the number of days change due to pandemic, please indicate number before pandemic days a week
(12) Average personal income/ month : see Table I in FORM I

B **STUDENT RESPONDENT ONLY**
(1) What is your current level of education : 1. Primary School 2. High School 3. Academy 4. Universities 5. Post Graduate
(2) SCHOOL ADDRESS: School Name : Street Name&N : Settlement : Postal Code : Municipality : City/Canton : Land Mark :
(3) Departure time for school : (24 hrs format)
(4) Arrival time at school : (24 hrs format)
(5) Departure time for going back home : (24 hrs format)
(6) Arrival time at home : (24 hrs format)
(7) Days to go to school in a week : days a week If the number of days change due to pandemic, please indicate number before pandemic days a week
(8) School type : 1. Public School 2. Private School

C **ALL RESPONDENTS**
(1) Travel by Car Availability: 1. Yes, always 2. Yes, sometimes 3. No
(2) Travel by Motorcycle Availability: 1. Yes, always 2. Yes, sometimes 3. No
If you answer questions 1 and 2 with (1. Yes, always), please also fill section E

For commuting worker or student only
(3) In general, how do you go to work or school?
1. Walk or bicycle
2. Public Transport (also fill Section D)
3. Private Vehicle (also fill section E)
4. Kiss & Ride (also fill sections D&E)
5. Park & Ride (also fill sections D&E)

D **FOR PUBLIC TRANSPORT USER**
(1) How many public transport modes do you take to reach your destination ? 1. one 2. two 3. three 4. four 5. five 6. more than five
(2) What is your main mode(s) of transport that you use? see table H
(If you have more than one mode, please indicate here) see table H
(4) How much do you spend a month for transport expenses ? BAM
(5) If you have a monthly public transport ticket, please write the cost of it.

E **FOR PRIVATE VEHICLE USER**
What type of private vehicle do you use ? 1. Motorcycle 2. Sedan, MPV, SUV 3. Pick Up/ Box 4. Truck
Who is driving the vehicle ? 1. myself 2. other
How many occupants are there in the vehicle ? 1. one (driving alone) 2. two 3. three 4. four 5. five 6. more than five
How much do you spend for monthly parking ? BAM

Table F
01. House/ boarding house
02. Government office/ Public facility
03. Company/private company office
04. Educational institution
05. Worship place (mosque, church, temple, etc)
06. Hospital, puskesmas, clinic
07. Hotel, lodge, entertainment place
08. Restaurant, food court, food stalls
09. Grocery store, traditional market, minimarket
10. Supermarket,
11. Shopping center, plaza, mall, department store
12. Grocery market, central market
13. Factory, workshop
14. Warehouse, storage
15. Station, bus terminal, airport
16. Installation (gas, water, electricity)
17. Recreational facility, Sports facility
18. Parks, national park
19. Agriculture, forestry, mining, fishery site
20. Construction, building works site
21. Others:

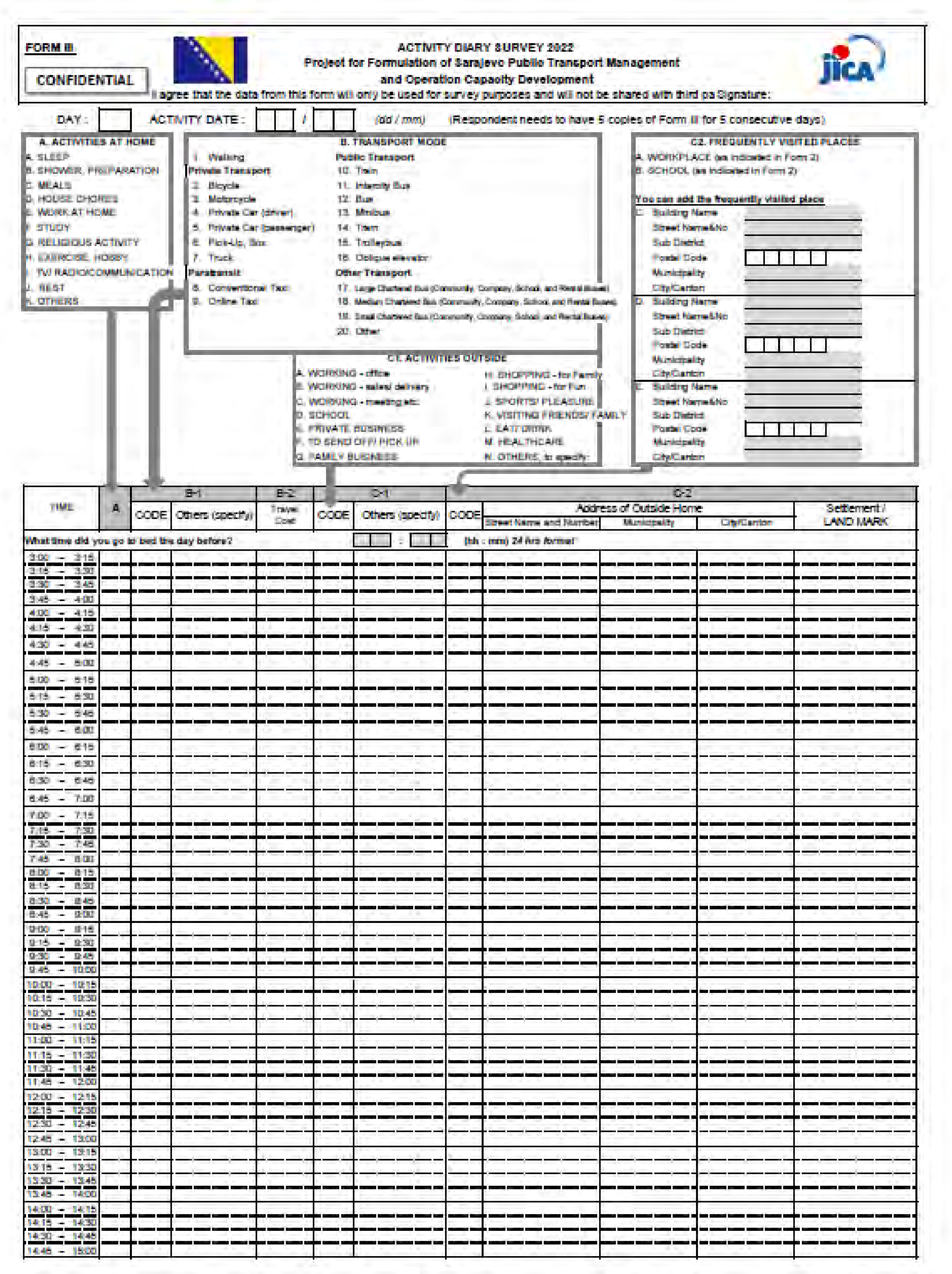
Table G
01. Agriculture/forestry/fishery
02. Mining/excavation/drilling
03. Industry/factory
04. Building/construction project
05. Transportation & communication
06. Bank, financial institution
07. Large and retail trade
08. Electricity, gas & drinking water
09. Cantonal government
10. Federational government
11. Armed forces/police
12. Rental services
13. Services (hotel, entertainment, research, doctor, consultant, spirituality, etc)
14. Others:

Table H
01. Train
02. Intercity Bus
03. Bus
04. Minibus
05. Tram
06. Trolley Bus
07. Oblique elevator
08. Private car
09. Drop off/ pick up (by car)
10. Motorcycle
11. Drop off/ pick up (by MC)
12. Bicycle
13. Walking

Source: JICA Expert Team

Figure A1.5.3 Survey Form 2

(3) Form 3: Activity-travel Diary



FORM III

CONFIDENTIAL

ACTIVITY DIARY SURVEY 2022
Project for Formulation of Sarajevo Public Transport Management
and Operation Capacity Development

I agree that the data from this form will only be used for survey purposes and will not be shared with third pa Signature:

DAY : ACTIVITY DATE : / (dd / mm) (Respondent needs to have 5 copies of Form III for 5 consecutive days)

A. ACTIVITIES AT HOME

A. SLEEP
B. SHOWER, PREPARATION
C. MEALS
D. HOUSE CHORES
E. WORK AT HOME
F. STUDY
G. RELIGIOUS ACTIVITY
H. EXERCISE, HOBBY
I. TV/ RADIO/COMMUNICATION
J. REST
K. OTHERS

B. TRANSPORT MODE

1. Walking

Private Transport
2. Bicycle
3. Motorcycle
4. Private Car (driver)
5. Private Car (passenger)
6. Pick-Up, Box
7. Truck

Paratransit
8. Conventional Taxi
9. Online Taxi

Public Transport
10. Train
11. Intercity Bus
12. Bus
13. Minibus
14. Tram
15. Trolleybus
16. Oblique elevator

Other Transport
17. Large Chartered Bus (Community, Company, School, and Rental Buses)
18. Medium Chartered Bus (Community, Company, School, and Rental Buses)
19. Small Chartered Bus (Community, Company, School, and Rental Buses)
20. Other

C1. ACTIVITIES OUTSIDE

A. WORKING - office
B. WORKING - sales/ delivery
C. WORKING - meeting etc.
D. SCHOOL
E. PRIVATE BUSINESS
F. TO SEND OFF/ PICK UP
G. FAMILY BUSINESS
H. SHOPPING - for Family
I. SHOPPING - for Fun
J. SPORTS/ PLEASURE
K. VISITING FRIENDS/ FAMILY
L. EAT/ DRINK
M. HEALTHCARE
N. OTHERS, to specify:

C2. FREQUENTLY VISITED PLACES

A. WORKPLACE (as indicated in Form 2)
B. SCHOOL (as indicated in Form 2)

You can add the frequently visited place

C. Building Name / Street Name&No / Sub District / Postal Code / Municipality / City/Canton
D. Building Name / Street Name&No / Sub District / Postal Code / Municipality / City/Canton
E. Building Name / Street Name&No / Sub District / Postal Code / Municipality / City/Canton

TIME	A	B-1 CODE	B-1 Others (specify)	B-2 Travel Cost	C-1 CODE	C-1 Others (specify)	C-2 CODE	Address of Outside Home: Street Name and Number	Address of Outside Home: Municipality	Address of Outside Home: City/Canton	Settlement / LAND MARK
What time did you go to bed the day before?					: (hh : mm) 24 hrs format						
3:00 – 3:15											
3:15 – 3:30											
3:30 – 3:45											
3:45 – 4:00											
4:00 – 4:15											
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14:45 – 15:00											

Source: JICA Expert Team

Figure A1.5.4 Survey Form 3

7) Survey Results and Findings

As elaborated in the sampling section of this report, two respondent indicators required for this survey. First is the number of households, and second is the number of respondents for the diary survey. In an ideal condition, these two indicators must have the same value of 6,000 respondents. However, as explained in this report's Methodology and Field Survey Challenges, this could not be achieved but would be compromised. The achievement table connected to the control table in the Sampling section is shown below.

Table A1.5.2 Sampling Achievement

Municipality	Target Sample	Collected Sample			
		Household	*Achievement (%)*	Diary Respondent	*Achievement (%)*
Centar	757	762	*101*	727	*96*
Hadzici	171	118	*69*	116	*68*
Ilidza	754	1,151	*153*	1,074	*142*
Ilijas	186	174	*94*	161	*87*
Novi Grad	2,199	1,898	*86*	1,803	*82*
Novo Sarajevo	1303	1,471	*113*	1,382	*106*
Stari Grad	387	344	*89*	326	*84*
Trnovo	54	61	*113*	59	*109*
Vogosca	223	238	*107*	230	*103*
Total	**6,034**	**6,217**	***103***	**5,876**	***97***

Source: JICA Expert Team

While the total collected sample exceeds the target sample, collected samples in Hadzici, Ilijas, Novi Grad, and Stari Grad are lower than the target sample. This condition reflects the hardships during the survey and the prominent result that can be achieved considering the time constraint. It is worth noting that the original plan of doing 3 months of field survey had been prolonged to 6 months due to the mentioned challenges and holiday season avoidance.

Furthermore, the survey results and findings are distinguished into two categories, resulting from the respondents' socioeconomic, demographic, and travel diary.

(1) Household size

Respondents come from various household sizes. The table below shows the number of surveyed households per household size.

Table A1.5.3 Household Size

Household Size (person)	Number of Surveyed Household
1	1,213
2	1,352
3	1,734
4	1,483
5+	435

Source: JICA Expert Team

The average household size is 2.75 persons per household, indicating that the standard composition of a household consists of a father, mother, and one child.

(2) Household Income

The following table presents the household income levels and the shares in ADS. If three income levels are assigned as low-, middle-, and high-income households, the shares in ADS are 8.8%, 63.3%, and 27.9%, respectively.

The average household income is about 2,300 BAM (or around 1,300 USD).

Table A1.5.4 Household Income

Household Income (BAM)	Income Class	ADS Share (%)	
< 450	Low	1.5	8.8
450–750		2.6	
750–1,050		4.7	
1,050–1,350	Middle	7.5	63.3
1,350–1,650		9.9	
1,650–1,950		9.1	
1,950–2,250		12.2	
2,250–2,550		14.9	
2,550–2,850		9.7	
2,850–3,150	High	10.6	27.9
3,150–3,450		6.1	
3,450–3,750		4.0	
> 3,750		7.2	

Source: JICA Expert Team

(3) Household Vehicle Ownership

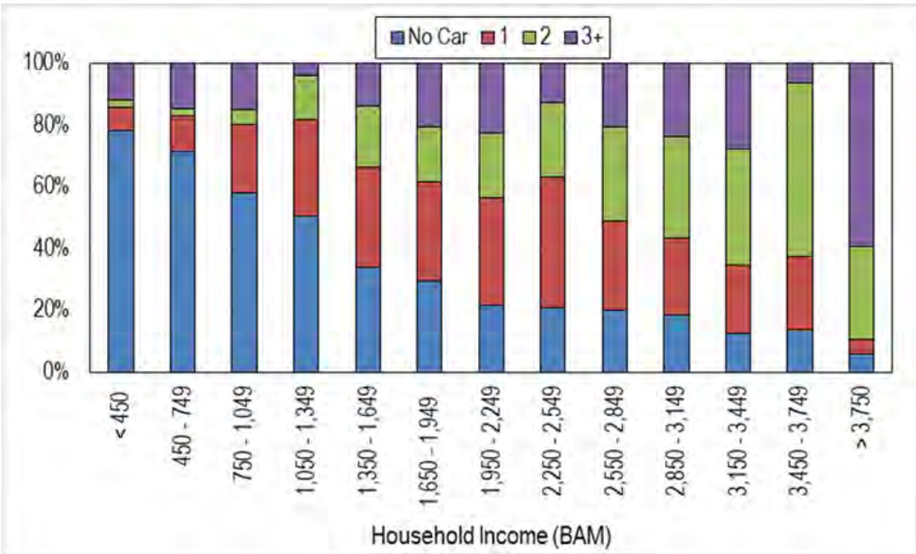
The percentage of private vehicles in a household by household income is shown in the table. Most private vehicles are cars, and a very small number are other types (i.e., motorcycles). Thus, motorcycles are negligible.

Table A1.5.5 Household Vehicle Ownership

Car Ownership	No. of Household	%	Total Cars
0	1,154	18.6	0
1	3,921	63.1	3,921
2	1,033	16.6	2,066
3+	109	1.8	340

Source: JICA Expert Team

The average number of private cars owned by households is 1.25.

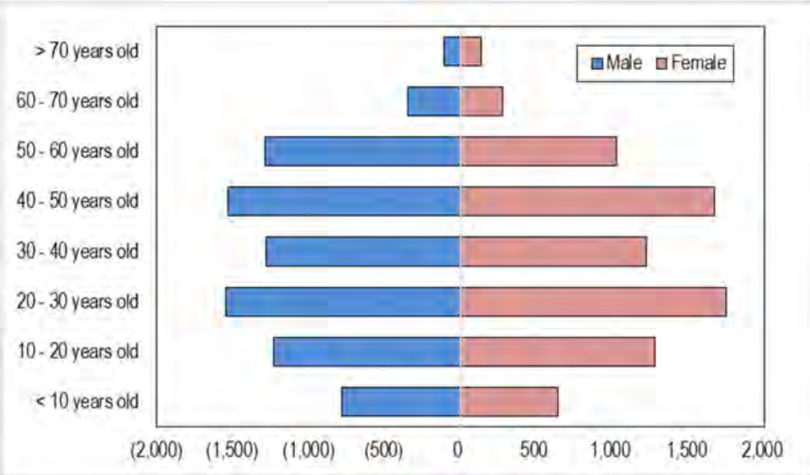


Source: JICA Expert Team

Figure A1.5.5 Household Income

(4) Household Member Age and Status

The demographic age of household members can be seen in the figure below. The figure shows fewer people in the age range of 30–40 than the upper and lower age ranges. This may reflect lower natality during the depression period caused by the war in the early 1990s.



Source: JICA Expert Team

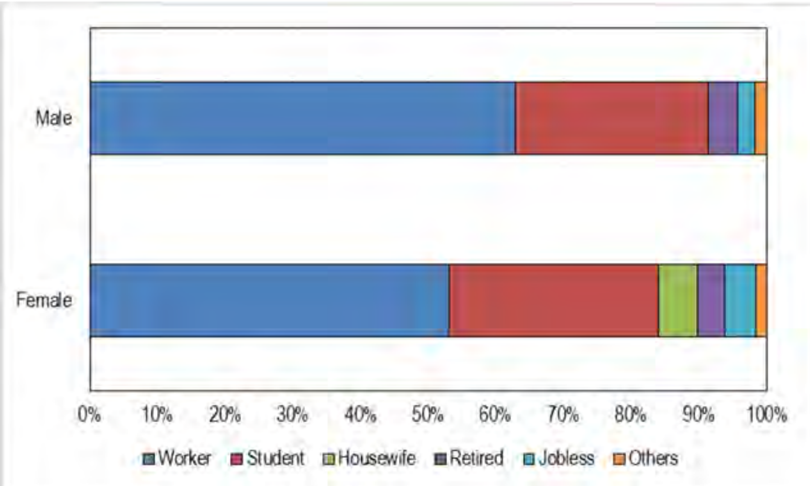
Figure A1.5.6 Household Gender

The household status or main activity to which household members are attributed is shown in the table below.

Table A1.5.6 Household Status

Status or Activity	Percentage
Worker	55.4
Student	28.4
Housewife	2.9
Retired	4.0
Jobless	3.3
Others	1.7
Did not answer	4.2

Source: JICA Expert Team



Source: JICA Expert Team

Figure A1.5.7 Household Status

The total number of household members recorded in this survey is 17,116. Most household members are workers, while students come in second place. The ratio between worker and student is 1.95:1. This “new” ratio is higher than the 2013 Census, which was 1.65:1. Therefore, the target respondents for the diary survey were adjusted as shown in the following table.

Table A1.5.7 Adjusted Targeted Respondents

Municipality	Target Sample	Adjusted based on 2013 Census		Adjusted based on Demographic of ADS 2022	
		Worker	Student	Worker	Student
Centar	757	471	286	500	257
Hadzici	171	106	65	113	58
Ilidza	754	469	285	498	256
Ilijas	186	116	70	123	63
Novi Grad	2,199	1,369	830	1,454	745
Novo Sarajevo	1303	811	492	861	442
Stari Grad	387	241	146	256	131
Trnovo	54	34	20	36	18
Vogosca	223	139	84	147	76
Total	**6,034**	**3,756**	**2,278**	**3,988**	**2,046**

Source: JICA Expert Team

(5) The Demographic of Diary Respondents

Despite the setup of selecting respondents by either worker or student following the so-called adaptive sampling method discussed in the Sampling section and the previous sub-section of “Household Member Age and Status” of this report’s Survey Results and Findings, the actual achievement of worker to student ratio that participated in the diary survey could not be kept as planned. The main reasons are elaborated in the Methodology and Survey Challenges section. Additionally, towards the end phase of the field survey, the race between the number of respondents, the survey timeline before termination, and the diary quality was very uptight, making the selection process more flexible. Finally, the achievement table of diary respondents is shown below.

Table A1.5.8 Demographic of Diary Respondents

Municipality	Adjusted based on Demographic of ADS 2022		Achievement of Diary Respondent of ADS 2022	
	Worker	Student	Worker	Student
Centar	500	257	520	206
Hadzici	113	58	86	30
Ilidza	498	256	814	260
Ilijas	123	63	124	37
Novi Grad	1,454	745	1,292	511
Novo Sarajevo	861	442	966	415
Stari Grad	256	131	242	84
Trnovo	36	18	58	1
Vogosca	147	76	164	66
Total	**3,988**	**2,046**	**4,266**	**1,610**

Source: JICA Expert Team

Finally, the ratio of workers to students from the diary survey is 2.65:1. This ratio has a higher share of workers compared to the ideal target worker-to-student ratio of 1.95:1.

Further adjustments—if not assumptions—are necessary for further use of this data. While these ideas of adjustments and assumptions require further investigation and research, the following are worth considering the hypothesis.

- Although the number of surveyed students is lower than planned, the gap is not too huge.

- The location of the educational facilities is not widely spread throughout Canton of Sarajevo but is rather more centered. This may allow a lower number of student respondents to be surveyed.

(6) Mode Share

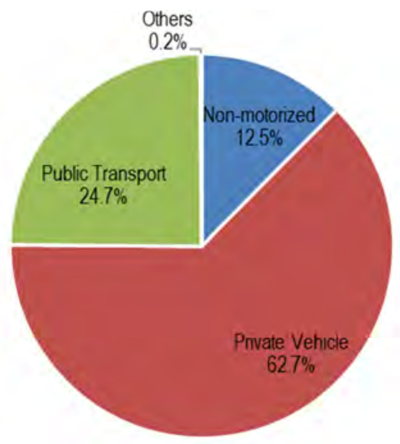
While the mode share calculation and definition have various contexts and parameters to include, this survey would define and calculate the mode share as the compulsive representation of linked trip mode being mainly and majorly used by respondents in multiple days of the survey. Below is the list of the shares by each mode.

Table A1.5.9 Mode Share

Mode	No. of Trips	%
Walking	6,907	11.8
Bicycle	375	0.6
Motorcycle	118	0.2
Private Car (driver)	32,020	54.8
Private Car (passenger)	4,423	7.6
Pick-Up, Box	65	0.1
Truck	8	0.0
Conventional Taxi	214	0.4
Online Taxi	6	0.0
Train	117	0.2
Intercity Bus	136	0.2
Bus	8,634	14.8
Minibus	583	1.0
Tram	2,861	4.9
Trolleybus	1,888	3.2
Oblique elevator	7	0.0
Large Chartered Bus (Community, Company, School, and Rental Buses)	1	0.0
Medium Chartered Bus (Community, Company, School, and Rental Buses)	11	0.0
Small Chartered Bus (Community, Company, School, and Rental Buses)	10	0.0
Others	67	0.1

Source: JICA Expert Team

The share of private cars for both the respondents as drivers and passengers is exceptionally high compared to other modes. This is quite a strong indication of Canton of Sarajevo being dominated by car-based trips. Bus, trolleybus, tram, and minibus altogether contribute to quite a high share, as well. This may indicate that the potential demand for public transport is there and waiting for further improvement in the capacity, performance, and level of public transport service itself.



Source: JICA Expert Team

Figure A1.5.8 Household Mode Share

Narrowed down to three categories of mode of transport, the share of private vehicles is nearly triple the public transport share and quintuple of the non-motorized transport share.

(7) Tour Purpose based on the Trip Diary

Considering the OD pair types that exist, the purpose of a tour is categorized into three purposes plus non-home based. The number of tours recorded from the survey and its share are shown below.

Table A1.5.10 Tour Purpose based on the Trip Daily

Mode	No. of Trips	%
Home-based Work	7,560	31.7
Home-based School	2,149	9.0
Home-based Others	8,053	33.8
Non-home-based	6,092	25.5
Grand total	**23,854**	**100.0**

Source: JICA Expert Team

A1.6 Trip Generation/Attraction Survey at Large-scale Establishment

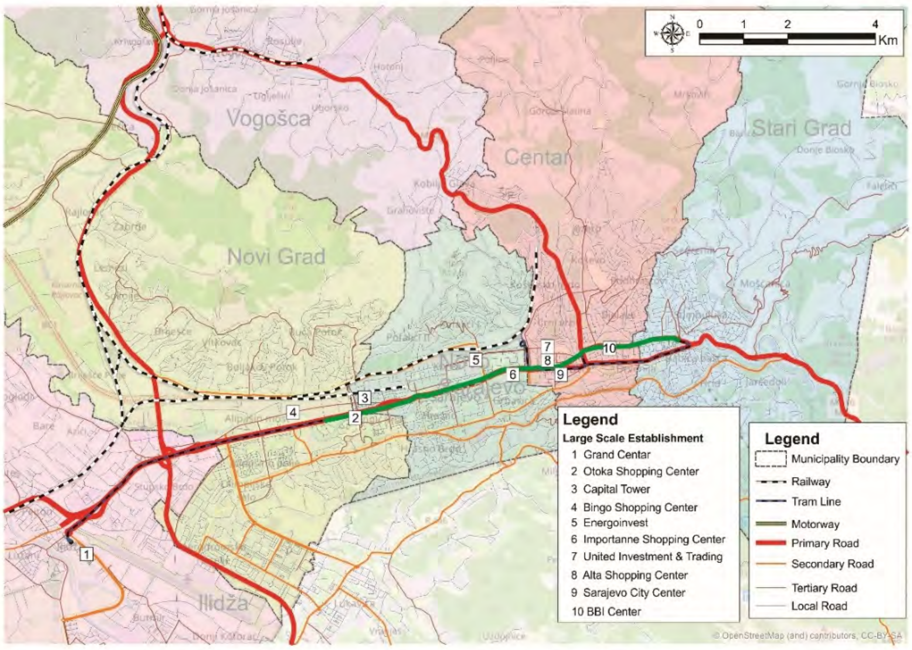
1) Objective

The main objective of the survey is to obtain data on trip generation and attraction rates for large-scale establishments (i.e., offices, shopping malls, etc.). This trip rate is used for the demand forecast as adjustment/calibration to OD matrices, including those from higher-income groups.

2) Survey Location

This survey was done at ten locations within the study area: Grand Centar, Otoka Shopping Center, Capital Tower, Bingo Shopping Center, Energoinvest, Importanne Shopping Center, United Investment and Trading, Alta Shopping Center, Sarajevo City Center, and BBI Center.

Respondents of this survey are either employees, tenants, or visitors. The survey was done on a typical weekday and as long as the business hours of the establishment.



Sources: JICA Expert Team

Figure A1.6.1 Large Scale Establishment Survey Location

3) Methodology

(1) Facility Inventory

Facility inventory data collection was done by requesting information from each building management, such as number of tenants, floor area, capacity, etc. However, such information was confidential to some building management and, thus, not all the items could be obtained.

(2) Person Count

Surveyors counted the number of persons entering and exiting the establishment every 15 minutes at the entrances and exits.

(3) Vehicle Count

Surveyors counted the number of entering and exiting vehicles by vehicle type at the parking facility's entrances/exits.

(4) Visitor, Tenant, and Employee Interview

Surveyors interviewed respondents who were visitors, tenants, or employees of the establishment and collected information on the respondents' OD. The number of respondents were 10% of the total person count or a maximum of 500 interviews.

4) Survey Item

This survey attempted to collect facility inventory on:

- tenant's name,
- type of business,
- number of employees, and
- floor area.

For the vehicle counting, this survey distinguished the type of vehicle, as follows:

- NMT,
- motorcycle,
- private vehicle,
- taxi,
- pick-up, box, truck, and
- bus.

Furthermore, the following items were recorded at each survey location:

- date of the survey,
- direction of traffic, and
- 15-minute segmented data of traffic count.

5) Survey Forms

The survey forms used are shown in the following pages.

(1) Facility Inventory

Facility Inventory
Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development

Name of Establishment		
Total floor area (incl. Parking)		m2
Parking facility floor area		m2

No.	Name of Tenant	Type of Business/Industry	No. Employee	Floor Area (m2)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

ID	Type of business/Industry
1	Agricultural
2	Mining
3	Manufacturing
4	Public services and utilities
5	Constrcution
6	Wholesale and retail
7	Accomodation and food services
8	Transportation and logistic services
9	Financial services
10	Real estate and commercial
11	Others (specify)

Sources: JICA Expert Team

Figure A1.6.2 Facility Inventory Survey Form

(2) Person Count

Person Count Survey Form
Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development

Date (DD/MM)	/ 2022
Name of Establishment	
Gate name	
Gate code	
Start Time	*24 hour format*
End Time	*24 hour format*

15 Minutes Interval		Enter	Exit	15 Minutes Interval		Enter	Exit
0:00	0:15			12:00	12:15		
0:15	0:30			12:15	12:30		
0:30	0:45			12:30	12:45		
0:45	1:00			12:45	13:00		
1:00	1:15			13:00	13:15		
1:15	1:30			13:15	13:30		
1:30	1:45			13:30	13:45		
1:45	2:00			13:45	14:00		
2:00	2:15			14:00	14:15		
2:15	2:30			14:15	14:30		

…….. continued

9:00	9:15			21:00	21:15		
9:15	9:30			21:15	21:30		
9:30	9:45			21:30	21:45		
9:45	10:00			21:45	22:00		
10:00	10:15			22:00	22:15		
10:15	10:30			22:15	22:30		
10:30	10:45			22:30	22:45		
10:45	11:00			22:45	23:00		
11:00	11:15			23:00	23:15		
11:15	11:30			23:15	23:30		
11:30	11:45			23:30	23:45		
11:45	12:00			23:45	0:00		

Sources: JICA Expert Team

Figure A1.6.3 Person Count Form

(3) Vehicle Count

Vehicle Count Survey Form

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development

Date (DD/MM)	/	2022
Name of Establishment		
Gate name		
Gate code		
Start Time		*24 hour format*
End Time		*24 hour format*

15 Minutes Interval		Enter						Exit					
		NMT	Motor Cycle	Private Vehicle	Taxi	Pick Up, Box, Truck	Bus	NMT	Motor Cycle	Private Vehicle	Taxi	Pick Up, Box, Truck	Bus
0:00	0:15												
0:15	0:30												
0:30	0:45												
0:45	1:00												
1:00	1:15												
1:15	1:30												
1:30	1:45												
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22:00	22:15												
22:15	22:30												
22:30	22:45												
22:45	23:00												
23:00	23:15												
23:15	23:30												
23:30	23:45												
23:45	0:00												

Sources: JICA Expert Team

Figure A1.6.4 Vehicle Count Form

(4) Visitor, Tenant, and Employee Interview

Interview Survey Form
Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development

Date (DD/MM)	/	2022
Name of Establishment		
Gate name		
Gate code		
Time		*24 hour format*

General Data

1 Sex		1. Male 2. Female
2 Age		1. Less than 20 y.o. 2. 20-29 y.o. 3. 30-39 y.o. 4. 40-49 y.o. 5. 50-59 y.o. 6. More than 59 y.o.
3 Status		1. Worker 2. Student 3. Jobless/Retired 4. Other (Specify)
4 Driver's License		1. Own 2. Do not own
5 Daily-use Vehicle		1. NMT (Bicycle, Romobil) 2. Motorcycle 3. Car 4. Do Not Own
6 Car Ownership in HH		unit
7 Motorcycle Ownership in HH		unit
8 Total HH Income		1. <500KM 2. 500-1,000 KM 3. 1,000-1,500KM 4. 1,500-2,000KM. 5. 2,000KM-2,500KM. 6. 2,500KM-3,000KM 7. >3,000KM
9 Size of HH (incl. you)		person (s)
10 Size of HH >17 y.o.		person (s)
11 Size of HH as worker		person (s)

Trip Data (Origin and Destination shall NOT be the same as the establishment)

1 Origin Place		1. Home 2. Office/Workplace 3. Shopping Center 4. School 5. Others
2 Address of Origin		
Street Name		
Street No.		
Municipality Name		
Sarajevo Kanton / Outside		1. Sarajevo Kanton 2. Outside
Landmark (if any)		
3 What time did you depart for this place?		*24 hour format*
4 What time did you arrive at this place?		*24 hour format*
5 What is your purpose in this place?		1. to work 2. to do business/private matter/shopping 3. to study 4. Others
6 What time will you leave this place for your next destination?		*24 hour format*
7 What time will you arrive at your next destination?		*24 hour format*
8 Address of Destination		
Street Name		
Street No.		
Municipality Name		
Sarajevo Kanton / Outside		1. Sarajevo Kanton 2. Outside
Landmark (if any)		
9 What type of vehicle did you use to do this trip?		1. NMT (Bicycle, Romobil) 2. Motorcycle 3. Car 4. Bus (Trolley Bus) 5. Tram 6. Others
10 How much does these all trips cost you? (incl. fare, fuel, parking, etc.)		KM

(try to estimate all the component of cost for these trips only, also applied to drop-off passenger; answer shall not be 0 unless they choose NMT for Question No.9)

Sources: JICA Expert Team

Figure A1.6.5 Visitor, Tenant, and Employee Interview Form

6) Survey Result and Finding

(1) Profile of the Establishment

The attempt to collect facility inventory information from all establishments was thoroughly conducted despite the confidentiality and privacy issues raised prior. The table displays most of what could be collected.

Table A1.6.1 Profile of Each Establishment

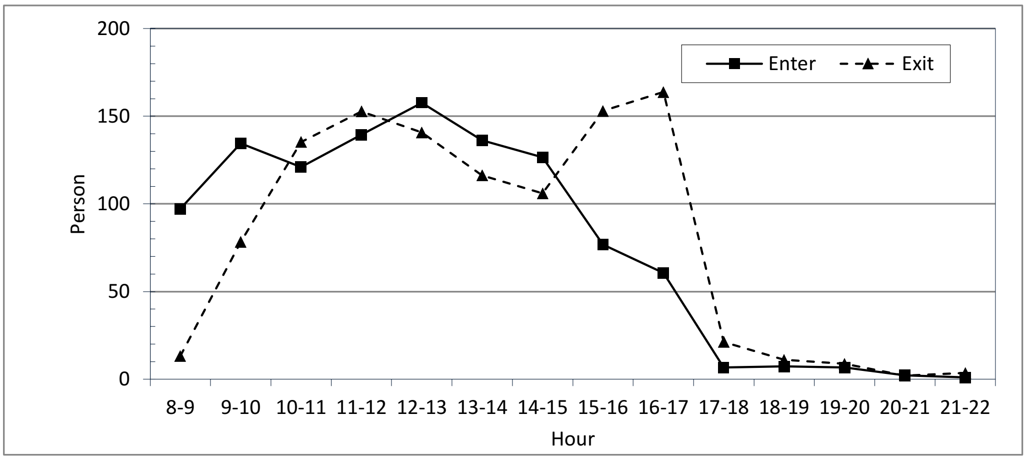
No.	Establishment	Total Floor Area (including Parking) (m²)	Parking Floor Area (m²)	No. of Tenant	No. of Employee
1	Grand Centar	20,000	8,000	64	Undisclosed
2	Otoka Shopping Center	25,255	Undisclosed	18	Undisclosed
3	Capital Tower	11,000	5,000	18	Undisclosed
4	Bingo Shopping Center	11,750	420	49	174
5	Energoivest	Undisclosed	Undisclosed	Undisclosed	Undisclosed
6	Importanne Shopping Center	Undisclosed	Undisclosed	Undisclosed	Undisclosed
7	United Investment and Trading	36,700	Undisclosed	Undisclosed	Undisclosed
8	Alta Shopping Center	Undisclosed	Undisclosed	Undisclosed	Undisclosed
9	Sarajevo City Center	Undisclosed	Undisclosed	167	Undisclosed
10	BBI Center	57,600	Undisclosed	Undisclosed	Undisclosed

Source: JICA Expert Team

While shopping malls are horizontally wide, office buildings are vertically high. Therefore, the floor area varies across establishment structure including the parking space.

(2) Activities

People's traffic is divided into two categories: entering and exiting people. The figure below displays the flow of average traffic going to the office and shopping by hour.

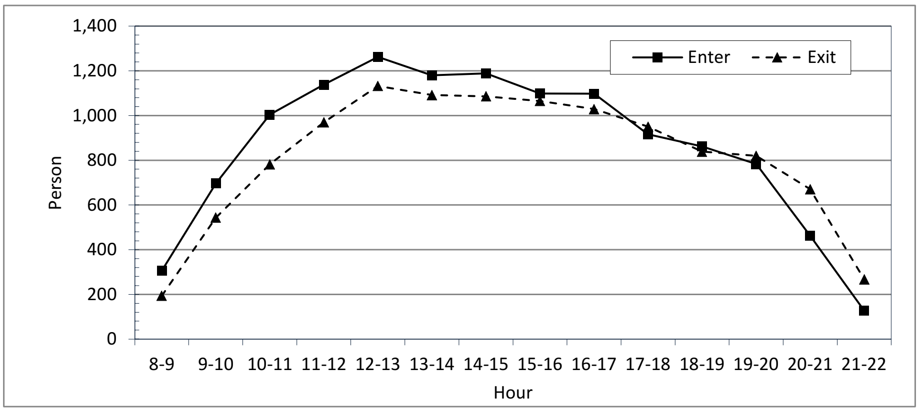


Source: JICA Expert Team

Figure A1.6.6 Hourly People's Traffic at Office

Generally, office hours are fixed: clock-in is from 8 to 9 AM, lunch break is around noon, and clock-out is around 4–5 PM. Therefore, such flow is depicted in the figure above. However, it is worth noting that a big leap in the line graph of exiting people is significant during clock-out, almost giving an impression this time range is definitely go-home time.

The average time spent in the office by purpose is 7.0 hours for work, 2.1 hours for business meetings or private matters, and 2.0 hours for other purposes.

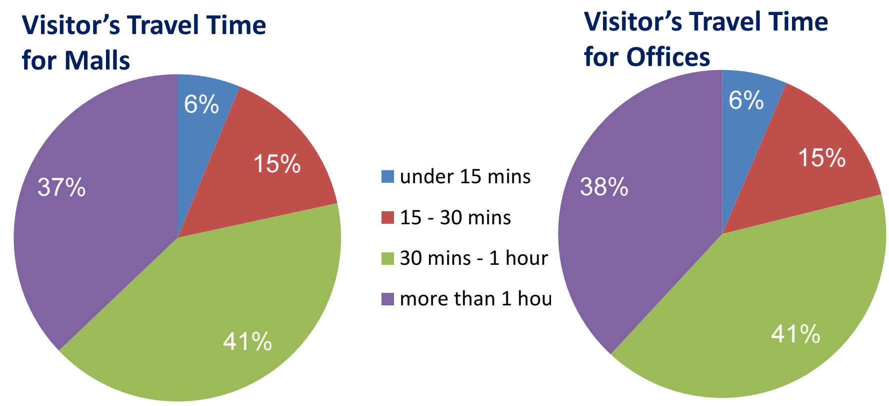


Source: JICA Expert Team

Figure A1.6.7 Hourly People's Traffic at Shopping Mall

The flow of people's traffic at shopping malls indicates a gradual increase from the morning to noon, a relatively stable flow during the afternoon, and a drop towards the night, which is when the closing business hour is (around 10 PM).

The average time spent in the shopping mall by purpose is 7.1 hours for work (tenant and employee), 1.8 hours for business meetings or private matters, 2.7 hours for studying (student), and 2.0 hours for other purposes.



Source: JICA Expert Team

Figure A1.6.8 Travel Time for the Establishment

In the figure above, the respondents' share of travel time to access and egress both office and shopping malls is shown. For both types of establishments, the indication is a very similar share. About 80% of the respondents would access/egress offices or shopping malls from 30 minutes to more than 1 hour. About 20% would do such a trip under 30 minutes. It can be inferred that the location of these large-scale establishments is, in general, not near a housing area.

A2 Technical Notes on Travel Demand Forecast

A2.1 Socioeconomic Framework and Urban Development Scenario

1) Existing Socioeconomic Data

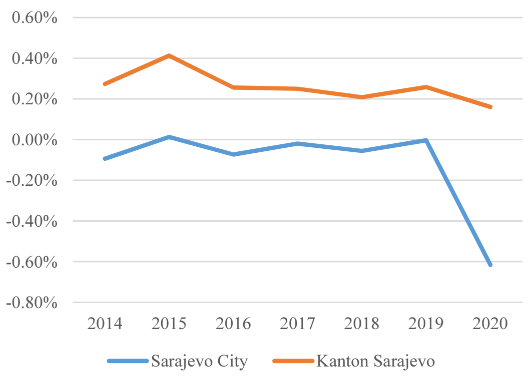
Social data of population census in 2013 by Enumeration Area (EA) was provided from the statistics department of Canton of Sarajevo. However, the individual data of population census in 2013 wasn't provided due to the privacy policy. It should also be noted that the latest available socioeconomic data is limited since population census is postponed due to the COVID-19 pandemic. Therefore, during this report preparation stage, socioeconomic data is being collected in ADS and will be used to supplement the statistical data.

Table A2.1.1 Available Socioeconomic Data

Contents	Municipality	Local Community	Enumeration Area (2013 Census)
Number of Zones	9	139	3101
Population 2013	✓	✓	✓
Population 2021	✓ (Estimation)	N/A	N/A
Number of Employees at Resident Place 2013	✓	✓	✓
Number of Employees at Resident Place 2021	✓ (Estimation)	N/A	N/A
Number of Student at Resident Place 2013	✓	✓	✓
Number of Student at Resident Place 2021	N/A	N/A	N/A
Household Income Distribution	N/A	N/A	N/A

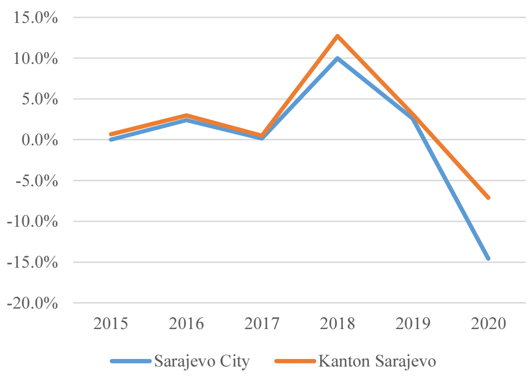
Source: JICA Expert Team summarized with the data provided by Statistics department of Canton Sarajevo

The total population of Canton of Sarajevo in 2021 was 419,762, of which Sarajevo City, composed of four municipalities (Stari Grad, Centar, Novo Sarajevo and Novi Grad), was 273,184 (65% of total). While the population growth rate between 2014 and 2020 in Canton of Sarajevo was 0.26%, the growth rate in Sarajevo City was -0.12%. The employment growth rate also showed a negative growth trend in Sarajevo City, which is faster than in other parts of Canton Sarajevo, indicating a growing migration.



Source: Statistics Bulletin, Canton Sarajevo

Figure A2.1.1 Annual Population Growth Rate in Canton Sarajevo



Source: Statistics Bulletin, Canton Sarajevo

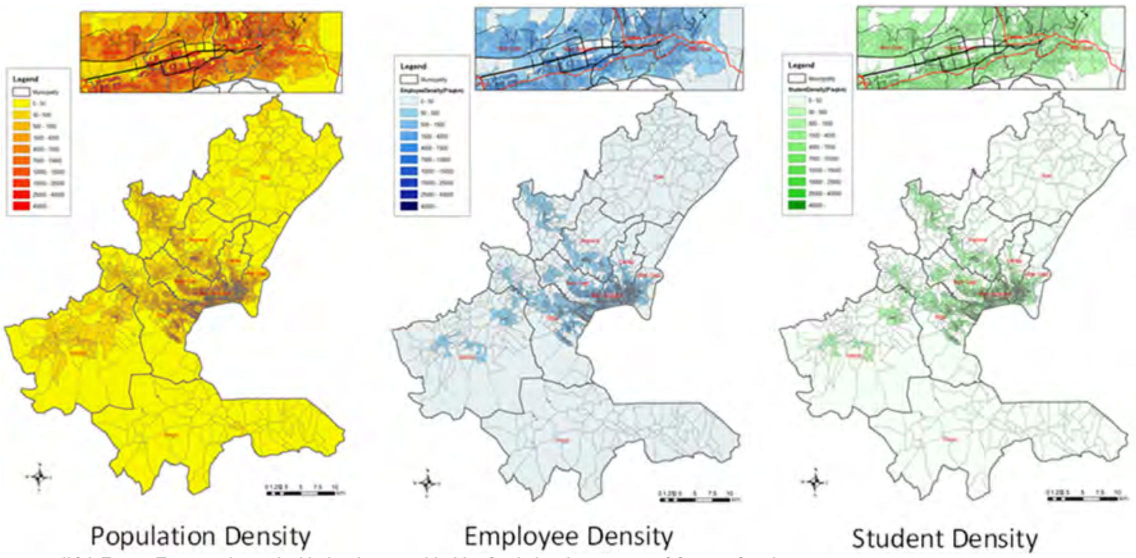
Figure A2.1.2 Annual Employment Growth Rate in Canton Sarajevo

The Statistics Department of Canton of Sarajevo provided the number of workers and students by municipality in 2021. To estimate the traffic demand based on the ADS, the socioeconomic data as of the survey period, the year 2022, is estimated considering the growth trend, as shown below.

Table A2.1.2 Estimated Socioeconomic Data

ID	Municipality	Population ('000)		Worker ('000)		Student ('000)	
		2013	2022	2013	2022	2013	2022
1	Centar	55.2	52.4	20.2	20.0	9.3	13.6
2	Novi Grad	118.6	122.8	39.7	41.2	20.3	16.5
3	Novo Sarajevo	64.8	62.8	24.4	23.6	10.6	11.6
4	Stari Grad	37.0	33.9	12.8	12.6	6.1	6.2
5	Hadzici	23.9	24.8	7.0	8.0	4.2	3.5
6	Ilijas	19.6	20.9	4.5	6.0	3.6	3.0
7	Vogosca	26.3	29.4	8.3	9.7	4.9	4.5
8	Ilidza	66.7	71.5	20.7	21.7	12.9	10.6
9	Trnovo	1.5	1.7	0.4	0.8	0.2	0.1
Total		413.6	420.2	137.9	143.8	72.1	69.6

Source: JICA Expert Team estimated with the data provided by Statistics department of Canton Sarajevo



Source: JICA Expert Team estimated with the data provided by Statistics department of Canton Sarajevo

Figure A2.1.3 Distribution of Population, Employee, and Student in 2022

2) Population Forecast

(1) Urban Plan

During the 3rd JCC in May 2022, it was confirmed that "Urban Plan 2016–2036," drafted by ZPRKS, would be referred for the future socio-economic framework, and the target year would be 2036 in line with the Urban Plan.

When analyzing the contents of the Urban Plan, its geographical boundary only covers the urban area of each municipality, while the Project area is equivalent to the size of Canton of Sarajevo, composed of nine municipalities.

In the Urban Plan, two options were shown in terms of population projection (2, 4, 5). The outlines of each option are as follows:

<u>Option 1</u>

(a) The number of inhabitants will increase considering the capacity of the space.

(b) Pronounced increase in the population in Novi Grad, Ilidža, and Vogošća with housing and commercial development.

Immigration to the City of Sarajevo will continue.

(c) The share of the young population will gradually increase (Ages 0–14: 15.1% in 2013 to 16.9% in 2036).

(d) The population aging process will slow down (Age 65+: 14.3% in 2013 to 12.7% in 2036).

(e) The number of households will increase (133,569 in 2013 to 205,240 in 2036).

Option 2

(a) Better utilization of existing housing capacities and infrastructure systems, especially in Stari Grad, Centar, and Novo Sarajevo urban areas.

Table A2.1.3 Population Projection of Urban Plan (Option 1&2)

	2013		2036 (Option 1)			2036 (Option 2)		
	Number	%	Number	%	CAGR *	Number	%	CAGR *
Stari Grad	36,605	10.0%	49,000	7.9%	1.28%	49,500	9.6%	1.32%
Centar	54,580	14.9%	74,000	11.9%	1.33%	74,800	14.5%	1.38%
Novo Sarajevo	64,814	17.7%	84,000	13.5%	1.13%	83,600	16.2%	1.11%
Novi Grad	118,553	32.3%	181,000	29.2%	1.86%	150,300	29.1%	1.04%
Ilidža	66,559	18.2%	190,000	30.6%	4.67%	118,000	22.9%	2.52%
Vogošća	25,440	6.9%	42,000	6.8%	2.20%	39,800	7.7%	1.96%
Urban Sarajevo	366,551		620,000		2.31%	516,000		1.50%

Source: JICA Expert Team summarized from Urban Plan 2016–2036, ZPRKS

It was found that a pronounced population increase in Ilidža, Hadžići, Ilijaš, and Trnovo is expected without specific housing, commercial, and business development plans (narrative descriptions were found, but no quantitative figures).

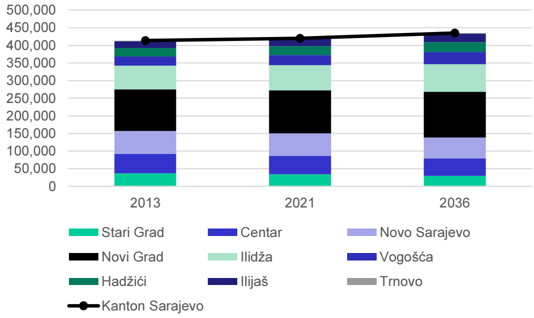
After consulting with MOT and ZPRKS, it was concluded that the population forecast developed in the Urban Plan is too optimistic considering the recent trends of declining population growth in Sarajevo City: -0.11% between 2014 and 2021 as well as the neighboring cities like Zagreb and Belgrade. These cities, which serve as regional centers with wider gravitational area, have minimal population growth or a decrease. Thus, the population forecast was decided to be developed by the JICA Expert Team in consultation with the stakeholders.

(2) Own population forecast

Three scenarios were developed to forecast the population of Canton of Sarajevo up to 2036.

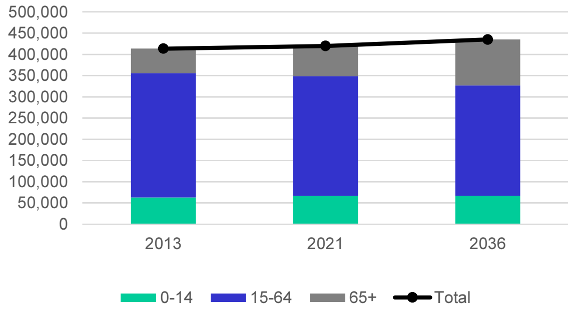
Scenario 1: Trend base scenario

The preconditions are that the population growth trend between 2013 and 2021 is applied to estimate the figure in 2036, and additional development is not expected.



Source: JICA Expert Team

Figure A2.1.4 Population by Municipality (Scenario 1)



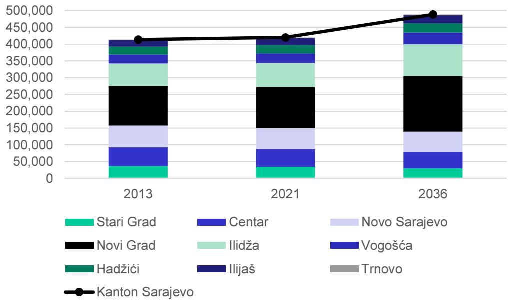
Source: JICA Expert Team

Figure A2.1.5 Population by Age Category (Scenario 1)

The results showed that the total population is expected to be 435,081 in 2036, a 5% increase from 2013, with a Compound Annual Growth Rate (CAGR) of 0.2%. A negative growth would be expected in Stari Grad, Centar, and Novo Sarajevo, but a positive growth would be expected in other municipalities. The aging population (+65 years old), estimated at 14% of the total population in 2013, would increase by 25% in 2036.

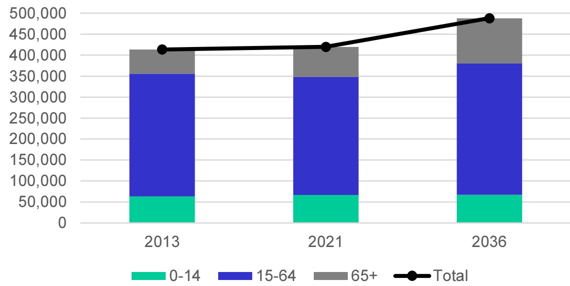
Scenario 2: High growth scenario

The preconditions are that the population growth trend between 2013 and 2021 is applied to estimate the figure in 2036, except for Novi Grad and Ilidža, where additional residential/commercial development is expected. A higher growth of the working age population (15-64) is expected in these municipalities, CAGR of 2.0% from 2021 to 2036.



Source: JICA Expert Team

Figure A2.1.6 Population by Municipality (Scenario 2)



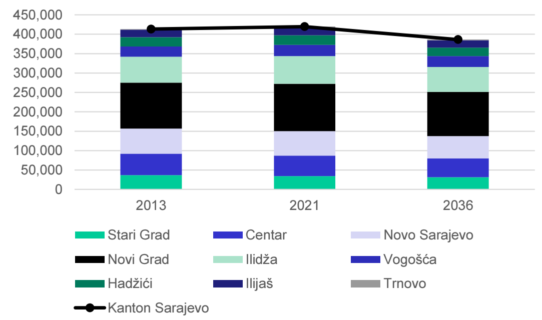
Source: JICA Expert Team

Figure A2.1.7 Population by Age Category (Scenario 2)

The results showed that the expected total population is 488,170 in 2036, an 18% increase from 2013, with a CAGR of 0.7%. The aging population (+65 years old), estimated at 14% of total population in 2013, would be 22% in 2036.

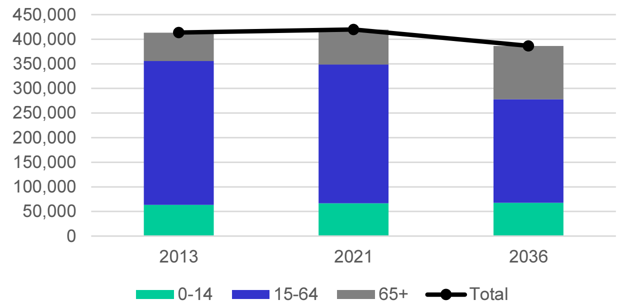
Scenario 3: Pessimistic scenario

The preconditions are that the population growth trend between 2013 and 2021 is applied to estimate the figure in 2036 except for working-age population (15–64), estimating faster migration outflow. The CAGR of -1.8% is applied to the working age population following the trend of Stari Grad between 2013 and 2021.



Source: JICA Expert Team

Figure A2.1.8 Population by Municipality (Scenario 3)



Source: JICA Expert Team

Figure A2.1.9 Population by Age Category (Scenario 3)

The results showed that the total population is expected to be 386,336 in 2036, a 7% decrease from 2013, with a CAGR of -0.3%. The aging population (+65 years old) would accelerate from 14% of the total population in 2013 to 28% in 2036.

<u>Conclusion</u>

After the discussion of the above three scenarios with ZPRKS, MOT, Agency for Statistics of BiH, and Institute of Statistics of Canton Sarajevo on 10 March 2023, it was concluded that the population projection scenario "(1): Trend base scenario" was selected for the Project.

3) GRDP forecast

The gross value data added by the economic activity in BiH and Canton Sarajevo, current price of 2013 and 2021 was obtained from the Federal Institute of Statistics. The GRDP per capita in Canton of Sarajevo for 2036 was estimated with the following steps:

(a) The GDP deflator of BiH was applied to estimate the constant price of Canton Sarajevo.

(b) Using the obtained data, the GRDP per capita of Canton Sarajevo in 2021 was estimated (current: 19,003 KM, constant: 18,128 KM).

(c) Following the trend base scenario applied in the population projection, the GRDP per capita growth rate of current at 4.62% and constant at 3.94% was utilized to project the GRDP per capita in Canton Sarajevo in 2036.

(d) The estimated GRDP per capita in Canton of Sarajevo for 2036 is 37,394 KM for current and 32,364 KM for constant.

Table A2.1.4 Gross Value Added by Economic Activities in BiH and Canton Sarajevo, current price (2013, 2021, 2036) (Unit: '000KM)

	BiH		Canton Sarajevo		
	2013	2021	2013	2021	2036
Total of activities	**14,944,873**	**21,851,250**	**4,699,530**	**6,855,302**	**13,977,192**
FISIM (-)	515,036	566,639	140,986	205,659	419,316
Gross value added, basic prices	**14,429,837**	**21,284,611**	**4,558,544**	**6,649,643**	**13,557,876**
Taxes on products less	2,948,943	3,945,154	911,709	1,329,929	2,711,575
Gross domestic product (GDP)	**17,378,780**	**25,229,765**	**5,470,253**	**7,979,572**	**16,269,452**
Population, mid-year estimate	**2,219,131**	**2,168,602**	**413,034**	**419,918**	**435,081**
Gross domestic product per capita, KM (current prices)	**7.831**	**11.634**	**13.244**	**19.003**	**37.394**
Gross domestic product per capita, KM (constant prices)	**7.869**	**11.099**	**13.308**	**18.128**	**32.364**

Source: Federal Institute of Statistics and JICA Expert Team

A2.2 Development of a Travel Demand Forecast Model

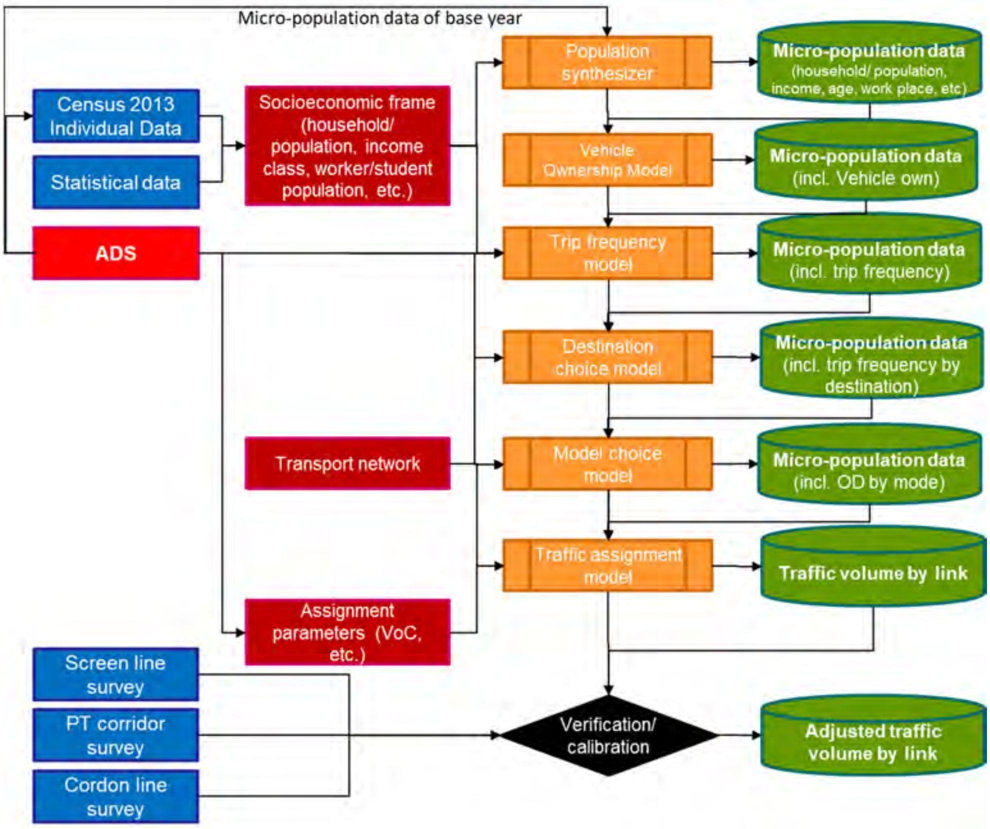
1) Outline

(a) Existing Travel Demand Forecast Model in Sarajevo

SYSTRA developed a transport model in Sarajevo in "The Study on Urban Transport Optimization and Development of a Long-Term Transport Plan for Canton Sarajevo" (hereafter called "SYSTRA study"). A person trip survey was conducted in this study for 2,000 households in 2009. After the study, Arup conducted the TA project on the transport model with VISUM software and updated the SYSTRA model. After a series of discussions with MOT and other concerned agencies, it was identified that the model isn't available in this study due to missing data. Therefore, the JICA Expert Team decided to develop the model from scratch.

(b) Workflow to Develop a Travel Demand Forecast Model

The travel demand forecast model was developed using a disaggregate four-step model based on the above ADS results. The flow of the travel demand forecast is shown in the following figure.



Source: JICA Expert Team

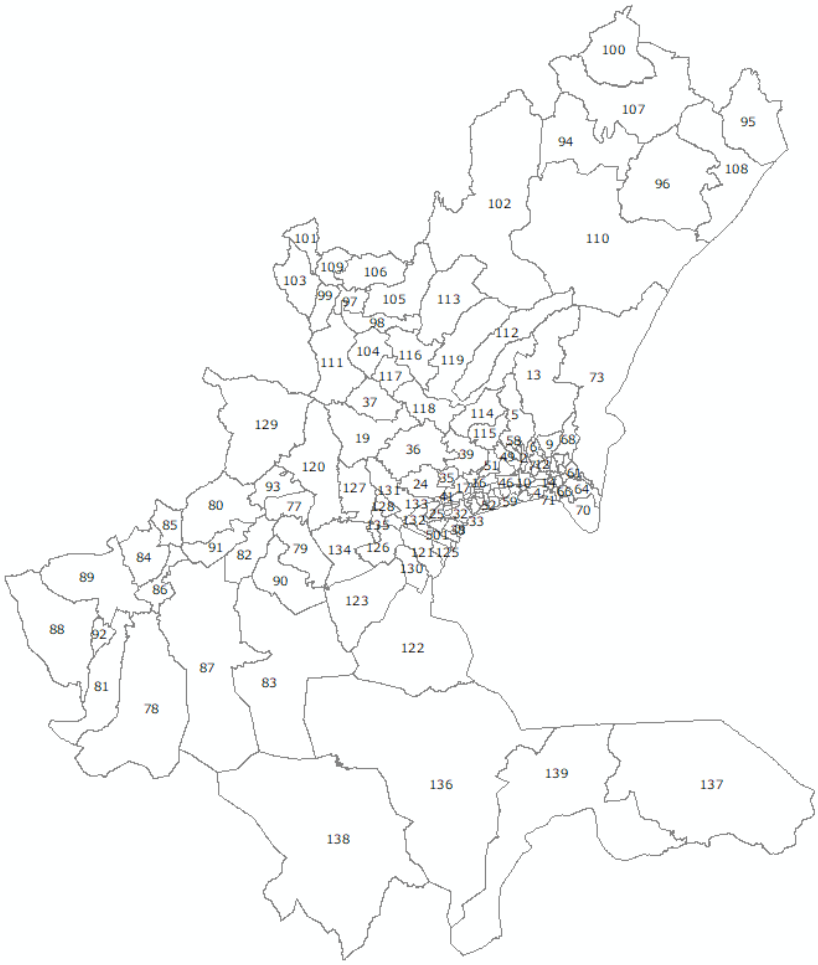
Figure A2.2.1 Flow of Travel Demand Forecast

In this model, individual population data with social attributes such as main activity, resident area by traffic analysis zones (TAZ), and household income is estimated. Then, vehicle ownership of each household and the trip frequency of each person are estimated. The destination of each trip is estimated by large traffic analysis zones (LTAZ) first. Then, the LTAZ OD data is further distributed to the TAZ level with socio-economic attributes of TAZ. (Details are shown in Figure A2.2.13.) See The TAZ OD data is split by modal choice model and assigned into the transport network of each mode.

2) Traffic Analysis Zone (TAZ)

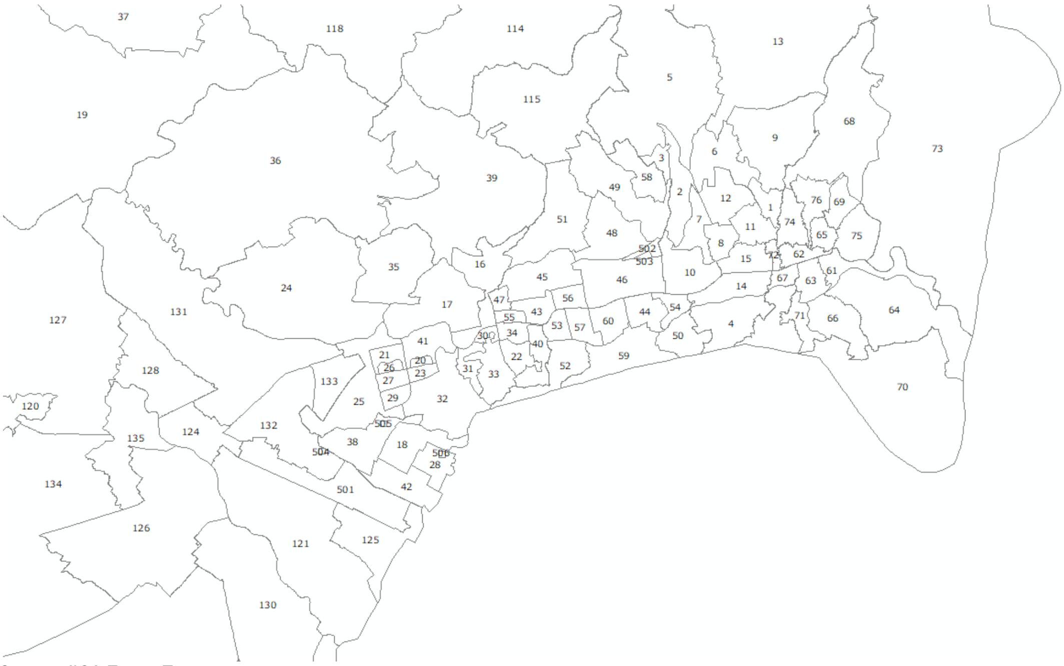
Canton of Sarajevo was divided into 139 zones for the traffic analysis in this study. The TAZ is compatible with the local community zone. Besides the 139 zones, 6 special zones are defined within the Canton of Sarajevo for the trip generation points to/from outside Canton of Sarajevo, namely, Sarajevo International Airport, Sarajevo Railway Station, Sarajevo Bus Terminal, Aerodom Bus Stop, Mojmilo II Bus Stop, and Dobrinja Bus Stop.

Also, LTAZ is defined in this study to understand the overview of the passenger movement. It is compatible with the administration boundary of municipalities.



Source: JICA Expert Team

Figure A2.2.2 Traffic Analysis Zone (TAZ)



Source: JICA Expert Team

Figure A2.2.3 TAZ (Central Area)

Source: JICA Expert Team

Figure A2.2.4 Large Traffic Analysis Zone (LTAZ)

To understand passenger movement to/from outside Canton of Sarajevo, this external area was divided into 16 external zones, as shown in the following figure. The external zones were decided considering the major road network to/from Canton of Sarajevo going to/from the external area.

Source: JICA Expert Team

Figure A2.2.5 External Zones

Table A2.2.1 Definition of TAZs

Mun. Code OPCINA		LTAZ	TAZ	Comm. Name	Comm. Code MJESNA	Mun. Code OPCINA		LTAZ	TAZ	Comm. Name	Comm. Code MJESNA
10839	Centar	1	1	Hrastovi I	116238	11584 (cont.)	Stari Grad	4	71	Toka Džeka	117854
			2	Koševsko Brdo	116289				72	Trg Oslobodjenja 2	117862
			3	Donji Velešići	116297				73	Hreša	117889
			4	Soukbunar	116416				74	Logavina 2	129216
			5	Šip	124567				75	Vratnik 2	129224
			6	Koševo II	124575				76	Medrese 1	129232
			7	Ciglane	124583	10847	Hadzici	5	77	Binježevo	116467
			8	Koševo I	124591				78	Budmolići	116475
			9	Hrastovi II	124605				79	Donji Hadžići	116483
			10	Marijin Dvor II	124613				80	Drozgometva	116491
			11	Mejtaš I	124621				81	Duranovići	116505
			12	Park	124630				82	Hadžići	116513
			13	Nahorevo	124648				83	Lokve	116521
			14	Podtekija	124656				84	Luke	116530
			15	Centar	124664				85	Mokrine	116548
10871	Novi Grad	2	16	Buča Potok	117064				86	Osenik	116556
			17	Alipašin Most II	117072				87	Pazarić	116564
			18	Dobrinja D	117099				88	Raštelica	116572
			19	Dobroševići	117102				89	Tarčin	116599
			20	Alipašino Polje C I	117129				90	Žunovica	116629
			21	Alipašino Polje A II	117137				91	Drozgometva	129402
			22	Aneks	117145				92	Duranovići	129429
			23	Alipašino Polje C II	117153				93	Binježevo	129437

Mun. Code OPCINA		LTAZ	TAZ	Comm. Name	Comm. Code MJESNA	Mun. Code OPCINA		LTAZ	TAZ	Comm. Name	Comm. Code MJESNA
			24	Briješće	117161	10863	Ilijas	6	94	Donji Čevljanovići	116874
			25	Saraj Polje	117170				95	Dragoradi	116882
			26	Alipašino Polje B II	117188				96	Gajevi	116904
			27	Alipašino Polje B I	117196				97	Ilijaš	116912
			28	Dobrinja C	117200				98	Ilijaš Stari	116939
			29	Olimpijsko Selo	117218				99	Kadarići	116947
			30	Otoka	117226				100	Kamenica	116955
			31	Švrakino Selo I	117234				101	Lješevo	116963
			32	Švrakino Selo II	117242				102	Ljubina	116971
			33	Švrakino Selo III	117269				103	Ljubnići	116980
			34	Čengić Vila	117277				104	Malešići	116998
			35	Alipašin Most I	117285				105	Misoča	117005
			36	Naselje Heroja Sokolje	117293				106	Mrakovo	117013
			37	Dobroševići	117307				107	Nišići	117021
			38	Dobrinja A	117315				108	Podlipnik	117030
			39	Dolac	117340				109	Podlugovi	117048
			40	Staro Hrasno	117358				110	Srednje	117056
			41	Alipašino Polje A I	117366				111	Ilijaš Stari	129780
			42	Dobrinja B	124559	10928	Vogosca	7	112	Blagovac	117986
11568	Novo Sarajevo	3	43	Čengić Vila I	117374				113	Gora	117994
			44	Grbavica I	117382				114	Hotonj	118001
			45	Dolac	117404				115	Kobilja Glava	118010
			46	Željeznička	117412				116	Semizovac	118028
			47	Kvadrant	117439				117	Svrake	118036
			48	Pofalići I	117447				118	Vogošća 1	118044
			49	Velešići	117455				119	Vogošća 2	118052
			50	Gornji Kovačići	117463	11550	Ilidza	8	120	Blažuj	116645
			51	Pofalići II	117471				121	Butmir	116653
			52	Lukavica	117480				122	Krupac	116670
			53	Hrasno	117498				123	Hrasnica 2	116688
			54	Kovačići	117501				124	Ilidža Centar	116696
			55	Čengić Vila II	117510				125	Kotorac	116726
			56	Malta	117544				126	Lužani	116742
			57	Trg Heroja	117552				127	Osijek	116769
			58	Gornji Velešići	117609				128	Otes	116777
			59	Vraca	117617				129	Rakovica	116785
			60	Grbavica II	124672				130	Sokolovići	116793
11584	Stari Grad	4	61	Babića Bašta	117684				131	Stup 1	116807
			62	Baščaršija	117692				132	Stup 2	116815
			63	Bistrik	117706				133	Stupsko Brdo	116823
			64	Hrid-Jarčedoli	117749				134	Vrelo Bosne	116840
			65	Kovači	117757				135	Vreoca	116858
			66	Mahmutovac	117781	11592	Trnovo	9	136	Presjenica	117927
			67	Mjedenica	117811				137	Delijaš	117935
			68	Sedrenik	117820				138	Šabići	117960
			69	Sumbuluša	117838				139	Trnovo	117978
			70	Širokača	117846						

Source: JICA Expert Team

Table A2.2.2 Definition of Special Zones and External Zones

	TAZ	Name / Area		TAZ	Name / Area
Special Zone	501	Sarajevo Int Airport	Special Zone (Cont.)	504	Aerodom Bus Stop
	502	Sarajevo Railway Station		505	Mojmilo II Bus Stop
	503	Sarajevo Bus Terminal		506	Dobrinja Bus Stop
External	1001	Repuplika Srpska (Istocno Sarajevo [Istocna Ilidza])	External (Cont.)	1009	Federacija Bosna i Hercegovina (Posavina [Odzak], Zenica-Doboj (Doboj South, Kakanj, Maglaj, Tesan/ Usora, Visoko, Zavidovici])
	1002	Repuplika Srpska (Istocno Sarajevo [East New Sarajevo])		1010	Federacija Bosna i Hercegovina (Central Bosnia [Kiseljak])
	1003	Repuplika Srpska (Istocno Sarajevo [Istocni Stari Grad])		1011	Federacija Bosna i Hercegovina (Central Bosnia [Kresevo])
	1004	Repuplika Srpska (Istocno Sarajevo [Trnovo])		1012	Federacija Bosna i Hercegovina (Herzegovina-Neretva (capljina, citluk, Jablanica, Konjic, Mostar, Neum, Ravno, Stolac), West Herzegovina (Grude, Ljubuski, Posusje, siroki Brijeg)
	1005	Federacija Bosna i Hercegovina (Bosnian Podrinje [Gorazde, Pale-Praca]), Repuplika Srpska (Foca [cajnice, Novo Gorazde, Rudo, Visegrad]), Istocno Sarajevo (Han Pijesak, Pale, Rogatica, Sokolac), Vlasenica (Bratunac, Milici, Osmaci, sekovici, Srebrenica, Vlasenica, Zvornik)		1013	Federacija Bosna i Hercegovina (Canton 10 (Bosansko Grahovo, Drvar, Glamoc, Kupres, Livno, Tomislavgrad), Herzegovina-Neretva [Prozor-Rama])
	1006	Brcko (Brcko (Brcko)), Federacija Bosna i Hercegovina (Posavina (Domaljevac-samac, Orasje), Tuzla (Banovici, celic, Doboj East, Gracanica, Gradacac, Kalesija, Kladanj, Lukavac, Sapna, Srebrenik, Teocak, Tuzla, zivinice), Zenica-Doboj [Olovo])		1014	Federacija Bosna i Hercegovina (Central Bosnia [Bugojno, Busovaca, Dobretici, Donji Vakuf, Fojnica, Gornji Vakuf-Uskoplje, Jajce, Novi Travnik, Travnik, Vitez])
	1007	Federacija Bosna i Hercegovina (Zenica-Doboj [Breza, Vares])		1015	Federacija Bosna i Hercegovina (Zenica-Doboj [Zenica, zepce]), Repuplika Srpska (Banja Luka [Banja Luka, Bosanska Gradiska, Bosanska Kostajnica, celinac, Dubica, Kotor Varos, Krupa na Uni, Laktasi, Novi Grad, Ostra Luka, Prijedor, Prnjavor, Skender Vakuf / Knezevo, Srbac, Teslic])
	1008	Federacija Bosna i Hercegovina (Bosnian Podrinje [Foca-Ustikolina]), Repuplika Srpska (Foca, Kalinovik), Trebinje (Berkovici, Bileca, Gacko, Ljubinje, Mostar, Nevesinje, Trebinje)		1016	Federacija Bosna i Hercegovina (Una-Sana [Bihac, Bosanska Krupa, Bosanski Petrovac, Buzim, Cazin, Kljuc, Sanski Most, Velika Kladusa]), Repuplika Srpska (Banja Luka [Istocni Drvar, Jezero, Kupres, Mrkonjic Grad, Petrovac, Ribnik, sipovo])

Source: JICA Expert Team

3) Transport Network

(1) Highway Network

The transport network data is required to develop the travel demand forecast model. The JICA Expert Team developed the existing highway network and public transport network using VISUM software.

(a) Road Capacity and Free Flow Speed

The following table shows the road capacity and free flow speed (speed without congestion) by road type in this study. Road capacity and speed was decided by referencing the SYSTRA study.

Table A2.2.3 Road Capacity and Free Flow Speed

Road Category	Capacity: C (PCU/hour/lane)	Free Flow Speed: Sf (km/h)
1. Footpath	N/A	4
2. Motorway	2,000	110
3. Rural Primary Highway	1,800	60
4. Rural Secondary Highway	1,500	50
5. Rural Arterial	1,200	45
6. Rural Collector	600	40
7. Urban Arterial	1,000	45
8. Urban Collector	600	35
9. Urban Local	300	25

Source: JICA Expert Team based on the information in the SYSTRA study

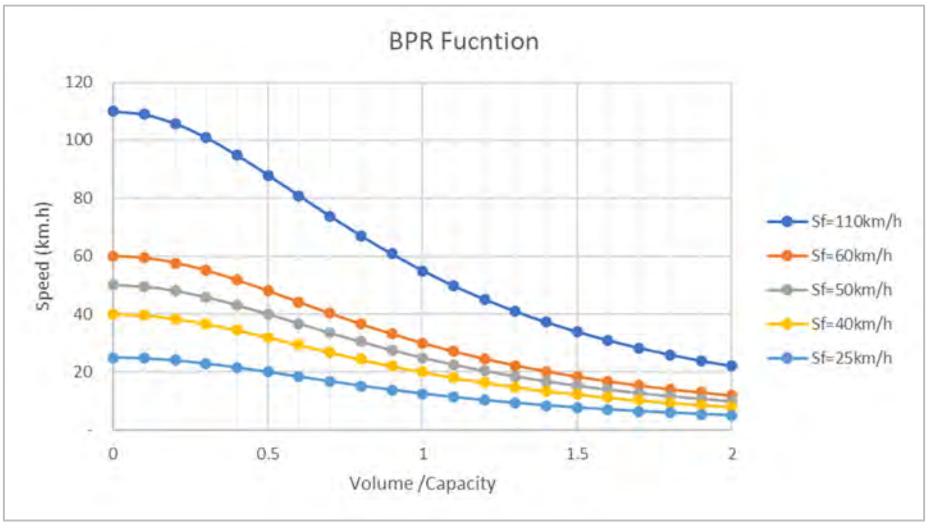
(b) Volume Delay Function

Traffic congestion impacts driving speed. The Bureau of Public Roads (BPR) equation is applied as the volume delay function in this study. Since the parameters of BPR are not available in the SYSTRA study, the standard value of parameters in VISUM software was applied. The BPR equation is:

$$S = \frac{S_f}{1+\alpha\left(\frac{V}{C}\right)^{\beta}}$$

where:

S = estimated mean speed
S_f = free flow speed
V = traffic volume
C = road capacity
$\alpha = 1$ (parameter)
$\beta = 2$ (parameter)



Source: JICA Expert Team

Figure A2.2.6 Volume Delay Function

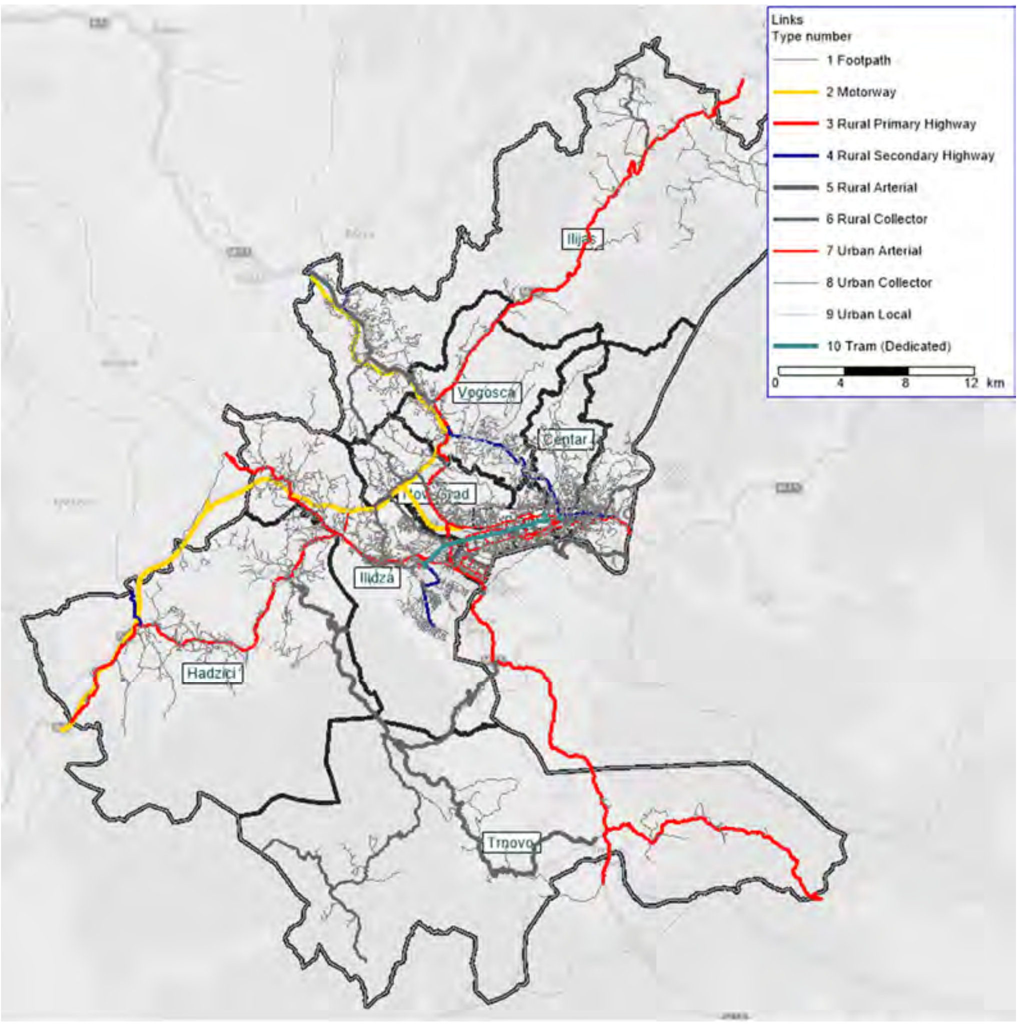
(c) Vehicle Category

The following table shows the vehicle category, passenger car unit (PCU), and average occupancy in this study. The PCU factor was decided, referencing the PCU factor in the SYSTRA study and the factor in the “Data Collection Survey on Public Transportation in Canton Sarajevo” (JICA, 2020). The average occupancy ratio is based on screen line survey (SLS) results.

Table A2.2.4 Vehicle Category

	Name	PCU	Average Occupancy (SLS)
1	Motorcycle	0.4	1.08
2	Passenger Car	1	1.44
3	Taxi	1	1.56
4	Pick Up	1	1.44
5	Small Truck	1	1.44
6	Medium Truck	1.5	1.16
7	Large Truck	2	1.05
8	Small Bus	1.5	8.75
9	Medium Bus	2	21.02
10	Large Bus	3.2	33.87

Source: JICA Expert Team



Source: JICA Expert Team

Figure A2.2.7 Existing Road Network in Sarajevo

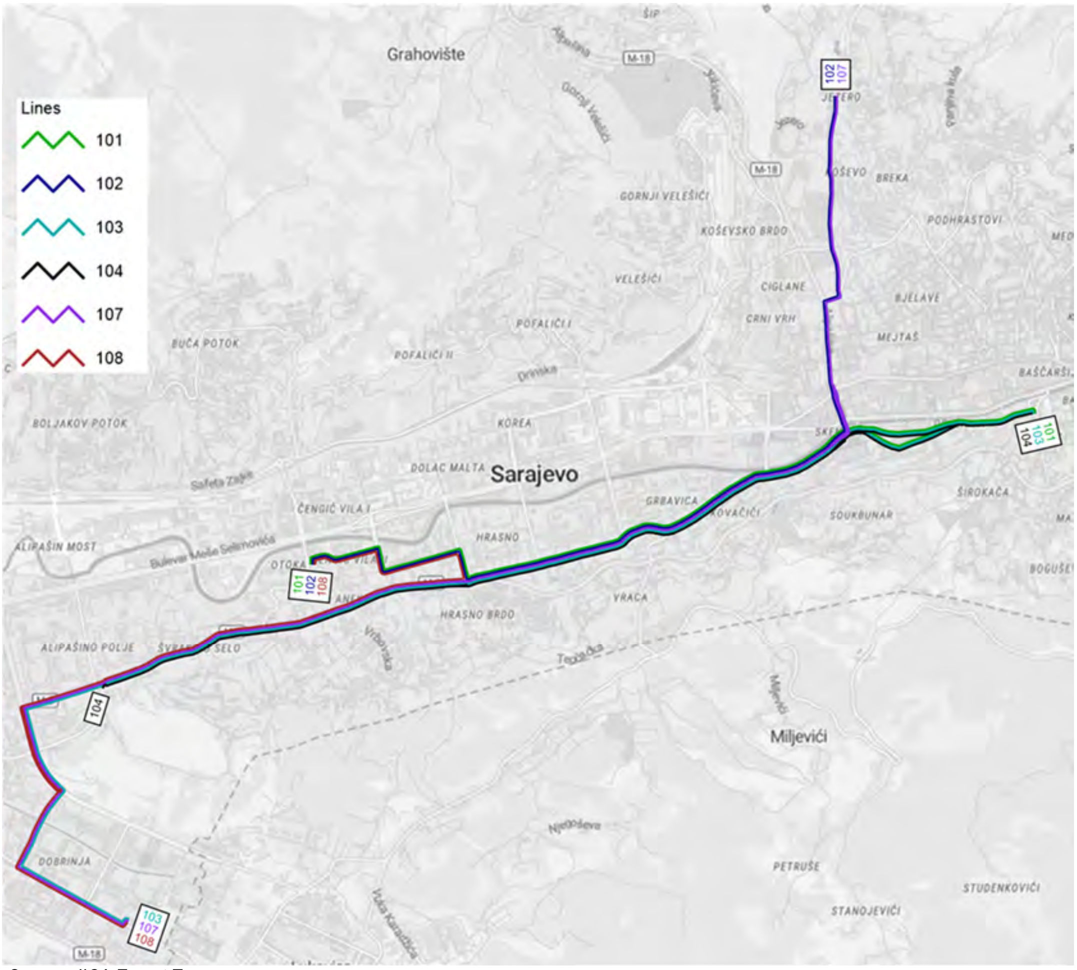
(2) Public Transport Network

(a) Public Bus Route and Bus Operator

Two operators, i.e., GRAS and CENTROTRANS, mainly operate the public transport network in Sarajevo. The public bus network is developed using VISUM software. The GRAS bus network is generated by the General Transit Feed Specification (GTFS) database and then integrated with the CENTROTRANS network, which was developed in VISUM. The current situation of the public transport network model is shown in the following figure.

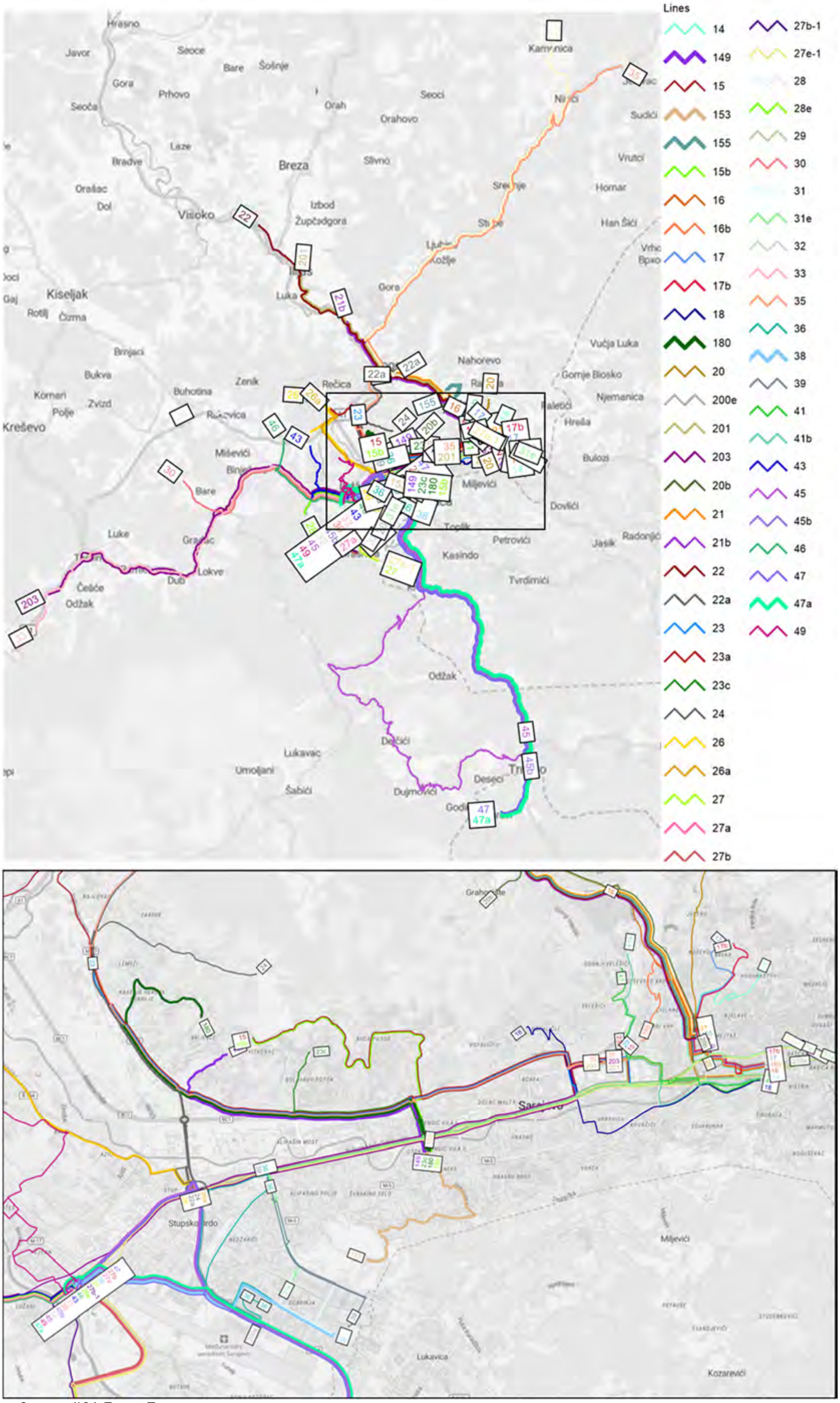
Source: JICA Expert Team

Figure A2.2.8 Public Transport Network (Tram)



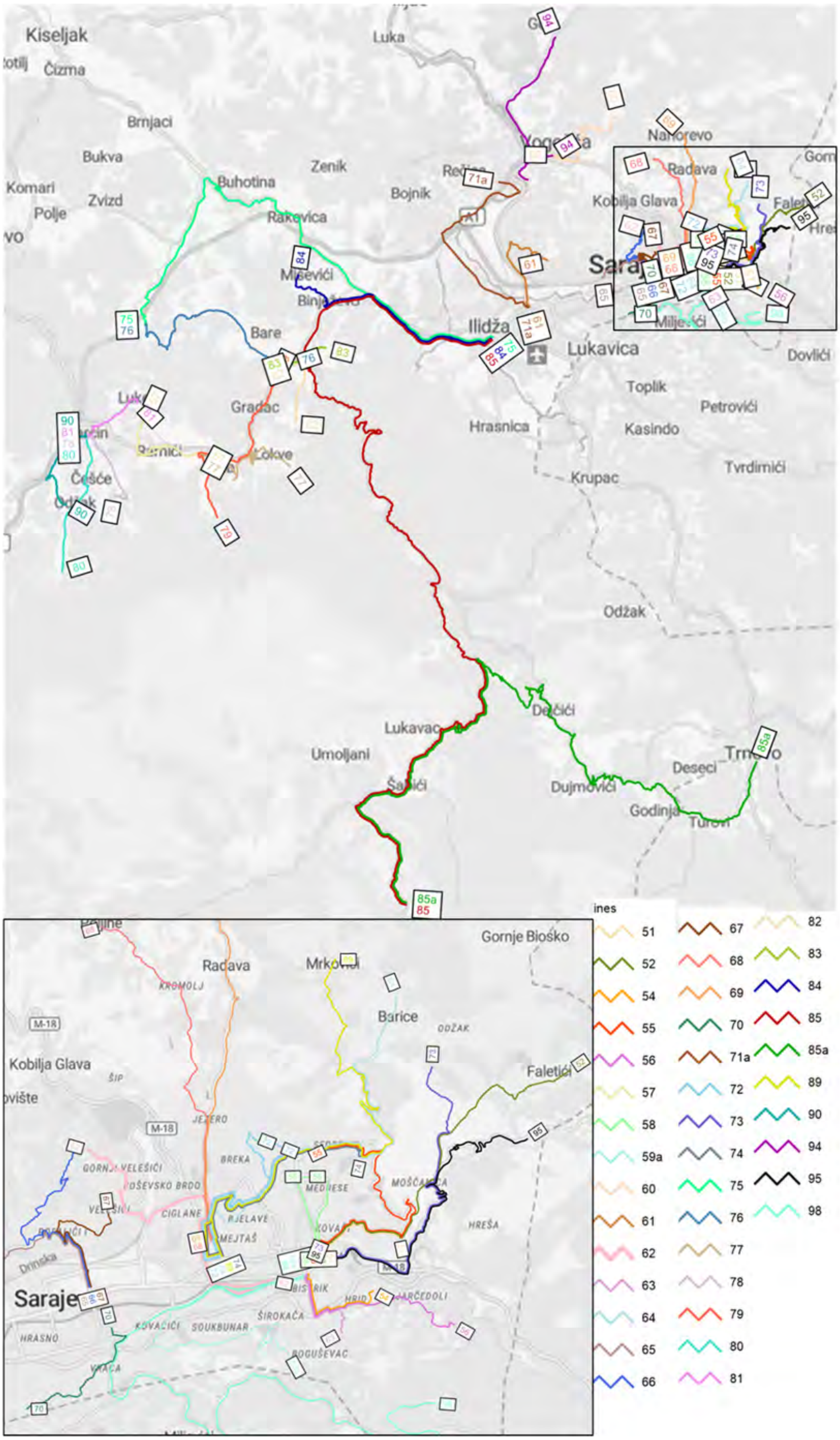
Source: JICA Expert Team

Figure A2.2.9 Public Transport Network (Trolleybus)



Source: JICA Expert Team

Figure A2.2.10 Public Transport Network (Bus)



Source: JICA Expert Team

Figure A2.2.11 Public Transport Network (Minibus)

(b) GRAS

GRAS Sarajevo is the dominant provider of public transport operations and services. It provides several modes, including trams, trolleybuses, buses, and minibuses. Six tram lines in Sarajevo are entirely operated by it, with a total length of 45.7 km connecting neighboring districts in the city center (see table below).

(c) CENTROTRANS

CENTROTRANS-Eurolines, with a fleet of more than 200 buses that meet European and world technical and operational standards, is a private bus company operator in Sarajevo. It currently operates with bus and minibus lines.

Table A2.2.5 The Public bus line, mode, operating length, and its operators in Sarajevo

No.	Mode	Section	Length(km)	Operator
1	Tram	Željeznička stanica–Baščaršija	3.2	GRAS
2	Tram	Čengić Vila–Baščaršija	5.2	GRAS
3	Tram	Ilidža–Baščaršija	11.0	GRAS
4	Tram	Ilidža–Željeznička stanica	8.8	GRAS
5	Tram	Nedžarići–Baščaršija	8.2	GRAS
6	Tram	Ilidža–Skenderija	9.3	GRAS
101	Trolleybus	Otoka–Trg Austrije	5.7	GRAS
102	Trolleybus	Otoka–Jezero	6.7	GRAS
103	Trolleybus	Dobrinja–Trg Austrije	9.5	GRAS
104	Trolleybus	Alipašino polje–Trg Austrije	6.9	GRAS
107	Trolleybus	Dobrinja–Jezero	10.6	GRAS
108	Trolleybus	Dobrinja–Otoka	6.9	GRAS
14	Bus	Dom Armije–Podhrastovi	3.3	GRAS/CENTROTRANS
15	Bus	Željeznička stanica–Buća Potok	8.2	GRAS/CENTROTRANS
15b	Bus	Otoka–Buća Potok	5.3	GRAS/CENTROTRANS
16	Bus	Dom Armije–Bare	3.8	GRAS/CENTROTRANS
16b	Bus	Dom Armije–Koševsko brdo	4.1	CENTROTRANS
17	Bus	Dom Armije–Breka	3.5	GRAS/CENTROTRANS
17B	Bus	Breka II–Dom Armije	3.2	GRAS/CENTROTRANS
18	Bus	Drvenija–Pofalići	4.8	GRAS/CENTROTRANS
20	Bus	Park–Jagomir	3.3	GRAS/CENTROTRANS
20b	Bus	Park–Šip–Bušća	5.1	GRAS/CENTROTRANS
21	Bus	Sutjeska–Vogošća	9.4	GRAS/CENTROTRANS
21b	Bus	Sutjeska–Donja Vogošća	14.5	GRAS/CENTROTRANS
22	Bus	Sutjeska–Ilijaš–Lješevo	26.0	GRAS/CENTROTRANS
22a	Bus	Stup–Vogošća	9.8	GRAS/CENTROTRANS
23	Bus	Željeznička stanica–Rajlovac	9.2	GRAS/CENTROTRANS
23a	Bus	Željeznička stanica–Reljevo Dom	24.2	GRAS
23c	Bus	Otoka–Boljakov Potok	3.3	GRAS/CENTROTRANS
24	Bus	Stup–Zabrđe–Smiljevići	6.8	GRAS/CENTROTRANS
26	Bus	Stup–Dobroševići–Ahatovići	8.3	GRAS
26a	Bus	Stup–Dobroševići	7.1	CENTROTRANS
27	Bus	Ilidža–Hrasnica	6.2	GRAS/CENTROTRANS
27a	Bus	Ilidža–Sokolovići	4.6	GRAS/CENTROTRANS
27b	Bus	Ilidža–Kovači–Hrasnica	5.9	GRAS/CENTROTRANS
27b-1	Bus	Ilidža–Kovači	5.0	CENTROTRANS
27e-1	Bus	Baščaršija–Hrasnica	17.0	CENTROTRANS
28	Bus	Ilidža–Rakovica–Kobiljača	14.2	GRAS/CENTROTRANS
28e	Bus	Ilidža–Vrelo Bosne	4.3	GRAS
29	Bus	Sutjeska–Kamenica	41.1	GRAS/CENTROTRANS
30	Bus	Ilidža–Hadžići	13.0	GRAS/CENTROTRANS
31	Bus	Nedžarići–Dobrinja	2.8	GRAS/CENTROTRANS
31e	Bus	Vijećnica–Dobrinja	9.5	GRAS/CENTROTRANS
32	Bus	Ilidža–Butmir–Kotorac	2.9	GRAS

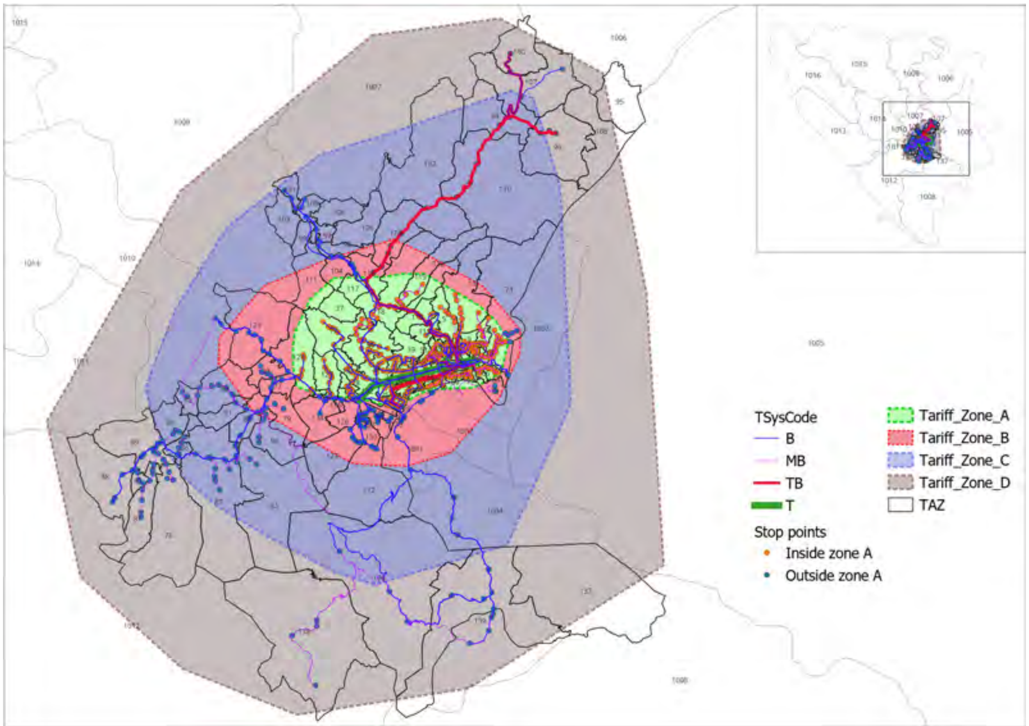
No.	Mode	Section	Length(km)	Operator
33	Bus	Ilidža–Tarčin–Vukovići	30.8	GRAS/CENTROTRANS
35	Bus	Autobuska stanica–Bakići	44.1	GRAS
36	Bus	Nedžarići–Naselje Aerodrom	3.6	GRAS/CENTROTRANS
38	Bus	Dobrinja–Ilidža	4.2	GRAS
39	Bus	Nedžarići–Dobrinja 4	2.8	GRAS/CENTROTRANS
41	Bus	Drvenija–Gornji Velešići	3.9	GRAS
41a	Bus	Drvenija–Donji Velešići	4.1	GRAS/CENTROTRANS
43	Bus	Ilidža–Osjek	7.3	GRAS/CENTROTRANS
45	Bus	Ilidža–Dejčići	47.3	GRAS/CENTROTRANS
45b	Bus	Ilidža–Garež	26.4	CENTROTRANS
46	Bus	Ilidža–Vlakovo	8.1	GRAS
47	Bus	Ilidža–Trnovo	30.5	GRAS
47a	Bus	Ilidža–Turovi	31.2	GRAS
49	Bus	Ilidža–Otes–Bare–Doglodi	3.7	GRAS
51	Minibus	Baščaršija–Vratnik	1.5	GRAS/CENTROTRANS
52	Minibus	Baščaršija–Faletići	5.5	GRAS/CENTROTRANS
54	Minibus	Latinska Ćuprija–Hošin Brijeg	1.7	GRAS/CENTROTRANS
55	Minibus	Baščaršija–Sedrenik	4.7	GRAS/CENTROTRANS
56	Minibus	Latinska Ćuprija–Jarčedoli	3.0	GRAS/CENTROTRANS
57	Minibus	Pazarić–Osenik	5.2	GRAS/CENTROTRANS
58	Minibus	Baščaršija–Mihrivode	1.2	GRAS
59	Minibus	Latinska Ćuprija–Širokača–Komatin	5.7	GRAS/CENTROTRANS
60	Minibus	Vogošća–Tihovići	5.9	GRAS
61	Minibus	Stup–Sokolje	5.6	GRAS
62	Minibus	Drvenija–Gornji Velešići (Hum)	5.0	GRAS/CENTROTRANS
63	Minibus	Latinska Ćuprija–Mahmutovac	1.4	GRAS/CENTROTRANS
64	Minibus	Park–Barice	8.8	GRAS
65	Minibus	Ekonomska škola–Obad	3.3	GRAS/CENTROTRANS
66	Minibus	Ekonomska škola–Hum	4.0	GRAS/CENTROTRANS
67	Minibus	Ekonomska škola–Bakarevac	2.4	GRAS/CENTROTRANS
68	Minibus	Sutjeska–Poljine	5.4	GRAS/CENTROTRANS
69	Minibus	Sutjeska–Nahorevo	6.0	GRAS/CENTROTRANS
70	Minibus	Grbavica–Hrasno Brdo	2.3	GRAS/CENTROTRANS
71	Minibus	Stup–Rječica	10.6	GRAS/CENTROTRANS
72	Minibus	Park–Hrastovi II	3.3	GRAS/CENTROTRANS
73	Minibus	Vijećnica–Gazin Han–Hladivode	5.4	GRAS/CENTROTRANS
74	Minibus	Park–Sedrenik (Rogina)	4.0	GRAS/CENTROTRANS
75	Minibus	Ilidža–Mokrine	24.4	GRAS
76	Minibus	Hadžići–Mokrine	10.1	GRAS
77	Minibus	Hadžići–Lokve	7.7	GRAS
78	Minibus	Tarčin–Budmolići	4.1	GRAS/CENTROTRANS
79	Minibus	Hadžići–Ljubovčići	9.5	GRAS
80	Minibus	Tarčin–Korča	6.4	GRAS
81	Minibus	Tarčin–Luke	3.3	GRAS
82	Minibus	Hadžići–Kasatići	3.2	GRAS
83	Minibus	Hadžići–Ušivak	1.7	GRAS
84	Minibus	Ilidža–Miševići	10.9	GRAS/CENTROTRANS
85	Minibus	Ilidža–Šabići–Sinanovići	49.3	CENTROTRANS
85a	Minibus	Sinanovići–Trnovo	41.2	CENTROTRANS
89	Minibus	Park–Mrkovići	8.9	GRAS/CENTROTRANS
90	Minibus	Tarčin–Trzanj	4.6	GRAS
94	Minibus	Vogošća–Ahmeda Rizve–Gora	10.5	GRAS
95	Minibus	Vijećnica–Brusulje	5.7	GRAS
98	Minibus	Latinska Ćuprija–Trebević	12.4	GRAS
149	Bus	Otoka–Briješće	4.8	CENTROTRANS
153	Bus	Otoka–Turkušići	3.7	CENTROTRANS
155	Bus	Sutjeska–Orahov brijeg	7.5	CENTROTRANS
180	Bus	Otoka–Sokolje	7.1	CENTROTRANS
200e	Bus	Bentbaša–Aerodrom	10.6	CENTROTRANS

No.	Mode	Section	Length(km)	Operator
201	Bus	Sarajevo–Ilijaš	21.3	CENTROTRANS
203	Bus	Sarajevo–Raštelica	36.2	CENTROTRANS

Source: JICA Expert Team

(d) Tariff zone

The tariff zone is divided into four: Zone A, Zone B, Zone C, And Zone D. Zone A is the bus fare zone in the city center, and Zone B, Zone C, and Zone D are the bus fare zones in the suburban area of Sarajevo. To study the bus fare using the VISUM model, the stops inside Zone A are defined as tariff zone type 1, while stops outside Zone A are defined as tariff zone type 2.

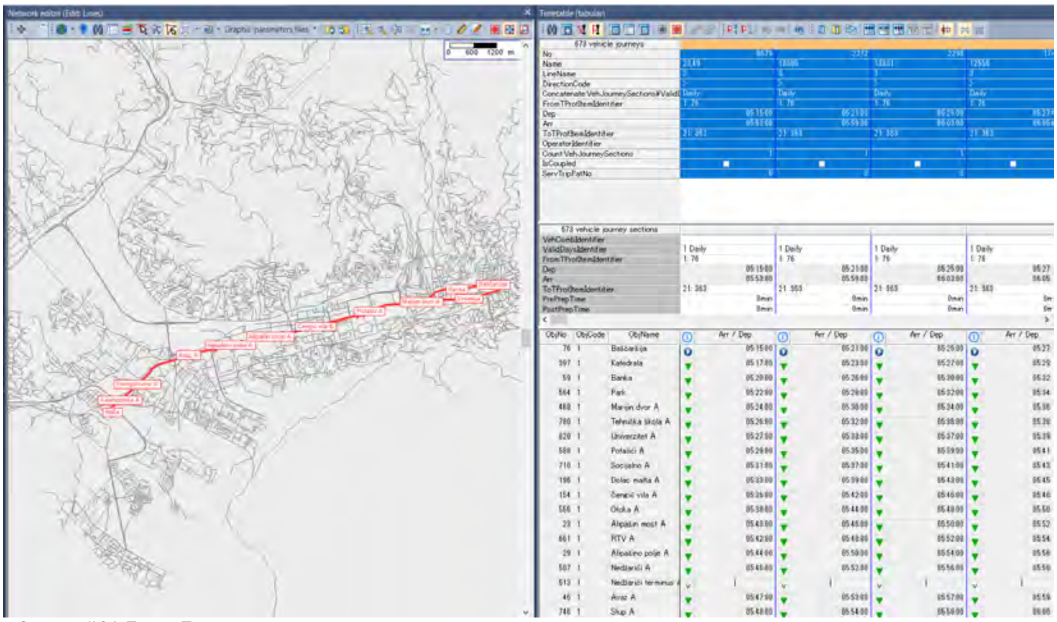


Source: JICA Expert Team

Figure A2.2.12 Tariff Zone

(e) Timetable

The existing timetables of each line route are computerized into VISUM.



Source: JICA Expert Team

Figure A2.2.13 Timetable (Tram Line 3)

4) Population Synthesis

To estimate the disaggregated travel behavior of each household and for each person in the Study Area, the attributes of the synthetic population generated must match those of the general population for each TAZ. PopGen, a software developed by Arizona State University and widely utilized for population synthesis in the United States and other countries, was used in the Study as a population synthesizer. It utilizes a typical iterative proportional fitting (IPF) to match persons and households based on their control total by TAZ.

Marginal control variables by household and personal attributes by each scenario in 2022, as shown in the following table are estimated for each TAZ.

As a result, 420,000 individual data with household information were created.

Table A2.2.6 List of Control Variables of Population Synthesis Models

Type	Attribute	Category	
Household	Monthly household income	1. Under 450 BAM 2. BAM 450–BAM 749 3. BAM 750–BAM 1,049 4. BAM 1,050–BAM 1,349 5. BAM 1,350–BAM 1,649 6. BAM 1,650–BAM 1,949 7. BAM 1,950–BAM 2,249	8. BAM 2,250–BAM 2,549 9. BAM 2,550–BAM 2,849 10. BAM 2,850–BAM 3,149 11. BAM 3,150–BAM 3,449 12. BAM 3,450–BAM 3,749 13. Over BAM 3,750
Household	No. of household members	1. 1 Person 2. 2 Persons 3. 3 Persons	4. 4 Persons 5. 5 Persons and more
Person	Gender	1. Male	2. Female
Person	Age group	1. 0–14 years 2.15–64 years	3. 65 years and more
Person	Social status	1. Worker 2. Student	3. Other

Source: JICA Expert Team

For household and person samples, the result of the ADS was utilized as it contains fundamental household and personal attributes that affect the estimation of travel behavior.

The number of household samples by household size and monthly household income, which are extracted from the samples of the ADS after data validation, is listed in the following tables. The number of person samples by age group and social status corresponding to the household samples are also in the tables.

Table A2.2.7 Number of Household Samples by Household Size

No. of Household Members	No. HH Samples
1 member	1,209
2 members	1,351
3 members	1,724
4 members	1,479
5 members and more	384
Total	6,147

Source: JICA Expert Team

Table A2.2.8 Number of Household Samples by Household Monthly Income

Household Monthly Income	No. of Household Samples
under 450 BAM	95
BAM 450–BAM 749	163
BAM 750 KM–BAM 1,049	287
BAM 1,050 KM–BAM 1,349	461
BAM 1,350–BAM 1,649	611
BAM 1,650–1,949 BAM	556
BAM 1,950–BAM 2,249	747
BAM 2,250–BAM 2,549	917
BAM 2,550–BAM 2,849	592
BAM 2,850–BAM 3,149	644
BAM 3,150–BAM 3,449	378
BAM 3,450–BAM 3,749	246
Over BAM 3,750	450
Total	6,147

Source: JICA Expert Team

Table A2.2.9 Number of Person Samples by Gender

Gender	No. of Person Samples
Male	8,062
Female	8,179
Total	16,241

Source: JICA Expert Team

Table A2.2.10 Number of Person Samples by Age Group

Age Group	No. of Person Samples
0-14 years	2,641
15 – 64 years	13,086
65 years and more	514
Total	16,241

Source: JICA Expert Team

Table A2.2.11 Number of Household Samples by Social Status

Social Status	Number of Sample Persons
Worker	9,412
Student	4,807
Other	2,022
Total	16,241

Source: JICA Expert Team

HHLTAZ	SAMPLE_ID	SEX	AGE	AGEG	OC	OCG	HHTAZ	SPop	SWrk	SStd	SWrk_WrkP	TNum	HHInc	HHVO	HHSIZE
フィルター	フィルター	フィルター	フ…	フィ…	フ…	フィ…	フィル…	フィ…	フィ…	フィ…	フィルター	フィ…	フィ…	フィ…	フィルター
1	1	2	55	2	1	1	1	4	4	4	0	1	1500	1	4
1	1	1	53	2	15	3	1	4	4	4	0	1	1500	1	4
1	1	1	23	2	14	2	1	4	4	4	0	1	1500	1	4
1	1	2	18	2	12	2	1	4	4	4	0	1	1500	1	4
1	3	2	30	2	1	1	1	4	4	4	0	1	3900	2	2
1	3	1	28	2	1	1	1	4	4	4	0	1	3900	2	2
1	4	2	22	2	14	2	1	4	4	4	0	1	2100	1	1
1	5	2	45	2	1	1	1	4	4	4	0	1	3300	1	3
1	5	1	42	2	2	1	1	4	4	4	0	1	3300	1	3
1	5	2	12	1	11	2	1	4	4	4	0	1	3300	1	3
1	6	1	19	2	14	2	1	4	4	4	0	1	1500	1	1
1	7	2	23	2	14	2	1	4	4	4	0	1	900	0	2
1	7	2	23	2	14	2	1	4	4	4	0	1	900	0	2

Source: JICA Expert Team

Figure A2.2.14 Synthesized Person Database

5) Vehicle Ownership Model (VOM)

(1) Model Structure

A household vehicle ownership model is developed as a discrete choice model using household samples of the ADS. The model divides households into three groups: "NCO" households not owning any car, "CO1" households owning one car, and "CO2+" households owning two or more cars.

The utility function of the model is formulated with the alternative specific constant (ASC) and household income as variables, as shown in Table A2.2.12. The representative values are used as variables. The choice probability of each alternative is calculated by the following formula using the utility function.

$$\mathrm{P}_i = \frac{\exp(V_i)}{\sum_i \exp\,(V_i)}$$

P_i : Probability of choosing vehicle ownership *i*
V_i : Utility function of vehicle ownership *i*

Table A2.2.12 Utility Function of Vehicle Ownership Model

Name	Specification
NCO	V_NCO = B_X1 * HHInc
CO1	V_CO1 = ASC_2 * one
CO2+	V_CO2+ = ASC_3 * one + B_X3 * HHInc

Note: B_X1, ASC_2, ASC_3, B_X3: Estimated parameters, HHInc: Household Income
Source: JICA Expert Team

Table A2.2.13 Household Monthly Income Group

ID	Group	Typical
1	under 450 BAM	225
2	BAM 450–BAM 749	600
3	BAM 750 KM–BAM 1,049	900
4	BAM 1,050 KM–BAM 1,349	1,200
5	BAM 1,350–BAM 1,649	1,500
6	BAM 1,650–BAM 1,949	1,800
7	BAM 1,950–BAM 2,249	2,100
8	BAM 2,250–BAM 2,549	2,400
9	BAM 2,550–BAM 2,849	2,700

ID	Group	Typical
10	BAM 2,850–BAM 3,149	3,000
11	BAM 3,150–BAM 3,449	3,300
12	BAM 3,450–BAM 3,749	3,600
13	over BAM 3,750	3,900

Source: JICA Expert Team

(2) Parameter Estimation Results

The summary and estimated parameters are shown in Table A2.2.14 and Table A2.2.15.

Table A2.2.14 Summary of Vehicle Ownership Model Parameter Estimation

Name	Value
Model:	Multinomial Logit
Number of estimated parameters:	3
Number of observations:	6147
Number of individuals:	6147
Null log likelihood:	-6753.17
Cte log likelihood:	-5578.239
Init log likelihood:	-6753.17
Final log likelihood:	-5141.189
Likelihood ratio test:	3223.961
Rho-square:	0.239
Adjusted rho-square:	0.238

Source: JICA Expert Team

Table A2.2.15 Estimated Parameter of Vehicle Ownership Model

Name	Value	Std err	t-test	p-value
ASC_2	0	fixed		0
ASC_3	-3.47	0.124	-28.06	0
B_X1	-0.000642	1.71E-05	-37.54	0
B_X3	0.000878	4.36E-05	20.13	0

Source: JICA Expert Team

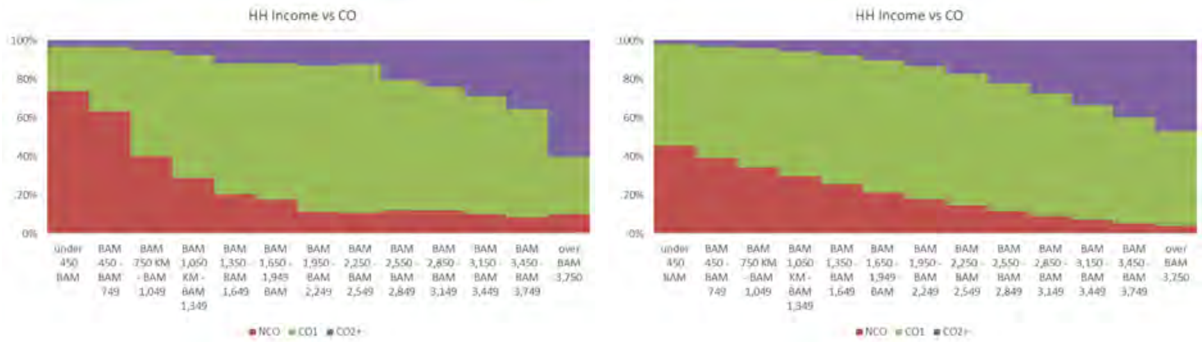
(3) Model Validation

Table A2.2.16 compares the ADS samples with the estimated number of households for each vehicle ownership group based on the developed model. The difference in the number of households is 1.9% maximum. Figure A2.2.15 shows the ratio of vehicle ownership groups by income group.

Table A2.2.16 Comparison of ADS and Model Estimation Results

	NCO	CO1	CO2+
A. ADS Result *1	1,080	3,911	1,156
B. Estimated Result	1,072	3,920	1,154
Relative Error (B-A)/A	-0.7%	0.2%	-0.2%

Unit: Households, *1: Before Expansion
Source: JICA Expert Team



ADS Result | Estimated Result

Source: JICA Expert Team

Figure A2.2.15 Model Validation by Household Monthly Income Level

6) Trip Frequency Model (TFM)

(1) Model Structure

A trip frequency model is developed for four trip purposes using samples from the ADS. As shown in Table A2.2.17, more than 99% of the samples for all purposes fall within the range of 0 to 2 trip frequencies, so a discrete selection model that selects 0, 1, and 2 trip frequencies for each purpose was employed. Samples that made three or more trips for the same purpose were grouped into the trip frequency 2 group and used for parameter estimation. The explanatory variables for the trip frequency model were gender, occupation, and household income, as shown in Table A2.2.18. The selection probability of each option is calculated by the following formula using the utility function.

$$P_i = \frac{\exp(V_i)}{\sum_i \exp(V_i)}$$

P_i : Probability of choosing option *i*
V_i : Utility function of option *i*

Table A2.2.17 Trip Frequency by Trip Purpose in PT Survey

Frequency	HBW	HBS	HBO	NHB	Total
0	30%	85%	66%	91%	68%
1	16%	6%	13%	8%	11%
2	53%	9%	19%	1%	21%
3	0%	0%	1%	0%	0%
4	0%	0%	1%	0%	0%
5 and more	0%	0%	0%	0%	0%

Note: HBW Home-based Work Trip (Home-to-work and work-to-home trip)
HBS: Home-based School Trip (Home-to-school and school-to-home trip)
HBO: Home-based Other Trip (Home-to-other and other-to-home trip)
NHB: Non-home-based Trip
Source: JICA Expert Team

Table A2.2.18 Explanatory Variables of Trip Frequency Model

Name	Specification
Wrkr	Dummy variable for workers as his/her attribute. 1 if he/she is worker.
Stdt	Dummy variable for students as his/her attribute. 1 if he/she is student.
Othr	Dummy variable for others as his/her attribute. 1 if he/she is not worker nor student.
Female	Dummy variable for female. 1 if he/she is female.
HHIncome	Household monthly income in BAM.
Age_Mid	Dummy variable for middle-aged person. 1 if he/she is 15–64 years old.

Source: JICA Expert Team

(2) Parameter Estimation Results

The structure of utility function and results of parameter estimation are shown in the following.

(a) Home-based Work (HBW)

Table A2.2.19 Utility Function of Trip Frequency Model (HBW)

Alternative	Utility Function
0	V_0 = ASC_0 * one
1	V_1 = ASC_1 * one + B_Worker * Worker
2	V_2 = ASC_2 * one + B_HHInc * HHIncome + B_Worker * Worker

Source: JICA Expert Team

Table A2.2.20 Summary of HBW Trip Frequency Model Parameter Estimation

Name	Value
Model	Multinomial Logit
Number of estimated parameters	4
Number of observations	4089
Number of individuals	4089
Null log likelihood	-4492.226
Cte log likelihood	-4064.313
Init log likelihood	-4492.226
Final log likelihood	-3237.093
Likelihood ratio test	2510.264
Rho-square	0.279
Adjusted rho-square	0.279

Source: JICA Expert Team

Table A2.2.21 Estimated Parameter of Trip Frequency Model (HBW)

Name	Value	Std err	t-test	p-value
ASC_0	0	fixed		
ASC_1	-3.12	0.0965	-32.34	0
ASC_2	-2.24	0.13	-17.19	0
B_HHInc	0.000127	4.21E-05	3.01	0
B_Worker	3.49	0.104	33.57	0

Source: JICA Expert Team

(b) Home-based School (HBS)

Table A2.2.22 Utility Function of Trip Frequency Model (HBS)

Alternative	Utility Function
0	V_0 = ASC_0 * one
1	V_1 = ASC_1 * one + B_Student * Student
2	V_2 = ASC_2 * one + B_Student * Student

Source: JICA Expert Team

Table A2.2.23 Summary of Trip Frequency Model Parameter Estimation (HBS)

Name	Value
Model	Multinomial Logit
Number of estimated parameters	3
Number of observations	4105
Number of individuals	4105
Null log likelihood	-4509.803
Cte log likelihood	-2174.129
Init log likelihood	-4509.803

Name	Value
Final log likelihood	-1310.295
Likelihood ratio test	6399.017
Rho-square	0.709
Adjusted rho-square	0.709

Source: JICA Expert Team

Table A2.2.24 Estimated Parameter of Trip Frequency Model (HBS)

Name	Value	Std err	t-test	p-value
ASC_0	0	fixed		
ASC_1	-4.41	0.112	-39.28	0
ASC_2	-3.96	0.106	-37.57	0
B_Student	4.41	0.13	33.92	0

Source: JICA Expert Team

(c) Home-based Others (HBO)

Table A2.2.25 Utility Function of Trip Frequency Model (HBO)

Alternative	Utility Function
0	V_0 = ASC_0 * one + B_Female * Female
1	V_1 = ASC_1 * one + B_Other * Other
2	V_2 = ASC_2 * one + B_Other * Other

Source: JICA Expert Team

Table A2.2.26 Summary of Trip Frequency Model Parameter Estimation (HBO)

Name	Value
Model	Multinomial Logit
Number of estimated parameters	4
Number of observations	4044
Number of individuals	4044
Null log likelihood	-4442.788
Cte log likelihood	-3465.343
Init log likelihood	-4442.788
Final log likelihood	-3434.235
Likelihood ratio test	2017.107
Rho-square	0.227
Adjusted rho-square	0.226

Source: JICA Expert Team

Table A2.2.27 Estimated Parameter of Trip Frequency Model (HBO)

Name	Value	Std err	t-test	p-value
ASC_0	0	fixed		
ASC_1	-1.82	0.0676	-26.9	0
ASC_2	-1.44	0.0631	-22.79	0
B_Female	-0.232	0.0716	-3.25	0
B_Other	1.05	0.149	7.07	0

Source: JICA Expert Team

(d) Non-Home Based (NHB)

Table A2.2.28 Utility Function of Trip Frequency Model (NHB)

Alternative	Utility Function
0	V_0 = ASC_0 * one
1	V_1 = B_HHInc * HHInc
2	V_2 = B_Age_Mid * Age_Mid

Source: JICA Expert Team

Table A2.2.29 Summary of Trip Frequency Model Parameter Estimation (NHB)

Name	Value
Model:	Multinomial Logit
Number of estimated parameters:	3
Number of observations:	4106
Number of individuals:	4106
Null log likelihood:	-4510.902
Cte log likelihood:	-1303.546
Init log likelihood:	-4510.902
Final log likelihood:	-1304.602
Likelihood ratio test:	6412.6
Rho-square:	0.711
Adjusted rho-square:	0.71

Source: JICA Expert Team

Table A2.2.30 Estimated Parameter of Trip Frequency Model (NHB)

Name	Value	Std err	t-test	p-value
ASC_0	2.79	0.164	17.04	0
B_Age_Mid	-1.14	0.135	-8.43	0
B_HHInc	0.000153	6.45E-05	2.38	0.02

Source: JICA Expert Team

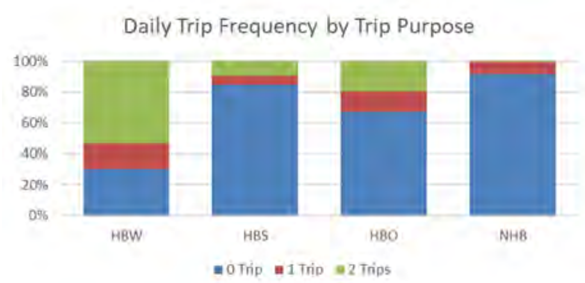
(3) Model Validation

The following table and figures show the number of persons by daily trip frequency and by purpose observed in ADS samples and that estimated by the developed model. It is confirmed that the distribution of trip frequency is similar.

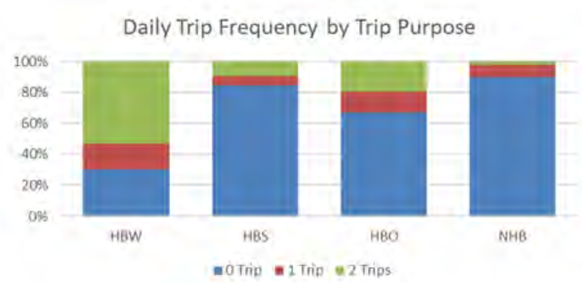
Table A2.2.31 Comparison of ADS and Model Estimation Results

Trip Purpose	HBW			HBS		
Trip Frequency	0	1	2	0	1	2
A. ADS Result *1	1,232	675	2,182	3,478	245	382
B. Estimated Result	1,232	674	2,183	3,477	244	383
Relative Error (B-A)/A	0.00%	-0.18%	0.05%	-0.02%	-0.26%	0.32%
Trip Purpose	**HBO**			**NHB**		
Trip Frequency	0	1	2	0	1	2
A. ADS Result *1	2,710	542	792	3,749	332	25
B. Estimated Result	2,711	541	791	3,697	325	85
Relative Error (B-A)/A	0.05%	-0.15%	-0.08%	-1.40%	-2.20%	239%

Unit: Households, *1: Before Expansion
Source: JICA Expert Team



ADS Result



Estimated Result

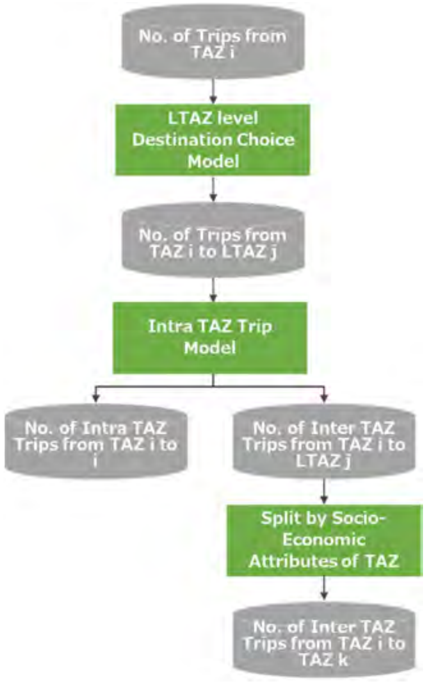
Source: JICA Expert Team

Figure A2.2.16 Model Validation by Trip Purpose

7) Destination Choice Model (DCM)

(1) Model Structure

After several trials, the three-step DCM, consisting of the LTAZ level destination model, Intra-TAZ trip model, and split by socioeconomic attributes, is shown below. Firstly, the LTAZ level destination model, a multinomial choice model, selects a destination from nine LTAZs. Secondly, the Intra-TAZ trip model, which is a binomial choice model, splits Intra-TAZ and Inter-TAZ trips in case the LTAZ of an origin and a destination are the same. Lastly, the Inter-TAZ trips are split by the socioeconomic attributes of TAZ. The utility functions and the result of parameter estimation are described in the following pages.



Source: JICA Expert Team

Figure A2.2.17 Flow of Destination Choice Model

(2) Parameter Estimation Results (LTAZ Destination Choice)

Table A2.2.32 Explanatory Variables of LTAZ DCM

Name	Specification
Wrk_WrkP_X	Number of workers at workplace in destination alternative LTAZ X.
Std_X	Number of students in destination alternative LTAZ X.
ImpX	Average impedance km between origin LTAZ and destination alternative LTAZ X.
LnImpX	Average natural log of impedance km between origin LTAZ and destination alternative LTAZ X.

Source: JICA Expert Team

Table A2.2.33 Utility Function of LTAZ DCM for HBW

Alternative	Utility Function
LTAZ01	V_01 = B_Imp * Imp1 + B_Wrkr * Wrk_WrkP_1
LTAZ02	V_02 = B_Imp * Imp2 + B_Wrkr * Wrk_WrkP_2
LTAZ03	V_03 = B_Imp * Imp3 + B_Wrkr * Wrk_WrkP_3
LTAZ04	V_04 = B_Imp * Imp4 + B_Wrkr * Wrk_WrkP_4
LTAZ05	V_05 = B_Imp * Imp5 + B_Wrkr * Wrk_WrkP_5
LTAZ06	V_06 = B_Imp * Imp6 + B_Wrkr * Wrk_WrkP_6
LTAZ07	V_07 = B_Imp * Imp7 + B_Wrkr * Wrk_WrkP_7
LTAZ08	V_08 = B_Imp * Imp8 + B_Wrkr * Wrk_WrkP_8
LTAZ09	V_09 = B_Imp * Imp9 + B_Wrkr * Wrk_WrkP_9

Source: JICA Expert Team

Table A2.2.34 Utility Function of LTAZ DCM for HBS

Alternative	Utility Function
LTAZ01	V_01 = B_LnImp * LnImp1 + B_Std * Std_1
LTAZ02	V_02 = B_LnImp * LnImp2 + B_Std * Std_2
LTAZ03	V_03 = B_LnImp * LnImp3 + B_Std * Std_3
LTAZ04	V_04 = B_LnImp * LnImp4 + B_Std * Std_4
LTAZ05	V_05 = B_LnImp * LnImp5 + B_Std * Std_5
LTAZ06	V_06 = B_LnImp * LnImp6 + B_Std * Std_6
LTAZ07	V_07 = B_LnImp * LnImp7 + B_Std * Std_7
LTAZ08	V_08 = B_LnImp * LnImp8 + B_Std * Std_8
LTAZ09	V_09 = B_LnImp * LnImp9 + B_Std * Std_9

Source: JICA Expert Team

Table A2.2.35 Utility Function of LTAZ DCM for HBO

Alternative	Utility Function
LTAZ01	V_01 = B_Imp * Imp1 + B_Wrkr * Wrk_WrkP_1
LTAZ02	V_02 = B_Imp * Imp2 + B_Wrkr * Wrk_WrkP_2
LTAZ03	V_03 = B_Imp * Imp3 + B_Wrkr * Wrk_WrkP_3
LTAZ04	V_04 = B_Imp * Imp4 + B_Wrkr * Wrk_WrkP_4
LTAZ05	V_05 = B_Imp * Imp5 + B_Wrkr * Wrk_WrkP_5
LTAZ06	V_06 = B_Imp * Imp6 + B_Wrkr * Wrk_WrkP_6
LTAZ07	V_07 = B_Imp * Imp7 + B_Wrkr * Wrk_WrkP_7
LTAZ08	V_08 = B_Imp * Imp8 + B_Wrkr * Wrk_WrkP_8
LTAZ09	V_09 = B_Imp * Imp9 + B_Wrkr * Wrk_WrkP_9

Source: JICA Expert Team

Table A2.2.36 Utility Function of LTAZ DCM for NHB

Alternative	Utility Function
LTAZ01	V_01 = B_LnImp * LnImp1 + B_Wrkr * Wrk_WrkP_1
LTAZ02	V_02 = B_LnImp * LnImp2 + B_Wrkr * Wrk_WrkP_2
LTAZ03	V_03 = B_LnImp * LnImp3 + B_Wrkr * Wrk_WrkP_3
LTAZ04	V_04 = B_LnImp * LnImp4 + B_Wrkr * Wrk_WrkP_4
LTAZ05	V_05 = B_LnImp * LnImp5 + B_Wrkr * Wrk_WrkP_5
LTAZ06	V_06 = B_LnImp * LnImp6 + B_Wrkr * Wrk_WrkP_6
LTAZ07	V_07 = B_LnImp * LnImp7 + B_Wrkr * Wrk_WrkP_7
LTAZ08	V_08 = B_LnImp * LnImp8 + B_Wrkr * Wrk_WrkP_8
LTAZ09	V_09 = B_LnImp * LnImp9 + B_Wrkr * Wrk_WrkP_9

Source: JICA Expert Team

Table A2.2.37 Summary of LTAZ DCM Parameter Estimation

HHVO=3 Car	HBW	HBS	HBO	NHB
Number of estimated parameters	2	2	2	2
Number of observations	4966	1032	2293	396
Number of individuals	4966	1032	2293	396
Null log-likelihood	-10911.4	-2267.536	-5038.24	-870.101
Cte log-likelihood	-8475.3	-1254.106	-3872.57	-621.453
Init log-likelihood	-10911.4	-2267.536	-5038.24	-870.101
Final log-likelihood	-8009.99	-1696.381	-3619.84	-591.446
Likelihood ratio test	5802.857	1142.31	2836.8	557.31
Rho-square	0.266	0.252	0.282	0.32
Adjusted rho-square	0.266	0.251	0.281	0.318

Source: JICA Expert Team

Table A2.2.38 Estimated Parameters of LTAZ DCM

Model	Name	Value	Std err	t-test	p-value
HBW	B_Imp	-0.131	0.0039	-33.55	0
	B_Wrkr	4.79E-05	1.76E-06	27.27	0
HBS	B_LnImp	-1.51	0.0662	-22.74	0
	B_Std	2.42E-05	9.39E-06	2.58	0.01
HBO	B_Imp	-0.157	0.00664	-23.65	0
	B_Wrkr	4.19E-05	2.75E-06	15.22	0
NHB	B_LnImp	-1.25	0.118	-10.6	0
	B_Wrkr	5.53E-05	7.48E-06	7.39	0

Source: JICA Expert Team

(3) Parameter Estimation Results (Intra-TAZ Destination Choice)

Table A2.2.39 Explanatory Variables of Intra TAZ DCM

Name	Specification
HBW	Dummy variable for HBW trip. 1 if the trip purpose is HBW.
HTS	Dummy variable for HBS trip. 1 if the trip purpose is HBS.

Source: JICA Expert Team

Table A2.2.40 Utility Function of Intra-TAZ DCM

Alternative	Utility Function
Inter-TAZ	V_0 = ASC_0 * one + B_HBS * HBS
Intra-TAZ	V_1 =ASC_1 * one + B_HBW * HBW

Source: JICA Expert Team

Table A2.2.41 Summary of Intra-TAZ DCM Parameter Estimation

Name	Value
Number of estimated parameters	3
Number of observations	8687
Number of individuals	8687
Null log-likelihood	-6021.37
Cte log-likelihood	-1839.4
Init log-likelihood	-6021.37
Final log-likelihood	-1831.31
Likelihood ratio test	8380.115
Rho-square	0.696
Adjusted rho-square	0.695

Source: JICA Expert Team

Table A2.2.42 Estimated Parameter of Intra-TAZ DCM

Name	Value	Std err	t-test	p-value
ASC_0	2.63	0.0772	34.14	0
ASC_1	0	fixed		
B_HBS	0.657	0.184	3.56	0
B_HBW	-0.273	0.1	-2.73	0.01

Source: JICA Expert Team

(4) Split by Socio-economic Attributes of TAZ

Whether trips of the destination in LTAZ is the same as the origin LTAZ or not, trips were split into Inter TAZ trip by socio-economic attributes of TAZ. The socioeconomic attributes are used as an explanatory variable of LTAZ DCM. For instance, the estimated HBW trips to LTAZ *i* are distributed to each TAZ in LTAZ *i* in proportion to the number of workers of the TAZ.

8) Modal Choice Model (MCM)

(1) Model Structure

After several trials, the MCM was developed with the RP data collected in the ADS. Considering the available transportation mode in Sarajevo, a 3-item choice model was employed, namely NMT, Private Vehicle (PV) and Public Transport (PuT). Model parameters for HBW and HBS trips were estimated for households with car ownership (HHVO=2,3) and for households without car ownership (HHVO=1) separately. The explanatory variables of the model are total travel time and total travel cost of each mode as well as constants for each choice. PuT trip will be divided into tram, bus and trolleybus users through the next assignment process.

Table A2.2.43 Utility Functions of MCM

Alternative	Utility Function
A1_NMT	V1 = ASC_NMT * one + B_TIME * T_NMT + B_COST * C_NMT
A2_PV	V2 = ASC_PV * one + B_TIME * T_Car + B_COST * C_Car
A3_PuT	V3 = ASC_PuT * one + B_TIME * T_PuT + B_COST * C_PuT

Source: JICA Expert Team

Table A2.2.44 Explanatory Variables for MCM

Name	Specification
T_X	Total travel time in minutes when travelling by travel mode X
C_X	Total travel cost in BAM when travelling by travel mode X

Source: JICA Expert Team

(2) Parameter Estimation Results

Table A2.2.45 Result of Parameter Estimation for MCM

	HBW		HBS	
Name	HHVO=1	HHVO=2,3	HHVO=1	HHVO=2,3
Number of estimated parameters:	4	3	3	4
Number of observations:	2628	6705	1067	3517
Number of individuals:	2628	6705	1067	3517
Null log-likelihood:	-2887.153	-7366.195	-1172.219	-3863.819
Cte log-likelihood:	-2603.919	-4625.503	-756.88	-2970.788
Init log-likelihood:	-2887.153	-7366.195	-1172.219	-3863.819
Final log-likelihood:	-2295.852	-4585.497	-623.087	-2449.933
Likelihood ratio test:	1182.603	5561.398	1098.265	2827.773
Rho-square:	0.205	0.377	0.468	0.366
Adjusted rho-square:	0.203	0.377	0.466	0.365

	HBO	NHB
Name	HHVO=1,2,3	HHVO=1,2,3
Number of estimated parameters:	3	3
Number of observations:	10921	2153
Number of individuals:	10921	2153
Null log-likelihood:	-11997.945	-2365.312
Cte log-likelihood:	-8934.307	-1617.28
Init log-likelihood:	-11997.945	-2365.312
Final log-likelihood:	-8908.641	-1564.57
Likelihood ratio test:	6178.607	1601.484
Rho-square:	0.257	0.339
Adjusted rho-square:	0.257	0.337

Source: JICA Expert Team

Table A2.2.46 Estimated Parameters for MCM

HBW HHVO=1

Name	Value	Std err	t-test	p-value
ASC_Car	-1.55	0.087	-17.87	0
ASC_NMT	-0.511	0.0934	-5.47	0
ASC_PuT	0	fixed		
B_COST	-0.443	0.0445	-9.97	0
B_TIME	-0.049	0.00252	-19.48	0

HBW HHVO=2,3

Name	Value	Std err	t-test	p-value
ASC_Car	0	fixed		
ASC_NMT	-0.735	0.14	-5.25	0
ASC_PuT	0	fixed		
B_COST	-0.474	0.0678	-7	0
B_TIME	-0.0465	0.00112	-41.61	0

HBS HHVO=1

Name	Value	Std err	t-test	p-value
ASC_Car	-4.18	0.191	-21.84	0
ASC_NMT	0	fixed		
ASC_PuT	0	fixed		
B_COST	-0.666	0.0852	-7.81	0
B_TIME	-0.0569	0.00391	-14.56	0

HBS HHVO=2,3

Name	Value	Std err	t-test	p-value
ASC_Car	-2.62	0.158	-16.62	0
ASC_NMT	0	fixed		
ASC_PuT	0.276	0.0906	3.04	0
B_COST	-0.589	0.0432	-13.63	0
B_TIME	-0.0652	0.00267	-24.44	0

HBO HHVO=1,2,3

Name	Value	Std err	t-test	p-value
ASC_Car	1.34	0.0296	45.38	0
ASC_NMT	0	fixed		
ASC_PuT	0	fixed		
B_COST	-0.0904	0.0202	-4.48	0
B_TIME	-0.00501	0.000534	-9.38	0

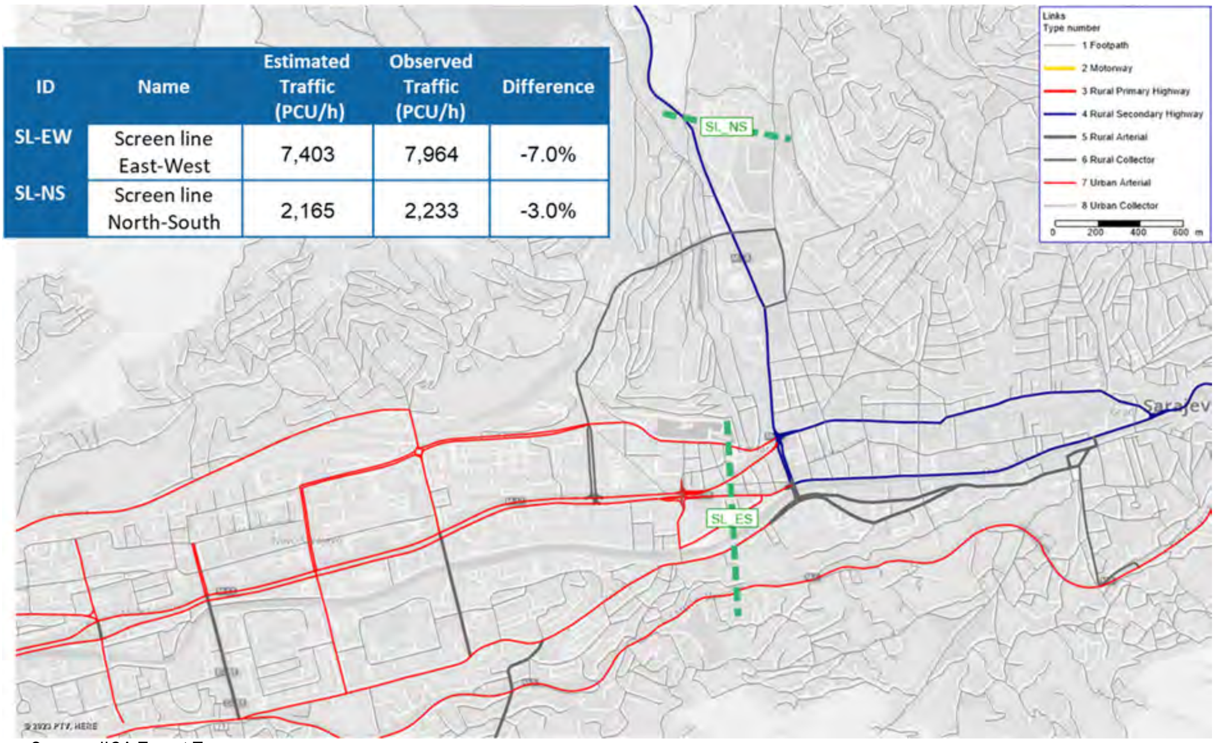
NHB HHVO=1,2,3

Name	Value	Std err	t-test	p-value
ASC_Car	1.25	0.0822	15.19	0
ASC_NMT	0	fixed		
ASC_PuT	0	fixed		
B_COST	-0.339	0.0545	-6.22	0
B_TIME	-0.0183	0.00202	-9.05	0

Source: JICA Expert Team

9) Validation and Calibration

The estimated traffic volume of private vehicles is validated with the screen line survey results. As shown in the following table, the difference between the estimated traffic volume and observed traffic volume in AM peak hour is less than 7%.



ID	Name	Estimated Traffic (PCU/h)	Observed Traffic (PCU/h)	Difference
SL-EW	Screen line East-West	7,403	7,964	-7.0%
SL-NS	Screen line North-South	2,165	2,233	-3.0%

Source: JICA Expert Team

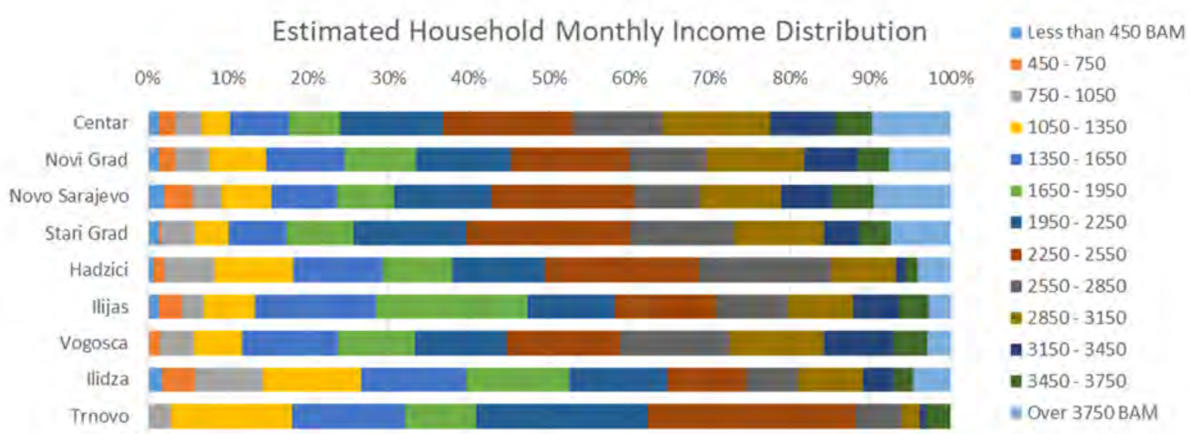
Figure A2.2.18 Mode Share Comparison

A2.3 Demand Forecasting

The existing traffic demand is estimated with the above-mentioned travel demand forecast model. This sub-chapter describes the result of traffic demand estimation.

1) Household Income Distribution

The following figure shows the distribution of household income by municipality based on the synthesized population data. As shown, the share of high-income households in the central area is larger than in suburban municipalities.



Source: JICA Expert Team

Figure A2.3.1 Estimated Household Monthly Income Distribution by Municipality

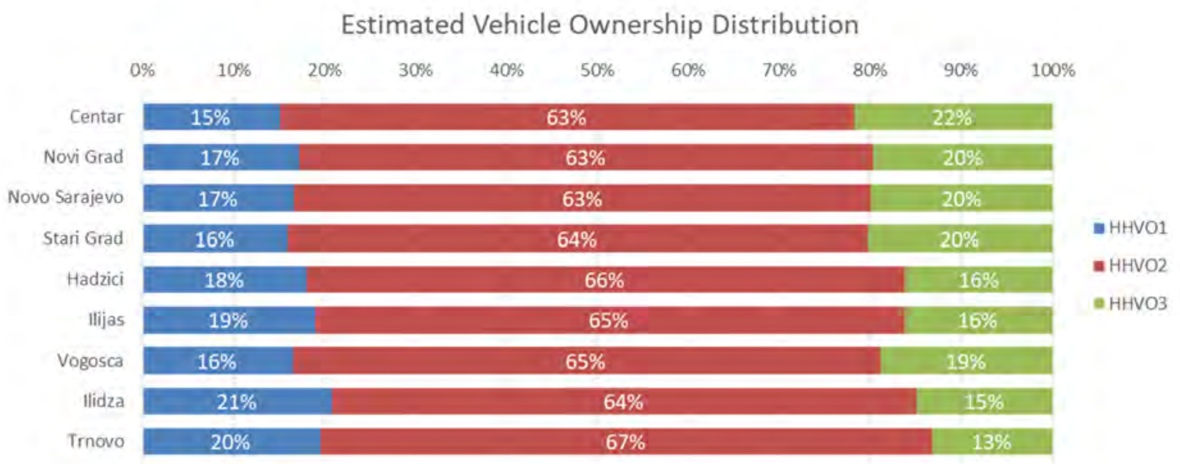
2) Vehicle Ownership Estimation

Vehicle ownership is estimated with the abovementioned vehicle ownership model (VOM) and household income distribution by TAZ. It is estimated that 124,000 households, or 83% of all households, own one or more cars.

Table A2.3.1 Estimated Vehicle Ownership

HHVO Code	Type	'000 Household	'000 Population
HHVO1	Households not owning any car	26	72
HHVO2	Households owning one car	96	268
HHVO3	Households owning two or more cars	28	80
Total		151	420

Source: JICA Expert Team



Source: JICA Expert Team

Figure A2.3.2 Estimated Vehicle Ownership by Municipality

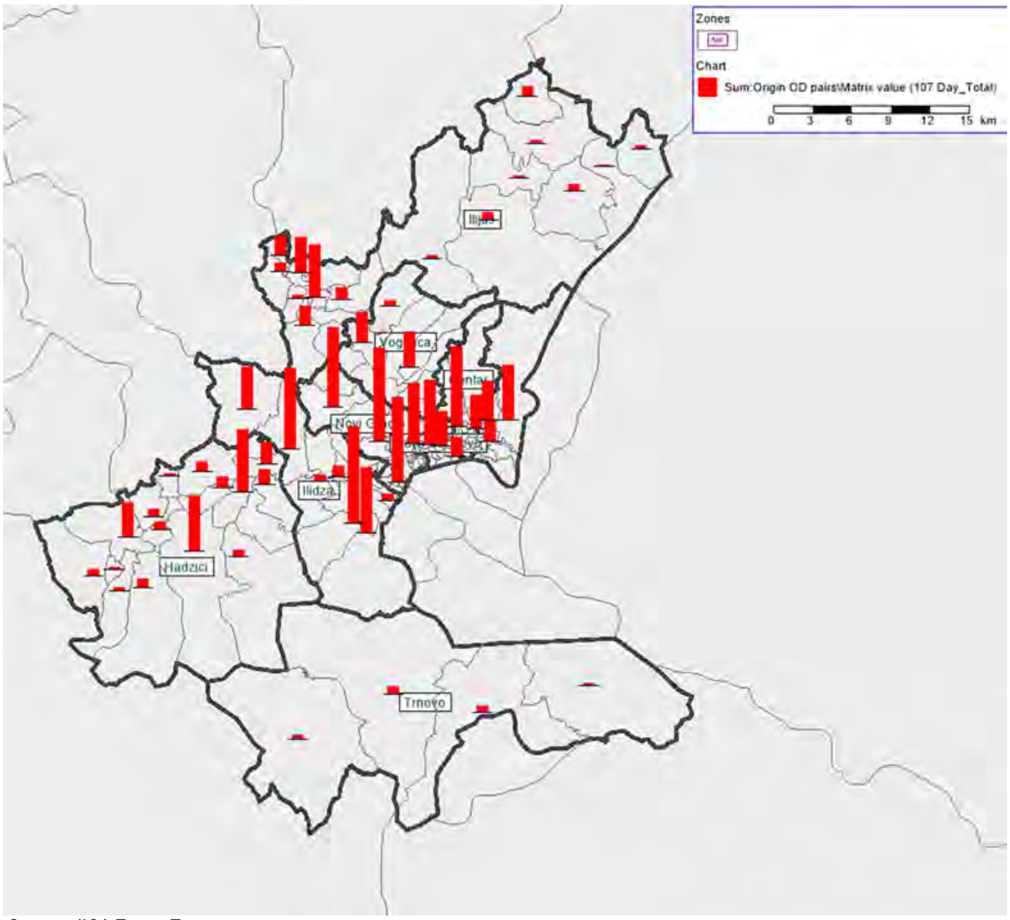
3) Trip Estimation

The following table shows the estimated total daily trips by purpose in Canto of Sarajevo. The highest volume is calculated for the HBW trip, followed by HBO, HBS, and NHB. In total, 736,000 trips are generated from Canton Sarajevo. It means the gross trip ratio is 1.75 trips per day per person. Trips are generated mainly from Novo Sarajevo, Novi Grad, Ilidza, and Stari Grad.

Table A2.3.2 Estimated Daily Trip by Purpose

Purpose	000 Trip/day	Share
HBW	293	40%
HBS	98	13%
HBO	288	39%
NHB	57	8%
Total	**736**	**100%**

Source: JICA Expert Team



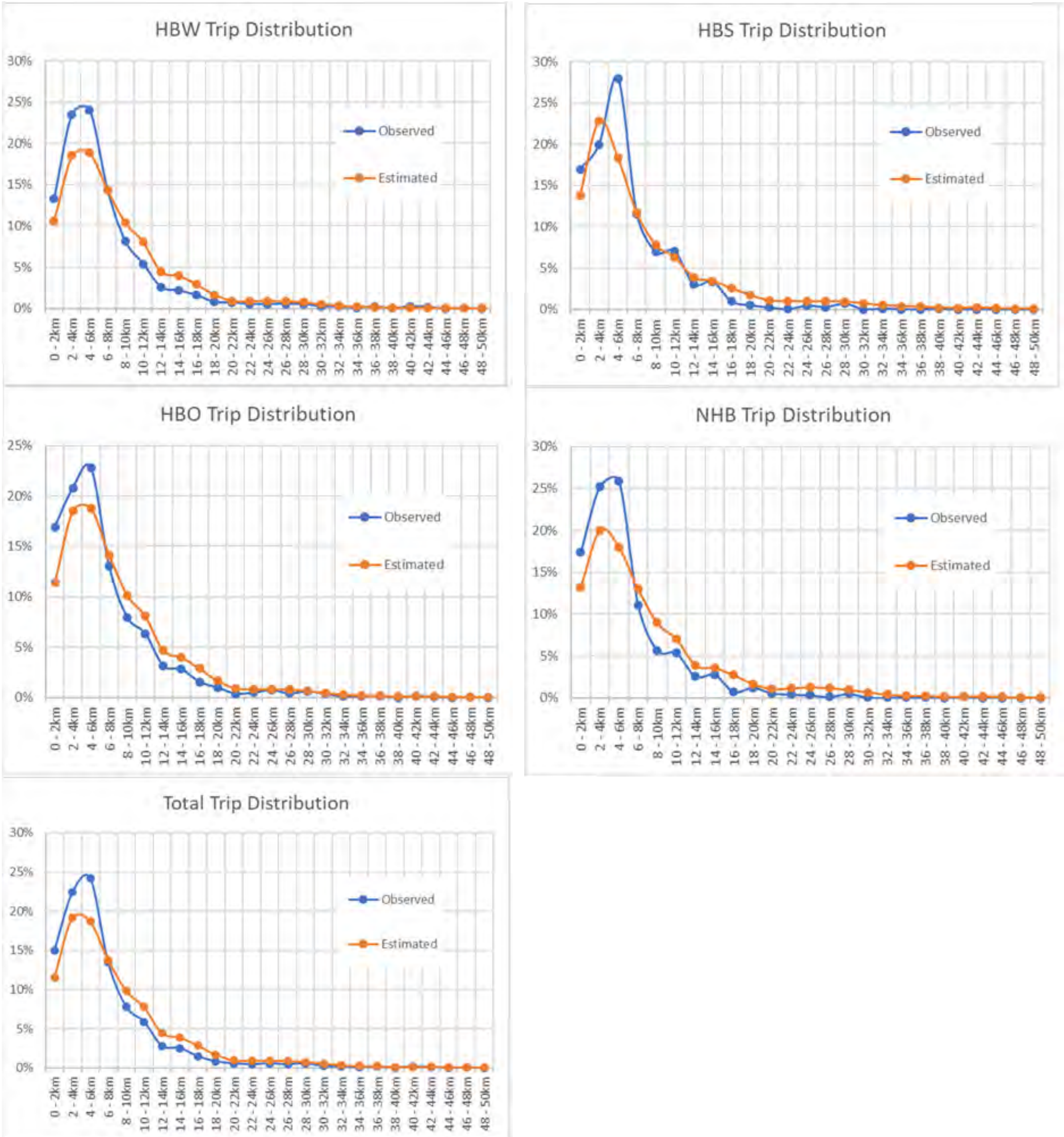
Source: JICA Expert Team

Figure A2.3.3 Estimated Trip Generation by TAZ

4) Trip Destination Estimation

The following figures show the estimated and observed distribution of trip length by trip purpose. The median, or 50th percentile, of the total trips is estimated at 4.08 km, excluding intra-zonal trips.

It should be noted that the observed trip distribution is based on the ADS sample without an expansion factor, while the estimated trip distribution is for the total population in Canton of Sarajevo. Comparing the estimated trip distribution of trip length and the observed, the share of short-distance trips in the estimated trip is slightly lower than the latter. It could be one of the reasons that the share of trips from each TAZ in the ADS sample trip are different from the share in the estimated trip. Also, the estimated trips from each TAZ by TFM are distributed to the destination LTAZ by the LTAZ DCM first. Then, it is further distributed to each TAZ based on the share of the number of workers and students of each TAZ within the LTAZ. The distance between each TAZ in LTAZ may also influence on the preference of destination TAZ.



Source: JICA Expert Team

Figure A2.3.4 Daily OD by LTAZ for All Purposes

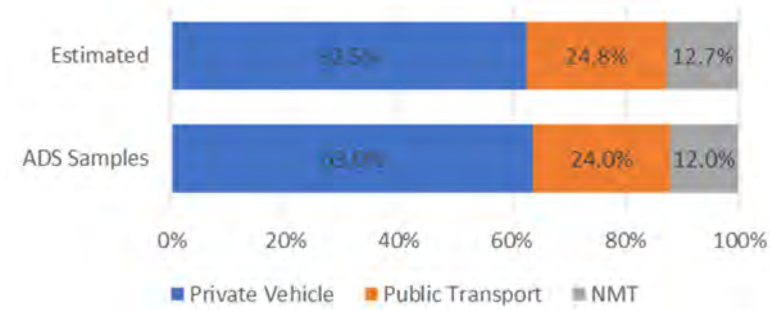
The following figure shows the estimated LTAZ desired line. It should be noted that the centroid of each LTAZ means the geographical center, not the center of trip generation point. Also, the LTAZs are not equal since the size and shape of each TAZ is unique.

Source: JICA Expert Team

Figure A2.3.5 Daily OD by LTAZ for Base Year

5) Modal Share Estimation

The following figure shows the estimated modal share in Canto of Sarajevo in the AM peak hour and the observed modal share in the ADS sample. The modal share of public transport is estimated at 24.8% of all trips.



Source: JICA Expert Team

Figure A2.3.6 Mode Share Comparison

6) Traffic Demand Forecasting

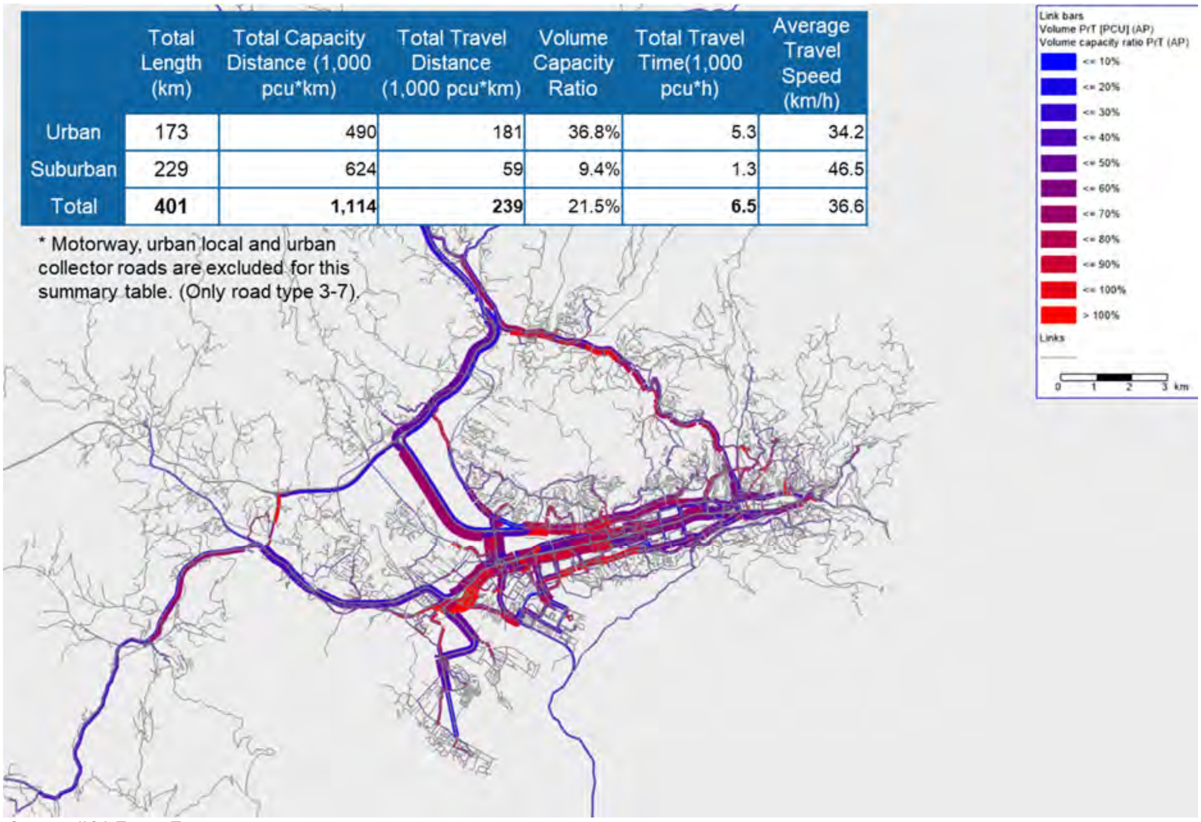
The subsequent figures show the assignment results for private vehicles and public transport, including the table that describes the performance index of the road network in AM Peak Hour in the study area. In the tables below, “urban” represents road links inside urban areas in the urban plan. The estimated volume/capacity (V/C) ratio is 36.6% in urban areas and 9.4% in suburban. Comparing the urban and suburban V/C results indicate severe congestion in urban areas. For public transport, the largest number of boarding passengers is estimated on tram line 3, as shown in Table A2.3.3.

Source: JICA Expert Team

Figure A2.3.7 Assignment Result for Private Vehicle in AM Peak Hour (7–8 AM)

	Total Length (km)	Total Capacity Distance (1,000 pcu*km)	Total Travel Distance (1,000 pcu*km)	Volume Capacity Ratio	Total Travel Time(1,000 pcu*h)	Average Travel Speed (km/h)
Urban	173	490	181	36.8%	5.3	34.2
Suburban	229	624	59	9.4%	1.3	46.5
Total	**401**	**1,114**	**239**	21.5%	**6.5**	36.6

* Motorway, urban local and urban collector roads are excluded for this summary table. (Only road type 3-7).



Source: JICA Expert Team

Figure A2.3.8 Assignment Result for Private Vehicle in AM Peak Hour (V/C Ratio)

Source: JICA Expert Team

Figure A2.3.9 Assignment Result for Public Transport Passenger in AM Peak Hour (7–8 AM)

Table A2.3.3 Estimated Passenger by Line by Direction in Peak Hour and Off Peak

ID	Name	Mode	Start Stop	End Stop	Length (km)	PAX (AM Peak: PAX/h)	PAX (Off-Peak: km/h)
1	1	Tram	Baščaršija	Željeznička stanica	3	59	35
1	1	Tram	Željeznička stanica	Baščaršija	3	128	78
2	2	Tram	Baščaršija	Čengić vila A	5	100	47
2	2	Tram	Čengić vila terminus	Baščaršija	5	87	68
3	3	Tram	Baščaršija	Ilidža	11	1,002	633
3	3	Tram	Ilidža	Baščaršija	11	1,557	627
4	4	Tram	Željeznička stanica	Ilidža	9	77	91
4	4	Tram	Ilidža	Željeznička stanica	9	106	58
5	5	Tram	Baščaršija	Nedžarići terminus A	8	166	65
5	5	Tram	Nedžarići terminus B	Baščaršija	8	198	43
6	6	Tram	Skenderija terminus	Ilidža	9	208	135
6	6	Tram	Ilidža	Skenderija terminus	9	441	174
7	101	Trolleybus	Otoka terminal	Trg Austrije	6	98	68
7	101	Trolleybus	Trg Austrije	Otoka terminal	6	136	112
8	102	Trolleybus	Otoka terminal	Jezero B	7	453	289
8	102	Trolleybus	Jezero B	Otoka terminal	7	271	159
9	103	Trolleybus	Dobrinja	Trg Austrije	10	666	431
9	103	Trolleybus	Trg Austrije	Dobrinja	10	577	432
10	104	Trolleybus	Alipašino polje terminus	Trg Austrije	7	164	0
10	104	Trolleybus	Trg Austrije	Alipašino polje terminus	7	238	0
11	107	Trolleybus	Dobrinja	Jezero B	11	569	268
11	107	Trolleybus	Jezero B	Dobrinja	11	404	181
12	108	Trolleybus	Otoka terminal	Dobrinja	7	266	176
12	108	Trolleybus	Dobrinja	Otoka terminal	7	144	122
13	14	Bus	Dom Armije	Podhrastovi	3	91	78
13	14	Bus	Podhrastovi	Dom Armije	3	69	57
14	15	Bus	Željeznička stanica terminal	Buća Potok	8	209	209
14	15	Bus	Buća Potok	Željeznička stanica terminal	8	288	185
15	15b	Bus	Otoka terminal	Buća Potok	5	45	22
15	15b	Bus	Buća Potok	Otoka terminal	5	46	28
16	16	Bus	Dom Armije	Bare	4	142	80
16	16	Bus	Bare	Dom Armije	4	234	89
17	16b	Bus	Dom Armije	Koševsko brdo	4	63	52
17	16b	Bus	Koševsko brdo	Dom Armije	4	27	9
18	17	Bus	Dom Armije	Breka	4	25	15
18	17	Bus	Breka	Dom Armije	4	32	16
19	17b	Bus	Dom Armije	Breka II	3	4	4
19	17b	Bus	Breka II	Dom Armije	3	13	3
20	18	Bus	Drvenija terminal	Donji Pofalići B	5	96	43
20	18	Bus	Donji Pofalići B	Drvenija terminal	5	69	37
21	20	Bus	Park terminal	Jagomir A	3	37	27
21	20	Bus	Jagomir B	Park terminal	3	37	35
22	20b	Bus	Park terminal	Vrbovska 1	5	55	72
22	20b	Bus	Vrbovska 1	Park terminal	5	31	0
23	21	Bus	Sutjeska	Vogošća A	9	297	183
23	21	Bus	Vogošća A	Sutjeska	9	466	167
24	21b	Bus	Sutjeska	Donja Vogošća	14	47	0
24	21b	Bus	Donja Vogošća	Sutjeska	15	113	74
25	22	Bus	Sutjeska	Lješevo	26	0	103

ID	Name	Mode	Start Stop	End Stop	Length (km)	PAX (AM Peak: PAX/h)	PAX (Off-Peak: km/h)
25	22	Bus	Lješevo	Sutjeska	26	0	111
26	22a	Bus	Stup terminal	Vogošća terminal	10	134	102
26	22a	Bus	Vogošća terminal	Stup terminal	9	216	141
27	23	Bus	Željeznička stanica terminal	Rajlovac A	9	69	36
27	23	Bus	Rajlovac A	Željeznička stanica terminal	9	148	77
28	23a	Bus	Autobuska stanica	Željeznička stanica	24	137	0
28	23a	Bus	Željeznička stanica	Autobuska stanica	24	241	110
29	23c	Bus	Otoka terminal	Boljakov Potok	3	71	40
29	23c	Bus	Boljakov Potok	Otoka terminal	3	131	44
30	24	Bus	Stup terminal	Smiljevići okretnica	7	65	19
30	24	Bus	Smiljevići okretnica	Stup terminal	7	22	18
31	26	Bus	Stup terminal	Gornji Ahatovići	9	0	0
31	26	Bus	Gornji Ahatovići	Stup terminal	9	96	59
31	26	Bus	Stup terminal	Ahatovići A	8	112	48
31	26	Bus	Ahatovići B	Stup terminal	8	0	0
32	26a	Bus	Stup terminal	Dobroševići A	7	83	78
32	26a	Bus	Dobroševići B	Stup terminal	7	151	82
33	27	Bus	Ilidža terminal	Hrasnica Famos	6	168	132
33	27	Bus	Hrasnica Famos	Ilidža terminal	6	151	134
34	27a	Bus	Ilidža terminal	Sokolović kolonija	5	106	85
34	27a	Bus	Sokolović kolonija	Ilidža terminal	5	187	62
35	27b	Bus	Ilidža terminal	Hrasnica terminus	6	6	0
35	27b	Bus	Hrasnica terminus	Ilidža terminal	6	68	0
36	27b-1	Bus	Ilidža terminal	Hrasnica terminus	5	27	0
36	27b-1	Bus	Hrasnica terminus	Ilidža terminal	5	20	0
37	27e-1	Bus	Baščaršija	Hrasnica Famos	17	203	200
37	27e-1	Bus	Hrasnica Famos	Baščaršija	17	442	230
38	28	Bus	Ilidža terminal	Kobiljača A	14	57	51
38	28	Bus	Kobiljača A	Ilidža terminal	14	162	48
39	28e	Bus	Ilidža terminal	Vrelo Bosne	4	0	0
39	28e	Bus	Vrelo Bosne	Ilidža terminal	4	0	3
40	29	Bus	Sutjeska	Kamenica-Crna rijeka	41	38	0
40	29	Bus	Kamenica-Crna rijeka	Sutjeska	41	0	10
41	30	Bus	Ilidža terminal	Hadžići A	11	17	0
41	30	Bus	Hadžići B	Ilidža terminal	11	51	0
41	30	Bus	Ilidža terminal	Drozgometva A	15	89	49
41	30	Bus	Drozgometva A	Ilidža terminal	15	107	41
42	31	Bus	Nedžarići terminal	Dobrinja	3	132	71
42	31	Bus	Dobrinja	Nedžarići terminal	3	222	214
43	31e	Bus	Dobrinja V A	Vijećnica terminal	9	250	157
43	31e	Bus	Vijećnica terminal	Dobrinja V A	10	311	168
44	32	Bus	Ilidža terminal	Butmir okretnica	3	81	18
44	32	Bus	Butmir okretnica	Ilidža terminal	3	61	23
45	33	Bus	Ilidža terminal	Vukovići	31	153	87
45	33	Bus	Vukovići	Ilidža terminal	31	287	103
46	35	Bus	Autobuska stanica	Krivojevići B	44	0	0
46	35	Bus	Krivojevići B	Autobuska stanica	44	0	0
47	36	Bus	Nedžarići terminal	Naselje Aerodrom MZ	3	35	0
47	36	Bus	Naselje Aerodrom MZ	Nedžarići terminal	4	77	0
48	38	Bus	Dobrinja	Ilidža terminal	4	49	77
48	38	Bus	Ilidža terminal	Dobrinja	4	168	80
49	39	Bus	Nedžarići terminal	Dobrinja IV	3	139	85
49	39	Bus	Dobrinja IV	Nedžarići terminal	3	46	26

ID	Name	Mode	Start Stop	End Stop	Length (km)	PAX (AM Peak: PAX/h)	PAX (Off-Peak: km/h)
50	41	Bus	Drvenija terminal	Gornji Velešići	4	84	24
50	41	Bus	Gornji Velešići	Drvenija terminal	4	68	35
51	41b	Bus	Drvenija terminal	Donji Velesici	4	13	8
51	41b	Bus	Donji Velesici	Drvenija terminal	4	5	8
52	43	Bus	Ilidža terminal	Hendekuša okretnica	7	132	95
52	43	Bus	Hendekuša okretnica	Ilidža terminal	7	199	85
53	45	Bus	Ilidža terminal	Garež A	46	0	0
53	45	Bus	Garež A	Ilidža terminal	48	0	0
54	45b	Bus	Ilidža terminal	Garež A	25	0	0
54	45b	Bus	Garež A	Ilidža terminal	27	0	0
55	46	Bus	Ilidža terminal	Vlakovo	8	53	68
55	46	Bus	Vlakovo	Ilidža terminal	8	55	48
56	47	Bus	Ilidža terminal	Trnovo centar A	28	15	0
56	47	Bus	Trnovo centar A	Ilidža terminal	30	0	0
56	47	Bus	Ilidža terminal	Turovi	31	0	3
56	47	Bus	Turovi	Ilidža terminal	33	0	0
57	47a	Bus	Ilidža terminal	Turovi	31	0	0
57	47a	Bus	Turovi	Ilidža terminal	31	0	0
58	49	Bus	Ilidža terminal	Doglodi okretnica	6	48	25
58	49	Bus	Doglodi okretnica	Ilidža terminal	4	30	26
58	49	Bus	Ilidža terminal	Otes okretnica	3	0	10
58	49	Bus	Trg Oteškog bataljona	Ilidža terminal	2	17	0
59	51	Minibus	Baščaršija terminal	Vratnik Višegradska kapija	1	53	25
59	51	Minibus	Vratnik Višegradska kapija	Baščaršija terminal	1	44	23
60	52	Minibus	Baščaršija terminal	Gornji Faletići	5	105	54
60	52	Minibus	Gornji Faletići	Baščaršija terminal	5	82	48
61	54	Minibus	Latinska ćuprija terminal	Hošin brijeg	2	6	0
61	54	Minibus	Hošin brijeg	Latinska ćuprija terminal	2	15	0
62	55	Minibus	Baščaršija terminal	Sedrenik samoposluga A	5	77	58
62	55	Minibus	Sedrenik samoposluga A	Baščaršija terminal	5	30	41
63	56	Minibus	Latinska ćuprija terminal	Popov gaj	3	63	35
63	56	Minibus	Popov gaj	Latinska ćuprija terminal	3	46	32
64	57	Minibus	Pazarić	Osenik	5	0	1
64	57	Minibus	Osenik	Pazarić	5	4	1
65	58	Minibus	Baščaršija terminal	Mihrivode	1	57	27
65	58	Minibus	Mihrivode	Baščaršija terminal	1	63	31
66	59a	Minibus	Latinska ćuprija terminal	Komatin okretnica	6	128	68
66	59a	Minibus	Komatin okretnica	Latinska ćuprija terminal	6	140	77
67	60	Minibus	Vogošća terminal	Tihovići okretnica	6	21	12
67	60	Minibus	Tihovići okretnica	Vogošća terminal	6	33	14
68	61	Minibus	Stup terminal	Buća Potok	6	147	85
68	61	Minibus	Buća Potok	Stup terminal	5	154	55
69	62	Minibus	Drvenija terminal	Gornji Velesici (HUM)	5	68	49
69	62	Minibus	Gornji Velesici (HUM)	Drvenija terminal	5	67	66
70	63	Minibus	Latinska ćuprija terminal	Mahmutovac	1	7	5

ID	Name	Mode	Start Stop	End Stop	Length (km)	PAX (AM Peak: PAX/h)	PAX (Off-Peak: km/h)
70	63	Minibus	Mahmutovac	Latinska ćuprija terminal	1	12	3
71	64	Minibus	Park terminal	Barice	8	0	0
71	64	Minibus	Barice	Park terminal	9	0	0
72	65	Minibus	Ekonomska škola A	Obad okretnica	3	31	0
72	65	Minibus	Obad okretnica	Ekonomska škola A	3	20	0
73	66	Minibus	Ekonomska škola A	Hum	4	29	22
73	66	Minibus	Hum	Ekonomska škola A	4	30	19
74	67	Minibus	Ekonomska škola A	Bakarevac	2	11	5
74	67	Minibus	Bakarevac	Ekonomska škola A	2	0	14
75	68	Minibus	Sutjeska	Poljine	5	4	2
75	68	Minibus	Poljine	Sutjeska	5	4	8
76	69	Minibus	Sutjeska	Nahorevo	6	78	37
76	69	Minibus	Nahorevo	Sutjeska	6	62	32
77	70	Minibus	Grbavica terminal	Hrasno brdo	2	19	0
77	70	Minibus	Hrasno brdo	Grbavica terminal	2	16	0
78	71a	Minibus	Stup terminal	Dom Paljevska A	11	0	0
78	71a	Minibus	Dom Paljevska A	Stup terminal	11	0	0
79	72	Minibus	Park terminal	Panjina kula	3	56	29
79	72	Minibus	Panjina kula	Park terminal	3	13	23
80	73	Minibus	Vijećnica terminal	Hladivode okretnica	5	40	12
80	73	Minibus	Hladivode okretnica	Vijećnica terminal	5	26	10
81	74	Minibus	Park terminal	Sedrenik Rogina	4	173	89
81	74	Minibus	Sedrenik Rogina	Park terminal	4	153	71
82	75	Minibus	Ilidža terminal	Mokrine	24	0	5
82	75	Minibus	Mokrine	Ilidža terminal	24	0	17
83	76	Minibus	Mokrine	Hadžići B	10	13	0
83	76	Minibus	Hadžići B	Mokrine	10	10	0
84	77	Minibus	Lokve	Pazarić	8	0	0
84	77	Minibus	Pazarić	Lokve	8	0	0
85	78	Minibus	Tarčin terminal	Budmolići	4	5	0
85	78	Minibus	Budmolići	Tarčin terminal	4	10	3
86	79	Minibus	Dupovci A	Ljubovčići	9	0	8
86	79	Minibus	Dupovci A	Ljubovčići	9	10	0
87	80	Minibus	Tarčin terminal	Korča	7	0	1
87	80	Minibus	Korča	Škola H.E.Šarić A	6	5	0
88	81	Minibus	Tarčin terminal	Luke okretnica	3	0	1
88	81	Minibus	Luke okretnica	Tarčin terminal	3	0	0
89	82	Minibus	Hadžići B	Kasatići okretnica	3	7	7
89	82	Minibus	Kasatići okretnica	Hadžići B	3	12	12
90	83	Minibus	Hadžići B	Ušivak I B	2	9	0
90	83	Minibus	Ušivak I B	Hadžići B	2	10	0
91	84	Minibus	Ilidža terminal	Miševići	11	0	11
91	84	Minibus	Miševići	Ilidža terminal	11	3	0
92	85	Minibus	Ilidža terminal	Sinanovići	49	13	0
92	85	Minibus	Sinanovići	Ilidža terminal	49	0	0
93	85a	Minibus	Sinanovići	Trnovo	41	0	0
93	85a	Minibus	Trnovo	Sinanovići	41	0	0
94	89	Minibus	Park terminal	Mrkovići	9	0	0
94	89	Minibus	Mrkovići	Park terminal	9	10	0
95	90	Minibus	Tarčin terminal	Trzanj okretnica	5	0	0
95	90	Minibus	Trzanj okretnica	Tarčin terminal	5	0	2
96	94	Minibus	Vogošća terminal	Gora	11	0	0
96	94	Minibus	Gora	Vogošća terminal	11	0	0
97	95	Minibus	Vijećnica terminal	Brusulje okretnica	6	0	0

ID	Name	Mode	Start Stop	End Stop	Length (km)	PAX (AM Peak: PAX/h)	PAX (Off-Peak: km/h)
97	95	Minibus	Brusulje okretnica	Vijećnica terminal	6	0	0
98	98	Minibus	Latinska ćuprija terminal	Trebević Vidikovac	12	0	0
98	98	Minibus	Trebević Vidikovac	Latinska ćuprija terminal	12	0	0
99	149	Bus	Otoka terminal	Brijesce (Okretaljka)	5	105	96
99	149	Bus	Brijesce (Okretaljka)	Otoka terminal	5	165	161
100	153	Bus	Otoka terminal	Rasima Turkusica 2	4	0	0
100	153	Bus	Rasima Turkusica 2	Otoka terminal	4	0	0
101	155	Bus	Sutjeska	Orahov Brijeg 31	8	0	0
101	155	Bus	Orahov Brijeg 31	Sutjeska	8	0	0
102	180	Bus	Otoka terminal	Sokolje A	7	128	99
102	180	Bus	Sokolje A	Otoka terminal	7	190	151
103	200e	Bus	Baščaršija bezistan	Aerodrom Sarajevo	11	0	101
103	200e	Bus	Aerodrom Sarajevo	Baščaršija bezistan	10	0	122
104	201	Bus	Autobuska stanica	Ilijas	22	203	152
104	201	Bus	Ilijas	Autobuska stanica	21	464	144
105	203	Bus	Autobuska stanica	Raštelica A	36	0	0
105	203	Bus	Raštelica A	Autobuska stanica	36	0	0

Source: JICA Expert Team

A2.4 Counterpart Training on Transport Model

To transfer the knowledge and skills on transport modelling and share the detailed information on the model developed in this project, counterpart training has been conducted in August 2023. The training was scheduled for 5 days. However, it was shortened to 4 days due to the availability of trainees. Trainees learned the transport modelling in general, VISUM software and the outline of the VISUM model developed in this project. Trainees practically operated the VISUM software and the model itself. Some practical questions were raised from trainees such as how to update the model in future.

Table A2.4.1 Schedule of Counterpart Training on Transport Model

Date	Day of Week	Hour	Receiver Name	Course session
28/8/2023	Mon	10:00–12:00	MOT: Benjamin, Osmancevic, Amila Vrbic FOT: Jasmina Sikira	Session 1: Familiar with VISUM software and know its general functionalities
29/8/2023	Tue	10:00–12:00	MOT: Benjamin, Osmancevic, Amila Vrbic FOT: Jasmina Sikira	Session 2: Outline of VISUM model for Canton Sarajevo
30/8/2023	Wed	10:00–12:00	MOT: Benjamin, Osmancevic, Amila Vrbic	Session 3: Hands-on Training with VISUM model for Canton Sarajevo
31/8/2023	Thu	10:00–12:00	FOT: Ajdin Dzananovic, Jasmina Sikira	Session 3: Hands-on Training with VISUM model for Canton Sarajevo

Source: JICA Expert Team


Source: JICA Expert Team

Figure A2.4.1 Photo of the Counterpart Training

Training Material for Session 1: Familiar with VISUM software and know its general functionalities

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan

Training on Transport Modelling

Session 1:Familiar with VISUM software and know its general functionalities

JICA Expert Team
Ministry of Traffic Sarajevo Canton

1. Introduction

- **Why Modelling?**
  - ❑ Help decision-makers in understanding what happens
  - ❑ Identify bottlenecks and shortcomings
  - ❑ Optimize proposals for future use
  - ❑ Predict effects of introducing measures
- **What is its limitations?**
  - ❑ Big uncertainties *COVID-19 Pandemic? Economic Clash?*
  - ❑ Cannot predict individual's behavior / choice
  - ❑ Aggregation of homogeneous population

1

1. Introduction

- **The Four-step model**

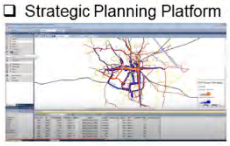
1st	Trip Generation	The number of trips produced from /attracted to a specific zone.
2nd	Trip Distribution	The number of trips between each pair of zones.
3rd	Modal Choice	The number/share of trips made by transport mode.
4th	Traffic Assignment	The number of trip/traffic assigned to the transport network (e.g., road, bus, railway)

Rail

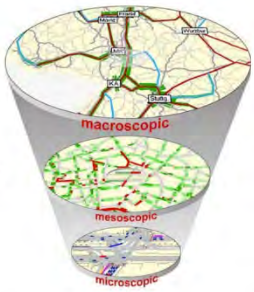
2

1. Introduction

- **VISUM: Macroscopic modelling**
  - ❑ Strategic Planning Platform



- **VISSIM: Microscopic modelling**
  - ❑ Microscopic Traffic & Transit Simulator



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2. VISUM Software

- **What is VISUM?**
  - ❑ macroscopic
  - ❑ multi-modal
  - ❑ GIS-based
  - ❑ traffic planning tool
- **Other similar choices**
  - ❑ TransCAD (https://www.caliper.com/tcovu.htm)
  - ❑ Cube (https://www.bentley.com/en/products/brands/cube)
  - ❑ Emme (https://www.inrosoftware.com/en/products/emme/)

4

2. VISUM Software

- **What VISUM can do?**
  - ❑ to model all private and public transport types (multimode transport planning, e.g. park & ride)
  - ❑ to analyze and plan a transportation system
  - ❑ to support strategic and operational decision making
  - ❑ for visualizing and testing future scenarios

5

2. VISUM Software

- **What VISUM can do for public transport?**
  - ❑ Planning and analysis of line networks
  - ❑ Design and analysis of timetables
  - ❑ Estimation of driver and vehicle requirements
  - ❑ Cost-benefit analyses
  - ❑ Display (graphic/tabular) of PuT-specific indicators (sold tickets number of passengers boarding/alighting, number of students per zone or stop)
  - ❑ Evaluation and display of passenger numbers and other indicators per transport system, link, stop, line, and operator
  - ❑ Creation of presentation graphics to illustrate different planning variants
  - ❑ Calculation and forecast of territory and operator-specific expenditure and revenue indicators
  - ❑ Operational indicators for line costing calculation
  - ❑ Generation of subnetworks with corresponding partial demand matrix

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2. VISUM Software

- **What VISUM can do for public transport?**

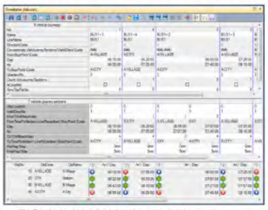
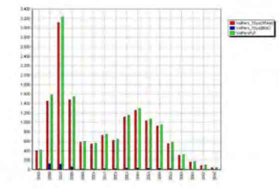
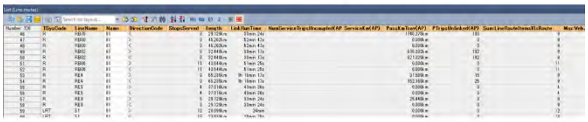


Image 274: Tabular timetable in the default view with vehicle journey items



mage 272: Column charts for time intervals



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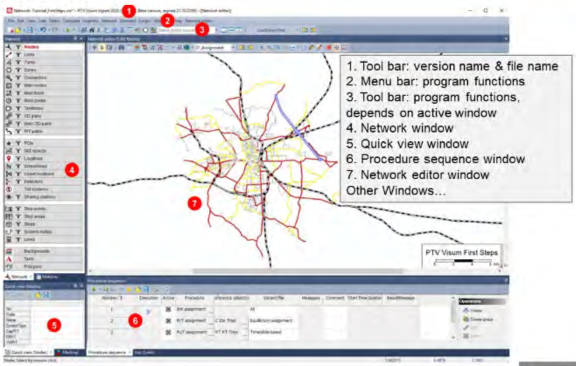
2. VISUM Software

- **Overview**



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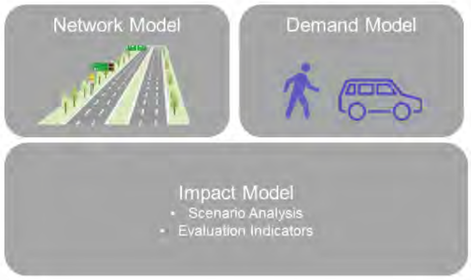
2. VISUM Software

- **Fundamentals of VISUM**
  - ❑ VISUM model consists of network model and demand model.
  - ❑ Impact model defines the indicator and scenario which will be evaluated.



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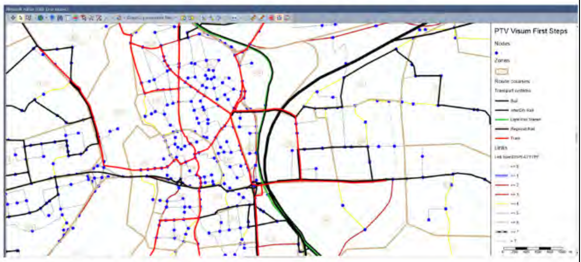
2. VISUM Software

- **Network Model**
  - ❑ The network model stores the transport supply-side. It consists of traffic zones, nodes, links, public transport stops and lines.



Real existing: node, link, stops, lines
Not existing(Imaginary objects): zone, connector

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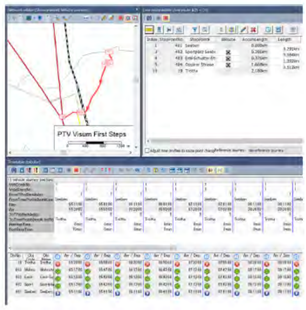
2. VISUM Software

- **Network Model**
  - ❑ Line hierarchy

Example
- ❑ East-west Line
- ❑ Tram Line 1
- ❑ Tram Line 1 Up
- ❑ 5 mins between stops
- ❑ Depart at 7:05AM
- ❑ New tram vehicle



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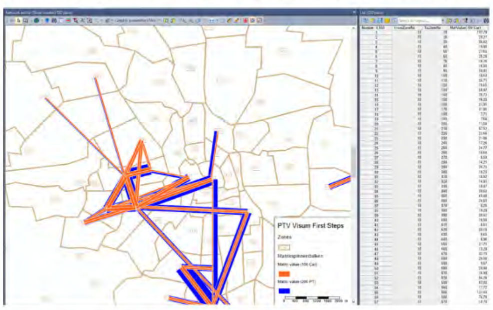
2. VISUM Software

- **Demand Model**
  - ❑ The demand model stores the transport demand-side. It consists of categorized demand group, class, purpose. (e.g. car owner, business trip)



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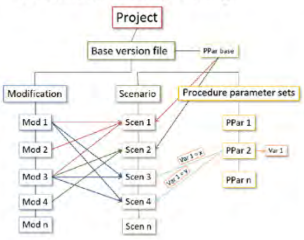
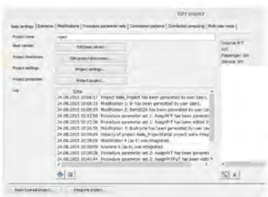
2. VISUM Software

- **Impact Model**
  - ❑ Scenario setting
  - ❑ Demand / Network Modification by Scenario
  - ❑ Evaluation indicator setting





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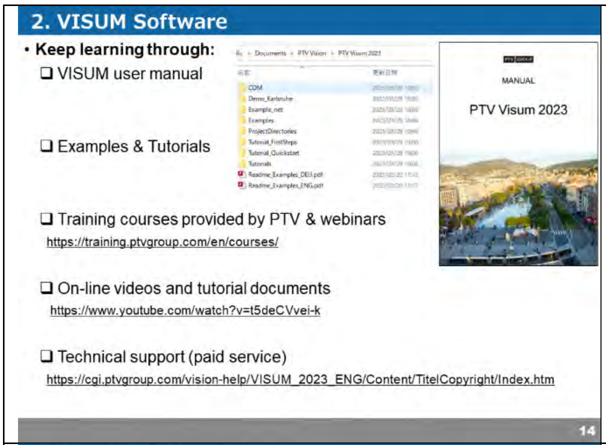
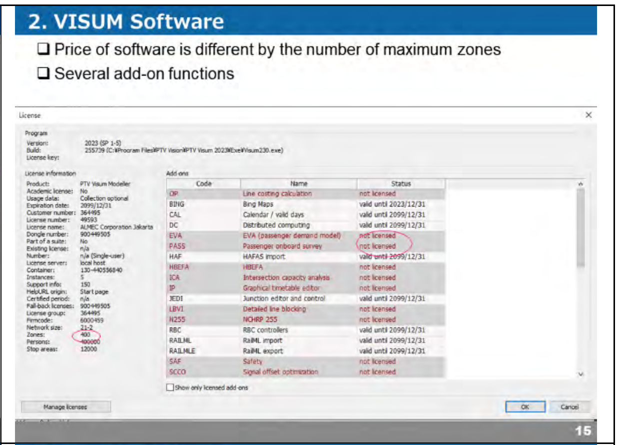
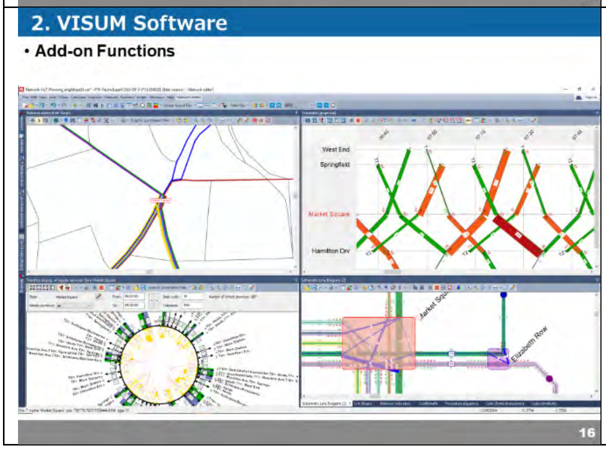
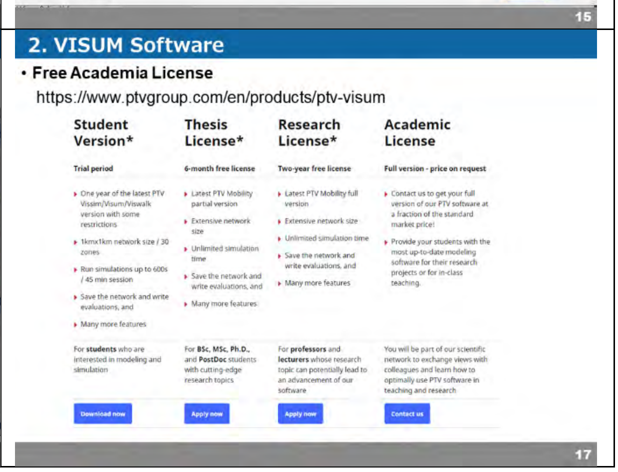
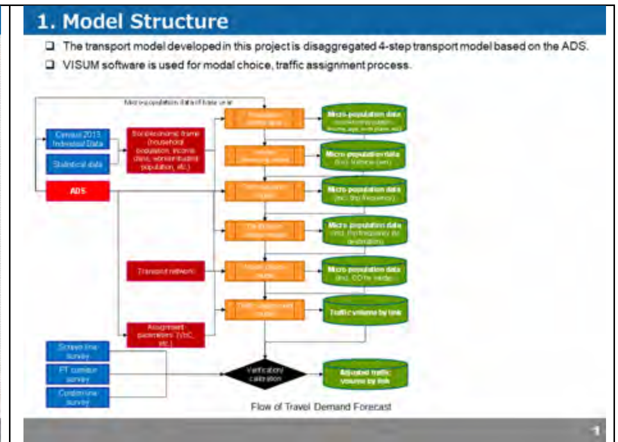


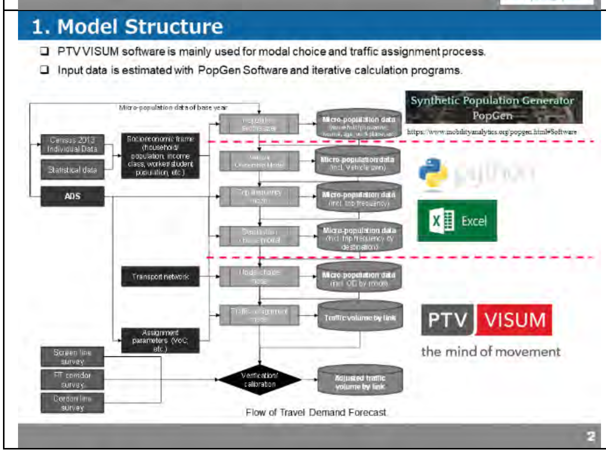


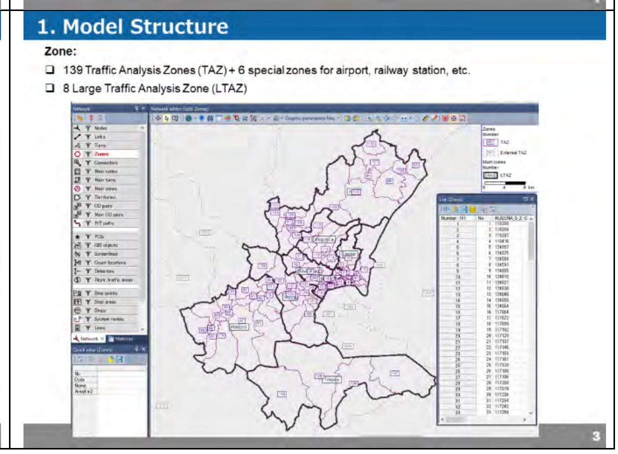




Training Material for Session 2: Outline of VISUM model for Canton Sarajevo

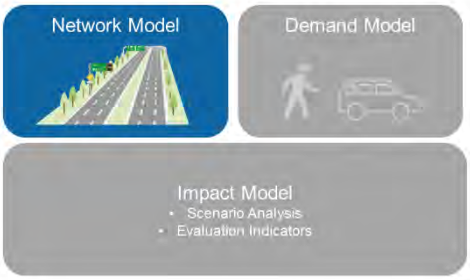






2. Network Model

- **Fundamentals of VISUM**
  - ❑ VISUM model consists of network model and demand model.
  - ❑ Impact model defines the indicator and scenario which will be evaluated.



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2. Network Model

Links:
- ❑ Approximately 30,000 Links

Nodes:
- ❑ Approximately 13,400 Nodes

5

2. Network Model

Links:
- ❑ Every links includes information on types, capacity, free flow speed and direction.
- ❑ Passenger demand on private vehicle users are converted into vehicle demand.

Road Category	Capacity (PCU/hour/lane)	Free Flow Speed (km/h)
1. Footpath	N/A	4
2. Motorway	2,000	110
3. Rural Primary Highway	1,800	60
4. Rural Secondary Highway	1,500	50
5. Rural Arterial	1,200	45
6. Rural Collector	600	40
7. Urban Arterial	1,000	45
8. Urban Collector	600	35
9. Urban Local	300	25

	Name	PCU	Average Occupancy (SLS)
1	Motorcycle	0.4	1.08
2	Passenger Car	1	1.44
3	Taxi	1	1.56
4	Pick Up	1	1.44
5	Small Truck	1	1.44
6	Medium Truck	1.5	1.16
7	Large Truck	2	1.05
8	Small Bus	1.5	8.75
9	Medium Bus	2	21.02
10	Large Bus	3.2	33.87

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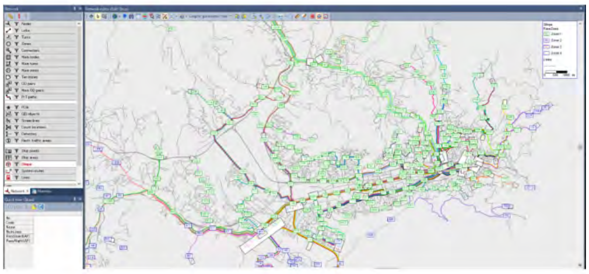
2. Network Model

Lines
- ❑ Approximately 120 Lines (Tram, trolleybus, bus, minibus)

Stops:
- ❑ Approximately 960 Stops



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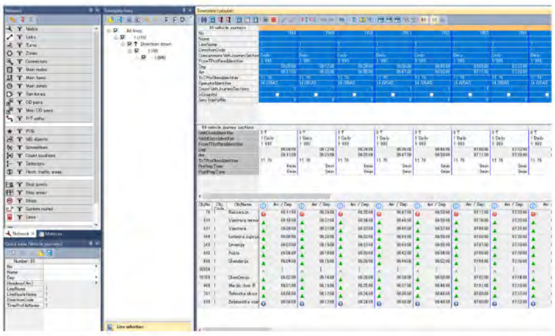
2. Network Model

Timetable
- ❑ Timetables of each line are inputted.



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3. Demand Model

- **Fundamentals of VISUM**
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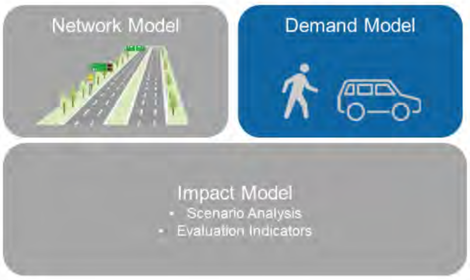
  - ❑ Impact model defines the indicator and scenario which will be evaluated.



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3. Demand Model

- **Transport Systems (TS)**
  - ❑ Transport system is decided considering major transport system in SJJ.

Transport systems | Modes | Demand segments

Group	Number: 15	Code	Name	Type	Modes	DSeg
TS in SJJ Kanton	1	B	Bus	PuT	PuT	PuT
	2	C	Car	PrT	C	C
TS from/to Outer Zone	3	C_B	Cordon Bus	PrT	C_B	C_B
	4	C_C	Cordon Car	PrT	C_C	C_C
	5	C_LT	Cordon Large Truck	PrT	C_LT	C_LT
	6	C_MB	Cordon Minibus	PrT	C_MB	C_MB
	7	C_MT	Cordon Medium Truck	PrT	C_MT	C_MT
	8	C_ST	Cordon Small Truck	PrT	C_ST	C_ST
TS in SJJ Kanton	9	MB	Minibus	PuT	PuT	PuT
	10	MC	Motorcycle	PrT	MC	MC
	11	PrW	Private Walk	PrT	NMT	PrW
	12	PuTW	Public Transport Walk	PuTWalk	PuT	PuT
	13	R	Railway	PuT	PuT	PuT
	14	T	Tram	PuT	PuT	PuT
	15	TB	Trolleybus	PuT	PuT	PuT

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3. Demand Model

- **Demand Matrices**
  - ❑ Trip OD data by trip purpose by vehicle ownership is inputted.
  - ❑ Trip OD data by mode will be calculated in VISUM.

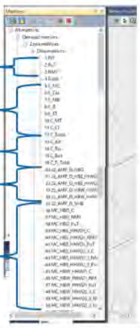
Demand Matrix for private transport(PrT), public transport (PuT) and non-motarized transport (NMT) in person

Demand matrix for motorcycle, car, etc. from/to outside of Sarajevo Kanton in vehicle

Demand matrix for PuT passengers from/to outside of Sarajevo Kanton in person

Demand matrix for trips by purpose by household vehicle ownership in peak hour in 2022

Demand matrix for PrT, PuT, NMT trips by purpose by household vehicle ownership in person



Input data

Calculated data

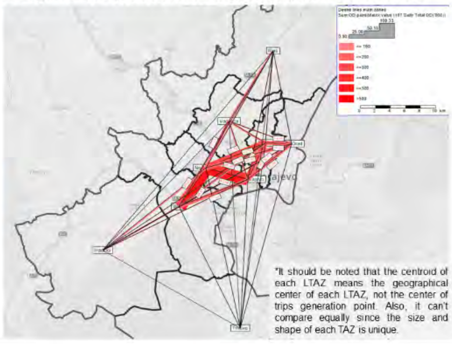
11

3. Demand Model

No	Code	
1	PrT	Demand matrix for private vehicle users in person
2	PuT	Demand matrix for public transport users in person
3	NMT	Demand matrix for non-motorized transport users in person
4	Total	Demand matrix for all modes in person
5	C_MC	Demand matrix for motorcycle from/to outside of Sarajevo Kanton in vehicle
6	C_Car	Demand matrix for sedan from/to outside of Sarajevo Kanton in vehicle
7	C_MB	Demand matrix for minibus from/to outside of Sarajevo Kanton in vehicle
8	C_B	Demand matrix for bus from/to outside of Sarajevo Kanton in vehicle
9	C_ST	Demand matrix for small truck from/to outside of Sarajevo Kanton in vehicle
10	C_MT	Demand matrix for medium truck from/to outside of Sarajevo Kanton in vehicle
11	C_LT	Demand matrix for large truck from/to outside of Sarajevo Kanton in vehicle
12	C_Total	Demand matrix for total number of vehicles from/to outside of Sarajevo Kanton
13	C_Air	Demand matrix for air passengers' access from/to outside of Sarajevo Kanton in person
14	C_Rw	Demand matrix for railway passengers' access from/to outside of Sarajevo Kanton in person
15	C_Bus	Demand matrix for inter-city bus passengers' access from/to outside of Sarajevo Kanton in person
16	C_P_Total	Demand matrix for total number of person from/to outside of Sarajevo Kanton by public transport
30	22_AMP_D_HBO	Demand matrix for home-based work trip in peak hour in person in 2022
31	22_AMP_D_HBS_HHVO1	Demand matrix for home-based school trip whose household doesn't own any car in peak hour in person in 2022
32	22_AMP_D_HBS_HHVO2_3	Demand matrix for home-based school trip whose household owns car in peak hour in person in 2022
33	22_AMP_D_HBW_HHVO1	Demand matrix for home-based work trip whose household doesn't own any car in peak hour in person in 2022
34	22_AMP_D_HBW_HHVO2_3	Demand matrix for home-based work trip whose household owns car in peak hour in person in 2022
35	22_AMP_D_NHB	Demand matrix for non-home-based trip in peak hour in person in 2022
36	MC_HBO_C	Demand matrix for car user for home-based other trip in peak hour in person in 2022
37	MC_HBO_NMT	Demand matrix for non-motorized transport user for home-based other trip in peak hour in person in 2022
38	MC_HBO_PuT	Demand matrix for public transport user for home-based other trip in peak hour in person in 2022
39	MC_HBS_HHVO1_C	Demand matrix for car user whose household doesn't own car for home-based school trip in peak hour in person in 2022
40	MC_HBS_HHVO1_NMT	Demand matrix for non-motorized transport user whose household doesn't own car for home-based school trip in peak hour in person in 2022
41	MC_HBS_HHVO1_PuT	Demand matrix for public transport user whose household doesn't own car for home-based school trip in peak hour in person in 2022
42	MC_HBS_HHVO2_3_C	Demand matrix for car user whose household owns car for home-based school trip in peak hour in person in 2022
43	MC_HBS_HHVO2_3_NMT	Demand matrix for non-motorized transport user whose household owns car for home-based school trip in peak hour in person in 2022
44	MC_HBS_HHVO2_3_PuT	Demand matrix for public transport user whose household owns car for home-based school trip in peak hour in person in 2022
45	MC_HBW_HHVO1_C	Demand matrix for car user whose household doesn't own car for home-based work trip in peak hour in person in 2022
46	MC_HBW_HHVO1_NMT	Demand matrix for non-motorized transport user whose household doesn't own car for home-based work trip in peak hour in person in 2022
47	MC_HBW_HHVO1_PuT	Demand matrix for public transport user whose household doesn't own car for home-based work trip in peak hour in person in 2022
48	MC_HBW_HHVO2_3_C	Demand matrix for car user whose household owns car for home-based work trip in peak hour in person in 2022
49	MC_HBW_HHVO2_3_NMT	Demand matrix for non-motorized transport user whose household owns car for home-based work trip in peak hour in person in 2022
50	MC_HBW_HHVO2_3_PuT	Demand matrix for public transport user whose household owns car for home-based work trip in peak hour in person in 2022
51	MC_NHB_C	Demand matrix for car user for non-home based trip in peak hour in person in 2022
52	MC_NHB_NMT	Demand matrix for non-motorized transport user for non-home based trip in peak hour in person in 2022
53	MC_NHB_PuT	Demand matrix for public transport user for non-home based trip in peak hour in person in 2022
54	MC_O_C	Demand matrix for car user for non-home based trip in peak hour in person in 2022
55	MC_O_PuT	Demand matrix for non-motorized transport user for non-home based trip in peak hour in person in 2022
56	MC_O_NMT	Demand matrix for public transport user for non-home based trip in peak hour in person in 2022

3. Demand Model

- **Estimated LTAZ OD**
  - ❑ Large volume of trips are estimated among Novo Sarajevo, Novi Grad and Ilidza.



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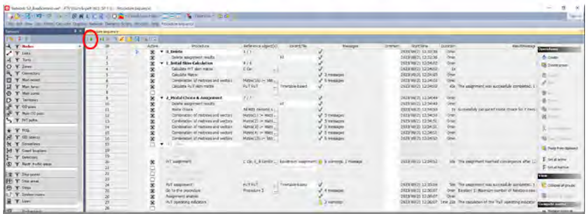
4. Running the Model

Procedure Sequence

- **0 Delete**
  - ❑ Deleting all the assignment results
- **1 Initial Skim Calculation**
  - ❑ To estimate the input data of modal choice model, skims (travel time and cost, etc.) by mode are calculated in advance.
- **2 Modal Choice & Assignment**
  - ❑ With the above-mentioned estimated skims, modal choice model is applied.
  - ❑ Estimated OD by mode is assigned on road network and public transport network.



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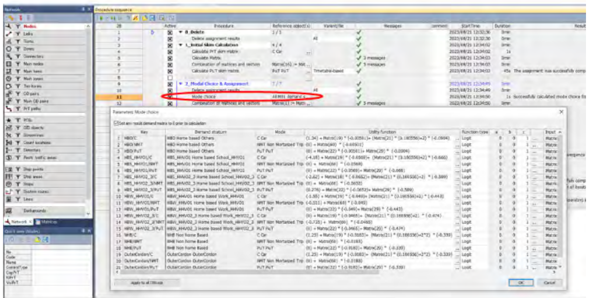
4. Running the Model

Mode Choice

- ❑ Input / output OD data and parameters of modal choice model are defined.
- ❑ Input OD data can be changed for year 2022 and year 2036.



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4. Running the Model

- **Modal Choice Model**
  - ❑ 3-item choice model was employed, namely Non-motorized Transport (NMT), Private Vehicle (PV) and Public Transport (PuT).
  - ❑ The explanatory variables of the model are **total travel time**, **total travel cost** and constants for each choice.
  - ❑ Model parameters for HBW and HBS trips were estimated for households with car ownership (HHVO=2,3) and for households without car ownership (HHVO=1) separately.
  - ❑ PuT trip will be divided into tram, bus and trolleybus users through the next assignment process.

$$P_i = \frac{\exp(V_i)}{\sum_i \exp(V_i)}$$

P_i : Probability of modal choice i
V_i : Utility function of modal choice i

Utility Function of Modal Choice Model (HBW)

Mode	Utility Function
A1_NMT	V1 = ASC_NMT * one + B_TIME * T_NMT + B_COST * C_NMT
A2_PV	V2 = ASC_PV * one + B_TIME * T_Car + B_COST * C_Car
A3_PuT	V3 = ASC_PuT * one + B_TIME * T_PuT + B_COST * C_PuT

Note: B_Time, B_Cost: Estimated parameters
T_X: Total travel time in minutes when travelling by travel mode X
B_X: Total travel cost in BAM when travelling by travel mode X
Utility Function is differed by trip purpose and car ownership

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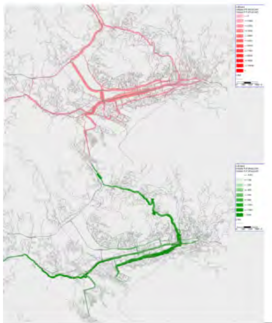
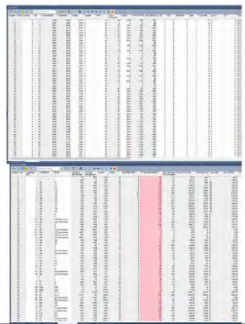
5. Impact Model

Confirming the Assignment Result

- ❑ Traffic volume can be confirmed by link and by line routes.





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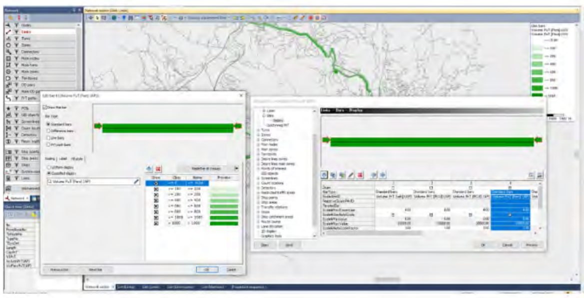
5. Impact Model

Confirming the Assignment Result

- ❑ Graphic parameter can be changed.



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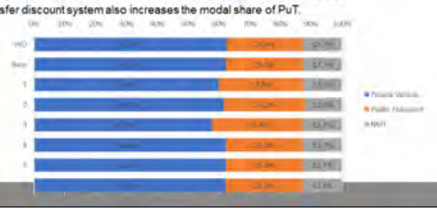
5. Impact Model

- Scenario Analysis
  - ❑ In total, 8 scenarios were analyzed for base year, 2022.

Improvement Policy and Projects	Scenario							
	WO*	Base	1	2	3	4	5	6
Tram Track Rehabilitation		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Renew Trolleybus Vehicle		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Renew Tram Rolling Stocks		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transfer Discount (50% discount)			Yes					
Distance Based Fare (0.8 + 0.27 BAM/km)				Yes				
Low Emission Zone (Car trip in LEZ reduce 19%)					Yes			
Minibus High Frequency (Double frequency)						Yes		
Minibus Limited-Service (Deleting low frequency route)							Yes	
Improved Operation Plan proposed by TRAMODE								Yes

- Estimated Modal Share (AM Peak hour) by Scenario
  - ❑ Low Emission Zone (S3) brings largest impact on Public Transport (PuT).
  - ❑ Transfer discount system also increases the modal share of PuT.



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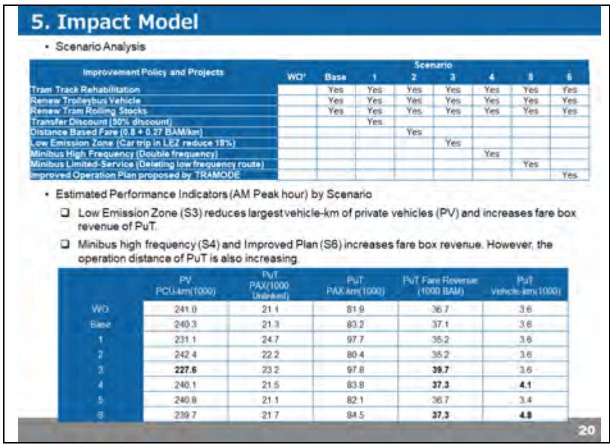

5. Impact Model

- Scenario Analysis

Improvement Policy and Projects	WO*	Base	1	2	3	4	5	6
			Scenario					
Tram Track Rehabilitation		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Renew Trolleybus Vehicle		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Renew Tram Rolling Stocks		Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transfer Discount (50% discount)			Yes					
Distance Based Fare (0.8 + 0.27 BAM/km)				Yes				
Low Emission Zone (Car trip in LEZ reduce 15%)					Yes			
Minibus High Frequency (Double frequency)						Yes		
Minibus Limited-Service (Deleting low frequency route)							Yes	
Improved Operation Plan proposed by TRAMODE								Yes

- Estimated Performance Indicators (AM Peak hour) by Scenario
  - ❑ Low Emission Zone (S3) reduces largest vehicle-km of private vehicles (PV) and increases fare box revenue of PuT.
  - ❑ Minibus high frequency (S4) and Improved Plan (S6) increases fare box revenue. However, the operation distance of PuT is also increasing.

	PV PCU-km(1000)	PuT PAX(1000 Unlinked)	PuT PAX-km(1000)	PuT Fare Revenue (1000 BAM)	PuT Vehicle-km(1000)
WO	241.0	21.1	81.9	36.7	3.6
Base	240.3	21.3	83.2	37.1	3.6
1	231.1	24.7	97.7	35.2	3.6
2	242.4	22.2	80.4	35.2	3.6
3	**227.6**	23.2	97.8	**39.7**	3.6
4	240.1	21.5	83.8	**37.3**	**4.1**
5	240.8	21.1	82.1	36.7	3.4
6	239.7	21.7	84.5	**37.3**	**4.8**

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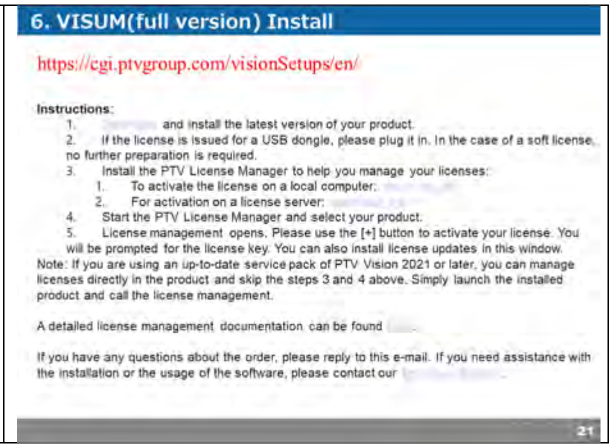

6. VISUM(full version) Install

https://cgi.ptvgroup.com/visionSetups/en/

Instructions:

1. and install the latest version of your product.
2. If the license is issued for a USB dongle, please plug it in. In the case of a soft license, no further preparation is required.
3. Install the PTV License Manager to help you manage your licenses:
   1. To activate the license on a local computer:
   2. For activation on a license server:
4. Start the PTV License Manager and select your product.
5. License management opens. Please use the [+] button to activate your license. You will be prompted for the license key. You can also install license updates in this window.

Note: If you are using an up-to-date service pack of PTV Vision 2021 or later, you can manage licenses directly in the product and skip the steps 3 and 4 above. Simply launch the installed product and call the license management.

A detailed license management documentation can be found

If you have any questions about the order, please reply to this e-mail. If you need assistance with the installation or the usage of the software, please contact our

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Training Material for Session 3: Hands-on Training with VISUM Model for Canton Sarajevo

Project for Formulation of Sarajevo Public Transport Management and Operation Capacity Development Plan

Training on Transport Modelling

Session 3: Hands-on Training with VISUM model for Sarajevo Kanton

Case Study for adding new public transport

JICA Expert Team
Ministry of Traffic Sarajevo Canton

1. Creating/Editing Network Objects

Network Editing Overview

- Networks can be created or edited by two following modes:
  1. Create mode icon, use to add new network objects (i.e., nodes, links, public transport stops ad lines, etc.).
  2. Edit mode icon, use to modify existing network objects.
- Network objects can be selected by three following modes:
  1. Single selection icon: point and click on the object in the network window
  2. Multiple selection icon: CTRL + point and click on multiple objects
  3. Spatial selection icon: freehand/territory polygon selection of multiple objects.

1

1. Creating/Editing Network Objects

- **Creating new network objects**
  - ❑ The existing network model sometime is needed to be adjusted to represent the actual ground situation.
  - ❑ The creation of new nodes and links are mostly required.
  - ❑ Link connect any start point to end point in the network model.
    1. Create new link
    2. Set properties for new link (e.g., speed, Type, number of lane, etc.)

2

2. Public Transport Objects

- **Create public transport stops:**

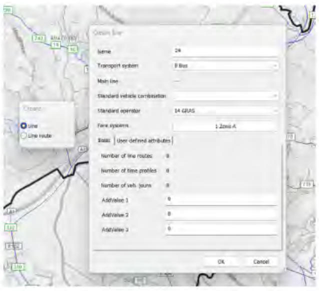
- ❑ Create new stop point (on link or node), stop area, and stop
- ❑ Give basic attributes: name, transport system, cost, and time profiles

3

2. Public Transport Objects

- **Create new line:**

In public transport line routes:
- ❑ Line refers to the overall container with primary route identifier (e.g., Bus line no. 24)
- ❑ Line route refers to the course and direction of the transit line (e.g., Bus line no. 24_1, direction up)

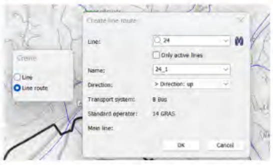


1. Create new bus line
2. Gives information such as name, transport system, operator, fare zone, etc.)

4

2. Public Transport Objects

- **Create new line route:**

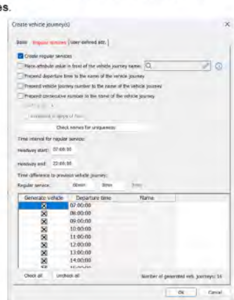


1. Create new line route
2. Allocated to line route to the corresponding line
3. Choose Direction then click OK
4. Draw the line route from departure to the destination bus stop.

5

2. Public Transport Objects

- **Create vehicle journeys:**
  - ❑ In the timetable window, use the vehicle journey creating tool
  - ❑ In the regular serviced, assign the departure time in the headway start and headway end.
  - ❑ Define the time interval between each departures.



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- **Practice:**
  1. Editing network objects:
     - Create some nodes and links
     - Editing the links attribute (transport system type, lane, Vo PrT)
     - Create new bus line and vehicle journey with service hour from 6:30 to 22:30, time interval for each trip is 30 minutes)

7

A3 Manual for Public Transport Planning and Operations

A3.1 Operations Planning and Monitoring

A3.1.1 Route Planning

1) General Conditions of Routes

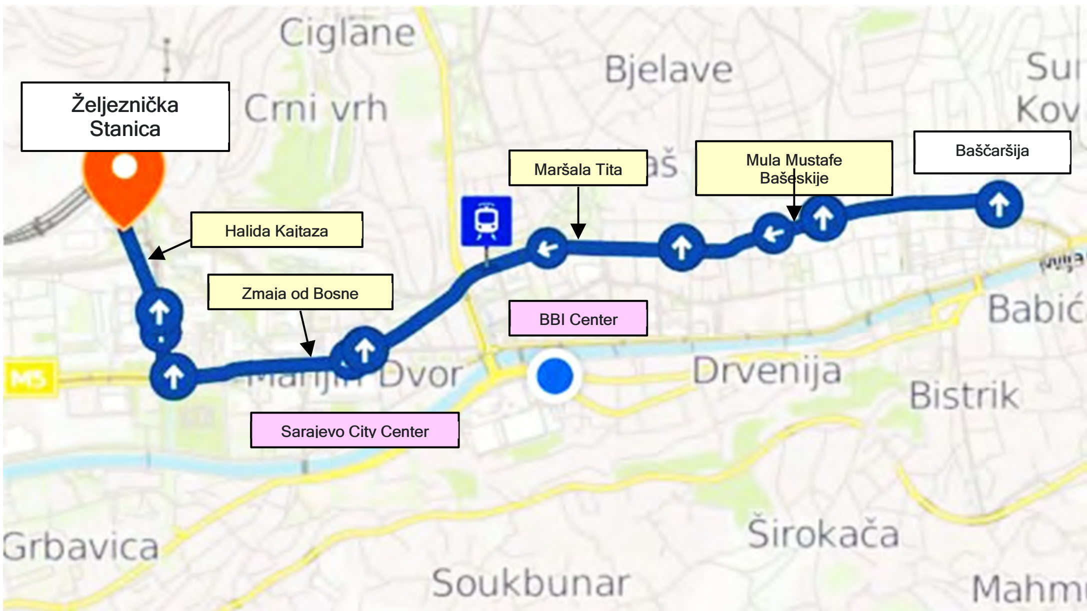
(1) Objectives

- Documentation of route conditions for transfer of knowledge to any parties operating the service route.
- Use of drawings to understand detailed route conditions and facilities (see sample in Figure A3.1.1).

(2) Input Data

- Route number or name
- Start & endpoints
- Road names
- Major landmarks (employment, shopping, hospital, tourism, etc.)
- Transport nodes (railway, inter-city station, etc.)

Route [number or name]



Source: JICA Expert Team

Figure A3.1.1 Sample route map with start/end points, road names and landmarks

(3) Route details in both directions

- Useful format for programming into passenger information display systems (see Figure A3.1.2).

<u>Route Details</u>

Table A3.1.1 Sample Route Details

Forward	From Baščaršija via Mula Mustafe Bašeskije, Maršala Tita, Zmaja od Bosne, Halida Kajtaza and Željeznička Stanica. Forward Distance: 3.1 km
Return	Return via Halida Kajtaza, Zmaja od Bosne, Hiseta, Obala Kulina bana, Telali and Baščaršija. Return Distance: 3.8 km
Round Trip Distance: 6.9 km	

Source: JICA Expert Team

Source: JICA Expert Team

Figure A3.1.2 Passenger Information Display Systems

(4) Stopping Points

- Every stopping point should be assigned a unique stop ID to facilitate data collection for operations monitoring.
- Timing points can be assigned at locations where service reliability is more important, such as major points of high boarding/alighting.

Table A3.1.2 Sample Route List of Stopping Points

Stop ID	Timing Point	Road Name	Stop Description
00000	Yes	Halida Kajtaza	Željeznička Stanica
00000		Halida Kajtaza	Tehnička Škola
00000		Zmaja od Bosne	Muzeji
00000		Hiseta	Marijin Dvor
00000	Yes	Obala Kulina bana	Skenderija
00000		Obala Kulina bana	Pošta
00000		Obala Kulina bana	Drvenija
00000		Obala Kulina bana	Latinska ćuprija
00000		Telali	Vijećnica
00000	Yes	Telali	Baščaršija
00000		Mula Mustafe Bašeskije	Katedrala
00000		Maršala Tita	Banka
00000	Yes	Maršala Tita	Park
00000		Zmaja od Bosne	Marijin Dvor
00000		Zmaja od Bosne	Muzeji
00000		Halida Kajtaza	Tehnička Škola
00000	Yes	Halida Kajtaza	Željeznička Stanica

Source: JICA Expert Team

2) Service Specifications

(1) Service frequency and timetables

- In bus contracts worldwide, the authority typically defines minimum service levels for the operator to prepare the timetables based on them. This is outlined in the prescribed service specifications in the example below.

Table A3.1.3 Sample Route Frequency and Trips Table

Period	Scheduled Frequency from [name of origin terminal]	Minimum Number of Scheduled Trips
First trip departure at 0608		
0608 – 0756	Every 12 min	10
0813 – 1046	Every 17 min	10
1103 – 1320	Every 16–17 min	10
1332 – 1520	Every 12 min	10
1532 – 1746	Every 17 min	10
1803 – 2036	Every 34 min	10
2053 – 2218	Every 17–34 min	4
Last trip departure no earlier than 2218		
Total minimum number of scheduled trips		64

Source: JICA Expert Team

- Similar tables are produced for other directions, other days of the week, or other seasons, as appropriate.
- However, it is understood that MOT, as in which it is prescribed by law, currently defines the timetables for bus routes tendered to new operators rather than defining service levels for the operator to prepare the timetables.
- Therefore, the above methodology may be adapted to the specific situation in Canton Sarajevo to be described as follows.

Table A3.1.4 Sample Line Timetable

Departures for [Mode] line number [number]: [name of origin terminal] to [name of destination terminal]									
From [name of origin terminal]									
6:08	6:20	6:32	6:44	6:56	7:08	7:20	7:32	7:44	7:56
8:13	8:30	8:47	9:04	9:21	9:38	9:55	10:12	10:29	10:46
11:03	11:20	11:37	11:54	12:11	12:28	12:44	12:56	13:08	13:20
13:32	13:44	13:54	14:08	14:20	14:32	14:44	14:56	15:08	15:20
15:32	15:44	15:56	16:08	16:21	16:38	16:55	17:12	17:29	17:46
18:03	18:20	18:37	18:54	19:11	19:28	19:45	20:02	20:19	20:36
20:53	21:10	21:44	**22:18**						
Number of Departures: 64									

Source: JICA Expert Team

- The timetable above corresponds to the exact service specifications in Table A3.1.3
- Similar tables are likewise produced for other directions, other days of the week, or other seasons, as appropriate.

(2) Service Headway & Occupancy

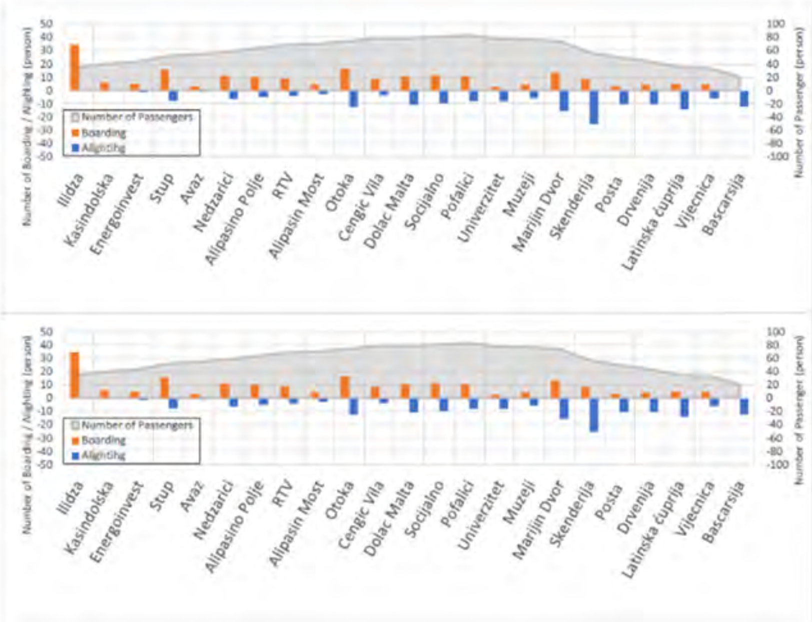
- To derive the service frequency and timetables, Table A3.1.5 provides some guidelines for service headway & occupancy that can be considered.
- The main consideration is the occupancy at the maximum load points of the service route using passenger counts.
- Determine the capacity needed for the service, for example, tram and trolleybus may require fewer trips than a normal bus or minibus, which need more trips to provide the same capacity.

Table A3.1.5 Guidelines to determine Service Frequency & Timetables

Parameters	Criteria	Measurement
Minimum headway or number of trips measured at maximum load points (Figure A3.1.3) Occupancy at maximum load points	Headway or number of trips provided should ensure: • Average occupancy during the peak 1-hour not exceeding X%. • Adequate number of trips to avoid long waiting time even though service loading is well below target utilization. High Frequency Services • Maximum headway should be within __ minutes during peak hours and __ minutes during off-peak hours. Low Frequency Services • Headway to be considered case-by-base in view of the low utilization. • An appropriate maximum headway should be defined.	Day of week • Weekday • Saturday • Sunday/Public Holiday Time of day • AM Peak • Day Off-Peak • PM Peak • Night Off-Peak Passenger counts Vehicle licensed capacity (seating + standing)

Source: JICA Expert Team

- To provide sufficient capacity so passengers can board the first arriving vehicle, occupancy (total passengers / total capacity) should be lower than X (seating capacity + 25% of standing capacity) / total capacity, where total capacity is the summation of seating capacity and standing capacity. This should allow most passengers to board the first bus to arrive when the scheduled interval between buses is every ten minutes or more. When the interval is less than this, passengers should normally be able to board within ten minutes of arriving at their stop.
- The value of X is set at 70% in the example of the calculation of vehicle requirements in A3.1.4 Operation plan to vehicle & personnel allocation.
- High- and low-frequency services will be discussed in 1.3 Structuring the Public Transport Network.



Source: JICA Expert Team

Figure A3.1.3 Load Profile & Maximum Load Point

(3) First & Last Service Timing

- Determined generally in line with operating hours of essential services.
- They can be decided based on ridership or coverage.
- The main purpose is to provide first and last-mile connectivity to/from the nearest transport nodes.

Table A3.1.6 Guidelines to determine First and Last Service Timing

Parameters	Criteria	Measurement
First trip leaving start terminal or specific stopping point. Last bus leaving start terminal or specific stopping point.	Generally aligned to operating hours of essential services. Ridership (demand-based) or coverage (supply-based) Provide first/last mile connectivity to/from transport nodes.	Scheduled departure time at terminals and stopping points. Timetables at stations and stopping points. GPS time stamp at bus stops. Vehicle arrival/departure time surveys.

Source: JICA Expert Team

- Last buses should not depart major attraction centers earlier than midnight.
- The times of first and last trains at rail interchanges must be considered in setting the times of early and late journeys.
- For special late events generating extra demand, additional or special services should be considered, in line with expected demand and efficient use of available funds.

(4) Run Times

- Together with layover and meal breaks, discussed in the Manual for

Vehicle/Personnel Allocation, the run times determine the turnaround time for a service, which will affect the number of vehicles/drivers needed.

- Two types of run time, as described in Table A3.1.7, need to be considered.

Table A3.1.7 Guidelines to determine Run Times

Parameter	Definition/Criteria	Measurement
On-Service Run Time	Journey time for operation of a trip carrying fare-paying passengers between any two points.	Test runs and surveys along other existing routes.
Off-Service Run Time	Operation time for vehicles to travel between depots and start/end terminals, as well as to travel empty between designated locations during on-service hours.	As above.

Source: JICA Expert Team

- A good practice for timetable creation is to have run times split into sectors between timing points over different times of the day, as shown in Table A3.1.8.

Table A3.1.8 Run Times by Sector and Time Period

Time Period	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Sector 7	Total
06:30-06:59	15	16	16	15	16	16	15	109
07:00-07:29	16	17	17	16	17	17	16	116
07:30-07:59	17	18	18	17	18	18	17	123
08:00-08:29	16	17	17	16	17	17	16	116

Source: JICA Expert Team

- Total run time for a trip starting between 06:30–06:59 = 116 mins

  (adding shaded cells)

- Total run time for a trip starting between 06:30–06:59 is not 109 minutes

  (adding across first row)

- For example, a trip that starts at 06:30 upon completing Sectors 1 & 2 would already incur 31 mins run time (15+16) at time 07:01, therefore Sectors 3 & 4 should use the run times of the next time period of 07:00-07:29. Likewise, upon completing Sectors 3 & 4, the run times of the next time period 07:30-07:59 should be used for Sectors 5 & 6.

3) Structuring the Public Transport Network

As discussed in 1.2 Service Specification – Service Headway & Occupancy, the public transport network consists of high-frequency services that form the backbone of the public transport network and the low-frequency services that provide additional first/last mile coverage to complement the high-frequency services.

(1) High-Frequency Services

- Justified by demand, high-frequency services allow passengers to use them without consulting a timetable, with the ability to "appear-and-go."
- Service frequencies are set to provide adequate capacity at the busiest times and

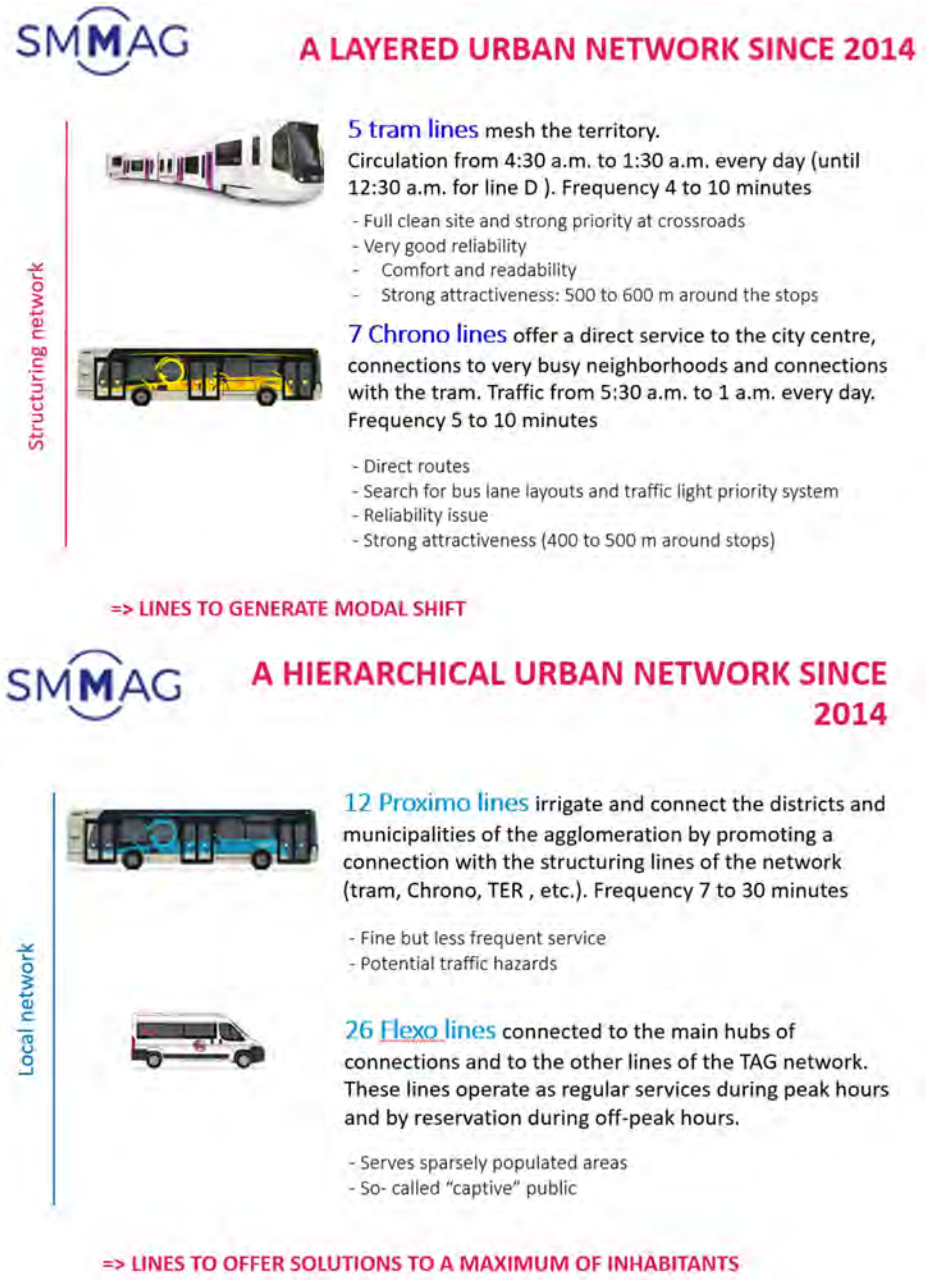
places.

- Has sufficient demand to support a maximum headway of 10 minutes.
- Key drivers in the public transport network to generate a modal shift from private transport.

(2) Low-Frequency Services

- Justified by coverage to provide first and last-mile connectivity with outlying areas in order to maximize the number of inhabitants served.
- Usually operated with clockface timetables for familiarity.
- Feeds to the nearest transport hub to connect to high-frequency services.

(3) Examples from Third Country Training Cities



Source: SMMAG

Figure A3.1.4 Urban Network Structure in Grenoble, France

A3.1.2 Route Management

1) Establishment of operation standards

(1) Objective:

- Set minimum acceptable standards for reliability, route performance, frequency and occupancy as the basis for service performance and satisfaction levels.
- Calibrated to be representative of the commuter experience.

(2) Possible standards for service reliability:

- % of scheduled trips/mileage operated (daily/monthly).
- % of trips that are on-time at timing points (daily/monthly).
- With stricter criteria for the first and last trip.

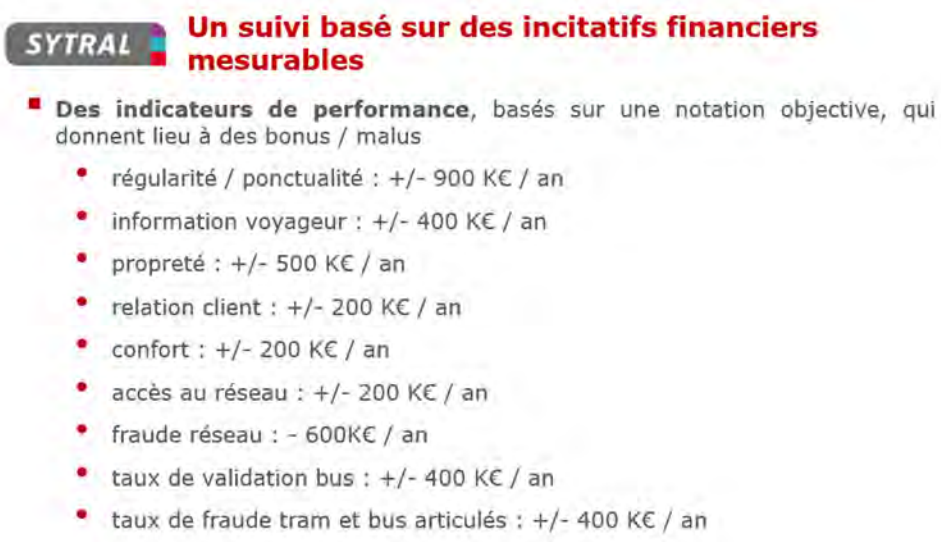
(3) Possible Incentives and Deductions for operator / route performance:

- Incentive of ___ per month for 100% operated trips.
- Deduction of ___ per month for <__% operated trips monthly.
- Incentive of ___ per month for >__% on-time adherence.
- Deduction of ___ per month for >__% on-time adherence

(4) Possible standards for service frequency & occupancy:

- __% of services having scheduled frequency of __ minutes during the peak hours and off-peak hours.
- Can be separated into main routes and feeder routes.
- Bus occupancy should not exceed:
    - __% for not more than __% of the trips.
    - An average of __% during the peak __hours.

(5) Examples from Third Country Training Cities



Source: Sytral

Figure A3.1.5 Performance Incentives/Penalties for SYTRAL in Lyon, France

2) Policy of setting bus stops

(1) Objective:

- Balance between accessibility and travel speed of public transport services.

(2) Main considerations:

- Site conditions/design capacity.
- Number of passengers.
- Accessibility via walking and routes passing through.

(3) Input Data:

- Number of passengers boarding/alighting from Passenger surveys and reports from e-payment systems.
- Public transport vehicle volume.
- Walkability studies.

(4) Possible criteria:

- Minimum spacing between stopping points (typically >300m).
- Number of passengers boarding/alighting per hour at least __ for __% of the time.
- Vehicle volume not exceeding __ per hour during peak periods, determined by the number of trips and passengers boarding / aligning at the stop.
- Dwell time not exceeding __ mins per trip from arrival to departure at the stop.
- Walkability score.
- Estimated benefits (e.g., net present value of estimated time savings) must justify _% of the investment.

3) Environment for transfers

(1) Objective:

- Minimize duplication by having direct service routes between every destination.

(2) Possible Measures:

- Infrastructural improvements
- Relocation of stops near junctions
- Route modifications to allow same-stop transfers
- Timetable coordination
- Multi-modal hubs

(3) Infrastructural Improvements

- Expand capacity or modify stop design to accommodate more passenger waiting space (Figure A3.1.6).
- This concept may be applied to enhance transfer points such as Trg Austrije / Latinska Ćuprija (Figure A3.1.7), Baščarsija (Figure A3.1.8) and Vijećnica.

Before After

Source: www.channelnewsasia.com

Figure A3.1.6 Examples of Typical Bus Stop Enhancements in Singapore

Source: www.scribblemaps.com

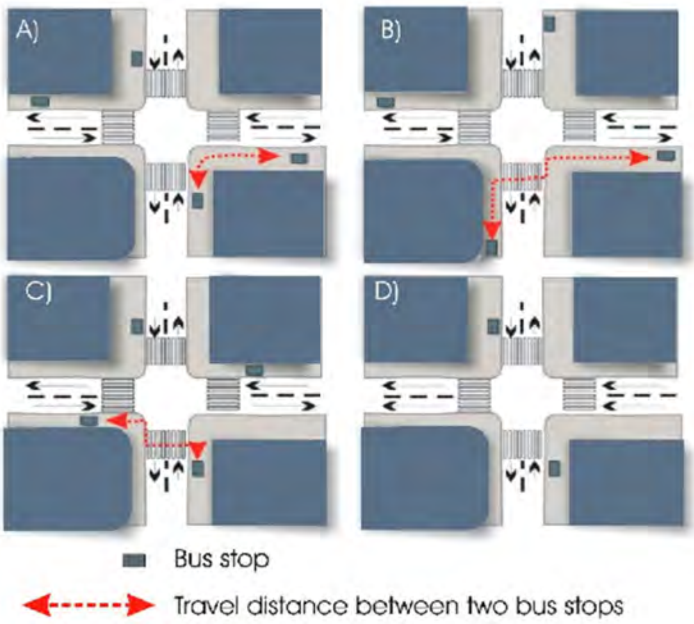
Figure A3.1.7 Schematic Map of Trg Austrije / Latinska Ćuprija

Source: www.scribblemaps.com

Figure A3.1.8 Schematic Map of Bašćarsija

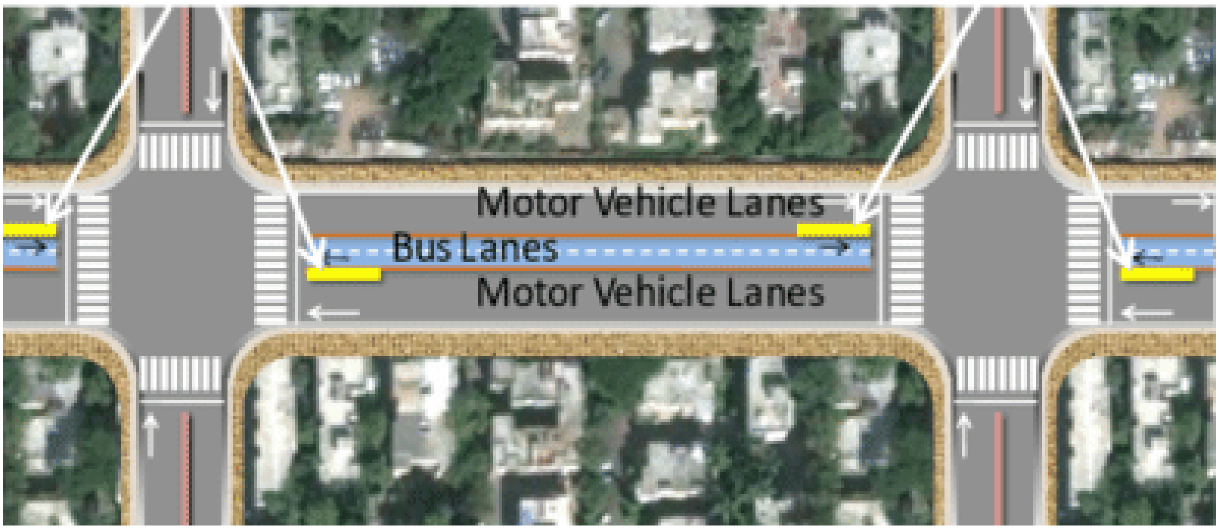
(4) Relocation of stops near junctions

- Facilitate transfers between routes that cross each other at major junctions (Figure A3.1.9 and Figure A3.1.10) as follow:
    - Reduced walking distances for passengers transferring between routes.
    - Stops near junctions are often more visible and easier for passengers to find as they are typically located in areas with higher pedestrian traffic.
- This concept may be applied to enhance transfer points such as Pofalići (Figure A.1.11) and Nedžarići.



Source: www.mdpi.com

Figure A3.1.9 Example for buses/trolleybuses



Source: Gandhi, S (2013). Comparative Evaluation of Alternate Bus Rapid Transit System (BRTS) Planning, Operation and Design Options. Figure 2.

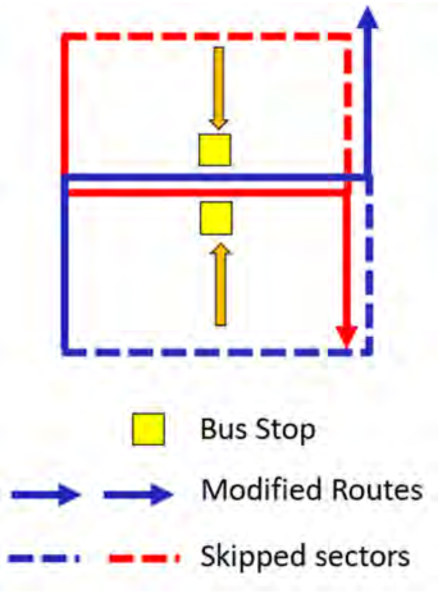
Figure A3.1.10 Example for trams

Source: www.scribblemaps.com

Figure A3.1.11 Pofalici Transfer Point

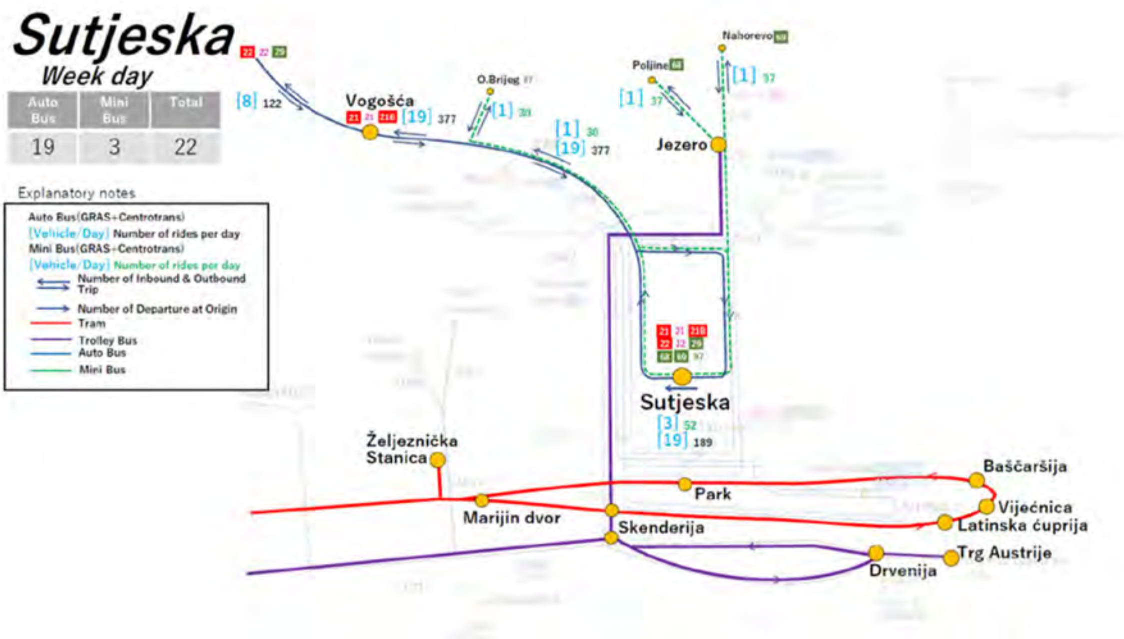
(5) Route modifications to allow same-stop transfers

- Routes adjustments (Figure A3.1.12) can be considered to facilitate such connection, such that the bus stops could be moved as shown in the orange arrows to allow connections between the blue and red routes.
- Bus stops must have sufficient capacity to allow transfers.
- Minimize the number of passengers along skipped sectors.
- This may be applied to enhance connectivity between buses at Sutjeska and the tram network (Figure A3.1.13).



Source: JICA Expert Team

Figure A3.1.12 Route Modifications

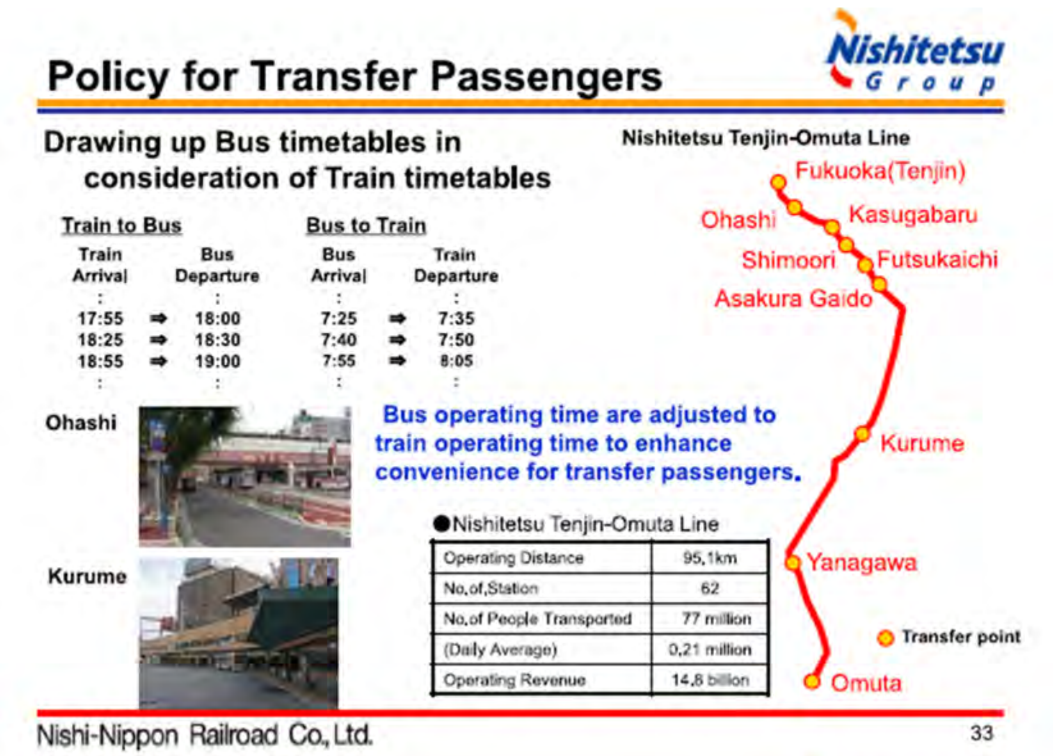


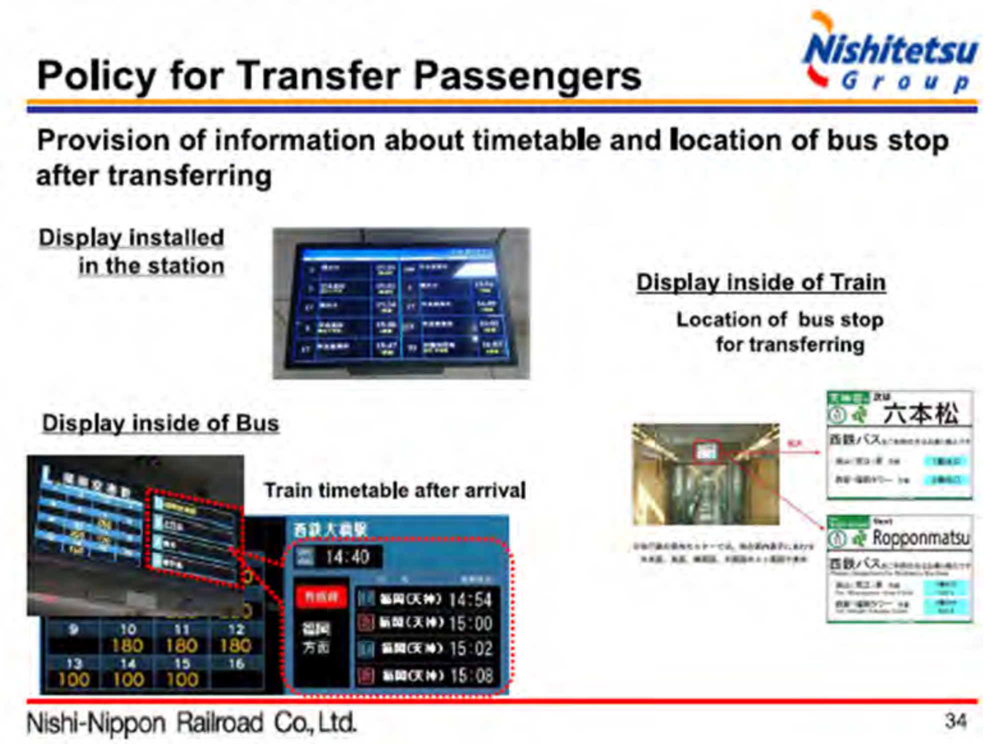
Source: GRAS

Figure A3.1.13 Operation Map of the Routes Connecting to Sutjeska

(6) Timetable coordination

- Where several services run together along sections of the road, then wherever possible, their timetables should be coordinated. This is also particularly useful in bus/rail transfers.
- This arrangement should be well publicized so users can plan their journey.
- An example in Fukuoka, Japan is shown in Figure A3.1.14 below.





Source: Nishitetsu

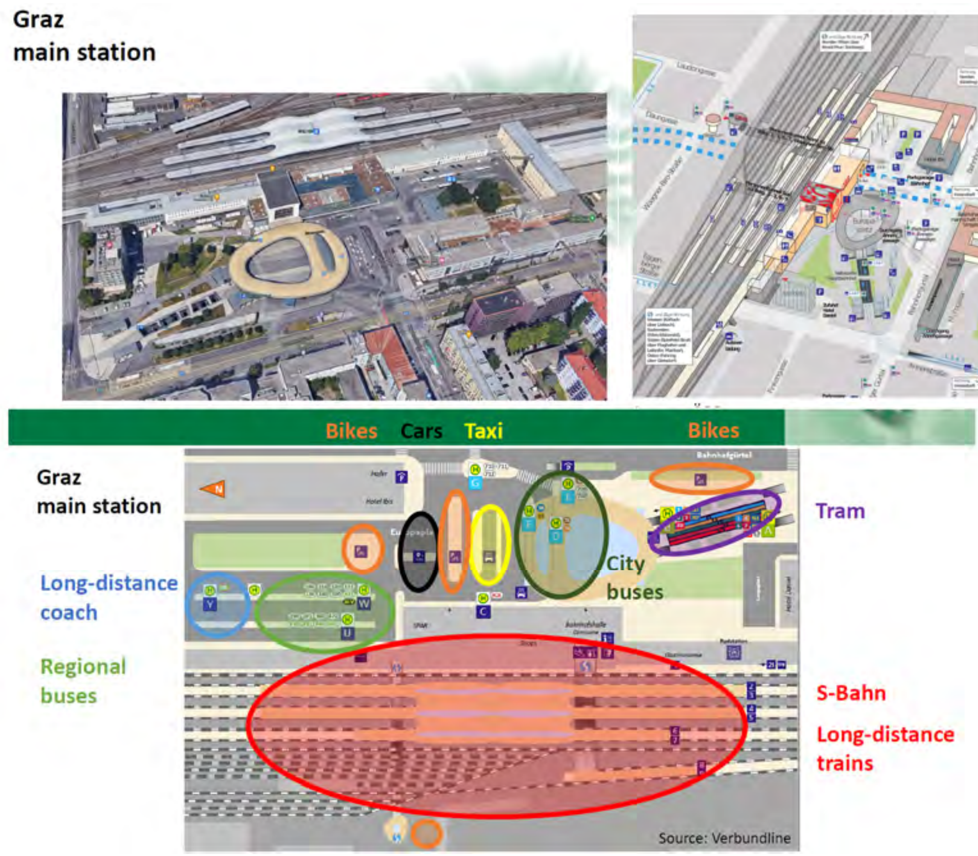
Figure A3.1.14 Policy for Transfer Passengers in Fukuoka, Japan

(7) Multi-modal hubs

- These are designed to facilitate transfer between different transport modes as safely and as seamlessly as possible by having them in close proximity and sheltered from the outdoor elements.
- They primarily aim to improve connectivity, reduce travel time, enhance passenger experience, and promote sustainable transportation, thereby minimizing traffic

congestion and optimizing the use of transportation infrastructure.

- Coordination of timetables for different modes, as discussed in 2.9, can further enhance connectivity.
- An example at Graz, Austria (Figure A3.1.15) can be applied to Sarajevo Railway Station (Figure A3.1.16), which serves as the only long-distance transportation hub for the city.



Source: OBB

Figure A3.1.15 Multi-modal hub at Graz, Austria

Source: www.scribblemaps.com

Figure A3.1.16 Sarajevo Railway Station

4) Installation of facilities

(1) Objective:

- Part of the route documentation process to identify areas for an operator taking over the route to be aware of and work with necessary agencies to resolve.

(2) Bus/Tram/Trolleybus Stops

- See Table A3.1.9 and Figure A3.1.17 for examples of input data and information required to maintain a bus/tram/trolleybus stops database.

Table A3.1.9 Bus/Tram/Trolleybus Stops Information

Input Data	Examples of Information
Stop ID	00000
Location Map	Schematic layout
Service Routes	Route numbers using the stop
Road Conditions	Photos of the area
Street Parking	Yes/No
Safety Management Problems	e.g. Blind spots, Private vehicles stopping, etc.
Availability of Bulletin Board Space	Yes/No

Source: JICA Expert Team

Source: JICA Expert Team, various sources

Figure A3.1.17 Bus/Tram/Trolleybus Stops Information

(3) Bus/Tram/Trolleybus Stations

- See Table A3.1.10 and Figure A3.1.18 for examples of input data and information required to maintain a bus/tram/trolleybus stations database.

Table A3.1.10 Bus/Tram/Trolleybus Stations Information

Input Data	Examples of Information
Stop ID	
Location Map	Schematic layout
Service Routes	Route numbers using the stop
Road Conditions	Photos of the area
Street Parking	Yes/No
Safety Management Problems	E.g., blind spots, private vehicles stopping, etc.
Availability of Bulletin Board Space	Yes/No
No. of parking lots	Total and number allocated to respective operators.
Meal / crew rest facilities	Yes/No

Note: Examples of additional information for stations
Source: JICA Expert Team

Source: JICA Expert Team, various sources

Figure A3.1.18 Bus/Tram/Trolleybus Stops Information

5) Policy of route modifications / introducing new routes

(1) Objective:

- Establish principles for service route/schedule modification through capacity and timetable adjustments or address permanent changes in demand and safety.
- Minimize the need to have direct service routes between every destination.

(2) Ways to modify a route:

- Timetable adjustment
- Add capacity
- Permanent route change

(3) When to modify a route:

- Changes in development, demand pattern, small new developments, feedback, etc.
- Growth or reduction in passenger trips by a defined quantum.
- Promotion of use and safety measures.
- Mitigate the impact of lost connections from other route modifications.
- Improve service reliability / reduce duplication.
- Enhance accessibility for transfers.
- Meet criteria for decisions such as longer journey time or lost connections should not affect more than __ rides per day.

(4) When to introduce a new route:

- Should only be considered as a last resort.
- Significant new large development.
- Relieve overcrowding on existing routes while providing new connections.
- Mitigate the impact of lost connections from other route modifications.
- At least introduced on trial over a pre-defined period that is communicated upfront to stakeholders.

A3.1.3 Monitoring Method for Operations of Public Transport

1) Data collection method: Analysis of operation records

- Time stamps at every stopping point (with assigned Stop ID) are the basic building block for measuring most aspects of route performance (see Figure A3.1.19).

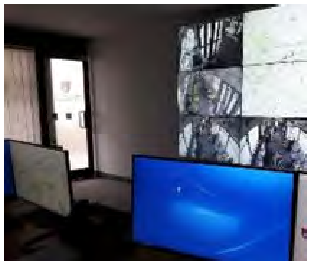
Source: JICA Expert Team

Figure A3.1.19 Time Stamps at Stopping Points

- Onboard GPS systems for time-stamping are widely available and can be linked to e-payment systems to capture travel patterns or vehicle telematics to track driving behavior. This information can be fed to a designated operations control center for fleet and safety management (Figure A3.1.20).
- Reports can be developed from time stamps to measure the following indicators:
    - Headway between vehicles
    - Punctuality against the schedule
    - Operated trips / mileage


Onboard data logger


e-payment systems


Operations Control Center

Source: JICA Expert Team, TNT Survellience

Figure A3.1.20 Data Tracking Devices

(1) Headway between vehicles

Source: JICA Expert Team

Figure A3.1.21 Calculation of Headway at a Stopping Point

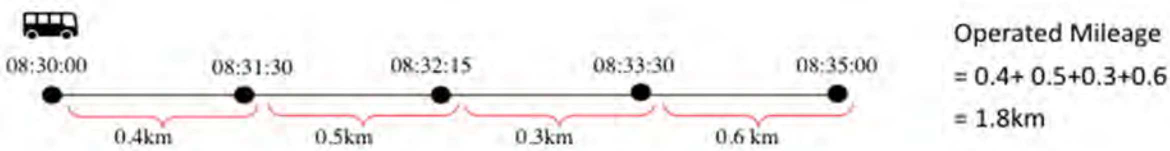
(2) Punctuality against schedule

Source: JICA Expert Team

Figure A3.1.22 Calculation of On-Time Compliance at Stopping Points

- Criteria for on-time may be less than _ mins early to not more than _ mins late.
- Stricter criteria may be applied to the first and last trips of the day.
- Reports on the distribution of early and late trips can be set up for more detailed analysis.

(3) Operated trips / mileage



Source: JICA Expert Team

Figure A3.1.23 Calculation of Operated Mileage for a Trip

- Operated trips can be counted by the number of valid time stamps at start and end points.
- Operated mileage is calculated by adding distance between timing points with valid time stamps.
- A database for bus stop-to-bus stop distance to be maintained.
- Using the same timing points as those for on-time compliance.

(4) Standards for service reliability:

- % of scheduled trips/mileage operated
- % of trips that are on-time at timing points
  - With stricter criteria for First and Last trip.

Table A3.1.11 Reporting of Service Reliability

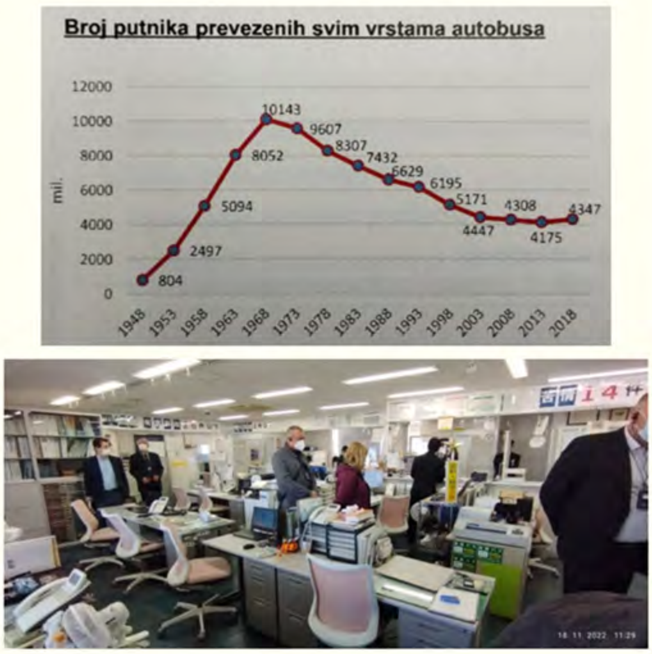
Parameter	Report Level	Frequency
No. of scheduled trips operated No. of on-time trips	By route By terminals By operator	Daily/Weekly/Monthly Monthly/Quarterly/ 6-Monthly/Yearly

Source: JICA Expert Team

2) Monitoring of operators' performance

1) Possible framework for monthly/quarterly dialogues between ministry and operators

- Overall compliance with % of trips operated (daily/monthly) – Pass/Fail
- Overall compliance with % of trips that are on-time (daily/monthly) – Pass/Fail
- Comparison between operators
  - E.g., Operator League tables (London)
- Operator Route Performance
  - List of routes that have failed.
- Customer Feedback and Satisfaction Statistics
  - Top complaints/complements by type and category
- Actions by Operator
  - Run Time Review
  - Resolve personnel-related issues
  - Traffic management & Safety measures
- Follow-up by Ministry
  - Raise important matters to higher authority



Source: JICA Expert Team

Figure A3.1.24 Professional Process Monitoring in Japan

A3.1.4 Operation plan to vehicle & personnel allocation

1) Formulation of Vehicle Allocation and Personnel Plans for Public Transport Operators

- Based on the Operations Plan developed in the Manual for Public Transport Operations Planning and Monitoring

(1) Vehicle allocation and personnel plans for trams, trolleybuses, buses, and minibuses:

- Consolidated database for weekdays, Saturdays, and Sundays containing peak requirements for the operator, service route, depot, vehicle type and numbers, and driver shift type and numbers.
- Conceptual format that can be filtered for various purposes is shown below.

Table A3.1.12 Sample Vehicle/Driver Allocation Plan

For period: 1 - 30 September 2021																		
Weekday (Mon - Fri)																		
Saturday																		
Sunday & Public Holiday																		
						Planned number of vehicles (peak requirement)					Planned number of driver duties					Number of drivers required		
Operator	Line#	Route	Service Type	Depot	Timetable date	Tram	Trolleybus	Articulated Bus	Standard Bus	Minibus	1st shift	2nd shift	3rd shift	Split shift	Total duties	Relief	Spare	Total drivers

Source: JICA Expert Team

(2) Considerations in preparing vehicle allocation and personnel plans:

- Peak requirements for vehicles and drivers are determined by the frequency and capacity of public transport modes, run times, rest times, and activities between trips.
- Run times and rest times determine resources needed.
- Run times calibrated based on data from bus telematics or fare collection systems, validated by driving surveys.
- Rest times to balance the cost of service and operational safety for drivers to have sufficient rest.
- Plans shall be translated into vehicle timetables and driver rosters.

2) Steps to Calculate Vehicle Requirement for a Service Route

Step 1: Determine vehicle occupancy at the maximum load point during the weekday peak period. The peak 1-hour in the heavier direction can represent this.

To illustrate the next steps, suppose the maximum load point is 600 passengers.

Step 2: Calculate the number of trips needed to provide enough capacity at the maximum load point.

A typical rule of thumb is to plan for an average occupancy of about 70% during the peak 1-hour period to minimize the possibility of any one trip being overcrowded or unable to pick up any more passengers.

Therefore, total capacity required for 400 passengers at 70% occupancy is

= 400 ÷ 0.7 = 571

Assuming the capacity per vehicle is 80 passengers, the number of trips required during the peak 1-hour is

= 571 / 80 = 7 trips

This will result in a scheduled headway during the peak 1-hour of

= 60 /7 = 8.5 (or 8–9 min)

Step 3: Run time of the service route and required rest times, then determine how many vehicles can fulfill the number of trips needed during the peak period.

Suppose the run time of the service route is 80 minutes with a provision of 5 minutes of rest time. Therefore, total turnaround time is

= 80 + 5 = 85 minutes

For the required scheduled headway of 8.5 in Step 2, the number of vehicles required will be

= 85 / 8.5 = 10 vehicles

Step 4: Spare vehicle provision for maintenance/repairs is then added to the peak vehicle requirement to arrive at the total vehicle requirement. This is typically done for a group of routes at a depot or a cluster of depots, depending on the inter-operability of buses between the identified depots.

<u>Step 5</u>: Repeat the above steps for off-peak periods to determine driver requirements to be described in the next section.

Applying the actual output from the demand forecast model representing the AM peak 1-hour period, the following steps are taken to determine the vehicle requirements for trams.

<u>Step 1</u>: Determine vehicle occupancy at the maximum load point during the weekday peak period. The peak 1-hour in the heavier direction can represent this.

Since the line information in the model was taken directly from the line timetables, it is not needed to examine vehicle occupancy in this exercise since the timetables that are in use would be able to provide sufficient trips to provide enough capacity at the maximum load points for each line.

<u>Step 2</u>: Calculate the number of trips needed to provide enough capacity at the maximum load point.

The essential parameters in the below model output are explained as follows:

Table A3.1.13 Model Output for Trams during the AM Peak

ID	LineName	Mode	StartStop	EndStop	Length(	Ave.Speed(AMF	NumDepurture(A
1	1	Tram	Baščaršija	Željeznička stanica	3	18	5
1	1	Tram	Željeznička stanica	Baščaršija	3	19	5
2	2	Tram	Baščaršija	Čengić vila A	5	19	7
2	2	Tram	Čengić vila terminus	Baščaršija	5	19	7
3	3	Tram	Baščaršija	Ilidža	11	17	15
3	3	Tram	Ilidža	Baščaršija	11	18	15
4	4	Tram	Željeznička stanica	Ilidža	9	17	2
4	4	Tram	Ilidža	Željeznička stanica	9	17	2
5	5	Tram	Baščaršija	Nedžarići terminus A	8	17	6
5	5	Tram	Nedžarići terminus B	Baščaršija	8	16	6
6	6	Tram	Skenderija terminus	Ilidža	9	17	7
6	6	Tram	Ilidža	Skenderija terminus	9	18	7

Source: JICA Expert Team

Column B (Line Name) – Represented by line number.
Column C: (Mode) – To represent tram, trolleybus, bus, or minibus
Column D: (Start Stop) – Origin terminal of the line
Column E: (End Stop) – Destination terminal of the line
Column F: (Length) – Line length from origin to destination
Column G: (Ave Speed) – Travel speed in km/h from origin to destination
Column H: (Num Departure) – Number of trips departing origin terminal

The number of trips in Column H is used to calculate the headway for each line using the formula Headway = 60 / [number of trips per hour], which is then reflected in Column S (AMP headway) in the below output.

Table A3.1.14 Calculation of Headway for Trams during the AM Peak

							1) Full Service Case (		5%		
LineName	Mode	StartStop	EndStop	Length(	Ave.Speed(AMF	NumDepurture(A	AMP headway	AMP run time	AMP rest time	AMP run time + rest time	AMP veh
1	Tram	Baščaršija	Željeznička stanica	3	18	5	12	10	5	15	2
1	Tram	Željeznička stanica	Baščaršija	3	19	5	12	11	5	16	2
2	Tram	Baščaršija	Čengić vila A	5	19	7	9	16	5	21	3
2	Tram	Čengić vila terminus	Baščaršija	5	19	7	9	17	5	22	3
3	Tram	Baščaršija	Ilidža	11	17	15	4	37	5	42	11
3	Tram	Ilidža	Baščaršija	11	18	15	4	38	5	43	11
4	Tram	Željeznička stanica	Ilidža	9	17	2	30	31	5	36	2
4	Tram	Ilidža	Željeznička stanica	9	17	2	30	32	5	37	2
5	Tram	Baščaršija	Nedžarići terminus A	8	17	6	10	28	5	33	4
5	Tram	Nedžarići terminus B	Baščaršija	8	16	6	10	32	5	37	4
6	Tram	Skenderija terminus	Ilidža	9	17	7	9	33	5	38	5
6	Tram	Ilidža	Skenderija terminus	9	18	7	9	32	5	37	5

Source: JICA Expert Team

In the above example, the headway of Line 1 is 60 / 5 = 12 minutes

<u>Step 3:</u> Run time of the service route and required rest times, then determine how many vehicles can fulfill the number of trips needed during the peak period.

The run time of each line is taken from Column F (length) divided by Column G (average speed), as represented in Column T (AMP run time)

In the above example, the run time of Line 1 is 3 / 18 = 0.167 hours, then multiply by 60 to arrive at 0.167 x 60 = 10 minutes.

Rest time provision is set as 5% of the run time, or 5 minutes, whichever is higher.

Since 5% of 10 minutes is just 0.5 minutes, a rest time of 5 minutes applies, as represented in Column U (AMP rest time).

Therefore, the turnaround time is the addition of Column T (AMP run time) and Column U (AMP run time + rest time).

The number of vehicles is then calculated using the turnaround time in Column U (AMP run time + rest time) divided by the headway in Column S (AMP headway).

In the above example, the turnaround time of Line 1 is 10+5 = 15 minutes, and the number of vehicles is 15 / 12 = 1.25, which is rounded up to give two vehicles.

The above calculation method is applied consistently to all modes and lines for different scenarios outlined in Volume 1, Chapter 4.1, Service Specifications of Public Transport Modes, such as the full-service case, ideal service case, and the optimal service case through adjustment of headways to meet capacity or headway targets for each scenario. The same exercise is repeated for the off-peak periods to determine driver requirements in the next steps.

The following steps were taken to determine the Optimal service case for Tram as outlined in Volume 1, Chapter 4.1.

Table A3.1.15 Calculation of Occupancy for Trams during the AM Peak

LineName	Mode	StartStop	EndStop	MAXLoad(AP)(PAX)	Vehicle Capacity	Max Load Pt Occupancy
1	Tram	Željeznička stanica	Baščaršija	85	125	14%
2	Tram	Baščaršija	Čengić vila A	67	125	8%
3	Tram	Ilidža	Baščaršija	882	125	47%
4	Tram	Ilidža	Željeznička stanica	56	125	22%
5	Tram	Nedžarići terminus B	Baščaršija	96	125	13%
6	Tram	Ilidža	Skenderija terminus	325	125	37%
101	Trolleybus	Otoka terminal	Trg Austrije	37	106	11%
101	Trolleybus	Trg Austrije	Otoka terminal	75	106	18%
102	Trolleybus	Jezero B	Otoka terminal	161	106	30%
103	Trolleybus	Trg Austrije	Dobrinja	296	106	28%
104	Trolleybus	Trg Austrije	Alipašino polje terminus	151	106	29%

Source: JICA Expert Team

Column B (Line Name) – represented by Line Number.
Column C: (Mode) – to represent Tram, Trolleybus, Bus, or Minibus
Column D: (Start Stop) – origin terminal of the line
Column E: (End Stop) – destination terminal of the line
Column I: (MAXLoad) – number of passengers per hour at the maximum load point
Column P: (Vehicle Capacity) – total seating + standing capacity of a vehicle
Column AL: (Max Load Pt Occupancy) – AM Peak Max Load Point Occupancy is calculated using number of passengers per hour at the maximum load point (Column I) divided by Vehicle Capacity (Column P).

Table A3.1.16 Tram Occupancy and Peak Vehicle Requirement

Line Number	AM Peak Max Load Point Occupancy	No of vehicles (Full-Service case)	No of vehicles (Optimal case)
1	14%	3	3
2	8%	6	4
3	47%	19	19
4	22%	3	3
5	13%	8	6
6	37%	8	7
		47	42

Source: JICA Expert Team

To estimate the expected AM peak max load point occupancy after vehicle reduction for example with Line 6, with 10 vehicles at an average occupancy of 37%, a reduction of 4 vehicles was tested to have an average occupancy of = 37% x 8 / 7 = 42%, which is still below the target average occupancy of 70%.

If the number of vehicles were reduced to 4, the average occupancy would have been 37% x 8 / 4 = 74%, which would have breached the target. While the optimal case would have been 4 vehicles for Line 6, it is kept as 7 vehicles in order to keep to a total of 42 vehicles in order not to severely degrade the tram service.

Steps to Driver Requirements for a group of Service Routes

Step 1: Determine the number of vehicles for a group of routes to be considered (by mode, by depot, etc.) during the weekday peak and off-peak using the steps described in the preceding section.

For example, the number of vehicles required for a group of routes is as follows:

Peak = 100 vehicles

Off-peak = 70 vehicles

Step 2: Determine the number of driver duties based on driver shift hours and hours of service operation.

Off-peak vehicle requirement forms the base of whole day driver duty requirement to be catered for typically with two straight (AM/PM) shifts.

Peak vehicle requirement then forms the additional driver duty requirement to be catered for with a single (split or day) shift.

Therefore, driver duties requirement for these periods are:

Off-peak requirement = 70 vehicles x 2 = 140 driver duties

Peak requirement = (100-70) x 1 = 30 driver duties

Total driver duties = 140 + 30 = 170 driver duties

Step 3: A relief requirement is added to cater for off/rest days.

In this example, a 6-day driver work week is assumed to cover 7 days of operations, with the relief requirement incorporated by taking the number of duties multiplied by 7/6.

Total driver duties with relief = 170 driver duties x 7/6 = 199 driver duties

(rounded up)

If an operator is practicing a 5-day work week for its drivers, the relief requirement then needs to be adjusted accordingly applying a factor of 7/5.

Step 4: A spare requirement is added to cater for annual leave, absenteeism, training, standby duties, and the number of public holidays in a year.

For example, if the spare requirement is 10%:

Total driver requirement including spares and relief

= 199 driver duties x 1.10

= 219 drivers

Likewise, this spare percentage may be adjusted according to an operator's annual leave and sick leave policies.

The above steps may similarly be applied to calculate driver requirements for each route. However, it is more practical to calculate driver requirements for a group of routes, as this would allow the spare drivers to be pooled together to drive several routes when required.

Applying the actual summary of vehicle requirements from the optimal service case outlined in Volume 1, Chapter 4.1, Service Specifications of Public Transport Modes, the outputs from the demand forecast model representing the AM peak 1-hour period, the following steps were taken to determine the driver requirements for trams.

Table A3.1.17 Vehicle and Driver Requirements for the Optimal service case

Mode	Peak Vehicle Requirement	Off-Peak Vehicle Requirement	Peak Driver Duties	Off Peak Driver Duties	Total Driver Duties	Relief Requirement	Spare Requirement	Total Driver Requirement
Tram	42	36	6	108	114	19	18	151
Trolleybus	32	26	6	78	84	14	13	111
Bus	106	86	20	172	192	32	31	255
Minibus	45	37	8	74	82	14	13	109
Total	**225**	**185**			**472**			**626**

Source: JICA Expert Team

Step 1: Determine the number of vehicles for a group of routes to be considered.

In this case, for trams

Peak = 42 vehicles

Off Peak = 36 vehicles

Step 2: Determine the number of driver duties based on driver shift hours and hours of service operation.

Therefore, driver duties requirement for these periods are:

Off Peak requirement = 36 vehicles x 3 = 108 driver duties

(Note: using 3 shifts for Tram/Trolleybus and 2 shifts for Bus/Minibus)

Peak requirement = (42-36) x 1 = 6 driver duties

Total driver duties = 108 + 6 = 114 driver duties

Step 3: A relief requirement is added to cater for off/rest days.

Total driver duties including Relief = 114 driver duties x 7/6 = 133 driver duties

Therefore, Relief Requirement = 133 – 114 = 19 driver duties

Step 4: A spare requirement is added to cater for annual leave, absenteeism, and training.

Using the spare requirement is 16%:

Total spare requirement

= 114 driver duties x 0.16

= 18 drivers (rounded up)

Then the total driver requirement is the addition of total driver duties, relief requirement, and spare requirement.

= 114 + 19 + 18 = 151 drivers

The above process is similarly repeated to calculate driver requirements for the other modes of trolleybus, bus, and minibus.

3) Basic Steps to Determine Technician & Maintenance Staff Requirement

Depends on the operators' O&M strategy, e.g., keep everything in-house or outsource some or all maintenance. In general, the method for determining the optimal technician and maintenance staff levels is as follows:

Step 1: Break down staff by location and/or sub-fleet (e.g., bus vs trolleybus vs tram).

Step 2: Adjust current staff to full-time equivalents (FTEs) and available productive hours using information on labor law, current technician staffing, other employees contributing to maintenance and data on breaks, vacations, and shifts.

Step 3: Calculate preventive maintenance, core maintenance, and unscheduled maintenance task hours required by the sub-fleet.

Step 4: Calculate the heavy maintenance and repair hours required.

Step 5: Model changes to fleet composition and usage from historical data.

Step 6: Model changes to typical maintenance times (i.e., time taken for vehicles to be repaired before return to service) or intervals (e.g., mean hours between failures).

Step 7: Account for overtime required.

Step 8: Benchmark results to other select public transport agencies/operators considered exemplary (e.g., UITP peer group).

4) Best Practices

- Start with good data. Data collection for scheduling can be conducted using traffic checkers, automatic passenger counters (APCs), and GPS-based automatic vehicle location (AVL) systems.

- Two types of checks are specific to vehicle/personnel allocation plans. They are vital for obtaining the information necessary for adjusting an existing schedule or building a new schedule.
- If APC and AVL data are not available, "point checks" and "ride checks" become essential:
    - Point check: A checker is stationed at a point on the bus route known to be where the largest number of people are consistently on board to ensure supply matches demand and determines the maximum load points in the network.
    - Ride check: On-board ride checkers record all boarding/alighting stops from end to end with scheduled time and time points for writing in the actual times and noting comments about drivers' performance in operating over the route.
- Other types of checks:
    - Farebox counts: Although fareboxes cannot tell the maximum number of passengers on board for each trip, the data helps to identify ridership trends. It is not helpful if fare leakage is suspected.
    - Cordon counts: The common method to count vehicles and people entering and leaving a specific area, typically a city center. Some of this information may be of strategic interest, but overall results are of little use for scheduling purposes.

A3.2 Personnel Management

A3.2.1 Working Conditions

This section proposes scheduling guidelines and optimization methods to complement the rulebook.

1) Driver Work Hours and Continuous Operation Time

- To be defined in accordance with local regulations and trade union agreements where applicable.

Table A3.2.1 Criteria for Driver Work Hours and Continuous Operation Time

Parameter	Criteria
Shift hours	• [number of hours] to [number of hours] between: — 1st shift [time] – [time] — 2nd shift [time] – [time] — Split shift [time] – [time]
Shift spread	• Not more than [number of hours] from the start to the end of workday. • Determined by minimum hours of overnight rest required by regulation or trade union (if applicable).

Parameter	Criteria
Continuous operation time for a workday	• Not more than [number of hours] from the start to the end of workday.
Continuous operation time before taking a break	• Not more than [number of hours: minutes] from the start of a driving trip.

Source: JICA Expert Team

- Shorter shift hours will increase the number of shifts and, thus, the number of drivers needed.
- Continuous operation time will determine the number of rest breaks required during the operation time that will affect the number of vehicles and drivers required, especially during the peak period.

2) Driver Rest Time & Meal Breaks:

- To be defined in accordance with local regulations and trade union agreements.

Table A3.2.2 Criteria for Driver Rest Time & Meal Breaks

Parameter	Criteria
Rest Time	• For every [number of hours] of continuous driving: Peak hours: — Minimum of [number of minutes] or [percentage%], whichever is greater Off-peak hours: — Minimum of [number of minutes] or [percentage%], whichever is greater
Meal Breaks	• Between [number of minutes] – [number of minutes] at these times for: 1st shift [time] to [time] 2nd shift [time] to [time] Split shift [time] to [time] for any continuous piece of at least [number of hours].

Source: JICA Expert Team

- Arrange rest time and meal breaks during off-peak as much as possible. This reduces the number of vehicles and drivers required and allows a longer rest time for drivers.

3) Operational Activities respecting regulations:

- Besides the normal rest and meal break times, additional time may need to be considered for operational activities in between trips, such as:
  - Vehicle inspection/cleaning.
  - Starting up or logging on to onboard e-payment or fleet management systems.
  - Walking between terminals and meal places, as well as between parking spots and rest areas.
- The above activities may be specific to a route or location where it terminates or passes by.
- These should be accounted for separately from run time and minimum rest time, as these could change over time.

4) Trade-Offs

- Rest times to balance the cost of service and operational safety for drivers to have sufficient rest.

Table A3.2.3 Effects of Excessive/Insufficient Run Times and Breaks

<table>
<tr><th>Parameter</th><th>Measure</th><th>Effects</th></tr>
<tr><td rowspan="2">Run Time</td><td>Excessive</td><td>• Slow driving
• Erratic frequency
• Customer complaints</td></tr>
<tr><td rowspan="2">Insufficient</td><td rowspan="2">• Traffic accidents
• Reduced customer confidence
• Poor driver retention</td></tr>
<tr><td rowspan="2">Rest/Mealtime</td></tr>
<tr><td>Excessive</td><td>• Long down time
• Increased cost of operation
• Parking congestion at terminals</td></tr>
</table>

Source: JICA Expert Team

5) Creating Cost-Effective and Implementable Timetables

- Reflect current road conditions and passenger volumes to ensure service reliability.
- Mix different shift types to minimize wastage, such as split shifts for peak hours.
- Multiple trips without rest for short trips to allow longer rest later after the peak hours.
- More/longer rest times and meal breaks during off-peak so vehicles avoid being idle during peak hours.
- Ensure drivers' welfare by giving adequate run time and rest time.

6) Continuous Improvement

- Refine scheduling guidelines by consulting with unions (if applicable) regularly to reflect true operating requirements.
  - Ensure reasonable working timetables for drivers.
  - Consider feedback from a representative sample of drivers.
  - Evolve to meet changing working conditions and operating environment.

7) Methods to track and optimize working hours of drivers.

Tracking and optimizing the work hours of drivers is crucial for ensuring their safety, preventing fatigue-related accidents, and complying with regulations. Some methods below can be used:

<u>Technological Tools</u>

- GPS and Fleet Management Systems provide insights into drivers' locations, routes, and driving times, enabling better optimization of work schedules and allocation of resources.
- Vehicle Telematics to track the number of driving hours and provide real-time information on driving hours, breaks, and rest periods to ensure compliance with

regulatory requirements and prevent drivers from exceeding maximum working hour limits.

- Integrated Mobile Apps and Software Solutions that can be used for viewing rosters as well as registering their leave applications and duty preferences can be enhanced to notify drivers of their working hours, breaks, and rest periods. Managers can also access and analyze this data to optimize schedules and ensure compliance.
- Develop a model for optimal scheduling of drivers based on passenger flow in the peak hour and the constraints in working hours to minimize situations of uneven work hours among drivers.

<u>Human Aspects</u>

- Open lines of feedback and communication with drivers to understand their needs, concerns, and challenges regarding work hours. Regularly seek schedule feedback and address any issues contributing to fatigue or excessive working hours.
- Regularly analyze and review working hour data to identify patterns, trends, and potential areas for optimization. Generate reports that provide insights into driver performance, compliance, and potential fatigue risks.
- Continuous Improvement: Continuously review and improve working hour tracking and optimization processes based on feedback, data analysis, and industry best practices. Adapt and refine strategies to better meet the needs of drivers and ensure their safety and well-being.
- Training and Education: Provide drivers with training and education on fatigue management, recognizing signs of fatigue, and the importance of adhering to working hour regulations. This is linked to Safety Management, discussed later in this manual.

Implementing these methods can help track and optimize the working hours of drivers, ensuring compliance with regulations, preventing fatigue-related incidents, and promoting a safe and efficient transportation operation.

A3.2.2 Labor Management

1) Objective of Work Schedule Policy

- Match demand and supply
  - Define the right number of staff (drivers, technicians, etc.) needed for the duties to be carried out.
  - Having staff at the right place and right time to provide reliable public transport services.
- Manage staff attendance issues
  - Ensure fairness in the distribution of work to keep healthy staff morale and attendance.
  - Minimize overtime regularly and prevent burnout.

- Enhance productivity for business competitiveness and survival
    - Optimize assignment of work in accordance with staff's skills and performance.
    - Motivate every staff to do their best to achieve organizational success

2) Setting the Work Schedule Policy

- Working days and hours
    - Number of hours worked in a day.
    - Number of hours or days worked in a week.
    - Number of continuous days worked before a rest day.
- Rotating shifts
    - 1st / 2nd / Split shifts, as well as standby duty.
    - Ensure fairness in the distribution of duties.
- Process in 3 steps:
    - Define timetables for vehicles.
    - Define work schedules to run timetables.
    - Allocate work schedules to specific drivers.

(1) Principles for Defining work schedules to run timetables

- Labor rules are at the heart of this step. They are the result of:
    - international (e.g., EU),
    - national (general labor laws),
    - branch (labor laws specific to urban public transport), and
    - operator (local agreements or usages) rules.
- Different labor rules can make the production of a given timetable considerably more expensive. Even if the process is three steps, timetables must be optimized according to labor rules.
- When defined locally or even at the branch level, labor rules can be questioned and renegotiated regularly, in particular, if acceptable changes can generate big productivity gains.
- Public transport is characterized by peak hours, peak periods, and service on Sundays and public holidays.
- This will be reflected in very different work schedules with variable driving time, long working hours with inactivity out of peaks, and work on holidays.

3) Possible Issues with Vehicle / Personnel Allocation

- Managing driver preferences

- Difficulties filling split shifts
- Dealing with absenteeism
- Conflicts between junior/senior drivers
- Proximity of accommodation (local/foreign drivers)

4) Collaboration with trade unions

(1) Main Considerations

- According to the country's cultural and political background and history, trade unions can be either:
  - constructive and seriously willing to improve working conditions;
  - or willing to fight against the capitalist system at any cost.
- It takes two to tango.
  - Management needs to determine at all times whether or not trade unions are willing to cooperate constructively.

(2) Steps to foster harmonious labor-management relations

- Negotiate all changes in allocated driving times. Jointly measure time in the field. Differentiate according to type of day, time period, and special event.
- Introduce transparent and fair rules for service allocation to drivers and enforce them. Trade unions is legitimate to demand rules are actually enforced. It is not abusing its influence to try to favor certain employees.
- Input of trade union is useful to identify and address all kinds of drivers' legitimate concerns and difficulties (e.g., driving time changes but also toilets at terminal stations or availability of drinking water during heat waves).
- Mutual good faith, the ability to solve little issues (irritating matters), and getting used to solving problems together are the best protection of the operator against major labor conflicts, which can be very damaging.
- Trade unions should never monopolize dialogues between workers and their management.

(3) Dealing with hostile trade unions

- Maintain authority and don't allocate too much time to non-cooperative trade unions.
- Communicate directly with personnel.
- Train management about trade union dialectics

A3.2.3 Safety Management

Public transport safety management aims to minimize the likelihood and severity of collisions and security threats to create a safe and reliable transportation experience for passengers while ensuring the well-being of employees. By implementing these safety measures, conducting ongoing monitoring and evaluation, and promoting a safety-conscious culture, public transport systems can minimize risks and enhance the overall safety and security of their operations.

To maximize effectiveness, safety issues should be automatically resolved and held on the ministry level, especially in accidents involving private vehicles, which are usually beyond the means of operators to resolve at their level. Safety performance indicators should be made visible and accepted on the cantonal level since, through them, the costs and consequences of accidents are felt.

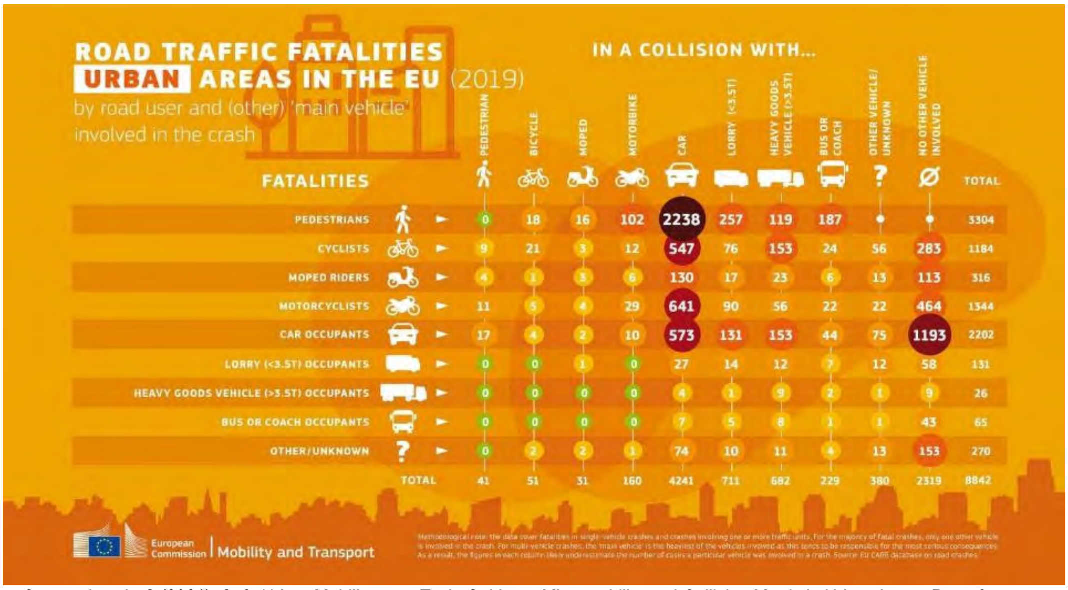
1) Accident rates and Analysis

(1) Possible Measurements

- Number of cases per 100,000 km
- Workplace Accident Rate
    - Accident severity rate = Man days lost / No. of man-hours worked
    - Aim to be lower than national average

(2) Ways to Analyze Accidents

- Fatal/non-fatal
- Type of collision (head-to-rear, sideswipe, etc.)
- By driver groups (e.g., length of service, nationality, etc.)
- By route or corridor
    - Identifying hotspots for traffic engineering improvements



Source: Lynch, S (2021). Safe Urban Mobility: new Topic Guide on Micromobility and Collision Matrix in Urban Areas. Page 8

Figure A3.2.1 Matrix Analysis for Road Traffic Fatalities in the EU

2) Identifying hotspots at route and corridor level

(1) Purpose

- To identify, monitor, and treat locations with a high number of traffic collisions.

(2) Key steps

- Identify major points of conflict

- Establish baseline period (usually 3 to 5 years)
- Identify clusters by defining a minimum limit in a defined radius.
- Define collision hotspot as an area where the number of collisions exceeds a defined limit during the baseline period.

(3) Examples of safety interventions

Addition of signalized pedestrian crossings

Change of traffic signals

Speed regulation measures

Enforcement cameras

Source: LTA Singapore

Figure A3.2.2 Road Safety Interventions in Singapore

(4) Expected Benefits

- Aim to reduce accidents by 75% over at least 3 years in the identified hotspot.
- Work towards removing 5 to 10 locations per year with accident rates falling below the defined limit.

3) Education and Training for Preventing Accidents

(1) For drivers

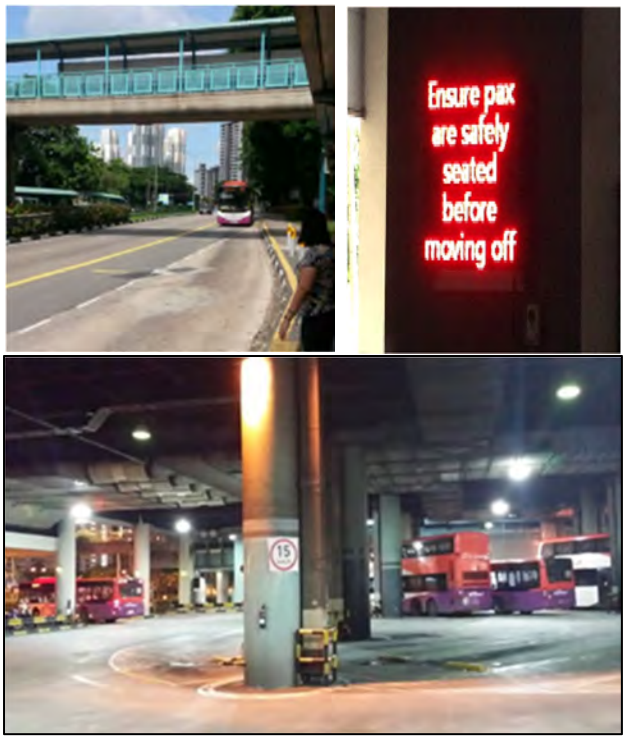
- Physical infrastructure

<u>Safety Drills</u>

- Junction Drill
- Pedestrian Crossing Drill
- Bus Stop Drill

<u>Safe Driving Rules</u>

- Safe following distance
- 2-second rule
- Speed limits at various locations



Source: LTA Singapore

Figure A3.2.3 Safety Drills and Safe Driving Rules in Singapore

- Refresher Programs

Source: LTA Singapore

Figure A3.2.4 Team Briefings to Bus Captains and Mechanics in Singapore

- Fatigue management

Provide drivers with training and education on fatigue management, recognize signs of fatigue and the importance of adhering to working hour regulations. Promote a culture of safety and well-being among drivers.

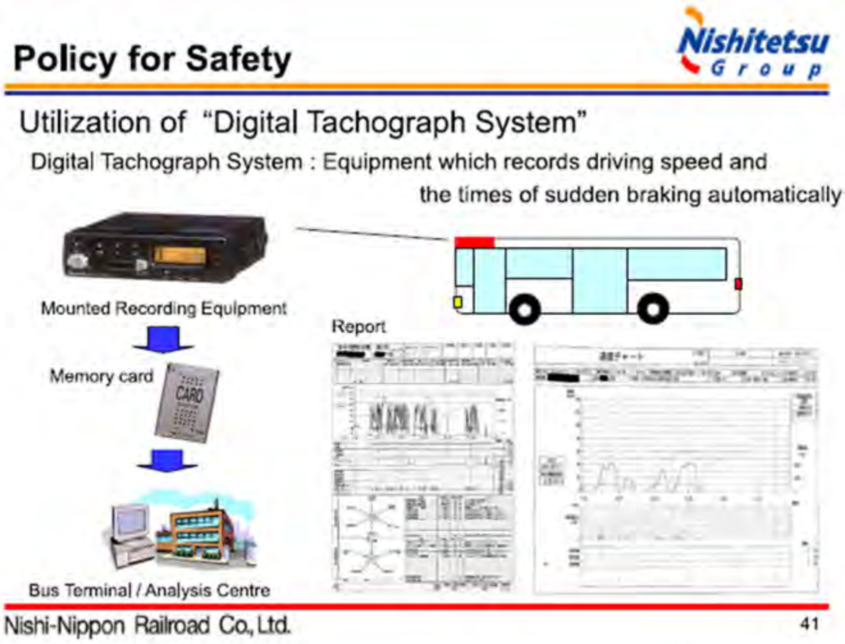
- Technology

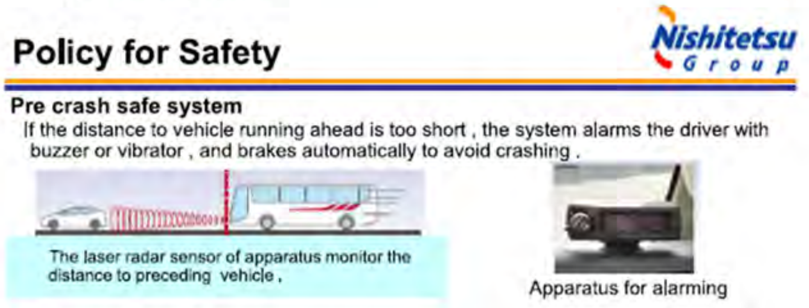
  <u>Telematics</u>

  - Onboard motion sensors, cameras, and mapping software.
  - Instructor uses video playback to coach the driver.
  - Real-time feedback of unsafe following distance, lane departure, and potential collisions to reinforce safe driving habits.

Source: LTA Singapore

Figure A3.2.5 Safety Systems for Public Buses in Singapore





Source: Nishitetsu

Figure A3.2.6 Safety Systems for Public Buses in Japan

<u>Fatigue Warning Systems</u>

- Utilize machine vision technology. Such detect and analyze erratic driving behavior or microsleeps and prompts drivers with visual and audio alerts.

Source: Land Transport GURU

Figure A3.2.7 Fatigue Warning Systems on Singapore buses

(2) For passengers

- Safety markings

Source: LTA Singapore

Figure A3.2.8 Safety Markings at Bus Stops / Interchanges in Singapore

- Campaigns

Source: SBS Transit, Singapore

Figure A3.2.9 "Hold-On" to Handrail Campaign in Singapore

4) Crime prevention on public transport vehicles

- Facilitate at the national level with cooperation among police, transport ministry, and operators.

Stop Abuse of Bus Drivers

Stop Molestation

Video on Spotting Suspicious Persons

Source: SBS Transit, Singapore

Figure A3.2.10 Public Transport Crime Prevention Campaigns in Singapore

- Drivers must check that CCTVs are in working condition and report any malfunctions immediately to their superior and the workshops.
- Drivers must walk through the bus before and after every revenue trip without fail and check for:
    - suspicious items,
    - any passengers still onboard, and
    - any damage to bus properties.

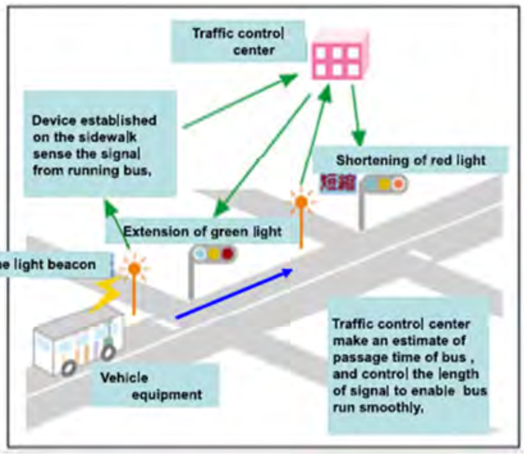
5) Mitigating Negative Impacts of Private Vehicles on Safety Management

Private vehicles will remain an integral part of the overall transport system and should be viewed as a complementary role, particularly in areas with limited or inadequate public transport services or infrastructure. This should be considered in developing comprehensive strategies for public transport safety management. The following measures help mitigate the negative effects of private vehicles.

(1) Improve Public Transport Priority Measures

Dedicated Lanes and Signal Priority: Lanes exclusively for public transport can reduce congestion and improve service reliability. Integrating signal priority systems that prioritize public transport vehicles at intersections can enhance safety and efficiency. Public transport priority measures complement the enhancement and expansion of public transportation networks to encourage more people to choose public transport that is more efficient than private vehicles.

Exclusive lanes and priority lanes



Public Transportation Priority System

Bus Priority Lane Network and Overhead Road Signs

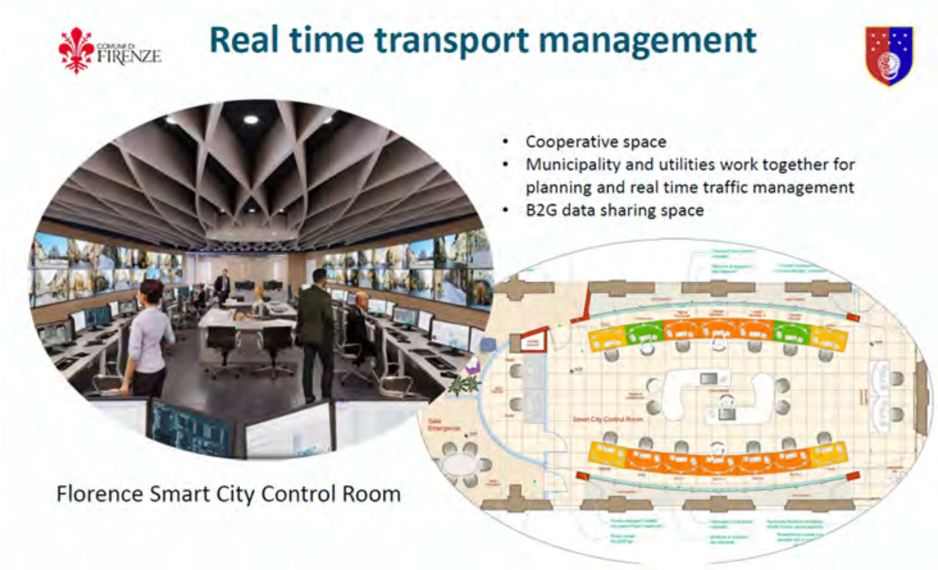
Source: JICA Expert Team, various sources

Figure A3.2.11 Bus Priority Measures in Japan

(2) Real-Time Transport Management

Having an integrated city operations control center using advanced technologies, such as GPS tracking, automated vehicle location systems, and predictive analytics, has significantly enhanced the capabilities of public transport authorities and operators. They play a vital role in improving the reliability, safety, and efficiency of public transportation services, ultimately benefiting commuters and reducing road congestion.

An example in Florence, Italy (Figure A3.2.12) is a cooperative space where municipalities and utilities work alongside each other for planning and real-time traffic management in a B2G data-sharing space. This is something that the current traffic control center in Sarajevo (Figure A3.2.13) could be further developed into.



Source: City of Florence

Figure A3.2.12 Real time Transport Management in Florence, Italy

Source: JICA Expert Team

Figure A3.2.13 Traffic Control Center in Sarajevo

(3) Enforcement

Security Measures: Deploying trained personnel, such as transit police or security officers, can help deter criminal activities and provide a sense of security for passengers. Implementing security measures like CCTV cameras, emergency alarms, and regular patrols can enhance safety and facilitate a rapid response in case of emergencies.

(4) Educational Campaigns

Education and Awareness: Conducting safety awareness campaigns and educational programs for both passengers and employees can promote a culture of safety. This can include providing safety guidelines, promoting etiquette and respectful behavior, and educating passengers on emergency procedures.

Source: www.milt.go.jp

Figure A3.2.14 Continuous Staff Education in Japan

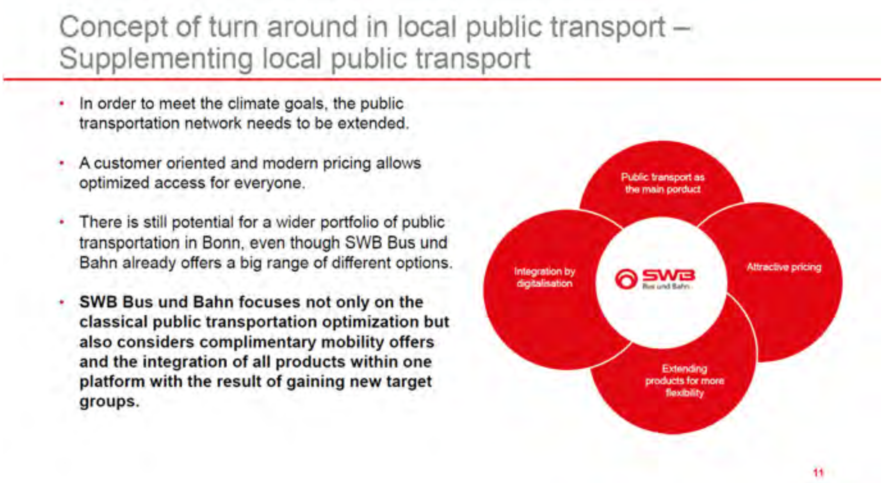
(5) Promote Sustainable Transportation Options

Active Transportation Infrastructure: Develop and improve infrastructure for walking, cycling, and other non-motorized modes of transportation. This includes creating pedestrian-friendly streets, dedicated cycling lanes, and safe crossings, making it easier and safer for people to choose active transportation options.

Integrated Mobility Solutions: Foster integration between different modes of transportation, such as public transport, cycling, walking, and shared mobility services. Develop seamless and interconnected transportation networks, including last-mile connectivity solutions, to make sustainable options more convenient and accessible.

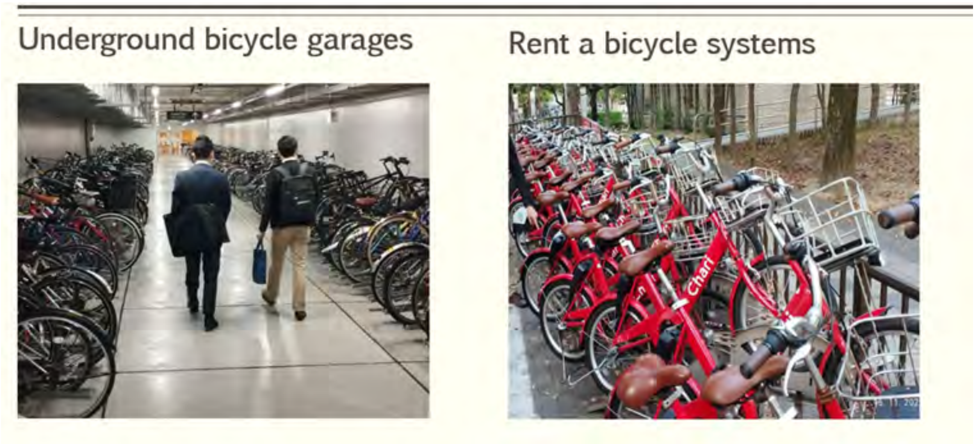
By implementing these strategies, public transport infrastructure can be enhanced to ensure the safety and well-being of passengers, creating a reliable and attractive transportation option.

See below examples in Germany & Japan (Figure A3.2.15) and Sarajevo (Figure A3.2.16).



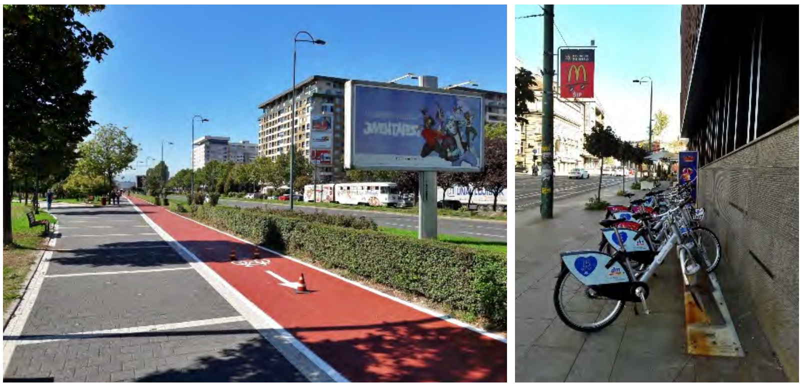
Source: City of Bonn

Figure A3.2.15 Supplementing Local Public Transport in Bonn, Germany



Source: JICA Expert Team

Figure A3.2.16 Promoting Cycling as a Mode of Commuting in Japan



Source: JICA Expert Team

Figure A3.2.17 Bicycle Lanes and Bike Sharing in Sarajevo

A3.3 Customer Experience

A3.3.1 Fare & Ticket Management

1) General Rules on Fares and Tickets

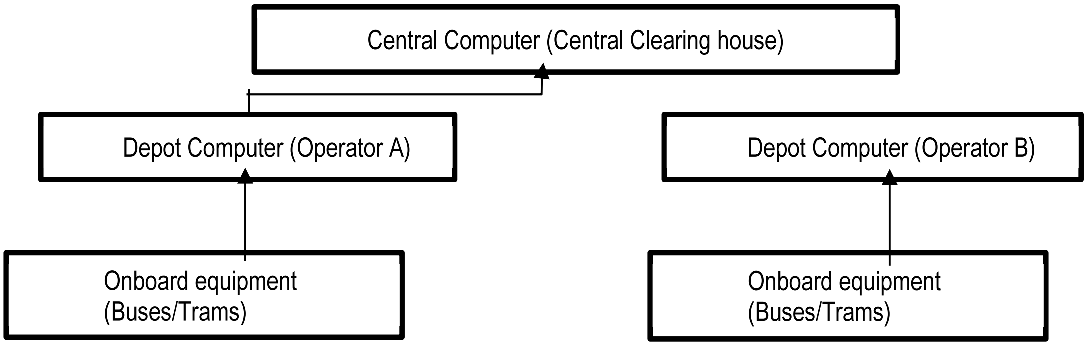
Fare and ticket management is an essential aspect of the transportation and travel industries, ensuring smooth operations and revenue generation. This section outlines general rules and best practices for fare and ticket management.

(1) Fare Collection System

A common fare payment system is recommended to be developed and deployed for both CENTROTRANS and GRAS. This system will use a common interoperable and intermodal ticket.

Another recommendation is for a common ticket agent to be assigned by the PT Regulator to assume the function of the central clearing house, which may include distribution and sales of tickets, collection of fares, cash collection, revenue sharing, and reconciliation of backend revenue.

Each operator shall maintain onboard devices (validators) and depot computers. The information shall be uploaded to a centralized computer system at the central clearing house. Please see the diagram below.



Source: JICA Expert Team

Figure A3.3.1 Clearing House for Revenue Allocation

Collecting all data at the central clearing house enables more efficient revenue sharing and operations and financial data analysis for the PT Regulator. PT Regulators can use the operation and financial data collected to better plan and adjust the resources according to SC needs.

Operator-specific data also allows operators to adjust their resources for daily operations and reconcile the revenue reported by the central clearing house, e.g., boarding at each bus stop for each line.

(2) Ticket Distribution Channels

Ticket agents may offer multiple ticket distribution channels, such as ticket counters/kiosks, automatic ticket vending machines, online platforms, and mobile apps, to make it convenient for passengers to purchase tickets. For cash transactions at the ticket counters/kiosks, cash must be collected from customers (in full view) before a ticket is issued or change is given.

(3) Refunds and Exchanges

Ticket agents shall establish clear policies for ticket refunds and exchanges, ensuring they are easily accessible and customer friendly. For example, all refunds and exchanges of tickets must be within the ticket validity period and unused.

(4) Fare Class Differentiation

Different passenger groups, e.g., adults, children, elderly, etc., must be charged varying fares or fares per trip, per week, or per month.

(5) Fraud Prevention

The ticket agent can engage ticket inspectors to conduct random checks onboard buses/trams to catch fare evaders. They can also conduct random cash audits at various ticket counters to ensure that the ticket sales and cash floats are appropriately accounted for at all times.

(6) Regulatory Compliance

PT Regulators shall set up relevant fares and ticketing regulations to ensure compliance with the use of tickets. Some rules and regulations may include, but are not limited to:

- Tickets must be used within the validity period.
- Expired tickets must be returned and refunded within the stipulated days. Failing to, however, will not be granted a refund.
- Season passes only apply to specific users identified by Canton of Sarajevo.

Interested parties may apply for a season pass at the ticket counter. Upon approval, a season pass holder can enjoy discounted fares. All season passes are strictly non-transferable.

(7) Customer Support

The ticket agent shall provide customer support regarding queries on ticket-related issues. This can be via ticket counter staff or telephone service.

(8) Fare Rules and Conditions

The ticket agent shall clearly communicate fare rules, terms, and conditions to customers at the time of purchase to avoid confusion or disputes later on. Communication can be in the form of posters, brochures, verbal, and website informatics.

2) Penalties

Setting penalties for fare offenders is essential to deter fare evasion and ensure the financial viability of public transportation systems. The penalties should be fair, proportionate, and enforced consistently. Here are some steps to establish penalties for fare offenders

(1) Legal Considerations

Ensure that the penalties comply with local and national laws and regulations governing fare evasion. Collaborate with legal advisors to establish a penalty structure that aligns with the legal framework.

(2) Fairness and Proportionality

Penalties should be fair and proportionate to the offense committed. Consider factors such as the frequency of offenses, intent, and the financial impact on the transportation system.

(3) Transparent Policies

Clearly communicate the penalty structure and the consequences of fare evasion to passengers through signage, websites, and public announcements. Transparent policies help passengers understand the importance of paying the right fares and the consequences of not doing so.

(4) Progressive Penalties

PT regulators can consider a progressive penalty system for repeat offenders. Gradually increase the penalty for each subsequent offense to discourage repeat fare evasion.

(5) Enforcement Procedures

Establish clear procedures for fare enforcement, including how ticket inspectors or personnel will issue penalties, the documentation required, and how passengers can appeal the penalties if they believe they were wrongly charged.

(6) Appeal Process

Set up an appeal process for passengers to dispute penalties if they believe they were wrongly charged. Ensure that the appeal process is independent and unbiased.

(7) Training for Staff

Train fare inspectors and other personnel responsible for enforcing penalties to handle situations professionally and courteously. They should be well-versed in the penalty structure and enforcement procedures.

(8) Data Analysis

PT regulators can continuously analyze fare evasion data to identify patterns and areas of concern. This data-driven approach can help optimize fare enforcement strategies. Ticket Inspectors can be more efficiently deployed with these data.

(9) Public Awareness Campaigns

Conduct public awareness campaigns to educate passengers about the importance of paying fares and the impact of fare evasion on the transportation system.

(10) Collaboration with Law Enforcement

Collaborate with law enforcement agencies to enforce the penalties, if necessary, especially in cases of persistent fare evasion or illegal activities.

3) Handling of Collected Fares

Handling collected fares is a crucial aspect of financial management for transport providers. Proper handling ensures accuracy, security, and accountability. Here's a guide on how to handle collected fares effectively:

(1) Collection Process

The use of validators on trams and buses helps the fare deduction process. Fares paid in cash are collected at the ticket counters/kiosks or ticket vending machines.

(2) Cash Management

Implement cash-handling procedures that include secure cash storage, regular reconciliation, and depositing funds in the bank promptly.

Limit the amount of cash kept on-site and establish a cash handling policy that minimizes the risk of theft or loss.

(3) Electronic Transactions

PT Regulator shall ensure that electronic payment systems are functioning correctly and transactions are processed securely. A clear set of user acceptance tests must be run before the system is rolled out, and periodic checks on the systems by generating transactions to verify its accuracy are necessary. The ticket agent and the operators shall regularly reconcile electronic payment records with actual cash collected to ensure accuracy and identify any discrepancies.

(4) Revenue Recording

The ticket agent shall maintain accurate and detailed records of fare collections, including transaction dates, types, and amounts, using a robust financial management system to track revenue and identify anomalies or discrepancies. All discrepancies shall be recorded and investigated.

(5) Reconciliation

Regularly reconcile fare collections against passenger counts and ticket sales to verify accuracy and detect any discrepancies.

(6) Audit Trails

Implement audit trails to track the flow of funds from collection points to the central accounting system.

Audit includes reconciling cash collected and on-the-spot float balance with system-declared figures.

These periodic internal audits can ensure compliance with financial procedures and identify potential fraudulent issues.

(7) Bank Deposits

The ticket agent shall make timely deposits of collected fares into designated bank accounts to reduce the risk of mishandling or loss.

(8) Fraud Prevention

Implement measures to prevent fare fraud and unauthorized access to fare revenue, such as ticket inspection and verification.

(9) Reporting and Accountability

Establish a system for regular financial reporting to management and relevant authorities. The staff must be accountable for fare handling responsibilities through proper supervision and performance evaluations.

(10) Contingency Plans

Ticket agents and operators shall jointly develop contingency plans to handle fare collection disruptions or system failures to minimize revenue losses.

(11) Continuous Improvement

The ticket agent shall regularly review fare collection processes and systems to identify areas for improvement and implement necessary changes.

By following these practices, operators can ensure the accurate and secure handling of collected fares, contributing to the financial stability and success of the organization.

4) Guidance to Crew Members

It is crucial to provide proper guidance and training to crew members on handling fares and tickets. Here are some essential guidelines to ensure efficient and customer-friendly fare and ticket management:

(1) Fare Structure and Ticket Types

Ticket agent staff, conductors, and drivers must know the different fare types, ticket options, and associated pricing. They must understand how to calculate fares based on the customer's requirements correctly. Appropriate training must be conducted to educate the staff.

(2) Ticket Sales and Payment Methods

The ticket agent must teach its' staff how to sell tickets using various methods such as cash, credit cards, and mobile payments. They must Instruct them on proper cash handling procedures and electronic ticketing systems.

(3) Ticket Validation

Operators must explain the ticket validation process to conductors and drivers, including using validators, scanners, or other validation methods. This is to know the importance of ensuring that all passengers must have a valid ticket before boarding.

(4) Fare Enforcement and Inspections

Conductors must learn how to conduct fare inspections professionally and respectfully. Related training on how to handle fare evaders and established penalty procedures to follow, if necessary.

(5) Handling Refunds and Exchanges

The ticket agent must be clear on handling ticket refunds and exchanges. Instructions on when and how to process these requests and the documentation required are necessary.

(6) Technology and Equipment

Operators and ticket agent must familiarize their staff with operating fare collection equipment, ticketing machines, and other technologies used in the process.

They must also be trained and equipped to handle and troubleshoot common issues; otherwise, they must know how to escalate the problems and seek technical support.

(7) Regulatory Compliance

Frontend staff must be informed about relevant laws, regulations, and policies related to fare and ticket management and the importance of adhering to these rules to avoid legal issues and penalties.

(8) Continuous Training and Updates

Both ticket agents and operators shall provide ongoing training sessions to keep crew members updated on any changes in fare structures, ticketing systems, or procedures.

They shall also encourage feedback from crew members to identify areas of improvement in the fare and ticket handling process.

A3.3.2 Service Delivery

Developing user services in public transport is essential to enhance the overall passenger experience, promote ridership, and improve the attractiveness of public transport as a preferred mode of transportation. Here are some key considerations for developing user services:

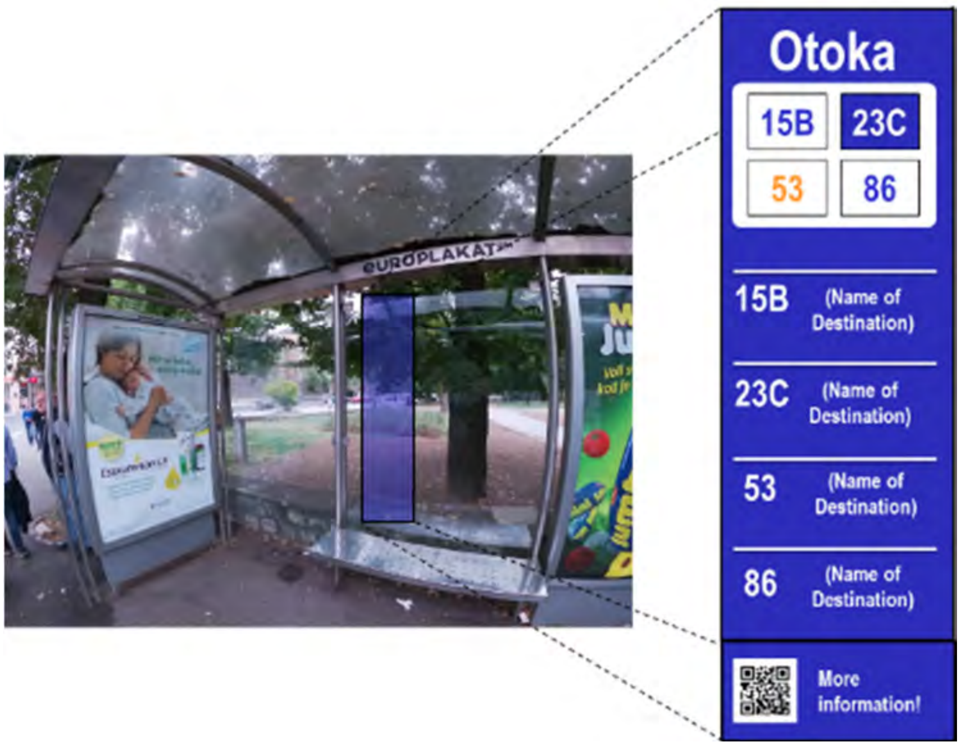
1) User Guidance

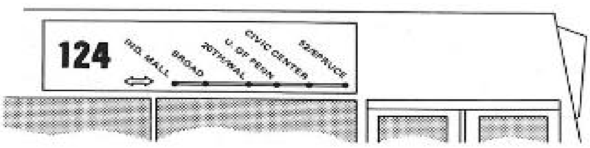
Related to information given to public transport users before, during, and after the trip.

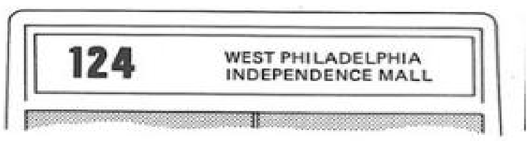
- Before the trip: Information about available services, schedules, routes, and rates. Automatic itinerary calculation (see Figure A3.3.2 and Figure A3.3.3).
- During the trip: Real-time information about possible disturbances. Re-routing advice and information about temporary and replacement services.
- After the trip: Dealing with user’s feedback.
- Users should feel comfortable at any time of the trip.
- Operator’s objective should be to always reassure the user to increase satisfaction.
- All possible communication channels should be used for that purpose.
- Written information at stops, internet, social media, drivers, and all operator’s staff.

Source: JICA Expert Team, various sources

Figure A3.3.2 Public Transport Service Information in Japan







Inside of Bus/Tram: Itinerary on Route
Front of Bus/Tram: Route Number and Destination

Source: JICA Expert Team

Figure A3.3.3 Proposed Public Transport Service Information in Sarajevo

2) Foreigners support

- Special information in English and other common foreign languages (i.e., Arabic, Turkish) should be made available to help foreigners use public transport.
    - Information about available tariffs and those more suitable for tourists.
    - Information about tourist destinations.
    - Special offers like bundle access to a site and transportation to this site.

Source: JICA Expert Team

Figure A3.3.4 Proposed Tourist Map for Sarajevo

- Printed documents and dedicated phone services

3) Cleaning & Greeting

(1) Cleaning

- Always maintain a clean environment.
- Vehicles and terminals should be cleaned and disinfected before the first revenue trip of the day.
- Vehicles may also be disinfected twice daily while taking a break at terminals.

Source: JICA Expert Team

Figure A3.3.5 Disinfection of Terminals

Source: JICA Expert Team

Figure A3.3.6 Disinfection of Vehicles

(2) Greeting

- Welcomed by drivers when entering buses or trolleybuses at the front door.
- Entering through the front door and having the driver greet has the following upsides:
  - Creates a social link with the driver.
  - Reduces cases of violence against drivers.
  - Gives authority to the driver (as captain of his bus).
  - Creates social pressure in favor of ticket validation.

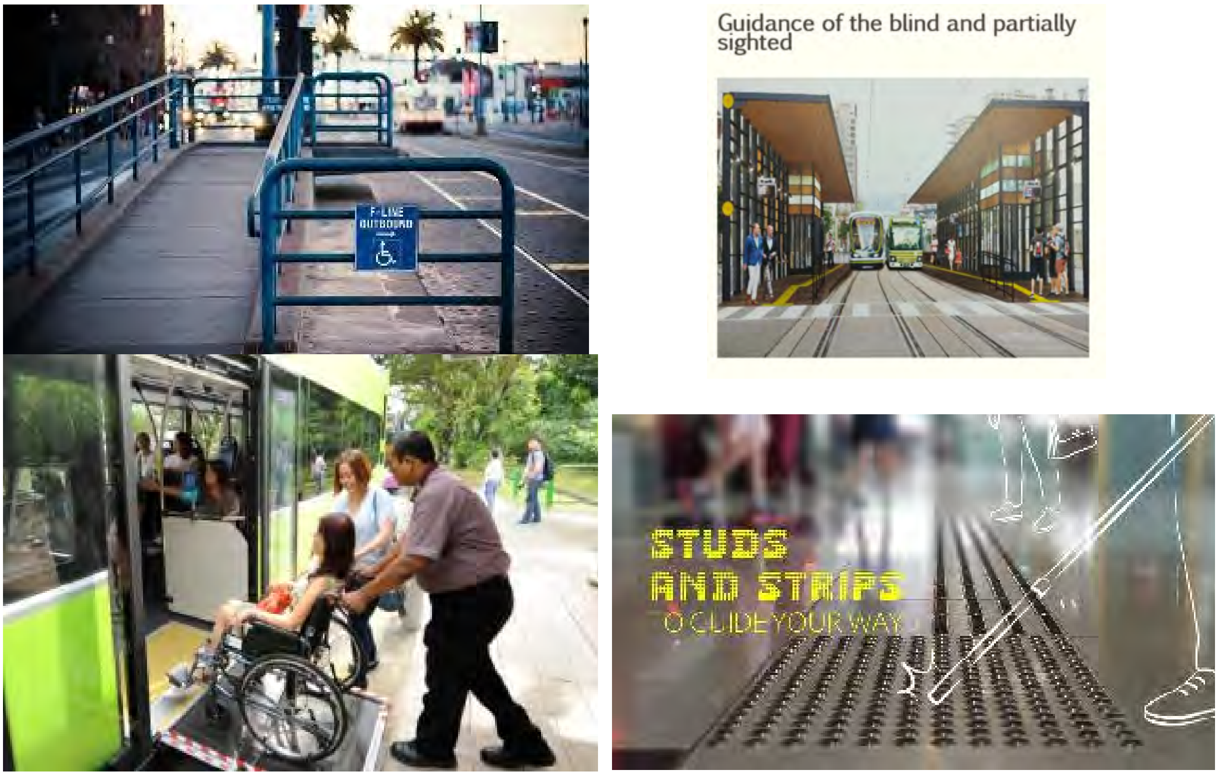
Source: www.jref.com

Figure A3.3.7 Uniformity & Friendliness of Staff

4) Support for the Disabled

- Modern rolling stock is usually adapted for persons with reduced mobility: Low floor and/or ramps for wheelchair access and wheelchair locations.

- Independent use of public transport by reduced mobility users should be preferred wherever possible.
- Train personnel to attend to users with reduced mobility.
- For blind users: Tactile paving and information on site in braille can be provided in some locations.



Source: www.ncfw.com, www.tetsudo-ch.com

Figure A3.3.8 Barrier Free Access in Singapore & Japan

5) Gender Support

- Public transport should not be where harassment is tolerated, yet promiscuity can facilitate it.
- A policy for prevention of harassment should be defined, which can include:
  - communication,
  - support to victims, and
  - systematic prosecution of offenders
- Work with relevant authorities to identify stops that are unsafe for the vulnerable to access to public transport.

Source: www.depositphotos.com

Figure A3.3.9 Example of Well Lighted Bus Stop at Night

Public transport plays a crucial role in defining the image and identity of a city. It shapes how residents and visitors perceive and experience the city's urban environment.

By focusing on developing user services prioritizing passenger convenience, comfort, safety, and accessibility, public transport systems can create a positive and enjoyable experience for passengers, ultimately encouraging greater ridership and promoting sustainable urban mobility.

If public transport were safer, better quality, more regular, and cleaner, which Sarajevo is working towards, citizens would use these services even more.

A3.3.3 Customer Survey & Relations

1) Objective

- To introduce methods to obtain passenger profile and satisfaction information in developing a public relations strategy to fine-tune public transport operations.

2) Questionnaire survey

(1) Purpose

- To investigate the purpose and selection criteria for using public transport
- To evaluate public satisfaction with current transport

(2) Content

- Assessment of public transport: Satisfaction

Q1 What kind of vehicle are you waiting for?
Unsang klaseha sa sakyanan ang imong gihuwat?

1. Bus / Minibus **2.** VAN/V-hire **3.** Jeepney / Multicab **4.** Taxi **5.** Ferry

Instruction: In case of the other modes, don't proceed with the interview and look for another interviewee.
(Kung uban nga klase sa sakyanan, ayaw padayon, pangita ug lain nga interbyuhon)

Q2 Please assess the service of the mode you are going to take now.
Palihug timbang-timbanga ang serbisyo sa sakyanan nga imong sakyan karon.

1. Frequency **Gidaghanon sa biyahe**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
2. Cost/Fare **Plete**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
3. Travel time **Oras sa pagbyahe**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
4. Crowdedness in the vehicle **Kapi-ot sa sakyanan**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
5. Onboard safety **Kaluwasan sa pagsakay**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
6. Onboard comfort **Kahayahay sa pagsakay**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
7. Onboard air quality **Kalidad sa hangin sa pagsakay**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
8. Onboard noise **Kasaba sa pagsakay**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
9. Cleanness of the vehicle **Kalimpyo sa sakyanan**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
10. Driver's/Conductor's behavior **Batasan sa driber/konduktor**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
11. Access to terminals or jeepney/ bus routes **Kasayon sa pag adto sa ruta**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
12. Easiness of transfer to another mode **Kasayon sa pagbalhin sa ubang sakyanan**	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
13. Information provision(announcement, route map, etc.) **Paghatag ug impormasyon** (pahibalo, mapa, etc)	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
14. Waiting conditions (safety, air quality, noise, shade, etc.) **Kondisyon sa huwatanan** (kaluwasan, kalidad sa hangin, kabanha, kasilungan, etc.)	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good
15. Terminal facilities (comfort room,bench, aircon, shops, etc.) **Mga Kabtangan sa Terminal** (Kasilyas, lingkuranan, aircon, mga tindahan, uban pa)	**1.** Very bad **2.** Bad **3.** Average **4.** Good **5.** Very good

Source: JICA Expert Team

Figure A3.3.10 Survey Questions on Mode Satisfaction

- Trip information: Trip purpose, trip frequency, selection criteria

Trip Information (Impormasyon sa Biyahe)

Q6 What is your origin to here? (Where did you come from?)
Diin ka gikan paingon dinhi?

____
Home / Landmark / Hotel etc. (Tima-ilhan: Balay, building, uban pa)

__________ __________ __________
Barangay Municipality/City Province

Q7 Where is your destination from here? (Where are you going?)
Asa ka paingon gikan dinhi?

____
Home / Landmark / Hotel etc. (Tima-ilhan: Balay, building, uban pa)

__________ __________ __________
Barangay Municipality/City Province

Q8 What is the purpose of this trip? (Choose one)
Unsay tuyo sa imong byahi karon? (Pili ug usa)

1. To home
Pauli sa balay
2. To work
Padulong sa trabaho
3. To school / Education
Padulong sa eskwelahan
4. Business/ Looking for passengers
Mahitungod sa negosyo/Mangita ug pasahero
5. Private (example: visit friends or family members trips, shopping, banking, etc.)
Kaungalingon (sampol: bisita sa amigo, lakaw sa pamilya, shopping, pa adto sa banko, uban pa)
6. To send/pick up other family members or friends
Pag-uban/pagsugat sa mga paryente o higala
7. Others (Specify) ____________
Uban (hinganli)

Q9 How often do you make this trip?
Unsa kadaghanon imong biyahe sama niini?

1. 5 times or more a week **5 ug labaw pa kada semana**
2. 1 – 4 times a week **1-4 kada semana**
3. 1 – 3 times a month **1-3 kada bulan**
4. Rarely **Talagsa-ra**

Source: JICA Expert Team

Figure A3.3.11 Survey Questions on Trip Purpose and Frequency

Q10 Which mode did you take to come here? (Choose one)
Unsay imong gisakyan paingon dire? (Pili ug isa)

1. Bicycle	**7.** VAN / V-hire	**13.** Bus
2. Motorcycle	**8.** PUJ / Multicab	**14.** Others (specify)
3. Car/Jeep/SUV/Pick-up	**9.** Small Delivery Truck	______________________
4. Pedicab	**10.** Truck	**15.** Walking
5. Tricycle	**11.** Trailer	**16.** Ferry
6. Taxi	**12.** Minibus	**17.** Airplane

Q11 Following Q10, if you used public transport, how far did you walk from public transport stop to here?
Kung pampubliko ang imong gisakyan (segu-sa Q10), unsa kalay-a imong gilakaw gikan sa imong gikana-ugan hangtod dinhi?

1. 0 m to 500 m (0 - 5 min. walk)	**4.** 1.5 km to 2.0 km (15 - 20 min. walk)
2. 500 m to 1.0 km (5 - 10 min. walk)	**5.** Over 2.0 km (over 20 min. walk)
3. 1.0 km to 1.5 km (10 - 15 min. walk)	**6.** I used private transport.

Q12 a. Do you have any alternative modes to make this trip? **1.** Yes (**Oo**) **2.** No (**Wala**)
Naa bay laing kasakyan para niini nga byahe?

b. If yes, which do you consider the best as an alternative mode to make this trip?
Kung Oo, unsa sa imong pag-tuo ang pinaka-maayo nga laing sakyanan para niining biyahe-a?

1. Bicycle	**7.** VAN / V-hire	**13.** Bus
2. Motorcycle	**8.** PUJ / Multicab	**14.** Others (specify)
3. Car/Jeep/SUV/Pick-up	**9.** Small Delivery Truck	______________________
4. Pedicab	**10.** Truck	**15.** Walking
5. Tricycle	**11.** Trailer	**16.** Ferry
6. Taxi	**12.** Minibus	**17.** Airplane

c. Why didn't you take the mode answered to question Q12. b for this trip? Choose 1 main reason.
Nganong wa man ka mosakay sa sakyanan nga imong gi-ingon sa question b? Pili ug isa.

1. Travel time **Gidugayon sa byahe**	**2.** Comfort **Komportable**	**3.** Convenience **Kahayahay**
4. Cost **Kantidad sa Plete**	**5.** Safety **Kaluwasan**	**6.** Others (specify) __________ **Uban** (hinganli)

Source: JICA Expert Team

Figure A3.3.12 Survey Questions on Mode Selection

- Personal information

3) Users' interview by class

(1) Person Trip Survey

- Form 1: Household information
  - Household composition
  - Household income
  - Vehicle ownership
  - Location, etc.

FORM 1: HOUSEHOLD INFORMATION
Instruction: To be completed by the household head

Household Code

Q1 Name ______________ ______________ ______________
First Name M.I. Last Name

Q2 Address of household ______ ______ ______ ______ ______
Landmark No. Street Barangay Municipality/City

Q3 How many members are there in your household?

Age	Under 5	5-59	60 & above
Male			
Female			

Q4 What is your total monthly household income (PHP)? *(Encircle one item)*

1. No income
2. Below 2,000
3. 2,000– 3,999
4. 4,000– 5,999
5. 6,000– 7,999
6. 8,000– 9,999
7. 10,000– 14,999
8. 15,000– 19,999
9. 20,000– 24,999
10. 25,000– 29,999
11. 30,000– 34,999
12. 35,000– 39,999
13. 40,000– 49,999
14. 50,000– 59,999
15. 60,000– 79,999
16. 80,000– 99,999
17. 100,000–149,999
18. 150,000–199,999
19. 200,000–299,999
20. 300,000–499,999
21. Above 500,000

Q5 How many vehicles are owned by your household?

TYPE	NO. OF UNITS OWNED
1. Bicycle	
2. Motorcycle	
3. Car / Jeep / SUV / Pick-up	
4. Pedicab	
5. Tricycle	
6. Taxi	
7. VAN / V-hire	
8. PUJ / Multicab	
9. Small Delivery Truck	
10. Truck	
11. Trailer	
12. Minibus	
13. Standard Bus (incl. company, school, tourist)	
14. Ferry / Boat	
15. Others ________	

Q6 How many of your household vehicles are parked in your garage/ near your house?

TYPE	NO. OF UNITS
1. Bicycle	
2. Motorcycle	
3. Car / Jeep / SUV / Pick-up	
4. Pedicab	
5. Tricycle	
6. Taxi	
7. VAN / V-hire	
8. PUJ / Multicab	
9. Small Delivery Truck	
10. Truck	
11. Trailer	
12. Minibus	
13. Standard Bus (incl. company, school, tourist)	
14. Ferry / Boat	
15. Others ________	

Q7 Does your household own or rent the house and the land?
Nag-abang bamo dinhi sa balay ug sa lote?

1. Land (**Lote**):	**1.** Owned **(Tag-iya)**	**2.** Rented **(Abang)**	**3.** Free **(Libre)**	**4.** Not Sure **(Di ko segurado)**
2. House (**Balay**):	**1.** Owned **(Tag-iya)**	**2.** Rented **(Abang)**	**3.** Free **(Libre)**	**4.** Not Sure **(Di ko segurado)**

Q8 If you chose 2. Rented of Q7, how much does your household pay for housing per month? Please include mortgage and/or rental charges for the house, and maintenance costs.
Kung nag-abang mo dinhi, pilay inyong gasto sa pagpuyo dinhi kada buwan? I-apil ang abang, o prenda ug uban pang gastos sa pag atiman sa panimalay.

______________________ **PHP / Month**

Q9 How long have you stayed in your current residence?
Unsa kadugay ka nangpuyo niining balaya?

______________________ **Years**

Q10 Where was your previous address? (If you stayed in other place since you had your family)
Diin ka magpuyo sa wa pa dinhi?

______ ______ ______ ______
Landmark Barangay Municipality/City Province

Source: JICA Expert Team

Figure A3.3.13 Form 1 - Household Information

- Form 2: Household Member Information
    - Age, gender
    - Income
    - Occupation
    - Income, workplace or school address, time, etc.
    - Driving license, etc.

FORM 2: HOUSEHOLD MEMBER INFORMATION
Instruction: To be completed by each household member

Member Code

Q1 Name ______ ______ ______
First Name / M.I. / Last Name

Q2 Age **(Edad)** _______ **Q3** Gender **(Hiyas sa Pagkatawo)** **1.** Male **(Lalaki)** **2.** Female **(Babae)**

Q4 Relationship to the household head **(Relasyon sa pangulo sa panimalay)**

1. Household head **Pangulo**	**2.** Husband/Wife **Bana/Asawa**	**3.** Son/Daughter **Anak**	**4.** Father/Mother **Amahan/Inahan**	**5.** Brother/Sister **Igsoon**
6. Grandchild **Apo**	**7.** Grandparent **Apohan**	**8.** Uncle/Auntie **Uyoan/Iyaan**	**9.** Nephew/Niece **Pag-umangkon**	**10.** Cousin **Ig-agaw**
11. House helper **Sulogoon**	**12.** Others (related): ______ **Uban pa (paryente)**		**13.** Others (unrelated): ______ **Uban pa (Dili Paryente)**	

Q5 Education Level (*The education level he/she completed.*)
1. Master's / Doctoral Degree **2.** Postgraduate Diploma **3.** Bachelor's Degree **4.** Associate Degree/Diploma
5. High School Graduate **6.** Elementary School Graduate **7.** None

Q6 Occupation **(Trabaho/Panginabuhi)** *(Encircle one item)*

1. Official of Government & Special Interest Organization, Corporate Executive, Manager **(Opisyal sa Goberno ug Espesyal nga Interest nga Organisasyon, Mga taas nga Position sa Kompanya, Manedyer)**
2. Professional **(Propesyonal)**
3. Technician & Associate Professionals **(Teknikal ug uban pang propesyon)**
4. Clerical Staff **(Klerikal nga Empleyado)**
5. Service Worker, Shop & Market Worker **(Trabaho nga naghatag ug serbisyo, sa Tindahan ug sa Merkado)**
6. Farmer, Forestry Worker & Fisherman **(Mag-uuma, Nagtrabaho sa Lasang ug Mangingisda)**
7. Trader & Related Worker **(Magpatigayon ug iglabot nga mga trabaho)**
8. Plant & Machine Operator & Assembler **(Sa Planta ug Makina nga operator ug Tig-asembol)**
9. Laborer & Unskilled Worker **(Ordinaryong Trabahador)**
10. Elementary School Student **(Studyante sa Elementarya)**
11. High School / College / University Student **(Studyante sa High School / Kolehiyo / Unibersidad)**
12. Housewife **(Asawa)**
13. Pensioner **(Pensyonado)**
14. Unemployed **(Walay Trabaho)**
15. OFW **(Nagtrabaho sa Gawas sa Nasud)**
16. Others **(Uban pa)**:______

Q7 Employment Sector **(Sektor sa Pagpangempleyo)** *(Encircle one item)*

1. Agriculture, Hunting & Forestry **(Agrkultura, Pagpangayam, ug Paglasang)**
2. Fishing **(Pangisda)**
3. Mining & Quarrying **(Minahan, Kwari)**
4. Manufacturing **(Industriya sa Paggama)**
5. Electricity, Gas & Water Supply **(Elektrisidad, Gas ug Pag suplay ug tubig)**
6. Construction **(Konstraksyon)**
7. Wholesale & Retail Trade; Repair of Motor Vehicles; Personal & Household Goods **(Tibuok ug Menudo nga Pamatigayon; Pagkumpuni sa mga sakyanan; Kaugalingon ug Pangbalay nga mga butang)**
8. Hotels& Restaurants **(Hotel ug Restawran)**
9. Transport, Storage & Communication **(Transportasyon, Tipiganan ug Komunikasyon)**
10. Financial Intermediation **(Pinansyal nga Pagpahusay sa Negosyo)**
11. Real Estate Development, Rental and Sale **(Pag ugmad sa kayutaan, Pagpaabang ug Pagpabaligya)**
12. Public Administration, Defense; Compulsory Social Security **(Pampublikong Pagdumala, Pagpanalipud sa Nasud; Gikinahanglan nga Seguridad sa Katilingban)**
13. Education **(Edukasyon)**
14. Health & Social Work **(Kahimsog ug Pangtawo nga mga Buhat)**
15. Other Community, Social & Personal Services **(Uban pang mga Serbisyo sa Katilingban, katawhan ug Personal)**
16. Private Households **(Pribadong mga Pamilya)**
17. Extraterritorial Organizations **(Mga Organisayon nga Gawas sa Limitasyon sa Teritoryo sa Nasud)**
18. Others **(Uban pa)**:______

Q8 Personal Monthly income (PHP) *(Encircle one item)*

1. No income
2. Below 2,000
3. 2,000– 3,999
4. 4,000– 5,999
5. 6,000– 7,999
6. 8,000– 9,999
7. 10,000– 14,999
8. 15,000– 19,999
9. 20,000– 24,999
10. 25,000– 29,999
11. 30,000– 34,999
12. 35,000– 39,999
13. 40,000– 49,999
14. 50,000– 59,999
15. 60,000– 79,999
16. 80,000– 99,999
17. 100,000–149,999
18. 150,000–199,999
19. 200,000–299,999
20. 300,000–499,999
21. Above 500,000

Q9 **Workplace address**
______ Landmark ______ Barangay ______ Municipality/City ______ Province

Q10 **School address**
______ Landmark ______ Barangay ______ Municipality/City ______ Province

Q11 Workplace/School Start Time (**Oras sa Pagsugod**) _______ : _______ (use military time)

Q12 Workplace/School Finish Time (**Oras sa Paghuman**) _______ : _______ (use military time)

Q13 Work/School hours **1.** Fixed Time **2.** Flexible Time **3.** Not Applicable

Q14 Type of Driver's License (**Klase sa lisensya sa pagmaneho**) **1.** None **2.** Student **3.** Non-Professional **4.** Professional

Q15 Number of vehicles for your own use
1. Motorcycle: ________ **2.** Car/SUV/Pick-up/Innova: ________ **3.** Others (Specify: ________): ________

Source: JICA Expert Team

Figure A3.3.14 Form 2 - Household Member Information

(2) Stated Preference Survey

Respondent

- At the bus terminal, train station, highway rest area, and airport, 400 respondents were interviewed.

Questionnaire Contents

- Personal Info: Income level, car ownership
- Scenarios: 400 respondents × 3 = 1200 samples

Methodology

- Discrete Choice Model

(3) Ways to Improve Survey Response Rates.

- To improve the response rate for a public transport survey, consider the following strategies:

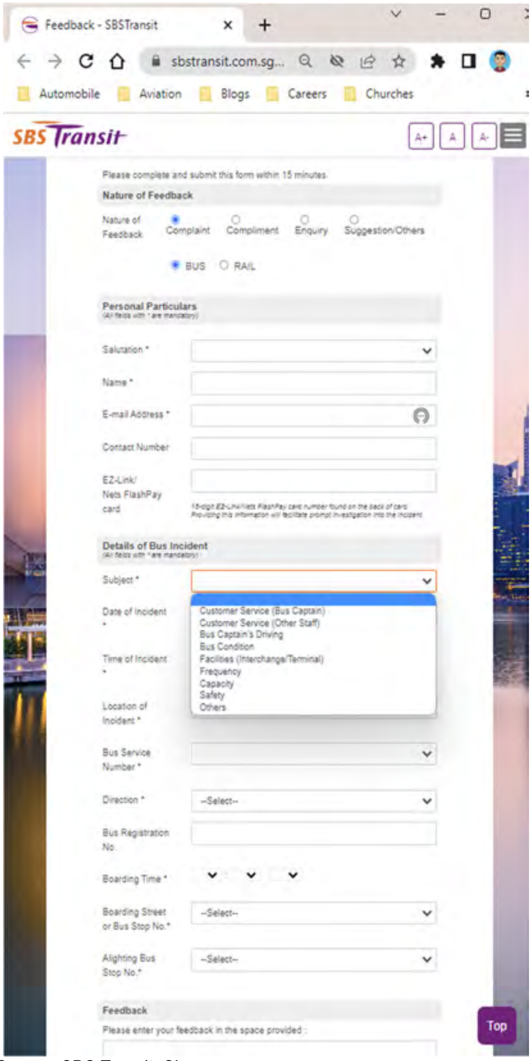
  - Clear and concise survey form design: Ensure the survey is easy to understand and complete. Keep the questions short, focused, and relevant to public transport experiences.
  - Keep it short: People are more likely to participate if the survey is brief and doesn't take up too much time. Limit the number of questions and only include essential information. The two steps above also make the surveyor's work simpler to focus on engaging the surveyed.
  - Use an appealing survey invitation: Craft a compelling and concise invitation message that highlights the importance and benefits of participating in the survey. Explain exactly how their feedback can contribute to improving public transport services.
  - Targeted distribution: Focus on reaching out to specific groups of individuals who are more likely to use public transport. Utilize targeted advertising, email campaigns, social media promotions, or collaborate with local community organizations to distribute the survey to relevant audiences.
  - Incentives: Consider offering small incentives to survey participants to encourage engagement. This could include discounts on public transport fares, vouchers, or entries into a prize draw.
  - Mobile-friendly survey: Optimize the survey for mobile devices since many people prefer to take surveys on their smartphones or tablets. A mobile-friendly survey design can improve accessibility and increase response rates. This is discussed further in Feedback via Internet or Mobile Channels.
  - Multiple survey channels: Utilize various channels to distribute the survey, such as online platforms, social media, email, physical flyers, and posters. Chances of capturing a broader range of responses are higher by reaching people through multiple channels.
  - Follow-up reminders: Send reminder notifications or emails to those who still need to complete the survey. A gentle nudge can prompt participants to act and submit their responses.
  - Engage local influencers or stakeholders: Collaborate with local influencers, community leaders, or public transport stakeholders to help promote the survey. Their endorsement can increase the survey's visibility and credibility, resulting in a higher response rate.
  - Transparent data usage and confidentiality: Clearly communicate how the collected data will be used, emphasizing its importance for improving public transport services. Assure participants that their responses will remain confidential, which can alleviate privacy concerns and encourage more people to participate.
- The key is to make the survey process as easy, appealing, and rewarding as possible for participants while making it easier for the surveyors to focus on engaging them. The above strategies can help to increase the response rate and gather valuable insights to enhance public transport services.

4) Feedback via Internet or Mobile Channels

- Internet and mobile channels should be utilized most of the time to gather large amounts of information related to public transport operations.
- This use of technology has the following advantages:
  - Wide Reach: Broader sample for data collection.
  - Cost-Effectiveness: Eliminate the need for printing, postage, and manpower, making them a more budget-friendly option.
  - Convenience and Accessibility: Respondents can participate at their own pace and preferred time, while analysts can collect data efficiently from anywhere.
  - Quick Data Collection: Responses can be collected rapidly in real-time, eliminating the need for manual data entry and reducing turnaround time.
  - Flexibility in Question Types: It could be multiple choice, rating scales, and open-ended questions. This flexibility allows analysts to gather different data types and gain deeper insights.
  - Anonymity and Privacy: Makes respondents more comfortable and encourages them to express their opinions more freely, leading to more accurate and unbiased data.
  - Data Accuracy and Quality: Built-in mechanisms to prevent errors and ensure data accuracy, such as skip logic and validation checks, reduced response errors, and improved data quality.
  - Easy Data Analysis and Interpretation: Analytical tools and software can streamline the data analysis process, allowing analysts to extract valuable insights efficiently.
  - Environmental Impact: By eliminating paper-based surveys, internet and mobile surveys contribute to environmental sustainability. They reduce paper waste and carbon emissions associated with printing and transportation.
  - Integration with Other Systems: Such as customer relationship management or data analysis tools to enable seamless data transfer and enhance the overall analysis process.

(1) Example: Singapore

- User-friendly internet form to collect important feedback information for effective classification, tracking and dissemination to the correct departments in charge.
- Can be adapted to mobile phone applications.



Source: SBS Transit, Singapore

Figure A3.3.15 Internet Feedback From, SBS Transit, Singapore

(2) Example: Australia

- Use of QR codes linking directly to mobile-friendly feedback form.

Source: www.transport.nsw.gov.au

Figure A3.3.16 QR codes feedback link, NSW, Australia

(3) Example: India

- QR codes can be adapted to specifically report vehicle defects directly to the operator's workshop.

Source: www.newsmeter.in

Figure A3.3.17 QR codes feedback on Bus Condition, India

(4) Overall Effectiveness

- Internet and mobile surveys offer numerous advantages, including wider reach, cost-effectiveness, convenience, quick data collection, flexibility in question types, anonymity, data accuracy, and environmental benefits.
- However, they still need to be complemented with surveys for specific data that cannot be collected through internet feedback that is predominantly anonymous.

5) Extraction of operational issues and directions for solution

Steps for effective follow-up on passenger feedback and surveys:

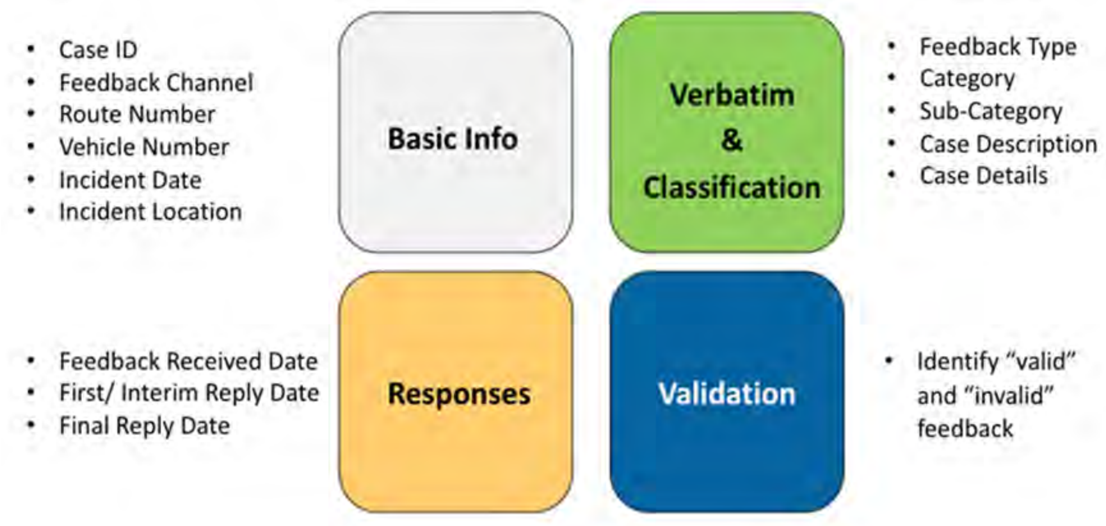
Step 1: Standardization of feedback treatment, submission, and classification.

Step 2: Set reporting standards and benchmarks.

Step 3: Analyze the top 10 complaints/compliments and major trends.

(1) Standardization of feedback treatment and submission across all operators

- Record all feedback received into a centralized feedback management system.
- Track all actions, including replies, investigation findings, and validation.

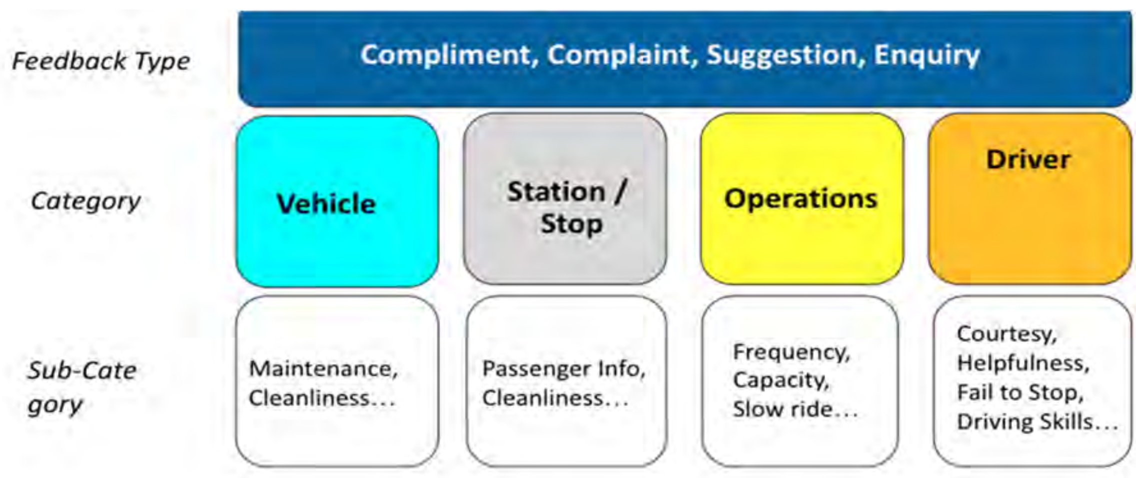


Source: JICA Expert Team

Figure A3.3.18 Feedback Management Process Flow

(2) Standardization of feedback classification across all operators

- Three-level classification
- Concise
- Focus on issues with high feedback volume



Source: JICA Expert Team

Figure A3.3.19 Classification of Feedback

(3) Reporting and Benchmark

- Possible actions and reporting with the data collected.

Source: JICA Expert Team

Figure A3.3.20 Feedback Management Process Flow

- Top 10 Complaints (Example)

Table A3.3.1 Analysis of the Top 10 Complaints for One Period

	Month/Quarter1			Month/Quarter2	
Rank	Top Complaints	Count	Rank	Top Complaints	Count
1	Passenger Safety	72	1	Fail to stop	86
2	Fail to stop	65	2	Passenger Safety	81
3	Waiting Time	42	3	Waiting Time	45
4	Courtesy	32	4	Courtesy	26
5	Helpfulness	30	5	Helpfulness	24
6	Driving skills	18	6	Bus Condition	17
7	Bus Condition	17	7	Driving Etiquette	16
8	Slow ride	14	8	Slow ride	15
9	Driving Etiquette	12	9	Fare Dispute	12
10	Comfort	11	10	Punctuality	12

Driver Service	(orange)
Driving related	(green)
Service Satisfaction	(yellow)
Vehicle-related	(cyan)
Fare-related	(pink)

Source: JICA Expert Team

- Can be further reported by operator or route as necessary.
- Top 10 compliments (example).

Table A3.3.2 Analysis of Top 10 Compliments for a Period

Rank	Month/Quarter1 Top Compliments	Count
1	Courtesy	479
2	Driver Service	193
3	Staff helpfulness	126
4	Driving skills	24
5	Passenger safety	17
6	Ride comfort	5
7	Knowledge	4
8	Driving Etiquette	2
9	Passenger education	1
10	Bus condition	1

Rank	Month/Quarter2 Top Compliments	Count
1	Courtesy	402
2	Driver Service	94
3	Staff helpfulness	88
4	Driving skills	18
5	Passenger safety	8
6	Ride comfort	7
7	Knowledge	4
8	Driving Etiquette	1
9	Passenger education	1
10	Publicity	1

Driver Service	
Driving related	
Service Satisfaction	
Vehicle-related	
Stations	

Source: JICA Expert Team

- Can be further reported by operator or route as necessary.

(4) Trends

- Percentage satisfied with public transport modes over the past 5 years.

Table A3.3.3 Public Transport Satisfaction Trends

	Year 1	Year 2	Year 3	Year 4	Year 5
Public Transport	94.5	97.9	99.4	97.6	92.0
Tram	96.7	98.0	99.3	97.3	90.8
Bus/Trolleybus	91.8	97.8	99.5	97.9	93.6

Source: JICA Expert Team

- Year-on-year comparison of satisfaction score and percentage of commuters satisfied with public transport service attributes.

Table A3.3.4 Public Transport Satisfaction Attributes

Public Transport Service Attributes	Satisfaction Score		Satisfied %	
	2020	2021	2020	2021
Waiting Time	7.4	7.3	84.7	80.9
Reliability	7.9	7.8	94.0	89.4
Route Information	7.7	7.8	87.2	89.2
Station/Stop Accessibility	8.0	8.0	91.1	91.9
Comfort	7.7	7.7	92.6	88.3
Travel Time	7.7	7.7	92.1	87.9
Customer Service	7.9	7.8	92.8	87.2
Safety/Security	8.2	8.0	95.6	89.9
Overall Satisfaction	7.8	7.8	97.6	92.0

Source: JICA Expert Team

A3.4 Line Details

1) Full-Service Case

Table A3.4.1 Full-Service Case Line Calculation

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
1	Tram	Baščaršija	Željeznička stanica	12	10	3	3	
1	Tram	Željeznička stanica	Baščaršija	12	10			
2	Tram	Baščaršija	Čengić vila A	7	10	6	5	
2	Tram	Čengić vila terminus	Baščaršija	7	10			
3	Tram	Baščaršija	Ilidža	4	4	19	19	
3	Tram	Ilidža	Baščaršija	4	4			
4	Tram	Željeznička stanica	Ilidža	30	23	3	4	
4	Tram	Ilidža	Željeznička stanica	30	15			
5	Tram	Baščaršija	Nedžarići terminus A	9	13	8	6	
5	Tram	Nedžarići terminus B	Baščaršija	9	13			
6	Tram	Skenderija terminus	Ilidža	10	9	8	8	
6	Tram	Ilidža	Skenderija terminus	10	9			
101	Trolleybus	Otoka terminal	Trg Austrije	7	7	12	12	
101	Trolleybus	Trg Austrije	Otoka terminal	5	5			
102	Trolleybus	Otoka terminal	Jezero B	36	28	2	3	
102	Trolleybus	Jezero B	Otoka terminal	36	23			
103	Trolleybus	Dobrinja	Trg Austrije	32	30	3	3	
103	Trolleybus	Trg Austrije	Dobrinja	32	30			
104	Trolleybus	Alipašino polje terminus	Trg Austrije	14		5		Peak hour service
104	Trolleybus	Trg Austrije	Alipašino polje terminus	14				Peak hour service
107	Trolleybus	Dobrinja	Jezero B	53	45	2	2	
107	Trolleybus	Jezero B	Dobrinja	53	60			
108	Trolleybus	Otoka terminal	Dobrinja	11	11	7	7	
108	Trolleybus	Dobrinja	Otoka terminal	11	11			
14	Bus	Dom Armije	Podhrastovi	13	13	3	3	
14	Bus	Podhrastovi	Dom Armije	13	13			
15	Bus	Željeznička stanica terminal	Buća Potok	96	38	1	2	

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
15	Bus	Buća Potok	Željeznička stanica terminal	69	50			
15b	Bus	Otoka terminal	Buća Potok	60	30	2	2	
15b	Bus	Buća Potok	Otoka terminal	30	60			
16	Bus	Dom Armije	Bare	45	40	1	1	
16	Bus	Bare	Dom Armije	45	40			
16b	Bus	Dom Armije	Koševsko brdo	30	30	2	2	
16b	Bus	Koševsko brdo	Dom Armije	30	30			
17	Bus	Dom Armije	Breka	24	20	2	2	
17	Bus	Breka	Dom Armije	24	20			
17b	Bus	Dom Armije	Breka II	60	30	1	1	
17b	Bus	Breka II	Dom Armije	40	60			
18	Bus	Drvenija terminal	Donji Pofalići B	30	30	2	2	
18	Bus	Donji Pofalići B	Drvenija terminal	20	30			
20	Bus	Park terminal	Jagomir A	30	60	1	1	
20	Bus	Jagomir B	Park terminal	60	30			
20b	Bus	Park terminal	Vrbovska 1	60	30	1	2	
20b	Bus	Vrbovska 1	Park terminal	30				Peak hour service in this direction
21	Bus	Sutjeska	Vogošća A	14	27	5	3	
21	Bus	Vogošća A	Sutjeska	14	27			
21b	Bus	Sutjeska	Donja Vogošća	60		1	2	Peak hour service in this direction
21b	Bus	Donja Vogošća	Sutjeska	60	60			
22	Bus	Sutjeska	Lješevo					No operations
22	Bus	Lješevo	Sutjeska					No operations
22a	Bus	Stup terminal	Vogošća terminal	30	30	2	2	
22a	Bus	Vogošća terminal	Stup terminal	30	30			
23	Bus	Željeznička stanica terminal	Rajlovac A				1	No operations
23	Bus	Rajlovac A	Željeznička stanica terminal					No operations
23a	Bus	Autobuska stanica	Željeznička stanica	150		2	4	Peak hour service in this direction
23a	Bus	Željeznička stanica	Autobuska stanica	150	75			

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
23c	Bus	Otoka terminal	Boljakov Potok	45	30	2	2	
23c	Bus	Boljakov Potok	Otoka terminal	30	60			
24	Bus	Stup terminal	Smiljevići okretnica	120	60	1	1	
24	Bus	Smiljevići okretnica	Stup terminal	60	60			
26	Bus	Stup terminal	Gornji Ahatovići					No operations
26	Bus	Gornji Ahatovići	Stup terminal	0	0	0	0	
26	Bus	Stup terminal	Ahatovići A	60	60	1	1	
26	Bus	Ahatovići B	Stup terminal					No operations in this direction
26a	Bus	Stup terminal	Dobroševići A	60	60	1	1	
26a	Bus	Dobroševići B	Stup terminal	60	60			
27	Bus	Ilidža terminal	Hrasnica Famos	15	15	4	4	
27	Bus	Hrasnica Famos	Ilidža terminal	10	15			
27a	Bus	Ilidža terminal	Sokolović kolonija	15	60	3	1	
27a	Bus	Sokolović kolonija	Ilidža terminal	15	30			
27b	Bus	Ilidža terminal	Hrasnica terminus	30		1		Peak hour service
27b	Bus	Hrasnica terminus	Ilidža terminal	60				Peak hour service
27b-1	Bus	Ilidža terminal	Hrasnica terminus					No operations
27b-1	Bus	Hrasnica terminus	Ilidža terminal					No operations
27e-1	Bus	Baščaršija	Hrasnica Famos					No operations
27e-1	Bus	Hrasnica Famos	Baščaršija					No operations
28	Bus	Ilidža terminal	Kobiljača A	60	30	2	2	
28	Bus	Kobiljača A	Ilidža terminal	30	30			
28e	Bus	Ilidža terminal	Vrelo Bosne					No operations
28e	Bus	Vrelo Bosne	Ilidža terminal					No operations
29	Bus	Sutjeska	Kamenica-Crna rijeka	120		1	1	Peak hour service in this direction
29	Bus	Kamenica-Crna rijeka	Sutjeska		180			Off-peak hour service in this direction

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
30	Bus	Ilidža terminal	Hadžići A					No operations
30	Bus	Hadžići B	Ilidža terminal					No operations
30	Bus	Ilidža terminal	Drozgometva A	100	50	1	2	
30	Bus	Drozgometva A	Ilidža terminal	100	38			
31	Bus	Nedžarići terminal	Dobrinja	30	30	1	1	
31	Bus	Dobrinja	Nedžarići terminal	30	30			
31e	Bus	Dobrinja V A	Vijećnica terminal	17	16	12	10	
31e	Bus	Vijećnica terminal	Dobrinja V A	17	24			
32	Bus	Ilidža terminal	Butmir okretnica	10	30	2	2	
32	Bus	Butmir okretnica	Ilidža terminal	30	30			
33	Bus	Ilidža terminal	Vukovići	48	18	5	5	
33	Bus	Vukovići	Ilidža terminal	16	36			
35	Bus	Autobuska stanica	Krivojevići B					No operations
35	Bus	Krivojevići B	Autobuska stanica					No operations
36	Bus	Nedžarići terminal	Naselje Aerodrom MZ	60		1		Peak hour service
36	Bus	Naselje Aerodrom MZ	Nedžarići terminal	60				Peak hour service
38	Bus	Dobrinja	Ilidža terminal	60		1		Peak hour service
38	Bus	Ilidža terminal	Dobrinja	60				Peak hour service
39	Bus	Nedžarići terminal	Dobrinja IV	60	30	1	1	
39	Bus	Dobrinja IV	Nedžarići terminal	30	60			
41	Bus	Drvenija terminal	Gornji Velešići					No operations
41	Bus	Gornji Velešići	Drvenija terminal					No operations
41b	Bus	Drvenija terminal	Donji Velesici					No operations
41b	Bus	Donji Velesici	Drvenija terminal					No operations
43	Bus	Ilidža terminal	Hendekuša okretnica	30	30	2	2	
43	Bus	Hendekuša okretnica	Ilidža terminal	30	20			

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
45	Bus	Ilidža terminal	Garež A					No operations
45	Bus	Garež A	Ilidža terminal					No operations
45b	Bus	Ilidža terminal	Garež A					No operations
45b	Bus	Garež A	Ilidža terminal					No operations
46	Bus	Ilidža terminal	Vlakovo	60	30	1	2	
46	Bus	Vlakovo	Ilidža terminal	60	60			
47	Bus	Ilidža terminal	Trnovo centar A					No operations
47	Bus	Trnovo centar A	Ilidža terminal					No operations
47	Bus	Ilidža terminal	Turovi					No operations
47	Bus	Turovi	Ilidža terminal					No operations
47a	Bus	Ilidža terminal	Turovi					No operations
47a	Bus	Turovi	Ilidža terminal					No operations
49	Bus	Ilidža terminal	Doglodi okretnica	60	60	1	1	
49	Bus	Doglodi okretnica	Ilidža terminal	60	60			
49	Bus	Ilidža terminal	Otes okretnica					No operations
49	Bus	Trg Oteškog bataljona	Ilidža terminal					No operations
51	Minibus	Baščaršija terminal	Vratnik Višegradska kapija	24	24	1	1	
51	Minibus	Vratnik Višegradska kapija	Baščaršija terminal	24	24			
52	Minibus	Baščaršija terminal	Gornji Faletići	30	30	2	2	
52	Minibus	Gornji Faletići	Baščaršija terminal	20	30			
54	Minibus	Latinska ćuprija terminal	Hošin brijeg					Currently combined with 56
54	Minibus	Hošin brijeg	Latinska ćuprija terminal					Currently combined with 56
55	Minibus	Baščaršija terminal	Sedrenik samoposluga A	60	24	1	2	
55	Minibus	Sedrenik samoposluga A	Baščaršija terminal	60	30			

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
56	Minibus	Latinska ćuprija terminal	Popov gaj	40	48	1	1	Currently combined with 54
56	Minibus	Popov gaj	Latinska ćuprija terminal	40	40			Currently combined with 54
57	Minibus	Pazarić	Osenik		30	1	1	Off-peak hour service
57	Minibus	Osenik	Pazarić		60			
58	Minibus	Baščaršija terminal	Mihrivode					No operations
58	Minibus	Mihrivode	Baščaršija terminal					No operations
59a	Minibus	Latinska ćuprija terminal	Komatin okretnica	26	26	2	2	
59a	Minibus	Komatin okretnica	Latinska ćuprija terminal	26	26			
60	Minibus	Vogošća terminal	Tihovići okretnica	60	15	1	2	
60	Minibus	Tihovići okretnica	Vogošća terminal	60	30			
61	Minibus	Stup terminal	Buća Potok	30	30	2	2	
61	Minibus	Buća Potok	Stup terminal	30	30			
62	Minibus	Drvenija terminal	Gornji Velesici (HUM)	60	60	1	1	
62	Minibus	Gornji Velesici (HUM)	Drvenija terminal	60	60			
63	Minibus	Latinska ćuprija terminal	Mahmutovac	40	30	1	1	
63	Minibus	Mahmutovac	Latinska ćuprija terminal	40	30			
64	Minibus	Park terminal	Barice					No operations
64	Minibus	Barice	Park terminal					No operations
65	Minibus	Ekonomska škola A	Obad okretnica					No operations
65	Minibus	Obad okretnica	Ekonomska škola A					No operations
66	Minibus	Ekonomska škola A	Hum	60	30	1	1	
66	Minibus	Hum	Ekonomska škola A	60	60			
67	Minibus	Ekonomska škola A	Bakarevac	60	60	1	1	
67	Minibus	Bakarevac	Ekonomska škola A		60			Off-peak hour service in this direction

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
68	Minibus	Sutjeska	Poljine	60	120	1	1	
68	Minibus	Poljine	Sutjeska	30	60			
69	Minibus	Sutjeska	Nahorevo	60	60	1	1	
69	Minibus	Nahorevo	Sutjeska	60	60			
70	Minibus	Grbavica terminal	Hrasno brdo	30		1	-1	Peak hour service
70	Minibus	Hrasno brdo	Grbavica terminal	60				Peak hour service
71a	Minibus	Stup terminal	Dom Paljevska A				-1	No operations
71a	Minibus	Dom Paljevska A	Stup terminal					No operations
72	Minibus	Park terminal	Panjina kula	30	60	1	1	
72	Minibus	Panjina kula	Park terminal	60	60			
73	Minibus	Vijećnica terminal	Hladivode okretnica	60	60	1	1	
73	Minibus	Hladivode okretnica	Vijećnica terminal	60	60			
74	Minibus	Park terminal	Sedrenik Rogina	30	30	2	2	
74	Minibus	Sedrenik Rogina	Park terminal	24	30			
75	Minibus	Ilidža terminal	Mokrine	120	120	1	1	
75	Minibus	Mokrine	Ilidža terminal	120	120			
76	Minibus	Mokrine	Hadžići B	60		1		Peak hour service
76	Minibus	Hadžići B	Mokrine	60				
77	Minibus	Lokve	Pazarić	60		1		Peak hour service in this direction
77	Minibus	Pazarić	Lokve					
78	Minibus	Tarčin terminal	Budmolići	60		1		Peak hour service
78	Minibus	Budmolići	Tarčin terminal	30				
79	Minibus	Dupovci A	Ljubovčići	60	30	1	2	
79	Minibus	Ljubovčići	Dupovci A					No operations
80	Minibus	Tarčin terminal	Korča	60	60	1	1	
80	Minibus	Korča	Škola H.E.Šarić A	60	60			
81	Minibus	Tarčin terminal	Luke okretnica					No operations
81	Minibus	Luke okretnica	Tarčin terminal					No operations
82	Minibus	Hadžići B	Kasatići okretnica	60	60	1	1	
82	Minibus	Kasatići okretnica	Hadžići B	60	60			
83	Minibus	Hadžići B	Ušivak I B	60		1		Peak hour service

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
83	Minibus	Ušivak I B	Hadžići B	60				Peak hour service
84	Minibus	Ilidža terminal	Miševići	60	30	1	2	
84	Minibus	Miševići	Ilidža terminal	60				Peak hour service in this direction
85	Minibus	Ilidža terminal	Sinanovići	120		1		Peak hour service in this direction
85	Minibus	Sinanovići	Ilidža terminal					No operations
85a	Minibus	Sinanovići	Trnovo					No operations
85a	Minibus	Trnovo	Sinanovići					No operations
89	Minibus	Park terminal	Mrkovići			1		No operations
89	Minibus	Mrkovići	Park terminal	60				Peak hour service in this direction
90	Minibus	Tarčin terminal	Trzanj okretnica					No operations
90	Minibus	Trzanj okretnica	Tarčin terminal					No operations
94	Minibus	Vogošća terminal	Gora					No operations
94	Minibus	Gora	Vogošća terminal					No operations
95	Minibus	Vijećnica terminal	Brusulje okretnica					No operations
95	Minibus	Brusulje okretnica	Vijećnica terminal					No operations
98	Minibus	Latinska ćuprija terminal	Trebević Vidikovac					No operations
98	Minibus	Trebević Vidikovac	Latinska ćuprija terminal					No operations
149	Bus	Otoka terminal	Brijesce (Okretaljka)					No operations
149	Bus	Brijesce (Okretaljka)	Otoka terminal					No operations
153	Bus	Otoka terminal	Rasima Turkusica 2					No operations
153	Bus	Rasima Turkusica 2	Otoka terminal					No operations
155	Bus	Sutjeska	Orahov Brijeg 31					No operations
155	Bus	Orahov Brijeg 31	Sutjeska					No operations
180	Bus	Otoka terminal	Sokolje A					No operations
180	Bus	Sokolje A	Otoka terminal					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
200e	Bus	Baščaršija bezistan	Aerodrom Sarajevo					No operations
200e	Bus	Aerodrom Sarajevo	Baščaršija bezistan					No operations
201	Bus	Autobuska stanica	Ilijas	60	80	2	3	
201	Bus	Ilijas	Autobuska stanica	60	40			
203	Bus	Autobuska stanica	Raštelica A					No operations
203	Bus	Raštelica A	Autobuska stanica					No operations
21a	Bus	Sutjeska-D. Vogošća				1	1	Lines in timetable but not in model
39b	Bus	Otoka terminal	Dobrinja IV			1	1	Lines in timetable but not in model
41a	Bus	Drvenija terminal	Velešići			1	1	Lines in timetable but not in model
44	Bus	Franje račkog	Bjelašnica			1	1	Lines in timetable but not in model
202	Bus	Autobuska stanica	Kamenica			1	1	Lines in timetable but not in model
220	Bus	Ilijaš	Bioča			1	1	Lines in timetable but not in model
221	Bus	Ilijaš	Misoča			1	1	Lines in timetable but not in model
222	Bus	Ilijaš	Srednje			1	1	Lines in timetable but not in model
223	Bus	Ilijaš	Kamenica (Crna rijeka)			1	1	Lines in timetable but not in model
224	Bus	Srednje	Kamenica (Crna rijeka)			1	1	Lines in timetable but not in model
225	Bus	Srednje	Sokolina			1	1	Lines in timetable but not in model
226	Bus	Ilijaš	Popovića			1	1	Lines in timetable but not in model
227	Bus	Autobuska stanica	Dragoradi			1	1	Lines in timetable but not in model
	Bus	Dobrinja	Ilidža			1	1	Lines in timetable but not in model

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
48	Minibus	Garež	Delijaši-Hamzići			0	0	Lines in timetable but not in model
53	Minibus	Otoka	Mojmilo Brdo (Turkušići)			1	0	Lines in timetable but not in model
67a	Minibus	Ekonomska škola	Bakarevac (Rezervoar)			0	0	Lines in timetable but not in model
71	Minibus	Stup	Rječica			1	0	Lines in timetable but not in model
	Minibus	Sutjeska	Orahov brijeg			1	0	Lines in timetable but not in model
	Minibus	Otoka	Biiješće			1	0	Lines in timetable but not in model
	Minibus	Otoka	Sokolje			1	0	Lines in timetable but not in model

Source: JICA Expert Team

Table A3.4.2 Full Service Case Line Summary

	AM Peak Number of Vehicles	Off Peak Number of Vehicles
Tram	47	45
Trolleybus	31	27
Bus	86	86
Minibus	38	28
Total	**202**	**186**

Source: JICA Expert Team

2) Hypothetical Service Case

Table A3.4.3 Ideal Service Case Line Calculation

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
1	Tram	Baščaršija	Željeznička stanica	8	10	5	3	
1	Tram	Željeznička stanica	Baščaršija	8	10			
2	Tram	Baščaršija	Čengić vila A	7	10	6	5	
2	Tram	Čengić vila terminus	Baščaršija	7	10			
3	Tram	Baščaršija	Ilidža	4	4	19	19	
3	Tram	Ilidža	Baščaršija	4	4			
4	Tram	Željeznička stanica	Ilidža	8	10	11	8	
4	Tram	Ilidža	Željeznička stanica	8	10			
5	Tram	Baščaršija	Nedžarići terminus A	8	10	9	8	
5	Tram	Nedžarići terminus B	Baščaršija	8	10			
6	Tram	Skenderija terminus	Ilidža	8	9	10	8	
6	Tram	Ilidža	Skenderija terminus	8	9			
101	Trolleybus	Otoka terminal	Trg Austrije	7	7	12	12	
101	Trolleybus	Trg Austrije	Otoka terminal	5	5			
102	Trolleybus	Otoka terminal	Jezero B	10	12	7	6	
102	Trolleybus	Jezero B	Otoka terminal	10	12			
103	Trolleybus	Dobrinja	Trg Austrije	10	12	10	8	
103	Trolleybus	Trg Austrije	Dobrinja	10	12			
104	Trolleybus	Alipašino polje terminus	Trg Austrije	10		7		Peak hour service
104	Trolleybus	Trg Austrije	Alipašino polje terminus	10				Peak hour service
107	Trolleybus	Dobrinja	Jezero B	10	12	11	9	
107	Trolleybus	Jezero B	Dobrinja	10	12			
108	Trolleybus	Otoka terminal	Dobrinja	10	11	8	7	
108	Trolleybus	Dobrinja	Otoka terminal	10	11			
14	Bus	Dom Armije	Podhrastovi	13	13	3	3	
14	Bus	Podhrastovi	Dom Armije	13	13			
15	Bus	Željeznička stanica terminal	Buća Potok	15	30	5	3	

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
15	Bus	Buća Potok	Željeznička stanica terminal	15	30			
15b	Bus	Otoka terminal	Buća Potok	15	30	6	3	
15b	Bus	Buća Potok	Otoka terminal	15	30			
16	Bus	Dom Armije	Bare	15	30	3	1	
16	Bus	Bare	Dom Armije	15	30			
16b	Bus	Dom Armije	Koševsko brdo	15	30	4	2	
16b	Bus	Koševsko brdo	Dom Armije	15	30			
17	Bus	Dom Armije	Breka	15	20	3	2	
17	Bus	Breka	Dom Armije	15	20			
17b	Bus	Dom Armije	Breka II	15	30	3	2	
17b	Bus	Breka II	Dom Armije	15	30			
18	Bus	Drvenija terminal	Donji Pofalići B	15	30	3	2	
18	Bus	Donji Pofalići B	Drvenija terminal	15	30			
20	Bus	Park terminal	Jagomir A	15	30	3	2	
20	Bus	Jagomir B	Park terminal	15	30			
20b	Bus	Park terminal	Vrbovska 1	15	30	3	2	
20b	Bus	Vrbovska 1	Park terminal	15				Peak hour service in this direction
21	Bus	Sutjeska	Vogošća A	14	27	5	3	
21	Bus	Vogošća A	Sutjeska	14	27			
21b	Bus	Sutjeska	Donja Vogošća	15		4	4	Peak hour service in this direction
21b	Bus	Donja Vogošća	Sutjeska	15	30			
22	Bus	Sutjeska	Lješevo					No operations
22	Bus	Lješevo	Sutjeska					No operations
22a	Bus	Stup terminal	Vogošća terminal	15	30	4	2	
22a	Bus	Vogošća terminal	Stup terminal	15	30			
23	Bus	Željeznička stanica terminal	Rajlovac A					No operations
23	Bus	Rajlovac A	Željeznička stanica terminal					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
23a	Bus	Autobuska stanica	Željeznička stanica	15		20	10	Peak hour service in this direction
23a	Bus	Željeznička stanica	Autobuska stanica	15	30			
23c	Bus	Otoka terminal	Boljakov Potok	15	30	5	3	
23c	Bus	Boljakov Potok	Otoka terminal	15	30			
24	Bus	Stup terminal	Smiljevići okretnica	15	30	6	2	
24	Bus	Smiljevići okretnica	Stup terminal	15	30			
26	Bus	Stup terminal	Gornji Ahatovići					No operations
26	Bus	Gornji Ahatovići	Stup terminal	0	0	0	0	
26	Bus	Stup terminal	Ahatovići A	15	30	4	2	
26	Bus	Ahatovići B	Stup terminal					No operations in this direction
26a	Bus	Stup terminal	Dobroševići A	15	30	4	2	
26a	Bus	Dobroševići B	Stup terminal	15	30			
27	Bus	Ilidža terminal	Hrasnica Famos	15	15	4	4	
27	Bus	Hrasnica Famos	Ilidža terminal	10	15			
27a	Bus	Ilidža terminal	Sokolović kolonija	15	30	3	2	
27a	Bus	Sokolović kolonija	Ilidža terminal	15	30			
27b	Bus	Ilidža terminal	Hrasnica terminus	15		3		Peak hour service
27b	Bus	Hrasnica terminus	Ilidža terminal	15				Peak hour service
27b-1	Bus	Ilidža terminal	Hrasnica terminus					No operations
27b-1	Bus	Hrasnica terminus	Ilidža terminal					No operations
27e-1	Bus	Baščaršija	Hrasnica Famos					No operations
27e-1	Bus	Hrasnica Famos	Baščaršija					No operations
28	Bus	Ilidža terminal	Kobiljača A	15	30	6	2	
28	Bus	Kobiljača A	Ilidža terminal	15	30			
28e	Bus	Ilidža terminal	Vrelo Bosne					No operations
28e	Bus	Vrelo Bosne	Ilidža terminal					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
29	Bus	Sutjeska	Kamenica-Crna rijeka	15		8	6	Peak hour service in this direction
29	Bus	Kamenica-Crna rijeka	Sutjeska		30			Off-peak hour service in this direction
30	Bus	Ilidža terminal	Hadžići A					No operations
30	Bus	Hadžići B	Ilidža terminal					No operations
30	Bus	Ilidža terminal	Drozgometva A	15	30	7	3	
30	Bus	Drozgometva A	Ilidža terminal	15	30			
31	Bus	Nedžarići terminal	Dobrinja	15	30	2	1	
31	Bus	Dobrinja	Nedžarići terminal	15	30			
31e	Bus	Dobrinja V A	Vijećnica terminal	15	16	13	10	
31e	Bus	Vijećnica terminal	Dobrinja V A	15	24			
32	Bus	Ilidža terminal	Butmir okretnica	10	30	3	2	
32	Bus	Butmir okretnica	Ilidža terminal	15	30			
33	Bus	Ilidža terminal	Vukovići	15	18	11	6	
33	Bus	Vukovići	Ilidža terminal	15	30			
35	Bus	Autobuska stanica	Krivojevići B					No operations
35	Bus	Krivojevići B	Autobuska stanica					No operations
36	Bus	Nedžarići terminal	Naselje Aerodrom MZ	15		4		Peak hour service
36	Bus	Naselje Aerodrom MZ	Nedžarići terminal	15				Peak hour service
38	Bus	Dobrinja	Ilidža terminal	15	0	4		Peak hour service
38	Bus	Ilidža terminal	Dobrinja	15	0			Peak hour service
39	Bus	Nedžarići terminal	Dobrinja IV	15	30	3	2	
39	Bus	Dobrinja IV	Nedžarići terminal	15	30			
41	Bus	Drvenija terminal	Gornji Velešići					No operations
41	Bus	Gornji Velešići	Drvenija terminal					No operations
41b	Bus	Drvenija terminal	Donji Velesici					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
41b	Bus	Donji Velesici	Drvenija terminal					No operations
43	Bus	Ilidža terminal	Hendekuša okretnica	15	30	4	2	
43	Bus	Hendekuša okretnica	Ilidža terminal	15	20			
45	Bus	Ilidža terminal	Garež A					No operations
45	Bus	Garež A	Ilidža terminal					No operations
45b	Bus	Ilidža terminal	Garež A					No operations
45b	Bus	Garež A	Ilidža terminal					No operations
46	Bus	Ilidža terminal	Vlakovo	15	30	4	3	
46	Bus	Vlakovo	Ilidža terminal	15	30			
47	Bus	Ilidža terminal	Trnovo centar A					No operations
47	Bus	Trnovo centar A	Ilidža terminal					No operations
47	Bus	Ilidža terminal	Turovi					No operations
47	Bus	Turovi	Ilidža terminal					No operations
47a	Bus	Ilidža terminal	Turovi					No operations
47a	Bus	Turovi	Ilidža terminal					No operations
49	Bus	Ilidža terminal	Doglodi okretnica	15	30	4	2	
49	Bus	Doglodi okretnica	Ilidža terminal	15	30			
49	Bus	Ilidža terminal	Otes okretnica					No operations
49	Bus	Trg Oteškog bataljona	Ilidža terminal					No operations
51	Minibus	Baščaršija terminal	Vratnik Višegradska kapija	24	24	1	1	
51	Minibus	Vratnik Višegradska kapija	Baščaršija terminal	24	24			
52	Minibus	Baščaršija terminal	Gornji Faletići	30	30	2	2	
52	Minibus	Gornji Faletići	Baščaršija terminal	20	30			
54	Minibus	Latinska ćuprija terminal	Hošin brijeg					Currently combined with 56
54	Minibus	Hošin brijeg	Latinska ćuprija terminal					Currently combined with 56
55	Minibus	Baščaršija terminal	Sedrenik samoposluga A	30	24	2	2	

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
55	Minibus	Sedrenik samoposluga A	Baščaršija terminal	30	30			
56	Minibus	Latinska ćuprija terminal	Popov gaj	30	48	1	1	Currently combined with 54
56	Minibus	Popov gaj	Latinska ćuprija terminal	30	40			Currently combined with 54
57	Minibus	Pazarić	Osenik		30		1	Off-peak hour service
57	Minibus	Osenik	Pazarić		60			
58	Minibus	Baščaršija terminal	Mihrivode					No operations
58	Minibus	Mihrivode	Baščaršija terminal					No operations
59a	Minibus	Latinska ćuprija terminal	Komatin okretnica	26	26	2	2	
59a	Minibus	Komatin okretnica	Latinska ćuprija terminal	26	26			
60	Minibus	Vogošća terminal	Tihovići okretnica	30	15	2	2	
60	Minibus	Tihovići okretnica	Vogošća terminal	30	30			
61	Minibus	Stup terminal	Buća Potok	30	30	2	2	
61	Minibus	Buća Potok	Stup terminal	30	30			
62	Minibus	Drvenija terminal	Gornji Velesici (HUM)	30	60	2	1	
62	Minibus	Gornji Velesici (HUM)	Drvenija terminal	30	60			
63	Minibus	Latinska ćuprija terminal	Mahmutovac	30	30	1	1	
63	Minibus	Mahmutovac	Latinska ćuprija terminal	30	30			
64	Minibus	Park terminal	Barice					No operations
64	Minibus	Barice	Park terminal					No operations
65	Minibus	Ekonomska škola A	Obad okretnica					No operations
65	Minibus	Obad okretnica	Ekonomska škola A					No operations
66	Minibus	Ekonomska škola A	Hum	30	30	2	1	
66	Minibus	Hum	Ekonomska škola A	30	60			
67	Minibus	Ekonomska škola A	Bakarevac	30	60	2	1	
67	Minibus	Bakarevac	Ekonomska škola A		60			Off-peak hour service

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
								in this direction
68	Minibus	Sutjeska	Poljine	30	60	2	2	
68	Minibus	Poljine	Sutjeska	30	60			
69	Minibus	Sutjeska	Nahorevo	30	60	2	1	
69	Minibus	Nahorevo	Sutjeska	30	60			
70	Minibus	Grbavica terminal	Hrasno brdo	30		2		Peak hour service
70	Minibus	Hrasno brdo	Grbavica terminal	30				Peak hour service
71a	Minibus	Stup terminal	Dom Paljevska A					No operations
71a	Minibus	Dom Paljevska A	Stup terminal					No operations
72	Minibus	Park terminal	Panjina kula	30	60	2	1	
72	Minibus	Panjina kula	Park terminal	30	60			
73	Minibus	Vijećnica terminal	Hladivode okretnica	30	60	2	1	
73	Minibus	Hladivode okretnica	Vijećnica terminal	30	60			
74	Minibus	Park terminal	Sedrenik Rogina	30	30	2	2	
74	Minibus	Sedrenik Rogina	Park terminal	24	30			
75	Minibus	Ilidža terminal	Mokrine	30	60	4	2	
75	Minibus	Mokrine	Ilidža terminal	30	60			
76	Minibus	Mokrine	Hadžići B	30		2		Peak hour service
76	Minibus	Hadžići B	Mokrine	30				Peak hour service
77	Minibus	Lokve	Pazarić	30		2		Peak hour service in this direction
77	Minibus	Pazarić	Lokve					
78	Minibus	Tarčin terminal	Budmolići	30		2		Peak hour service
78	Minibus	Budmolići	Tarčin terminal	30				
79	Minibus	Dupovci A	Ljubovčići	30	30	2	2	
79	Minibus	Ljubovčići	Dupovci A					No operations
80	Minibus	Tarčin terminal	Korča	30	60	2	1	
80	Minibus	Korča	Škola H.E.Šarić A	30	60			
81	Minibus	Tarčin terminal	Luke okretnica					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
81	Minibus	Luke okretnica	Tarčin terminal					No operations
82	Minibus	Hadžići B	Kasatići okretnica	30	60	2	1	
82	Minibus	Kasatići okretnica	Hadžići B	30	60			
83	Minibus	Hadžići B	Ušivak I B	30		2		Peak hour service
83	Minibus	Ušivak I B	Hadžići B	30				Peak hour service
84	Minibus	Ilidža terminal	Miševići	30	30	2	2	
84	Minibus	Miševići	Ilidža terminal	30				Peak hour service in this direction
85	Minibus	Ilidža terminal	Sinanovići	30		4		Peak hour service in this direction
85	Minibus	Sinanovići	Ilidža terminal					No operations
85a	Minibus	Sinanovići	Trnovo					No operations
85a	Minibus	Trnovo	Sinanovići					No operations
89	Minibus	Park terminal	Mrkovići			2		No operations
89	Minibus	Mrkovići	Park terminal	30				Peak hour service in this direction
90	Minibus	Tarčin terminal	Trzanj okretnica					No operations
90	Minibus	Trzanj okretnica	Tarčin terminal					No operations
94	Minibus	Vogošća terminal	Gora					No operations
94	Minibus	Gora	Vogošća terminal					No operations
95	Minibus	Vijećnica terminal	Brusulje okretnica					No operations
95	Minibus	Brusulje okretnica	Vijećnica terminal					No operations
98	Minibus	Latinska ćuprija terminal	Trebević Vidikovac					No operations
98	Minibus	Trebević Vidikovac	Latinska ćuprija terminal					No operations
149	Bus	Otoka terminal	Brijesce (Okretaljka)					No operations
149	Bus	Brijesce (Okretaljka)	Otoka terminal					No operations
153	Bus	Otoka terminal	Rasima Turkusica 2					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
153	Bus	Rasima Turkusica 2	Otoka terminal					No operations
155	Bus	Sutjeska	Orahov Brijeg 31					No operations
155	Bus	Orahov Brijeg 31	Sutjeska					No operations
180	Bus	Otoka terminal	Sokolje A					No operations
180	Bus	Sokolje A	Otoka terminal					No operations
200e	Bus	Baščaršija bezistan	Aerodrom Sarajevo					No operations
200e	Bus	Aerodrom Sarajevo	Baščaršija bezistan					No operations
201	Bus	Autobuska stanica	Ilijas	15	60	8	4	
201	Bus	Ilijas	Autobuska stanica	15	40			
203	Bus	Autobuska stanica	Raštelica A					No operations
203	Bus	Raštelica A	Autobuska stanica					No operations
21a	Bus	Sutjeska-D. Vogošća				1	1	Lines in timetable but not in model
39b	Bus	Otoka terminal	Dobrinja IV			1	1	Lines in timetable but not in model
41a	Bus	Drvenija terminal	Velešići			1	1	Lines in timetable but not in model
44	Bus	Franje račkog	Bjelašnica			1	1	Lines in timetable but not in model
202	Bus	Autobuska stanica	Kamenica			1	1	Lines in timetable but not in model
220	Bus	Ilijaš	Bioča			1	1	Lines in timetable but not in model
221	Bus	Ilijaš	Misoča			1	1	Lines in timetable but not in model
222	Bus	Ilijaš	Srednje			1	1	Lines in timetable but not in model
223	Bus	Ilijaš	Kamenica (Crna rijeka)			1	1	Lines in timetable

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
								but not in model
224	Bus	Srednje	Kamenica (Crna rijeka)			1	1	Lines in timetable but not in model
225	Bus	Srednje	Sokolina			1	1	Lines in timetable but not in model
226	Bus	Ilijaš	Popovića			1	1	Lines in timetable but not in model
227	Bus	Autobuska stanica	Dragoradi			1	1	Lines in timetable but not in model
	Bus	Dobrinja	Ilidža			1	1	Lines in timetable but not in model
48	Minibus	Garež	Delijaši-Hamzići			0	0	Lines in timetable but not in model
53	Minibus	Otoka	Mojmilo Brdo (Turkušići)			1	0	Lines in timetable but not in model
67a	Minibus	Ekonomska škola	Bakarevac (Rezervoar)			0	0	Lines in timetable but not in model
71	Minibus	Stup	Rječica			1	0	Lines in timetable but not in model
	Minibus	Sutjeska	Orahov brijeg			1	0	Lines in timetable but not in model
	Minibus	Otoka	Biješće			1	0	Lines in timetable but not in model
	Minibus	Otoka	Sokolje			1	0	Lines in timetable but not in model

Source: JICA Expert Team

Table A3.4.4 Ideal Service Case Line Summary

	AM Peak Number of Vehicles	Off Peak Number of Vehicles
Tram	60	51
Trolleybus	55	42
Bus	193	113
Minibus	62	32
Total	**370**	**238**

Source: JICA Expert Team

3) Optimal Service Case

Table A3.4.5 Optimal Service Case Line Calculation

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
1	Tram	Baščaršija	Željeznička stanica	12	10	3	3	
1	Tram	Željeznička stanica	Baščaršija	12	10			
2	Tram	Baščaršija	Čengić vila A	11	16	4	3	
2	Tram	Čengić vila terminus	Baščaršija	11	16			
3	Tram	Baščaršija	Ilidža	4	4	19	19	
3	Tram	Ilidža	Baščaršija	4	4			
4	Tram	Željeznička stanica	Ilidža	30	23	3	4	
4	Tram	Ilidža	Željeznička stanica	30	15			
5	Tram	Baščaršija	Nedžarići terminus A	12	25	6	3	
5	Tram	Nedžarići terminus B	Baščaršija	12	25			
6	Tram	Skenderija terminus	Ilidža	11	17	7	4	
6	Tram	Ilidža	Skenderija terminus	11	17			
101	Trolleybus	Otoka terminal	Trg Austrije	8	7	10	11	
101	Trolleybus	Trg Austrije	Otoka terminal	6	5			
102	Trolleybus	Otoka terminal	Jezero B	24	28	3	3	
102	Trolleybus	Jezero B	Otoka terminal	24	23			
103	Trolleybus	Dobrinja	Trg Austrije	19	30	5	3	
103	Trolleybus	Trg Austrije	Dobrinja	19	30			
104	Trolleybus	Alipašino polje terminus	Trg Austrije	24		3		Peak hour service

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
104	Trolleybus	Trg Austrije	Alipašino polje terminus	24				Peak hour service
107	Trolleybus	Dobrinja	Jezero B	26	45	4	2	
107	Trolleybus	Jezero B	Dobrinja	26	60			
108	Trolleybus	Otoka terminal	Dobrinja	11	11	7	7	
108	Trolleybus	Dobrinja	Otoka terminal	11	11			
14	Bus	Dom Armije	Podhrastovi	13	13	3	3	
14	Bus	Podhrastovi	Dom Armije	13	13			
15	Bus	Željeznička stanica terminal	Buća Potok	96	38	1	2	
15	Bus	Buća Potok	Željeznička stanica terminal	69	50			
15b	Bus	Otoka terminal	Buća Potok	60	30	2	2	
15b	Bus	Buća Potok	Otoka terminal	30	60			
16	Bus	Dom Armije	Bare	45	40	1	1	
16	Bus	Bare	Dom Armije	45	40			
16b	Bus	Dom Armije	Koševsko brdo	20	30	3	2	Improve bus capacity
16b	Bus	Koševsko brdo	Dom Armije	20	30			Improve bus capacity
17	Bus	Dom Armije	Breka	24	20	2	2	
17	Bus	Breka	Dom Armije	24	20			
17b	Bus	Dom Armije	Breka II	60	30	1	1	
17b	Bus	Breka II	Dom Armije	40	60			
18	Bus	Drvenija terminal	Donji Pofalići B	30	30	2	2	
18	Bus	Donji Pofalići B	Drvenija terminal	20	30			
20	Bus	Park terminal	Jagomir A	30	60	1	1	
20	Bus	Jagomir B	Park terminal	60	30			
20b	Bus	Park terminal	Vrbovska 1	60	30	1	2	
20b	Bus	Vrbovska 1	Park terminal	30				Peak hour service in this direction
21	Bus	Sutjeska	Vogošća A	12	27	6	3	Improve bus capacity
21	Bus	Vogošća A	Sutjeska	12	27			Improve bus capacity
21b	Bus	Sutjeska	Donja Vogošća	30		2	2	Improve bus capacity
21b	Bus	Donja Vogošća	Sutjeska	30	60			Improve bus capacity

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
22	Bus	Sutjeska	Lješevo					No operations
22	Bus	Lješevo	Sutjeska					No operations
22a	Bus	Stup terminal	Vogošća terminal	20	30	3	2	Improve bus capacity
22a	Bus	Vogošća terminal	Stup terminal	20	30			Improve bus capacity
23	Bus	Željeznička stanica terminal	Rajlovac A					No operations
23	Bus	Rajlovac A	Željeznička stanica terminal					No operations
23a	Bus	Autobuska stanica	Željeznička stanica	100		3	4	Improve bus capacity
23a	Bus	Željeznička stanica	Autobuska stanica	100	75			Improve bus capacity
23c	Bus	Otoka terminal	Boljakov Potok	45	30	2	2	
23c	Bus	Boljakov Potok	Otoka terminal	30	60			
24	Bus	Stup terminal	Smiljevići okretnica	60	60	2	1	Improve bus capacity
24	Bus	Smiljevići okretnica	Stup terminal	30	60			Improve bus capacity
26	Bus	Stup terminal	Gornji Ahatovići					Improve bus capacity
26	Bus	Gornji Ahatovići	Stup terminal	0	0	1	0	Improve bus capacity
26	Bus	Stup terminal	Ahatovići A	30	60	2	1	Improve bus capacity
26	Bus	Ahatovići B	Stup terminal					No operations in this direction
26a	Bus	Stup terminal	Dobroševići A	30	60	2	1	Improve bus capacity
26a	Bus	Dobroševići B	Stup terminal	30	60	1		Improve bus capacity
27	Bus	Ilidža terminal	Hrasnica Famos	12	15	5	4	Improve bus capacity
27	Bus	Hrasnica Famos	Ilidža terminal	8	15			Improve bus capacity
27a	Bus	Ilidža terminal	Sokolović kolonija	15	60	3	1	
27a	Bus	Sokolović kolonija	Ilidža terminal	15	30			
27b	Bus	Ilidža terminal	Hrasnica terminus	15		2		Improve bus capacity
27b	Bus	Hrasnica terminus	Ilidža terminal	30				Improve bus capacity
27b-1	Bus	Ilidža terminal	Hrasnica terminus					No operations
27b-1	Bus	Hrasnica terminus	Ilidža terminal					No operations
27e-1	Bus	Baščaršija	Hrasnica Famos					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
27e-1	Bus	Hrasnica Famos	Baščaršija					No operations
28	Bus	Ilidža terminal	Kobiljača A	40	30	3	2	Improve bus capacity
28	Bus	Kobiljača A	Ilidža terminal	20	30			Improve bus capacity
28e	Bus	Ilidža terminal	Vrelo Bosne					No operations
28e	Bus	Vrelo Bosne	Ilidža terminal					No operations
29	Bus	Sutjeska	Kamenica-Crna rijeka	120		1	1	Peak hour service in this direction
29	Bus	Kamenica-Crna rijeka	Sutjeska		180			Off-peak hour service in this direction
30	Bus	Ilidža terminal	Hadžići A					No operations
30	Bus	Hadžići B	Ilidža terminal					No operations
30	Bus	Ilidža terminal	Drozgometva A	100	50	1	2	
30	Bus	Drozgometva A	Ilidža terminal	100	38			
31	Bus	Nedžarići terminal	Dobrinja	30	30	1	1	
31	Bus	Dobrinja	Nedžarići terminal	30	30			
31e	Bus	Dobrinja V A	Vijećnica terminal	15	16	13	10	Improve bus capacity
31e	Bus	Vijećnica terminal	Dobrinja V A	15	24			Improve bus capacity
32	Bus	Ilidža terminal	Butmir okretnica	7	30	3	2	Improve bus capacity
32	Bus	Butmir okretnica	Ilidža terminal	20	30			Improve bus capacity
33	Bus	Ilidža terminal	Vukovići	34	18	7	5	Improve bus capacity
33	Bus	Vukovići	Ilidža terminal	11	36			Improve bus capacity
35	Bus	Autobuska stanica	Krivojevići B					No operations
35	Bus	Krivojevići B	Autobuska stanica					No operations
36	Bus	Nedžarići terminal	Naselje Aerodrom MZ	60		1		Peak hour service
36	Bus	Naselje Aerodrom MZ	Nedžarići terminal	60				Peak hour service
38	Bus	Dobrinja	Ilidža terminal	30		2		Improve bus capacity
38	Bus	Ilidža terminal	Dobrinja	30				Improve bus capacity
39	Bus	Nedžarići terminal	Dobrinja IV	30	30	2	1	Improve bus capacity

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
39	Bus	Dobrinja IV	Nedžarići terminal	15	60			Improve bus capacity
41	Bus	Drvenija terminal	Gornji Velešići					No operations
41	Bus	Gornji Velešići	Drvenija terminal					No operations
41b	Bus	Drvenija terminal	Donji Velesici					No operations
41b	Bus	Donji Velesici	Drvenija terminal					No operations
43	Bus	Ilidža terminal	Hendekuša okretnica	20	30	3	2	Improve bus capacity
43	Bus	Hendekuša okretnica	Ilidža terminal	20	20			Improve bus capacity
45	Bus	Ilidža terminal	Garež A					No operations
45	Bus	Garež A	Ilidža terminal					No operations
45b	Bus	Ilidža terminal	Garež A					No operations
45b	Bus	Garež A	Ilidža terminal					No operations
46	Bus	Ilidža terminal	Vlakovo	60	30	1	2	
46	Bus	Vlakovo	Ilidža terminal	60	60			
47	Bus	Ilidža terminal	Trnovo centar A					No operations
47	Bus	Trnovo centar A	Ilidža terminal					No operations
47	Bus	Ilidža terminal	Turovi					No operations
47	Bus	Turovi	Ilidža terminal					No operations
47a	Bus	Ilidža terminal	Turovi					No operations
47a	Bus	Turovi	Ilidža terminal					No operations
49	Bus	Ilidža terminal	Doglodi okretnica	60	60	1	1	
49	Bus	Doglodi okretnica	Ilidža terminal	60	60			
49	Bus	Ilidža terminal	Otes okretnica					No operations
49	Bus	Trg Oteškog bataljona	Ilidža terminal					No operations
51	Minibus	Baščaršija terminal	Vratnik Višegradska kapija	24	24	1	1	
51	Minibus	Vratnik Višegradska kapija	Baščaršija terminal	24	24			
52	Minibus	Baščaršija terminal	Gornji Faletići	30	30	2	2	
52	Minibus	Gornji Faletići	Baščaršija terminal	20	30			

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
54	Minibus	Latinska ćuprija terminal	Hošin brijeg					Currently combined with 56
54	Minibus	Hošin brijeg	Latinska ćuprija terminal					Currently combined with 56
55	Minibus	Baščaršija terminal	Sedrenik samoposluga A	60	24	1	2	
55	Minibus	Sedrenik samoposluga A	Baščaršija terminal	60	30			
56	Minibus	Latinska ćuprija terminal	Popov gaj	40	48	1	1	Currently combined with 54
56	Minibus	Popov gaj	Latinska ćuprija terminal	40	40			Currently combined with 54
57	Minibus	Pazarić	Osenik	0	0	0	0	Combine with 79
57	Minibus	Osenik	Pazarić	0	0			Combine with 79
58	Minibus	Baščaršija terminal	Mihrivode					No operations
58	Minibus	Mihrivode	Baščaršija terminal					No operations
59a	Minibus	Latinska ćuprija terminal	Komatin okretnica	26	26	2	2	
59a	Minibus	Komatin okretnica	Latinska ćuprija terminal	26	26			
60	Minibus	Vogošća terminal	Tihovići okretnica	60	15	1	2	
60	Minibus	Tihovići okretnica	Vogošća terminal	60	30			
61	Minibus	Stup terminal	Buća Potok	30	30	2	2	
61	Minibus	Buća Potok	Stup terminal	30	30			
62	Minibus	Drvenija terminal	Gornji Velesici (HUM)	60	60	1	1	
62	Minibus	Gornji Velesici (HUM)	Drvenija terminal	60	60			
63	Minibus	Latinska ćuprija terminal	Mahmutovac	0	0	0	0	Combine with 54 & 56
63	Minibus	Mahmutovac	Latinska ćuprija terminal	0	0			Combine with 54 & 56
64	Minibus	Park terminal	Barice					No operations
64	Minibus	Barice	Park terminal					No operations
65	Minibus	Ekonomska škola A	Obad okretnica					No operations
65	Minibus	Obad okretnica	Ekonomska škola A					No operations
66	Minibus	Ekonomska škola A	Hum	60	30	1	1	

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
66	Minibus	Hum	Ekonomska škola A	60	60			
67	Minibus	Ekonomska škola A	Bakarevac	60	60	1	1	
67	Minibus	Bakarevac	Ekonomska škola A		60			
68	Minibus	Sutjeska	Poljine	0	0	0	0	Combine with 69
68	Minibus	Poljine	Sutjeska	0	0			Combine with 69
69	Minibus	Sutjeska	Nahorevo	60	60	1	1	Combine with 68
69	Minibus	Nahorevo	Sutjeska	60	60			Combine with 68
70	Minibus	Grbavica terminal	Hrasno brdo	30		1		
70	Minibus	Hrasno brdo	Grbavica terminal	60				
71a	Minibus	Stup terminal	Dom Paljevska A					No operations
71a	Minibus	Dom Paljevska A	Stup terminal					No operations
72	Minibus	Park terminal	Panjina kula	0	0	0	0	Combine with 74
72	Minibus	Panjina kula	Park terminal	0	0			Combine with 74
73	Minibus	Vijećnica terminal	Hladivode okretnica	60	60	1	1	
73	Minibus	Hladivode okretnica	Vijećnica terminal	60	60			
74	Minibus	Park terminal	Sedrenik Rogina	30	30	2	2	Combine with 72
74	Minibus	Sedrenik Rogina	Park terminal	24	30			Combine with 72
75	Minibus	Ilidža terminal	Mokrine	120	120	1	1	
75	Minibus	Mokrine	Ilidža terminal	120	120			
76	Minibus	Mokrine	Hadžići B	60		1		
76	Minibus	Hadžići B	Mokrine	60				
77	Minibus	Lokve	Pazarić	60		1		Peak hour service in this direction
77	Minibus	Pazarić	Lokve					
78	Minibus	Tarčin terminal	Budmolići	60		1		Combine with 80
78	Minibus	Budmolići	Tarčin terminal	30	0			Combine with 80
79	Minibus	Dupovci A	Ljubovčići	0	0	0	1	Combine with 57
79	Minibus	Ljubovčići	Dupovci A					Combine with 57
80	Minibus	Tarčin terminal	Korča	0	0	0	0	Combine with 78
80	Minibus	Korča	Škola H.E.Šarić A	0	0			Combine with 78

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
81	Minibus	Tarčin terminal	Luke okretnica					No operations
81	Minibus	Luke okretnica	Tarčin terminal					No operations
82	Minibus	Hadžići B	Kasatići okretnica	60	60	1	1	Combine with 83
82	Minibus	Kasatići okretnica	Hadžići B	60	60			Combine with 83
83	Minibus	Hadžići B	Ušivak I B	0	0	0	0	Combine with 82
83	Minibus	Ušivak I B	Hadžići B	0	0			Combine with 82
84	Minibus	Ilidža terminal	Miševići	60	30	1	2	Combine with 85
84	Minibus	Miševići	Ilidža terminal	60				Combine with 85
85	Minibus	Ilidža terminal	Sinanovići	0	0	0	0	Combine with 84
85	Minibus	Sinanovići	Ilidža terminal	0	0			Combine with 84
85a	Minibus	Sinanovići	Trnovo					No operations
85a	Minibus	Trnovo	Sinanovići					No operations
89	Minibus	Park terminal	Mrkovići			1		No operations
89	Minibus	Mrkovići	Park terminal	60				Peak hour service in this direction
90	Minibus	Tarčin terminal	Trzanj okretnica					No operations
90	Minibus	Trzanj okretnica	Tarčin terminal					No operations
94	Minibus	Vogošća terminal	Gora					No operations
94	Minibus	Gora	Vogošća terminal					No operations
95	Minibus	Vijećnica terminal	Brusulje okretnica					No operations
95	Minibus	Brusulje okretnica	Vijećnica terminal					No operations
98	Minibus	Latinska ćuprija terminal	Trebević Vidikovac					No operations
98	Minibus	Trebević Vidikovac	Latinska ćuprija terminal					No operations
149	Bus	Otoka terminal	Brijesce (Okretaljka)					No operations
149	Bus	Brijesce (Okretaljka)	Otoka terminal					No operations
153	Bus	Otoka terminal	Rasima Turkusica 2					No operations
153	Bus	Rasima Turkusica 2	Otoka terminal					No operations
155	Bus	Sutjeska	Orahov Brijeg 31					No operations
155	Bus	Orahov Brijeg 31	Sutjeska					No operations

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
180	Bus	Otoka terminal	Sokolje A					No operations
180	Bus	Sokolje A	Otoka terminal					No operations
200e	Bus	Baščaršija bezistan	Aerodrom Sarajevo					No operations
200e	Bus	Aerodrom Sarajevo	Baščaršija bezistan					No operations
201	Bus	Autobuska stanica	Ilijas	60	80	2	3	
201	Bus	Ilijas	Autobuska stanica	60	40			
203	Bus	Autobuska stanica	Raštelica A					No operations
203	Bus	Raštelica A	Autobuska stanica					No operations
21a	Bus	Sutjeska-D. Vogošća				1	1	Lines in timetable but not in model
39b	Bus	Otoka terminal	Dobrinja IV			1	1	Lines in timetable but not in model
41a	Bus	Drvenija terminal	Velešići			1	1	Lines in timetable but not in model
44	Bus	Franje račkog	Bjelašnica			1	1	Lines in timetable but not in model
202	Bus	Autobuska stanica	Kamenica			1	1	Lines in timetable but not in model
220	Bus	Ilijaš	Bioča			1	1	Lines in timetable but not in model
221	Bus	Ilijaš	Misoča			1	1	Lines in timetable but not in model
222	Bus	Ilijaš	Srednje			1	1	Lines in timetable but not in model
223	Bus	Ilijaš	Kamenica (Crna rijeka)			1	1	Lines in timetable but not in model
224	Bus	Srednje	Kamenica (Crna rijeka)			1	1	Lines in timetable but not in model
225	Bus	Srednje	Sokolina			1	1	Lines in timetable but not in model
226	Bus	Ilijaš	Popovića			1	1	Lines in timetable but not in model
227	Bus	Autobuska stanica	Dragoradi			1	1	Lines in timetable but not in model

Line Number	Mode	Terminal 1	Terminal 2	AM Peak Headway	Off Peak Headway	AM Peak Number of Vehicles	Off Peak Number of Vehicles	Remarks
	Bus	Dobrinja	Ilidža			1	1	Lines in timetable but not in model
48	Minibus	Garež	Delijaši-Hamzići			0	0	Lines in timetable but not in model
53	Minibus	Otoka	Mojmilo Brdo (Turkušići)			1	0	Lines in timetable but not in model
67a	Minibus	Ekonomska škola	Bakarevac (Rezervoar)			0	0	Lines in timetable but not in model
71	Minibus	Stup	Rječica			1	0	Lines in timetable but not in model
	Minibus	Sutjeska	Orahov brijeg			1	0	Lines in timetable but not in model
	Minibus	Otoka	Biiješće			1	0	Lines in timetable but not in model
	Minibus	Otoka	Sokolje			1	0	Lines in timetable but not in model

Source: JICA Expert Team

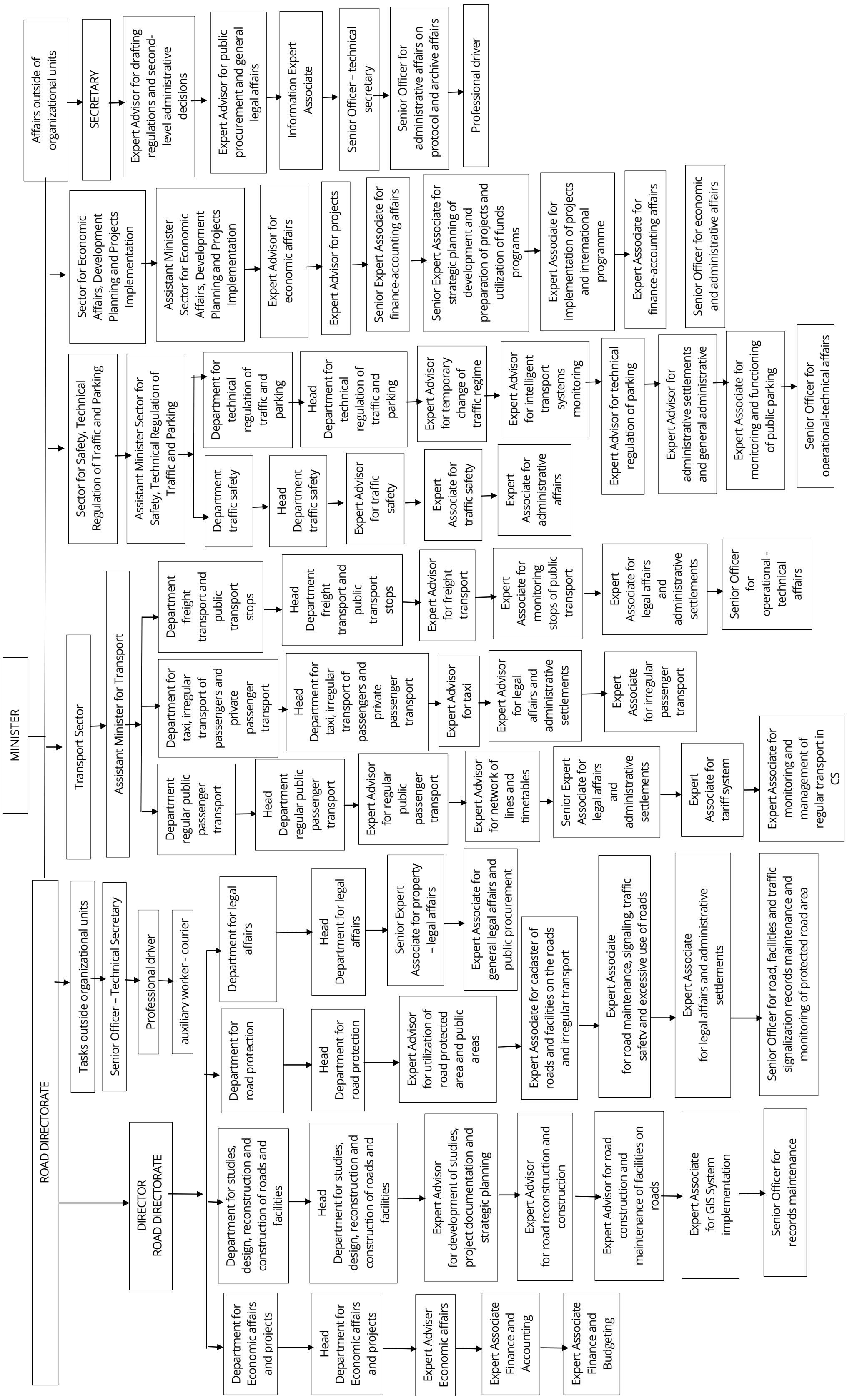
Table A3.4.6 Optimal Service Case Line Summary

	AM Peak Number of Vehicles	Off-Peak Number of Vehicles
Tram	42	36
Trolleybus	32	26
Bus	106	86
Minibus	30	22
Total	**210**	**170**

Source: JICA Expert Team

A4 Appendices to Chapter 6

A4.1 Organization Chart of the Ministry of Traffic of Canton Sarajevo 2022



A4.2 List of Relevant Legal/Regulatory Documents Identified

Level	Regulations
BiH	Constitution of Bosnia and Herzegovina (Official Gazette of Bosnia and Herzegovina, No. 25/09, 327/09)
BiH	Law on Roads (Official Gazette of Bosnia and Herzegovina, No. 12/10, 16/10)
BiH	Law on the Basics of Traffic Safety in Bosnia and Herzegovina (Official Gazette of Bosnia and Herzegovina, No. 6/06, 75/06, 44/07, 84/09, 48/10, 18/13, 8/17, 89/ 17 and 9/18)
BiH	Law on Civil Services in the Institutions of Bosnia and Herzegovina (Official Gazette of Bosnia and Herzegovina, No. 19/02)
BiH	Law on Public Procurement (Official Gazette of Bosnia and Herzegovina, No. 39/14 and 59/22)
FBiH	Constitution of the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina, No. 1/94, 13/97, 16/02, 22/02, 52/02, 60/02, 18/03, 63/03)
FBiH	Law on Road Transport (Official Gazette of the Federation of Bosnia and Herzegovina, No. 23/98, 28/06, 2/10, 66/13, 57/20)
FBiH	Rulebook on the license for public transport in road traffic "Official Gazette of the Federation of Bosnia and Herzegovina, No. 65/06 and 18/08, amended by Rulebook No 06-27-1301-1/10 dated July 2010)
FBiH	Rulebook on Minimum Technical Conditions for the Construction and Use of Bus Stops (Official Gazette of the Federation of Bosnia and Herzegovina, No. 69/10)
FBiH	Rulebook on Maintenance of Public Roads (Official Gazette of the Federation of Bosnia and Herzegovina, No. 6/10)
FBiH	Law on Development Planning and Development Management in the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina, No. 32/17),
FBiH	Law on the Organization of Administrative Bodies in the Federation Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina, no 35/05)
FBiH	Law on Principles of Local Self-Government in the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of BiH, No. 35/05);
FBiH	Law on International and Inter-Entity Road Transport (Official Gazette of BiH, No. 1/02 and 14/03)
FBiH	Law on Civil Service in the Federation BiH (Official Gazette of the Federation of Bosnia and Herzegovina , No. 29/03; 23/04; 39/04; 54/04; 67/05; 8/06)
FBiH	Law on Physical Planning of the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina , No. 52/02)
FBiH	The Law about Spatial Planning and Land Use at the Level of the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina, No.2/06)
FBiH	Rulebook on the method, criteria and procedure for harmonizing, certifying and registering timetables, and the content and manner of keeping the register (Official Gazette of the Federation of Bosnia and Herzegovina, No. 79/13 with amendments 91/14, 98/14 and 84/15)
FBiH	Law on Privatization of Enterprises (Official Gazette of the Federation of Bosnia and Herzegovina, no. 27/97, 8/99, 32/00, 45/00, 54/00, 61/01, 27/02, 33/02, 28/04, 44/04, 42/06 and 4/09)
FBiH	Law on Air Protection (Official Gazette of the Federation of Bosnia and Herzegovina , No 33/03 and No.4/10)
FBiH	Rulebook on limits for emissions of pollutants into the air (Official Gazette of the Federation of Bosnia and Herzegovina, No. 12/05),
FBiH	Law on Business Companies (Official Gazette of the Federation of Bosnia and Herzegovina, No. 81/15 and 75/21)
FBiH	Law on Public Enterprises in Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina No. 8/2005, 81/2008. 22/2009 and 109/2012)
FBiH	Law on Environmental Protection of the Federation of Bosnia and Herzegovina (Official Gazette of the Federation of Bosnia and Herzegovina No. 33/03 and 38/09)
CS	Constitution of Sarajevo Canton, 1996 (Official Gazette of Sarajevo Canton, br. 1/1996, 2/1996 - corrected, 3/1996 - corrected., 16/1997 - Amendment I-XIII, 14/2000 - Amendment XIV i XV, 4/2001 - Amendment XVI-XVIII, 28/2004 - Amendment XIX-XLII, 6/2013 - Amendment XLIII-XLIX i 31/2017 - Amendment L-LVII)
CS	Law on the Government of Canton Sarajevo (Official Gazette of Sarajevo Canton, No 36/14 and 37/14)
CS	Law on Roads of Canton Sarajevo (Official Gazette of Sarajevo Canton, No 1/22)
CS	Law on the Regulation of Traffic in the Sarajevo Canton (Official Gazette of Canton of Sarajevo, No. 30/17, 46/17, 1/22)
CS	Law on the Public Transport of Passengers (Official Gazette of Canton of Sarajevo, No. 1/22)
CS	Instruction of the Ministry of Transport of Sarajevo Canton for Subsidizing Public Transport in the Area of Sarajevo Canton (No 04-11-4758/23 dated 20/02/2023)
CS	Regulation (Government) on Subsidizing the Cost of Public Transport in Canton Sarajevo (Official Gazette of Canton of Sarajevo, No. 36/06 and 08/17)
CS	Regulation (Government) on the Price of a Monthly Ticket for the Transportation of Unemployed Persons Using Public Transportation of Passengers in Canton Sarajevo (Official Gazette of Canton of Sarajevo, No. 32/20)

Level	Regulations
CS	Regulation (Government) on the Conditions, Manner and Specificity of the Organization of Public Regular Passenger Transport in Sarajevo Canton (Official Gazette of Canton of Sarajevo, No. 28/06)
CS	Regulation (Minister of Traffic) on inventory of assets and liabilities of the Ministry of Traffic (Official Gazette of Canton of Sarajevo, No. 12/23)
CS	Rulebook (Minister of Traffic) on Amendments to the Rulebook on the Internal Organization of the Ministry of Traffic of Sarajevo Canton (Official Gazette of Canton of Sarajevo, No. 12/23 and 14/23)
CS	Rulebook on Amendments to the Regulation on the Internal Organization of the Ministry of Transport No. 04-04-20679/22 dated July 2022
CS	Regulation (Minister of Traffic) on the Organization of Parking, Public Parking Areas, Parking Zones, the Construction of New Parking Lots and the Organization of a Unified Parking Charging System (Official Gazette of the Sarajevo Canton, No.34/23)
CS	Rulebook (Minister of Traffic) on the Internal Organization of the Ministry of Traffic of Sarajevo Canton (No. 04-34-39863/19 dated January 2020, adjusted through No 02-04-35583-18/20 in September of the same year)
CS	Parking regulation in the Sarajevo Canton (Official Gazette of the Sarajevo Canton, No.25/16)
CS	Regulation on Principles for Determining Internal Organization of Cantonal, City and Municipal Administrative Bodies and Organizations (Official Gazette of the Sarajevo Canton, No.36/06, 8/12, 39/16)
CS	Decision (Minister of Traffic) on subsidizing and participation in the costs of transportation in public urban and suburban transport for full-time and full-time self-financing students at higher education institutions (Official Gazette of the Sarajevo Canton, No.42/15, 34/22)
CS	Law on Obligations and Authorities of the Controller Operator of Public Passenger Transport in the Canton of Sarajevo (Official Gazette of the Sarajevo Canton, No. 37/14)
CS	Decision on the Protection and Improvement of Air Quality in Canton Sarajevo (Official Gazette of the Sarajevo Canton, No. 1/13),
CS	Decision on the adoption of the action plan for reducing emissions of particles in the area of the SC (Official Gazette of the Canton Sarajevo, No 16/13)
CS	Decision (Cantonal Assembly) on the Declaration of the Common Good and Natural Wealth of Parts of the Company Managed by KJKP "GRAS" doo Sarajevo and Exclusion from the Initial Balance Sheet and Privatization Program (Official Gazette of the Sarajevo Canton, No. 1/21, 25/21)
CS	Decision on the Adoption of the Action Plan for Reducing Emissions of Particles in the Area of Sarajevo Canton (Official Gazette of the Sarajevo Canton, No. 16/13)
CS	Law on Spatial Planning of Canton Sarajevo (Official Gazette of the Sarajevo Canton No. 24/17, 1/18)
CS	Law on Civil Service in the Canton of Sarajevo (Official Gazette of Sarajevo Canton, No.31/12 and 45/19)
CS	Law on Concessions of Sarajevo Canton (Official Gazette of Sarajevo Canton, No. 27/11, 33/12 and Decisions No. 15/13 and 1/22)
CS	Decision (Canton Assembly) dated 5 November 2005 on the Harmonization of the Status of the Public Utility Enterprise Gradksi Saobracaj Sarajevo with the Law on Public Enterprises in the Federation of Bosnia-Herzegovina (No 01-05-30033/05)
CS	Law on the Public Service in the Canton of Sarajevo (Official Gazette of Sarajevo Canton, No. 31/16 and 45/19)
CS	Rule on Public Procurement (Ministry of Justice and Administration, Official Gazette of Sarajevo Canton, No.26/23)
CS	Regulation on Public Procurement Control in all Institutions Canton Sarajevo Has Established (Prime Minister, Official Gazette of Sarajevo Canton, No.27/19, 29/19, 48/19, 13/20)
CS	Law on Public Private Partnership (Official Gazette of Sarajevo Canton, No. 27/11 and 16/17)
CS	Law on Inspection of Sarajevo Canton (Official Gazette of Sarajevo Canton, No. 2/17 and 37/21)
CS	Law on Communal Activities (Official Gazette of the Canton of Sarajevo, No. 14/16, 43/16, 10/17- Corrigendum, 19 /17, 20/18 and 22/19)
CS	Law on the Ministers and Other Bodies of the Administration of the Canton of Sarajevo (Official Gazette of Sarajevo Canton, No. 40/22)

Source: JICA Expert Team

A4.3 Example of Public Transport Contract Structure: Case of Grenoble Metropolitan Area (Contract 2013–2021)

Components	Names
Part 1	**Objective and Duration**
Article 1	Nature and Purpose of the Service
Article 2	Duration of the Contract and Effectiveness (the contract entries into effect)
Article 3	Prerogatives of the local government (represented by the MOT)
Article 4	Commitment of the government and the authority (the MOT)
Article 5	Tasks of the Operating Company
Article 6	Continuity of the Service
Article 7	Sub-contractors
Article 8	Contracts Concluded with Third Parties Relating to Transport Services
Article 9	Assistance of the Delegate & Support for the Development of Studies and Surveys
Article 10	Change of the Service
Article 11	Commercial and Communication Policy
Article 12	Quality of service and the sustainable development approach
Part 2	**Regime of Property**
Article 13	Provision of Goods Necessary for Exploitation (made available by the parties)
Article 14	Immaterial goods, trademarks and logos
Article 15	Multiannual Investment Forward Programmes
Article 16	Compliance and Security of Assets Necessary for Operation
Article 17	Care and Maintenance of Property
Part 3	**Financial Regime**
Article 18	The General Operating Statement of the Service
Article 19	Tariff Provisions
Article 20	Amount of the Government' s Contribution
Article 21	Update of the Government's Contribution
Article 22	Arrangements for payment of the Government's contribution
Article 23	Accounts at the entry into force of the Convention
Article 24	Revision of the Provisions of the Contract in the Case of Events not Depending on the Contracting Parties
Article 25	Taxes (exc. VAT)
Article 26	VAT
Article 27	Control of the Implementation of the Contract by the Delegating Organization
Article 28	Obligations of the Operator
Article 29	Content of the Reporting to the Delegating Organization
Part 4	**Dedicated Company, Responsibilities, Insurance, Sanctions**
Article 30	Dedicated Local Company
Article 31	Liability and Insurance
Article 32	Duty to Inform the Delegating Power
Article 33	Contract Release
Article 34	Penalties
Part 5	**End of the Contract**
Article 35	Termination without Indemnity
Article 36	Unilateral Termination for Reasons Linked to the General Interest
Article 37	Settlement of Disputes
Article 38	List of Annexes to the Contract
Appendices	**(Selection from the Original Contract Only)**
Appendix 1	Consistence of the Service: The fate of Goods after the End of the Contract
Appendix 2	Regulation for Operation and Safety Rules
Appendix 3	Inventory of Goods
Appendix 4	Marketing Plan and Planning for Studies
Appendix 5	Capital Investment Program
Appendix 6	Planned Operating Statement
Appendix 7	Content of Monthly and Yearly Reports of the Operator
Appendix 8	Terms of Reference for the Quality of Service
Appendix 9	List of Dedicated Staff
Appendix 10	Unit Cost Variations in Case of Modification of the Service
Appendix 11	Status of the Operating Company
Appendix 12	Sustainable Development Policy

Source: JICA Expert Team

A4.4 Public Call Characteristics for the Assignment of 9 bus Lines (Deadline on 14 August 2023)

Public Call Process	Characteristics
Contracting authority	MOT
Selection Committee	Yes, established by the MOT
Minimum number of responses required	Not specified in the public call document; 1 application received and applicant selected (CENTROTRANS)
Restriction to national firms	No: Applications from foreign accepted, provided that they can provide certificates, licenses etc. delivered by competent authorities from Bosnia and Herzegovina
Language	Bosnian, whether in Latin or Cyrillic script
Purpose	Operation of 9 lines, including 1 minibus line
Operation period required	Up to 3 years (for both packages)
Packages	2 x packages of lines: Package 1 (5 lines) and Package 2 (4 lines)
Selection Committee	Yes, established by the MOT
Selection mechanism	Scoring of compliance with criteria; scoring calculation method indicated in the public call document
Scored criteria: Applicant's vehicles to be assigned the lines	1. Number and quality of the applicant's fleet, determined on the basis of the evaluation of the following contents: 1.1. Number of vehicles available; 1.2. Age of vehicles; 1.3. Possession of air conditioning in vehicles; 1.4. External and internal appearance of vehicles; 1.5. Benefits of emissions of exhaust gases (according to euro characteristics of the engine); 1.6. Height of the floor in vehicles; 1.7. Number and surface of the door on vehicles (wrist/solo); 1.8. Vehicle capacities (wrist/solo); 1.9. Type of propellant; 1.10. Degree of accessibility of vehicles to people with mobility difficulties;
Scored criteria: Applicant's infrastructure	- Technical and personnel equipment, - Capacity to maintain the vehicle, - Parking area, car wash area, - Towing vehicle and service vehicle;
Scored criteria: Applicant's references	- Interest of the offer for the implementation of measures for the preservation and protection of the environment; - Adaptability to the existing system of informing passengers on and in the vehicle; - Transport management system (radio connection, satellite monitoring of operation); - Other circumstances that may affect the quality of public transport; - Business creditworthiness of the operator (not scored) - Professional and qualified personnel for the organization of public passenger transport, maintenance and repair of vehicles; - Previous experience and success in the performance of public regular passenger transport.
Ownership and staffing required	- Ownership of the necessary infrastructure for quality transport and maintenance of vehicles; - Professional and qualified staff for the organization of public transport of passengers, maintenance, the repair of vehicles; - Ownership of sufficient number of vehicles to carry out transport on the lines assigned to the applicant, as well as for new lines for which it applies; - Minimum of 50 % of the vehicles owned; - Maximum of 50 % of vehicles under a leasing contract; - Ownership of a vehicle for removal - removal of defective vehicles of public regular passenger transport; - Ownership of a service vehicle for the elimination of malfunctions on a faulty vehicle; - Adequate space for daily maintenance and cleaning of vehicles; - Possession of a normative act on the organization, operation of vehicle crews and internal control; - Applicant accepts to take over and apply a single tariff system established by the competent cantonal authority; - Ownership of thirty (30) buses with a vehicle license "AB" on routes up to 60 km long - for the bus network of lines; - Ownership of ten (10) minibuses with a license of vehicles "AB" on routes up to 60 km long - for a minibus network of lines.
Documents required (examples)	- Registered activity for city and suburban land transport of passengers - License for transport of passengers - Minimum number of drivers per package as specified in the public call + driving licenses of drivers - Quality of vehicles per package - Certificate that obligations relating to pensions disabilities health care and taxes are settled
Documents provided	- Maps of each line and length (km) - Timetable for each line

Source: JICA Expert Team, adapted from tendering document published by MOT (month not specified; 2023)

A5 Results of the Training in Third Countries

A5.1 Overview

The training in third countries allows counterpart representatives to gain insights into their policy, management, and organization of their public transport services and utilize the lessons learned and positive practices for the Canton of Sarajevo public transport system. Initially, the program was planned as a two-week-long visit to two countries at a time. However, since it was difficult for participants to find a common available schedule for two weeks, the program was instead implemented four times as a one-week visit to one country at a time. The table below shows the countries and cities visited.

Table A5.1.1 Countries and Cities Visited for Training in Third Countries

Country	Cities Visited	Training Period	Main Contents
Austria	Graz	17–23 October 2021	・ Operation by one single public corporation operating all public transport modes ・ Several suburban railway operators ・ Mobility management
Italy	Florence Bologna	20–25 March 2022	・ Tramway expansion planning with an emphasis on enhancement of transfer nodes (Florence) ・ Tram operation and maintenance ・ Traffic control system ・ Operation of low emission zone (LEZ) ・ Courtesy call to the mayor (Bologna)
France	Lyon Grenoble	9–15 October 2022	・ Transport authority and a private operator operating most of the public transport modes (Lyon) ・ Details of public service contract ・ One single public corporation operating all public transport modes (Grenoble)
Germany	Bonn	15–19 March 2023	・ Operation by one single public corporation operating all public transport modes ・ Tram refurbishment program ・ Bus fleet planning and maintenance system (Visit to Munich was scheduled but cancelled at the last minute due to the strike in the country.)

Source: JICA Expert Team

Profiles of public transport systems in the cities visited are summarized in the subsequent tables.

Table A5.1.2 Profiles of Public Transport Systems: Graz, Florence and Bologna

City	Population	Metropolitan Area	Transport Authority (TA)	Public Transport Modes	Operators (OP)	Operation Length	Annual Passengers	Public Transport Mode Share	Contract Model	Operating Revenues (million EUR)	Subsidy (%)
Graz	443,006 (2019)	Graz / Metropolitan area of Styria	City of Graz	Bus (24 lines)	Public: Holding Graz	415 km	49 million (2013)	(2018) Public transport: 20% Walk: 19% Bicycle: 19% Car driver: 34% Car passenger: 8%	**Contracting Out**: (The service is delivered through competitive bidding for each line, not the whole mode.)	(2013) Total ticket revenue: 43 (45%) Total expense: 80	In 2018, the city covered losses from the Graz holding company with 55 million EUR.
				Tram (6 lines)			55 million (2013)				
				Schlossbergbahn (Castle Hill Railway)		201 m	417,315 (2013)				
			1: Republic of Austria 2,3: State of Styria	S-Bahn Steiermark	Public: 1. Public:ÖBB (The Austrian Federal Railways) 2. Steiermärkische Landesbahnen (StB) Private: 3. Graz-Köflacher Bahn (GKB)	61,7 km	40,000 pax/day		**Regulated Competition** (The railways are under the control of ÖBB-Holding AG, a holding company wholly owned by the Austrian state)		
Florence	711,000 (2023)	Florence Metropolitan area	City of Florence	Tram (2 lines)	Private: GEST (JV of RATP 51% and ATAF 49%)	16.8 km	30.7 million (2022)	(2001) Public transport: 21% Walk: 8% Bicycle: 4% Other: 67%	**Private Monopoly**		(2022) 12.7 million EUR
				Bus (85 lines)	Public: ATAF		112 million (2019)		**Public Monopoly**	(2019) Revenue: 90.21 (>100%) Operation cost: 72.42	No subsidy
Bologna	394,463 (Jan. 2021)	Bologna Metropolitan City	Emilia-Romagna Region, Municipality of Bologna, Metropolitan City of Bologna	Railway (9 lines)	Public: Trasporto Passeggeri Emilia-Romagna (TPER) (Emilia-Romagna passenger transportation)		12 million (2019)	(2018) Car: 42% Motorcycle: 4% Walk: 27% Bicycle: 5% Public transport: 21% Other: 1%	**Public Monopoly**	Revenue: 328 (2019)	TPER does not receive subsidy to run its services.
				Tram (1 line)		16.5 km					
				Urban Bus (67 lines)			117 million (2019)				
				Trolleybus (4 lines)		195 km					
				Suburban and Interurban Bus (14 lines)			19 million (2019)				
				Exurban Bus (134 lines)							

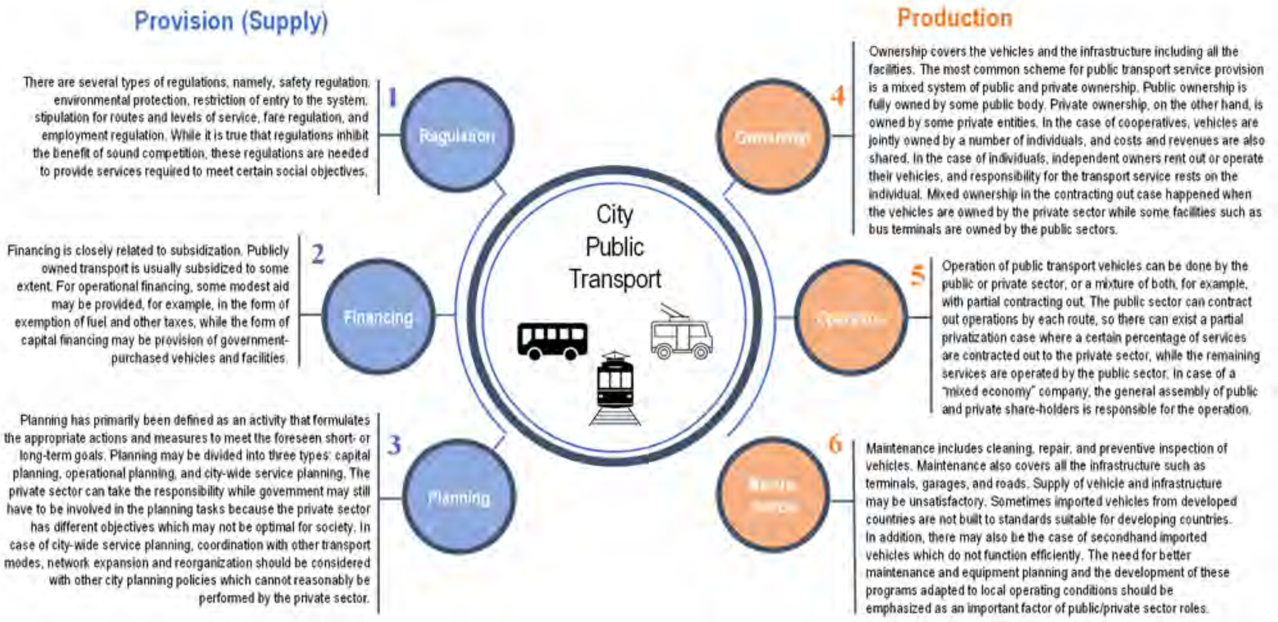
Source: JICA Expert Team

Table A5.1.3 Profiles of Public Transport Systems: Lyon, Grenoble and Bonn

City	Population	Metropolitan Area	Transport Authority (TA)	Public Transport Modes	Operators (OP)	Operation Length	Annual Passengers	Public Transport Mode Share	Contract Model	Operating Revenues (million EUR)	Subsidy (%)
Lyon	1.4 million	Métropole of Lyon (3,200 km2)	Intercommunal Syndicate (Inter-communal Cooperation Public Organization): SYTRAL Mobilités	Metro (4 lines, with 73 trains and 3 maintenance depots)	Private: Keolis	32 km	205,590,000 (2017)	(2015) Walk: 38.2% Bicycle: 1.9% Bus: 5.9% Rail: 0.1% Car: 41.5% Metro: 8.3%	**Private Monopoly** 6-year Gross Cost Contract OP Revenues = Based on cost per km (contract) + bonus/malus for service quality + other supports provided to TA OP collects Fare Revenues (FR) and transfers to TA	Mobility Tax: 388.9 (47.9%) Urban Public Transport Users: 241.8 (29.5%) Transfers (local government members + national): 189.3 (23.1%) Total Revenue: 820 (100%)	23.1%
				Funicular (2 lines)		1.2 km					
				Tram (6 lines, with 92 trains and 2 maintenance depots)		70 km	95,033 (2017)				
				Bus (26 trunk lines and 109 complementary lines, with 54 articulated trolleybuses, 70 trolleybuses, 237 articulated buses, 567 buses, and 26 minibuses, and 8 depots)		2500 km	164,544 (2017)				
Grenoble	0.64 million	Grenoble-Alpes Métropole (1,616 km2)	The Joint Syndicate for Mobility in the Grenoble Area (SMMAG)	Tram (5 lines, with 53 TFS and 50 high-capacity CITADIS trains)	Public: Société d'Économie Mixte des Transports Publics de l'Agglomération Grenobloise (SEMITAG) (JV between the previous public operator and a private group TRANSDEV)	47 km	89.2 million trips (2019)	(2019) Tram: 64% Chrono: 22% Proximo: 13% Flexo: 1% Public transport takes a share of about 20%	**Public Monopoly** Public service delegation contract (2013 - 2021) Transitory Contract (2022-2023) SEMITAG (which remained OP) was transformed into a local public company (M TAG: 100% owned by Grenoble Metropole and other local governments): Fares + Transport Policy: Decided by the TA	Mobility Tax: 125 (63.8%) Urban Public Transport Users: 34.7 (17.7%) Transfers (local government members + national): 32 (16.3%) Bicycles + Parking: 1.1 (0.5%) Other Revenues: 3.2 (1.6%) Total Revenue: 196 (100%)	16.3%
				Bus (26 lines with 52 articulated buses and 193 buses)		70 km of Chrono lines 163 km of Proximo lines 248 km of Flexo lines					
Bonn	320,178 (2023)	Rhine-Ruhr Metropolitan Region	City of Bonn Ticket sales: Verkehrsverbund Rhein-Sieg (VRS)	Regional Trains (S-Bahn and Regionalbahn) Rhine-Ruhr S-Bahn	DB Regio NRW, Regiobahn (S28), Vias (S7)	676 km	130 million	Car: 40% Public transport: 17% Walk: 27% Bicycle: 16% (2008)	**Public Monopoly**	496.5 (2020)	
				Stadtbahn light rail (6 lines)	Stadtwerke Bonn Verkehrs GmbH (SWB)	95.84 km	92 million (2013)				No subsidy
				Tram (3 lines)		29.52 km					
				Bus (30 lines)		663 km					

Source: JICA Expert Team

In considering the contract model in the above tables, the role of the public or private sectors and donors in the provision and production of services needs to be discussed. As shown in the figure below, there are six dimensions: regulation, financing, planning, ownership, operation, and maintenance. The provision of services includes the first three dimensions, i.e., regulation, financing, and planning, while the production of services includes ownership, operation, and maintenance.



Source: Yagi, S. (1994). Alternative Strategies for Public Transport Improvement in Developing Countries: A Case Study of Beirut. Master's Thesis, Massachusetts Institute of Technology.

Figure A5.1.1 Six Dimensions for Public/Private Sector Participation

Based on the six dimensions of public transport services mentioned above, public and private sector involvement in public transport services is modeled with summary of the regulators' roles, features, and the strengths and weakness are analyzed in each model in the following table.

Table A5.1.4 Overview of Model for Public/Private Sector Involvement in Public Transport

Contract Model	Description	Representative City
Public Monopoly	The public corporation provides all public transport services, and governments also own the vehicles and facilities. Vehicles, equipment, and infrastructure are typically operated and maintained by public corporations or state-owned companies. The public corporation is responsible for all capital and operation planning until system expansion.	Valladolid (Spain), Luxemburg, Bologna (Italy), Grenoble (France), Bonn (Germany)
Private Monopoly	A private company monopolizes the ownership, operation, maintenance, investment, and project planning. Regulator’s role: Safety and environmental standards, market-entry strategy, fares, line service area, capital, and subsidy on operational (if required), and management.	Reggio Emilia (Italy), Thessaloniki (Greece), Lyon (France)
Contracting Out	Regulator's role: Contracting out a private company through a bidding process for a specified period, and deciding the route/line, fares, schedules, type of vehicle and services, as well as safety standards. It is common that the operation of transit service routes is awarded to the lowest bidder through competitive bidding.	Warsaw (Poland) Graz (Austria) Ljubljana (Slovenia) Tallinn (Estonia)

Contract Model	Description	Representative City
Threatened Competition	Service area or groups of routes that each route is served exclusively by only one private operator. The provision of services would be determined by the private sector rather than the regulator. The regulator's role is to set the minimum service standards.	Zurich (Switzerland), Copenhagen (Denmark), New South Wales (Australia) Gothenburg (Sweden), Amsterdam (Netherlands)
Regulated Competition (no contract)	Operator's role: Vehicle ownership, capital, and operation planning Regulator's role: determine safety and maintenance standards, fares, entry system, routes, level of service, employment standards, environmental standards regulation, and monitor private sector services.	Malta, Buenos Aires (Argentina), Sarajevo (BiH)
Unregulated Competition (no contract)	Regulator's role: Provide regulations regarding ownership, operation, maintenance, equipment, safety, and infrastructure maintenance, such as terminal facilities and roads.	Manchester (UK), Buckinghamshire (UK)

Source: JICA Expert Team

A5.2 Third Country Training in Austria (Graz)

1) Training Program

Table A5.2.1 Training Program in Austria (Graz)

Day		Time	Activities
1	17 Oct 2021	PM	Sarajevo – Vienna – Graz
2	18 Oct 2021	AM	Meeting & Discussion: City of Graz
		PM	Site Visit: Schlossbergbahn (Castle Hill Railway)
3	19 Oct 2021	AM	Meeting & Discussion: Public Transport Operator - Holding Graz
		PM	Site Visit: Holding Graz Depots, Maintenance Workshops
4	20 Oct 2021	AM	Site Visit: Graz Bus, Trams and discussion with JICA, JICA Expert Team
		PM	Site Visit: Austrian Federal Railways (OBB) Graz Main Station
5	21 Oct 2021	AM	Meeting & Discussion: Suburban Train Operator - Graz-Köflacher Bahn (GKB)
		PM	Meeting & Discussion: Province of Styria and Styrian Transport Association
6	22 Oct 2021	AM	Meeting & Discussion: Suburban Train Operator - Steiermarkbahn (StB) and Steiermärkische Landesbahnen (StlB)
		PM	Site Visit: Weiz City, and Greening Tram Field Survey
		PM	Group Discussion: Discussion on Action Plan and Wrap Up
7	23 Oct 2021	AM	Graz – Vienna – Sarajevo

Source: JICA Expert Team

2) Participants

Table A5.2.2 Participants in Austria (Graz)

No	Name	Position
1	Mr. Emir Hota	Assistant Minister of Traffic, Canton Sarajevo, BiH
2	Mr. Muamer Kukan	Assistant Minister of Traffic, Canton Sarajevo, BiH
3	Mr. Tarik Bašović	Assistant Minister of Traffic, Canton Sarajevo, BiH
4	Mr. Esad Mujagic	GRAS-Head of Tram Sector
5	Mrs. Lejla Imamović	GRAS- Head of Traffic Management Sector
6	Mr. Hajrudin Omerbegović	Advisor of Director, Institute for Development Planning
7	Mr. Ajdin Džananović	Faculty of Traffic and Communication, University of Sarajevo

Source: JICA Expert Team

3) About Graz

- Graz is the capital of the Styria Region and the second largest city in Austria.
- With currently around 331,500 residents and a population increase of approximately 5,000 per year, it is a fast-growing city and a city of short distances, too.
- Like Sarajevo, it is surrounded by mountains and hills, with the Mur River dividing it into two parts.
- Due to its topographic situation, it also faces good air quality issues.
- Graz is a green city with a surrounding green belt of approximately 50%, but with a continued requirement for new construction land, it is facing a challenge to maintain a green belt and simultaneously comply with the needs for further developments.

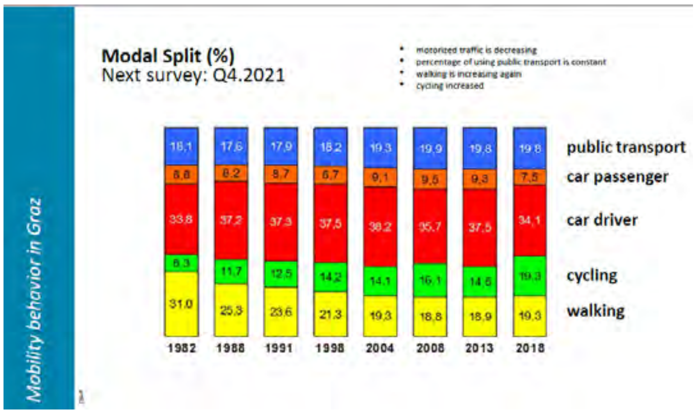
4) City of Graz, Traffic Planning Department

The City of Graz strives to clearly switch from mobility to soft mobility public transport and works together with the region to achieve its goals. It promotes soft mobility through investments in the necessary infrastructure through traffic calming projects developed together with the citizens and many small campaigns that encourage the switch.

Source: City of Graz

Figure A5.2.1 Sustainable Urban Mobility Plan in Graz

This aligns with the redeveloped mobility strategy, which is in line with the EU and smart urban mobility plans (SUMP), mainly focusing on sustainability.



Source: City of Graz

Figure A5.2.2 Modal Split in Graz

It is currently conducting a transport survey[1] to have the latest figures for a modal split in 2021. Based on the data from the previous surveys, the use of public transport has been steady. The plan is to increase cycling and use of public transport by 30% by reducing car usage.

The City of Graz is investigating new ways of PPP in transport infrastructure, urban development contracts for low emission, and other similar in order to respond to the development needs and carefully utilize public funds.

(1) Covid period

During the pandemic, most people used bicycles, and the number of passengers on public transport was reduced by 25% in the summer and 40% in the spring. This was also due to the restrictions on leisure travel.

(2) Mobility

The City of Graz is an urban node on the Baltic-Adriatic Core Corridor of Trans European Network. The corridor is the backbone for interconnectivity where Federal railways

[1] A sample of 6000 citizens of Graz will receive printed detailed questionnaires to fill in on a predetermined key date. The transport survey for commuters will be conducted later.

commuter lines connect with the public transport tram network.

(3) City logistics

Source: City of Graz

Figure A5.2.3 City Logistics in Graz

For more leisure space in the center and to fight air pollution, the City of Graz started a pilot project.

Electric vehicles purchased by the city are utilized for deliveries from the main distribution center outside and into the city. Deliveries with low emission and noise reduction vehicles can be done throughout the day, whilst deliveries with conventional vehicles are allowed only until 12:00NN.

(4) New developments and Mobility contracts

Due to the regulations, Graz does not have buildings higher than the clock tower (60 m) but is developing high-density areas.

In the west of the city, the Reininghaus (former brewery area) and "Smart City Graz" (former industrial area that is near the main station) projects focus on innovative, urban district development. The New Reininghaus district is developed for around 10,000 people to live and work in the future and Smart City for around 3000 people.

A mobility contract is concluded between the City of Graz and the executing property developers during development plans and serves to reduce motor vehicle traffic. Push-and-pull measures are agreed upon. With a lower car parking space, which is well below the current standard, offers and information are simultaneously provided for easier use of public transport, walking, and cycling, as well as car sharing and e-mobility created by property developers. This leads to a win-win-win situation for everyone involved.

(5) Cycling

Source: City of Graz

Figure A5.2.4 Cycling in Graz

As mentioned earlier, Graz is a city with short distances, with 90% of the trips having a distance of 10 km and 50% shorter than 3 km. It is ideal for walking or cycling.

It developed a cycling master plan in 2019, and the region allocated a total of 100 mil EUR for the project on improvement of cycling network infrastructure with an aim to increase cycling modal share up to 30% by 2030.

It also has bike-sharing programs, which provide an alternative and eco-friendly way to navigate the city.

(6) MaaS Graz Mobil

Source: City of Graz

Figure A5.2.5 MaaS Graz Mobil

Since 2016, Graz has been building multimodal nodes, "tim."[2] The idea is to have an environmentally friendly, flexible, and sustainable mobility service to reduce private ownership of cars or a second car and consequently improve air quality. The concept is to provide an option of switching to alternative means of transport like (e-)car sharing, then switching to an e-taxi and charging private e-cars free of charge. Tim is one of the leading car-sharing services in Austria, operated by Holding Graz in Graz. Its locations are easily accessible by public transport or by bicycle.

(7) Priority signaling

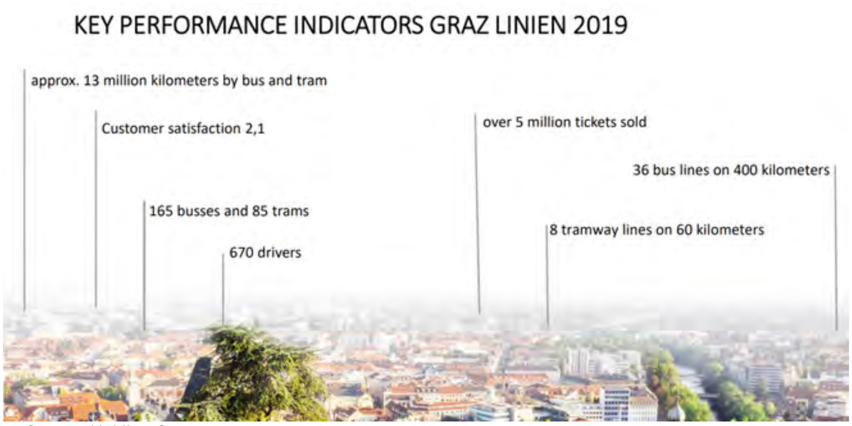
In the Graz urban area, several traffic light systems can prioritize public transport vehicles (bus or tram). This priority switching is enabled in trams through a switch contact on the overhead lines by setting the direction of travel at points or installing a ground loop. Buses use so-called "radio telegrams" issued by the on-board computer in a specified sequence. These radio telegrams are logging points and must be re-configured whenever a route or bus stop is moved.

5) Holding Graz

Holding Graz is a service company that works in public transport, water and waste management, cleanliness, energy supply, leisure facilities, and others.

It is the second largest municipal company in Austria. The city of Graz holds 99.84% of the shares in Holding Graz, and Gebäude und Baumanagement Graz GmbH (GBG) has the remaining 0.16%.

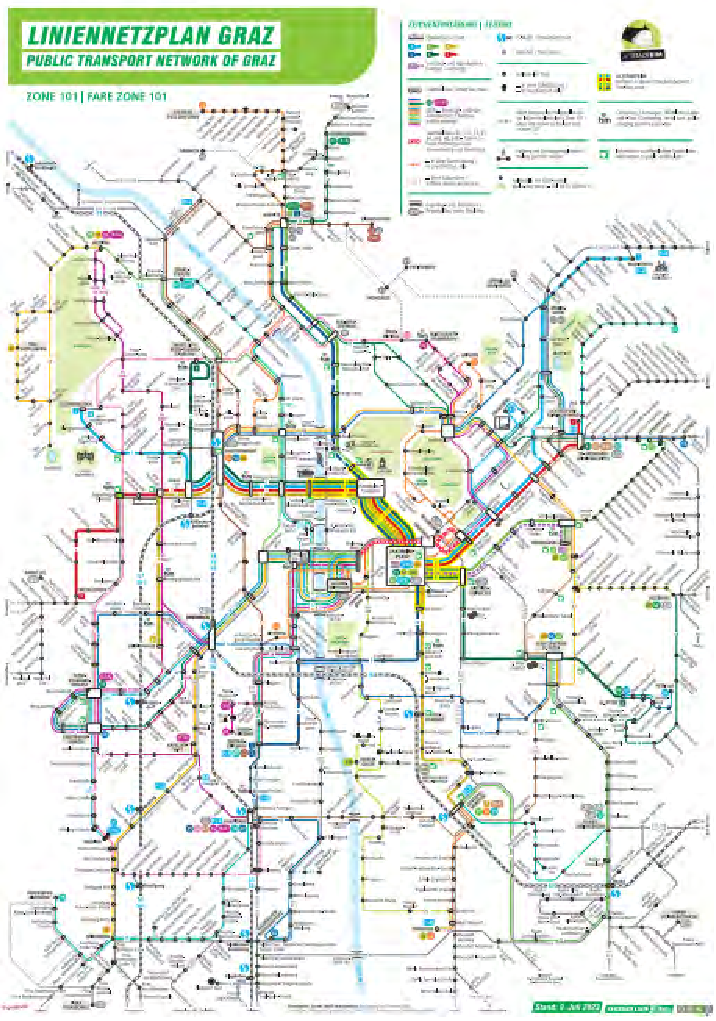
[2] Part of the project "KombiMo II" funded by the Federal Ministry for Transport, Innovation, and Technology.



Source: Holding Graz

Figure A5.2.6 Key Performance of Holding Graz

(1) Public transport system



Source: City of Graz

Figure A5.2.7 Public Transport System in Graz

The City of Graz has a well-developed and well-integrated public transportation system that allows passengers to transfer seamlessly between trams and buses using a single ticket within a certain time frame. It is also designed to be accessible to people with reduced mobility.

The public transport network is primarily trams and buses, with around 900 bus and tram stops. In total, the length of the tram tracks is 73.612 km (including all sheds, workshops, and sidings), of which 61.778 km are actually driven on by trams as part of the scheduled service. Calculated over the entire year, buses travel approximately 25,000 km a day on average and trams at approximately 41,500 km.

Graz Linien company, Graz Holding subsidiary[3] is the operator. OBB, the Austrian Federal Railways, operates the commuter rail for suburban areas. Bus operates in inner urban areas, and only a few lines cross the city border for legal reasons.

Graz Linien annually transports approximately 50.5 million passengers by tram, 41.5 million by bus, and 0.7 million by the Schlossbergbahn and the Schlossberg lifts, a total of 92.7 million passengers per year.

The plan is to extend the tram network further, operate more bus lines, and especially use alternative energy for the buses (change diesel to zero-emission fleet).

(2) Timetables for public transport operation

Unlike Sarajevo, the City of Graz prepares a strategy for public transport operations, and it is up to the operator to develop timetables and respect them.

(3) Fare system

Styria is subdivided into different zones, and Graz is in fare zone 101. This fare zone extends far beyond the city limits. Every ticket for this zone is valid for all modes of public transport.[4]

Tickets[5] range from individual hourly to monthly tickets. Also, the KlimaTicket will be available as of the end of October.

Source: City of Graz

Figure A5.2.8 Fare System in Graz

(4) Schlossberg funicular

Holding Graz operates it. The funicular single-track railway overcomes a gradient of 60%. The car has a glass roof and operates every 15 minutes.

(5) Tram fleet

Currently, Graz-Linien has 85 trams in its fleet.[6] In the company's early peak, 66 of these

[3] Graz Linien, integrated into the Styrian Transport Association, employs around 800 people.
[4] Tram and bus lines with single and two-digit line numbers, the Schlossberg funicular, regional buses with three-digit line numbers, and all trains.
[5] Hourly, 10-zone, daily, weekly, monthly, semi-annual, and annual tickets for various target groups.
[6] - The most modern, 45 vehicles of Stadler Pankow GmbH: “Variobahn” has 47 seats and 98 standing spaces.

are in use. The average operation life of trams is 40 years.

The trams undergo preventive maintenance and technical checks by qualified Liebherr service technicians every year. The tailor-made customer service for the air-conditioning systems enables both the highest possible availability of the vehicles and a high level of comfort for the passengers.

Also, in 2024, 15 new trams will be used. Their procurement was put to tender in the first or second quarter of 2021 at the latest. When buying, there is also the option of ordering 40 models. Graz Linien expects costs of around 56 million euros. This will allow even more passengers to be transported at even shorter intervals. Incidentally, Graz Linien currently brings more than 300,000 passengers safely to their destinations every day.

In the future, 79 trams will operate in the early peak. In the first step, the Graz lines need these 15 new trams.

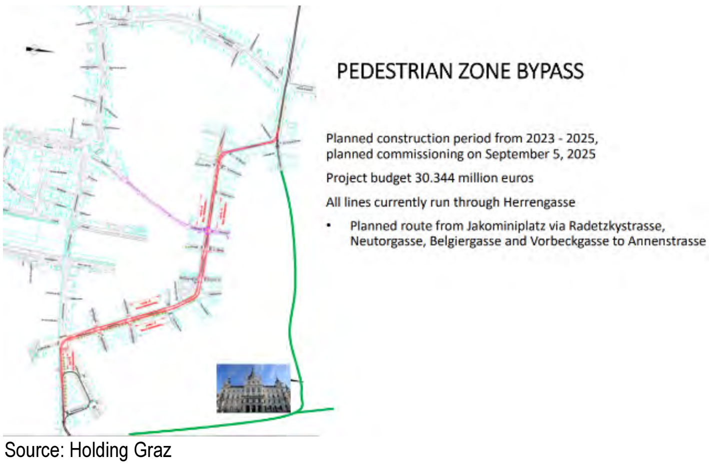
(6) New technology on wheels and rails

Since the end of last year, 10 tram vehicles have been equipped with a "Condition Monitoring System."[7] The system's sensors installed on the bogie record accelerations and vibrations and permanently monitor rails and wheels condition in real-time, detecting flat spots in an early stage. The innovative solution enables a significant advantage in predictive maintenance planning and digital, permanent condition monitoring.

(7) Tram network

The tram network is extensive and covers most parts of the city. It is a popular and efficient mode of transportation. By the end of 202,1 the tram network of currently 33.2 km will be expanded to 36.5 km.

The control committee approved funds of 62 million EUR for the purchase of 15 new trams of a length between 28 and 40 meters with an option for 40 additional trams and subsequent necessary expansion of the hall and parking infrastructure (tracks) in Remise 3 in Eggenberg.[8] The order will take place at the end of 2021 or beginning of 2022 so that operation will be ensured from autumn 2024.



Source: Holding Graz

Figure A5.2.9 Pedestrian Zone Bypass

- 18 Bombardier Transportation vehicles: "Cityrunner" have 54 seats and 90 standing spaces.
- 22 Older tram vehicles from other tram manufacturers primarily in operation at peak times and as replacement vehicles.

[7] developed by ZF Friedrichshafen AG

[8] The cost is a little more than 9 million EUR for expansion.

Graz will build a city center tramline bypass by 2025. A mockup of the future situation was organized at the end of September during the European Mobility Week 2020: Promoting Zero-Emission Mobility for All.

Source: Holding Graz

Figure A5.2.10 Tram Extension to Reininghaus and Smart City

The total cost of the two tram extensions is 72.5 million euros. Reininghaus has a 1.8-km long tram line, costing 44.2 million, and Smart City has a 1.5 km long tram line, costing 28.3 million. The Province of Styria bears a third of the costs incurred. Extensions of tram lines also included the development of surrounding areas, including cycling and walking paths. Both lines will be opened in November 2021.

The total investment of over EUR 150 million focusing on the workshop and shed infrastructure in Steyrergasse South is one of the central expansion projects of Holding Graz over the next 10 years. This will enable state-of-the-art maintenance of trams in one central location.

(8) Bus traffic

The route network covers a length of 369 km, and Graz Linien covers an annual distance of 13.2 million km with its vehicle fleet.

The tendering process for the selection of bus operators is every 5 years, but the public operator, Graz Linien, operates 99.9% of the Graz lines.

(9) Bus fleet

The fleet includes 151 low-floor municipal line buses,[9] 99% of which are air-conditioned. Except for a leased hybrid bus from Volvo, all models are from Mercedes.

Buses run at an average of 10 to 14 years.

Two 12-metre-long electric buses trail operated from 18 April 2017 to spring 2019 on Line 50. The electric buses operated on line 34E in December 2017 and lasted until autumn 2018. Since 2018, electric buses (Heuliez Bus, Irizar, and EvoBus) have been tested on various lines.

In mid-August 2019 and August / September 2021, a hydrogen bus from Solaris was tested in Graz. On 16 September 2021, the Graz City Council approved a budget of 250,000 EUR for the purchasing and testing a hydrogen bus from Hyundai.

[9] - “Sprinter City 77” (number: 1): This midibus has 11 seats and 24 standing spaces.
- “O 530 N3L CITARO“ (number: 19): These 15-meter buses have 46 seats and 76 standing spaces.
- “Citaro 628 03” (number: 64): These rigid buses have 30 seats and 61 standing spaces.
- “Citaro G 628 03” (number: 67): These articulated buses have 40 seats and 102 standing spaces.

6) ÖBB

The state-owned Austrian Federal Railways (ÖBB or ÖBB-Konzern) is the largest railway company in Austria, which is 100% owned by the Republic of Austria.

Graz Main Train Station (Graz Hauptbahnhof): Graz Hauptbahnhof is the main railway station in Graz and an important hub for both national and international train services operated by ÖBB. It connects Graz to major cities within Austria, as well as to destinations in neighboring countries like Germany, Hungary, and Slovenia.

Regional and Intercity Services: ÖBB operates a variety of train services in and around Graz, including regional trains connecting nearby towns and cities, as well as intercity and EuroCity services that connect Graz to other major Austrian cities and European destinations.

Ticketing and Reservations: ÖBB offers a range of ticketing options, including single and return tickets, as well as various discounts and rail passes for frequent travelers. Reservations are recommended for some long-distance and international trains.

Rail Passes: ÖBB participates in various international rail pass programs, such as the Eurail Pass and Interrail Pass, which allow travelers to explore multiple European countries using a single pass.

Nightjet Sleeper Trains: ÖBB's Nightjet sleeper trains connect Graz to other European cities, offering comfortable overnight travel options. These trains often provide sleeping compartments, couchettes, and other amenities.

Services and Facilities: Graz Hauptbahnhof offers various services and facilities, including waiting areas, shops, restaurants, and information counters. The station is generally well-equipped to serve the needs of travelers.

7) Graz-Köflacher Bahn und Busbetrieb GmbH (GKB)

GKB has existed since 1854. It is a railway company owned by the Republic of Austria, primarily providing passenger and freight rail services connecting the city of Graz with various towns and communities in the surrounding area. The trains are 99.4% on time. Currently, GKB operates three suburban S-Bahn train lines in and western of Graz. In 2019, it operated 1.7 million train km and transported 6.2 million passengers. With additional bus lines, it transported 6 million passengers in 2019, and it also provides on-demand service for the “last mile” to and from the station for the passengers.

GKB has an education center for railway professionals. It operates railway stations, 91 km of rail infrastructure, and P+R sites at stations.

GKB is important in providing sustainable transportation options for local communities, helping reduce road congestion, and contributing to environmental goals.

GKB plans to electrify the infrastructure by 2028, which should help reduce approximately 480,000 tons of CO_2 within 30 years and expand annual train kilometers to approximately 2.8 million by 2029 while station modernization is ongoing. They expect a rise in number of passengers.

8) Steiermärkische Landesbahnen (StlB)

“Steiermärkische Landesbahnen” (“Styrian State Railways”) is founded in 1890. The Federal State of Styria, Austria, owns it. It maintains 124 km of its railway infrastructure, railway stations, and terminal Graz South. It has an ECM-certified workshop for the maintenance of their vehicles and vehicles of third-party companies. In the Weiz workshop, 40 trained professional workers are employed to maintain locomotives, railcars, and passenger railcars, maintenance and repair of freight wagons, and apprenticeship training.

In the control center, Weiz controls the regional lines of Gleisdorf–Weiz and Peggau–0belbach. Communication between the center and trains is via a digital train radio system. It has up to 90 passengers daily.

9) Styrian transport association

The Styrian Transport Association (Steirische Verkehrsverbund or "STV") is a regional public transportation authority. It is a member of the Austrian Mobility Associations and is responsible for coordinating and organizing public transportation services across the region, including buses, trams, trains, and other forms of public transit. STV's primary goal is to provide efficient, integrated, and sustainable transportation options for residents and visitors in Styria.

STV manages a unified ticketing system that allows passengers to use a single ticket for multiple modes of transportation, making it easier to transfer between different forms of transit.

STV provides comprehensive information about timetables, schedules, and routes for all the services it coordinates. This information is accessible through various platforms, including websites, mobile apps, and printed materials.

STV emphasizes on environmentally friendly transportation solutions, contributing to the region's sustainability goals and reducing traffic congestion.

STV also manages public tenders for public transport services and contracts. The call for public tender has to be issued for public transport services, except railways, until 2023. Railways have two types of contracts: net contracts with OBB and gross contracts with STB and GKB. The regional bus is gross contract while the on-demand bus is applied funding guidelines.

A5.3 Third Country Training in Italy (Florence and Bologna)

1) Training Program

Table A5.3.1 Training Program in Italy (Florence and Bologna)

Day		Time	Activities
1	20 Mar 2022	AM	Sarajevo–Vienna–Frankfurt–Florence
2	21 Mar 2022	AM	Presentation & Discussion: Municipality of Florence
		PM	Meeting: Diplomatic Counsellor of the Mayor
3	22 Mar 2022	AM	
		PM	Technical Meeting: TRAM Company
4	23 Mar 2022	AM	
		PM	Site Visit: Viale Rosselli 5/7 to visit the operations room (GEST)
5	24 Mar 2022	AM	Site Visit: Viale Rosselli 5/7 to visit tram routes
		PM	Florence–Bologna by train
6	25 Mar 2022	AM	Site Visit: transportation in Bologna
		PM	Bologna–Vienna–Sarajevo

Source: JICA Expert Team

2) Participants

Table A5.3.2 Participants in Italy (Florence and Bologna)

No	Name	Position
1	Mr. Emir Hota	Assistant Minister of Traffic, Canton Sarajevo, BiH
2	Mr. Muamer Kukan	Assistant Minister of Traffic, Canton Sarajevo, BiH
3	Ms. Džana Berkovac	Advisor for Public Relations and Promotion, Canton Sarajevo, BiH
4	Mr. Esad Mujagic	GRAS-Head of Tram Sector
5	Mrs. Lejla Imamović	GRAS- Head of Traffic Management Sector
6	Mr. Hajrudin Omerbegović	Advisor of Director, Institute for Development Planning
7	Mr. Ajdin Džananović	Faculty of Traffic and Communication, University of Sarajevo

Source: JICA Expert Team

3) About Florence

Florence is the capital city of the Tuscany region in Italy, with 349,296 inhabitants in 2020. The surrounding municipalities are Scandicci, with approximately 50,000 inhabitants, Campi Bisenzio and Sesto Florentino, with 40,000 to 50,000 inhabitants, and Bagno a Ripoli, with 25,000 inhabitants.

Florence, like Sarajevo, is surrounded by hills, and the Arno River divides it into two parts. It is a historic and cultural hub with a rich history and significance.

Moving around the city is easy thanks to a sustainable and well-developed public transport system focusing on electric and soft mobility.

Beyond the city limits, the wider Tuscany region has a well-connected regional transport system that includes trains and buses, making it relatively easy to travel to other cities and towns.

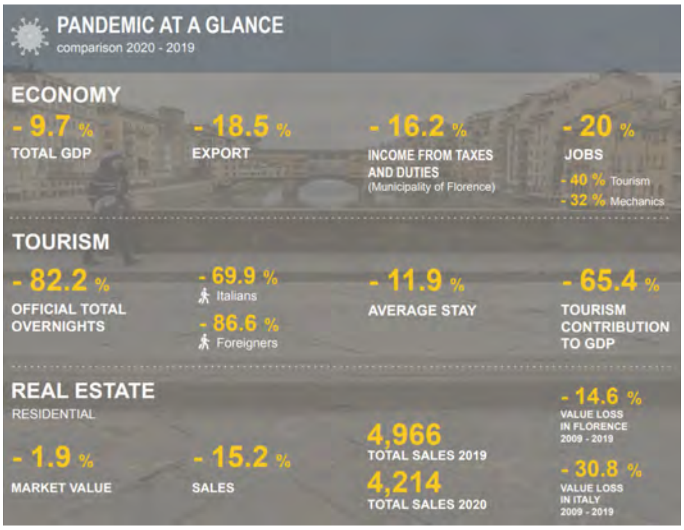
(1) Administration

The mayor of Florence is the highest-ranking official in the city's government, responsible for representing the city, managing local administration, and implementing policies.

The municipal administration is responsible for day-to-day operations and services within the city (public services, urban planning, transportation, and social programs). The city council is the legislative body of the local government responsible for making decisions on local matters, passing ordinances, and approving the budget.

Tuscany Regional government has authority over education, healthcare, transportation, and economic development.

(2) COVID-19 pandemic



Source: City of Florence

Figure A5.3.1 Pandemic in Florence

4) Mobility Planning in Florence

Source: City of Florence

Figure A5.3.2 Mobility Planning in Florence

According to an analysis conducted in 2010, 34% of the pollution in Florence comes from mobility. Florence supports an integrated strategy for smart mobility with all forms of movement of vehicles and people in the city coordinated and monitored in an integrated and organic way. Its goal is sustainable development towards a zero-emissions city.

Florence has 17 km of tramway network in operation, 94 km of cycle paths, and 9 km of cycle lanes; the bus fleet is renewed, and the sharing service is active.[10] It has a modern tram system that contributes to improving public transportation options and reducing congestion. There are 140 thousand people who use the tram every day. This has translated in ten years into 30 million fewer trips on private vehicles.

[10] 900 Electric scooters, 600 electric Vespa-type scooters, 100 electric cars, bike sharing service with 1,000 e-bikes, and 2,000 standard bikes.

(1) Sharing

Florence is promoting free-flow car sharing with a substantial number of e-vehicles. It is a leading Italian city in innovating free-flow bike-sharing. Three hundred thousand users registered before the pandemic, and more than 1.5 million kilometers were biked in a year. E-scooters are added to a sharing service.

(2) Electric vehicles

Since 2015, the local administration has built and managed around 200 charging stations, intending to add 100 more through private investments. It also purchased 1,000 e-bikes, 900 e-scooters, and 600 Vespa-type scooters. E-bike use was adapted to the city commuter journeys.

(3) Cycling

Florence is the second city globally to launch a bike-sharing service that allows companies to deploy their bikes on the street. The infrastructure is in place; however, using bicycles on daily journeys is still low (only 7%).

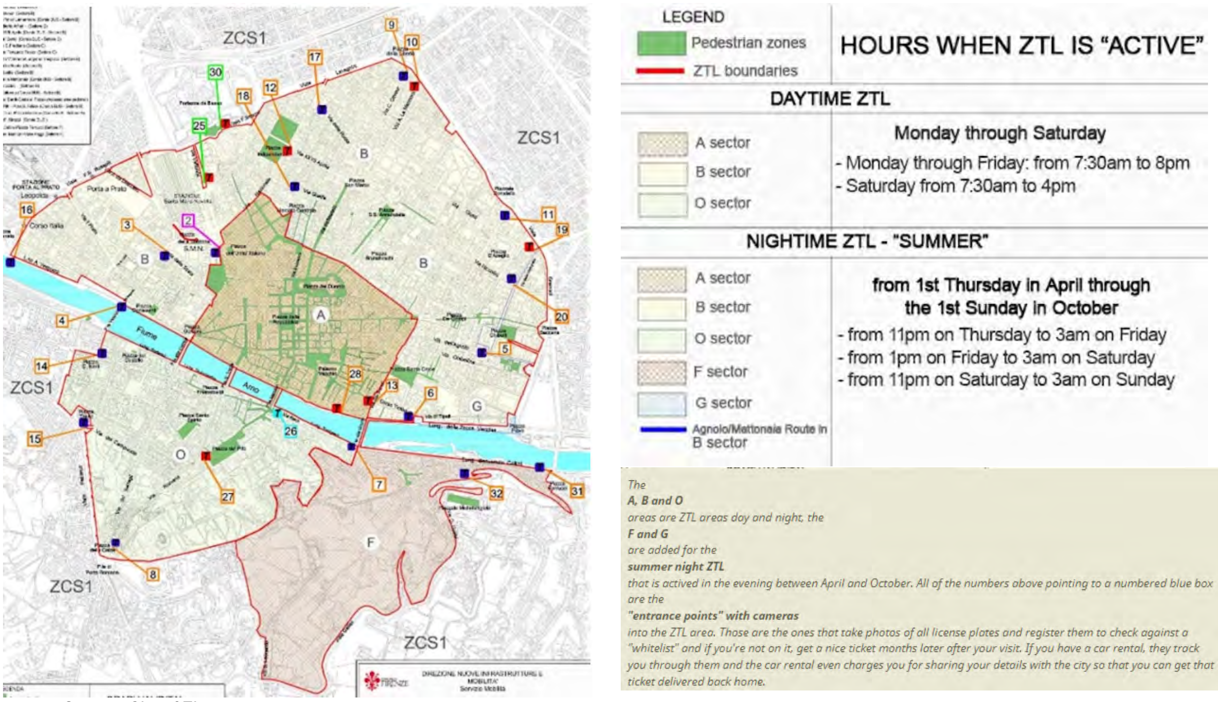
The 1001 bike rental service rents bikes in the city center.[11] It is possible to rent a bike at one of the four pick-up points and return it at a different location.

(4) 30 Zone concept

The city council implemented the concept of 30 zones to improve road safety. They cover 135 km, almost 10% of Florentine roads.

(5) Low emission zone

- Green Shield



Source: City of Florence

Figure A5.3.3 Low Emission Zone in Florence

By the end of 2022, the City of Florence's low emissions zone (LEZ) is expected to be

[11] 1 hour: € 2,00 - 5 hours: € 5,00 - 24 hours: € 10,00

operational. It is the biggest LEZ in Europe, considering the extension of this area relating to the municipality zone. The zone has a perimeter of about 50 km and covers about 38 km^2, which is equal to 66% of the city and 37% of the wider municipal area.

The zone is enforced by a network of 81 automatic number plate recognition cameras positioned along the main entry axes of the city. It allows access to tram terminals and park-and-ride infrastructure.

The implementation requires an investment of €4.4 million, of which €1.5 million comes from European funds, €2 million from state funds, and €900,000 from the municipality.

According to the simulations carried out, the "Green Shield," together with other interventions for sustainable mobility, will result in a reduction of up to 18% of private vehicle journeys in the urban area (capital and municipalities of the first belt) and up to 13% on the road network within the metropolitan city. Even more significant was the reduction in travel times, with drops of 22% in the urban area and 18% in the metropolitan city. While car use reduces, the simulations show an increase in the use of public transport, including trains, trams, and buses (up 151,000, 124,000, and 25,000 passengers per day, respectively).

Due to a massive problem with over-tourism, especially in the city center, this system will be used for tourist buses too, providing specific parking areas around the city and mobility hubs to move tourists to the center by other means.

(6) Interchange nodes and parking

The new network foresees hierarchical interchange nods. Currently, a new underground rail is being worked on to reduce the load on rail in the city center.

The plan is to create hubs at crucial points, such as motorways, to channel all traffic to public transport.

The interchange hub for the high-speed rail network connects the station at Santa Maria Novella and other nodes in other municipalities. The hub in the west part is important as it connects motorway, rail, and tram. In line with the above, a hub was created with the parking on the motorway so vehicles entering the parking do not exit to the motorway.

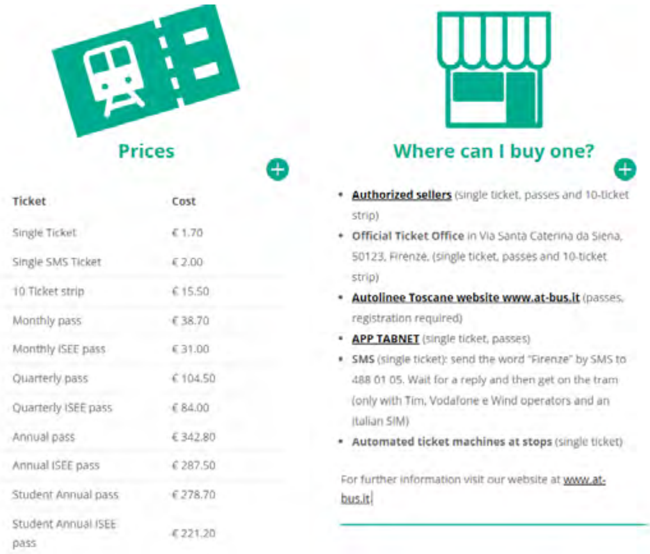
Parking lots (park-and-ride) are built as part of the interchange hubs with affordable and favorable fees to allow easier transfer to public transport at the end terminals of the tramlines.

5) Public Transport in Florence

Azienda Trasporti Area Fiorentina (ATAF) is a joint-stock company that manages local public transport in Florence and part of its province. It provides an extensive network of bus routes and tram lines.

It is estimated that 100,000 daily journeys out of 650,000 in Florence are car journeys. To reduce this number and decongest the urban spaces from cars, Florence aims to develop an efficient intermodal exchange system.

(1) Tariff system



Prices

Ticket	Cost
Single Ticket	€ 1.70
Single SMS Ticket	€ 2.00
10 Ticket strip	€ 15.50
Monthly pass	€ 38.70
Monthly ISEE pass	€ 31.00
Quarterly pass	€ 104.50
Quarterly ISEE pass	€ 84.00
Annual pass	€ 342.80
Annual ISEE pass	€ 287.50
Student Annual pass	€ 278.70
Student Annual ISEE pass	€ 221.20

Where can I buy one?

- **Authorized sellers** (single ticket, passes and 10-ticket strip)
- **Official Ticket Office** in Via Santa Caterina da Siena, 50123, Firenze, (single ticket, passes and 10-ticket strip)
- **Autolinee Toscane website www.at-bus.it** (passes, registration required)
- **APP TABNET** (single ticket, passes)
- **SMS** (single ticket): send the word "Firenze" by SMS to 488 01 05. Wait for a reply and then get on the tram (only with Tim, Vodafone e Wind operators and an Italian SIM)
- **Automated ticket machines at stops** (single ticket)

For further information visit our website at www.at-bus.it

Source: City of Florence

Figure A5.3.4 Tariff System in Florence

Currently single ticket can be used for bus and tram. Students' annual ticket is 48 EUR. Next step is to integrate all public transport in Florence metropolitan area (44 municipalities) and have one single ticket for all modes with unique tariff system.

(2) Bus system

Source: City of Florence

Figure A5.3.5 Bus System in Florence

ATAF operates a comprehensive network of buses that covers both the city center and suburban areas. The bus is a crucial mode of transportation for residents and visitors.

Autolinee Toscane SpA, as per awarded tender, has been managing public transport services since November 2021. With the introduction of trams, the number of bus lines remained the same but was modified to direct passengers to trams.

There are 60 hybrid buses, 70 e-buses, and the rest are Euro 6 standard.

(3) Tram system

Source: City of Florence

Figure A5.3.6 Tram System in Florence

Development of the tram network began in 2005. The T1 line was finished in February 2010, and the construction of the T2 line in 2019 and the T3.1 line, which is an extension of the T1 line, completed in 2018.

The tramline corridor is separated from the other traffic. To ensure maximum safety, as well as comfort for users, pedestrian crossings along all lines have traffic lights, and stops have platforms partly covered with seats and lighting. The platforms have displays indicating waiting times, loudspeakers, ticket machines, and CCTV. Continuous rail coating is on the Embedded Rail System to dampen the noise and vibrations. The damping platform is equipped with an "elastic mattress," which prevents the transmission of vibrations to the surrounding ground.

GEST (Gestione ed Esercizio del Sistema Tramviario S.p.A.) is an Italian company controlled by the French RATP Dev, part of the RATP group, which manages the tram operations in Florence.

The Sirio Firenze tram has large, glazed surfaces, six automatically operated doors per side, low floors, air conditioning, a closed-circuit video surveillance system, and communication systems with the control center.

From the periodic research carried out by GEST, more than 90% of passengers are satisfied with the service, and 97% appreciate the punctuality and regularity of the service. These surveys indicate that 22% of respondents replaced private vehicles with trams (19% cars and 3% two-wheelers).

(4) Tram network

Line 1: Connects the municipality of Scandicci with Santa Maria Novella station. It is 7.5 km long with 14 stops and a depot.

Line 2: Connects the center with the airport. It is 5 km long with 12 stops, a 25-minute ride, and has 4.2 min. service frequency.

Line 3: Extension of line 1. It is 11.5 km long with 26 stops, a 40-minute ride, and has a 4.2-minute service frequency.

Santa Maria Novella is a joint station for both lines.

Until the introduction of the second line, there were 14 million users per annum, and with line extension in 2018, there were 26 million users in 2019. The plan is to increase annual users to 37 million on both lines.

For lines 1 and 2, there are almost 2 million passengers on average per month for 2021 compared to 1.7 million in 2020.

The second and the third lines were awarded through tender to a private company with the right to manage it for 30 years. It was built in 2018 and 2019 and financed by public-private funds. Tramlines connect the center with a motorway, airport, court, university, sports center, and hospital.

The planned construction of line 3.2.1 (Piazza della Libertà, Bagno a Ripoli) and line 4 (Stazione Leopolda, Piagge, Campi Bisenzio) represent indispensable completion of Florence's tram network, managed by Gest, a network that is increasingly becoming a strong element of mobility in the Florentine area.

Line 3.2.1 to Bagno a Ripoli will be 7.2 km long with 17 stops, extending to the southeast of the city. Line 4 will be about 12 km long, with 24 stops, and complete the network from north to west of Florence from the stop of the T1 tram line at Porta al Prato. The line will run partly on the current site of the Florence–Empoli railway (which will cease rail service) to the current station at Cascine and partly on its newly built site. Due to certain constraints, some parts of the lines will be without catenary. At the end of each new line will be depot. The city will fully fund these lines.

6) Smart City Control Center in Florence

The new center is under construction. It is in a repurposed building next to the former Leopolda Station, where various operators from the city's main services will have a station. From a mobility aspect, it is important as it will collect data in real-time and analyze it in order to digitally manage traffic flows and remotely control traffic lights and the interface tram control system with the city traffic lights. It will use the information to keep citizens updated via a free app about traffic.

(1) IF application

It is an official Florence app through which citizens receive real-time information about traffic, availability of shared e-vehicles, etc.

(2) Traffic lights control system

Societa' Illuminazione Firenze e Servizi (SILFI) is a public company owned by almost all the municipalities in the Metropolitan City of Florence. It is in charge, among others, of public lighting and traffic control. Its control room provides services of traffic light synchronization, traffic control with sensors and cameras, mobility control of electricity and car & bike sharing, and public lighting monitoring and its consumption.

The SILFI control room provides a huge and useful amount of data about traffic and public lighting, including energy consumptions, environmental data on air quality and weather. Two large screens show all monitored activities.

The green wave in the side streets traffic with prescribed speed was introduced to reduce pollution. Although some streets were given priority, the traffic lights' waves can be changed in real-time depending on the situation. Trams are given priority at the junctions.

7) About Bologna

Bologna, located in northern Italy, is a historic capital city of the Emilia-Romagna region. It's situated at the foot of the Apennine Mountains.

The city has a wealth of historic architecture, including medieval towers, churches, and palaces. Its historic center is well-preserved and features narrow streets, porticoed walkways, and vibrant piazzas.

It is home to one of the oldest universities in the world, the University of Bologna, founded in 1088.

Bologna is well-connected by road, rail, and air. The Bologna Guglielmo Marconi Airport is a major transportation hub in the region. The city also has a developed public transportation system, including buses and a central train station.

(1) Mobility

Bologna is an urban node of the Scan-Med corridor. The national railway station is in the city center, and the national highway crosses the whole metropolitan territory. It is a strategically important hub.

Bologna plans to transform public transport by improving bicycle paths and building a four-line tram network as a part of the urban sustainable mobility plan.

It plans to purchase 127 hydrogen-powered buses and introduce trolleybuses in the city center. The project is implemented and funded jointly with the public transport company.

(2) Public transport

The city bus network is extensive and efficient in Bologna. Many routes in the city are operated by the TPER company, which operates in Bologna, Imola, and Ferrara.

The trolleybus system, part of the public transport network of the city and municipality of Bologna, has been in operation since 1991. The current system comprises five urban lines: 13, 14, 15, 32, and 33. On 1 July 2020, the first line, 15, with a partially optical guidance system of the trolleybus network expansion, started operating.

(3) 30 Zone concept

Bologna intends to introduce a speed limit of 30 km/h across the city and is collecting citizens' signatures for this petition with an aim to promote sustainable, active mobility.

(4) Cooperation with Sarajevo

Both parties were interested in establishing cooperation, and it was agreed to exchange SUMP documents to start the cooperation with the possibility of working on some EU projects jointly.

A5.4 Third Country Training in France (Lyon and Grenoble)

1) Training Program

Table A5.4.1 Training Program in France (Lyon and Grenoble)

Day		Time	Activities
1	09 Oct 2022	AM	Sarajevo–Vienna–Lyon
2	10 Oct 2022	AM	Presentation & Discussion: TRAMODE Team and Suez Consulting Mobilities
		PM	Presentation & Discussion: URBALYON
3	11 Oct 2022	AM	Field visit: KEOLIS Lyon tram workshop and bus depot
		PM	Discussion with KEOLIS Lyon
4	12 Oct 2022	AM	Presentation & Discussion: SYTRAL Mobilités
		PM	Lyon–Grenoble by train
5	13 Oct 2022	AM	Presentation & Discussion: SMMAG
		PM	Field visit: Transportation in Grenoble
6	14 Oct 2022	AM	Presentation & Discussion: SMMAG
		PM	Field visit: Newly rehabilitated intermodal railway station area in Grenoble
7	15 Oct 2022	AM	Grenoble–Lyon by train
		PM	Lyon–Vienna–Sarajevo

Source: JICA Expert Team

2) Participants

Table A5.4.2 Participants in France (Lyon and Grenoble)

No	Name	Position
1	Mr. Emir Hota	Assistant Minister of Traffic, Canton Sarajevo, BiH
2	Mr. Muamer Kukan	Assistant Minister of Traffic, Canton Sarajevo, BiH
3	Mr. Tarik Basović	Assistant Minister of Traffic, Canton Sarajevo, BiH
4	Mr. Senad Mujagić	General Manager, GRAS (only from October 12 to 15)
5	Mr. Safudin Čengić	General Manager, CENTROTRANS
6	Mr. Vedad Smailhodzić	Director of Department for Urban and Sub-urban Transport, CENTROTRANS
7	Mr. Amel Kosovac	Dean, Faculty of Traffic and Communications (only until October 12)
8	Mr. Mustafa Mehanović	Professor, Faculty of Traffic and Communications, University of Sarajevo

Source: JICA Expert Team

3) Mobility in France

France is the European leader in the fight against climate change. Transportation and sustainable mobility are priority sectors for the French government. While the goal is to comply with the EU target of a 37.5% reduction in emissions by 2030, France plans to exceed the EU target by 2050.

Digital mobility services, real-time information search, route calculation, and ticketing tools have become complementary to transport services and form an enhanced offer essential to operators to meet the new habits of transport users. While their development is accompanied by an increase in the share of ticket sales via digital channels, their impact on the modal shift or on the increase in travels using several different modes of transport (intermodality) has yet to be proven on a large scale.

France has been implementing policies to encourage sustainable transport modes, such as public transport, cycling, and walking. These efforts include improving public transport networks, creating dedicated cycling lanes, and enhancing pedestrian infrastructure.

It has set ambitious transition goals towards electric and low-emission vehicles. The French government has implemented tax incentives for businesses and individuals to encourage the use of sustainable transport modes and electric vehicles.

(1) Mobility tax

The mobility tax in France is imposed on companies with 11 or more employees if at least 50% use personal vehicles to commute to work. The tax is designed to promote sustainable modes of transportation and reduce the environmental impact of commuting.

Certain exemptions and deductions could apply depending on the efforts made by the company to reduce car commuting. If the company could demonstrate that it had implemented sustainable mobility solutions, it might qualify for reduced or exempted tax rates.

(2) COVID-19

The COVID-19 crisis resulted in a 24% reduction in passenger numbers over 2020 compared to 2019. While air and bus transport have been the most affected by this crisis, private vehicles and soft modes have seen smaller falls and a faster recovery.

4) About Lyon

Lyon, the capital of the Rhône département and the Auvergne-Rhône-Alpes région, is on a hilly site at the confluence of the Rhône and Saône rivers. It is the third largest city in France. The current population of the Lyon metro area is 1,748,000 citizens, with a 0.81% increase from 2021.

Lyon is well-connected by transportation networks with a major international airport, Lyon-Saint Exupéry Airport, and a hub for high-speed train (TGV) services.

5) URBALYON

The Urban Community Planning Agency was established in 1978 initially to help the metropole of Lyon design land use plans. Since then, they have increased their partnerships as well as the territory where they work, transforming from an agency on the territory of Lyon to a metropolitan scale. It is a non-profit association helping local bodies to have mandatory urban planning documents.

It supported SYTRAL mobility to define mobility strategy and develop a new mobility plan. Both strategic and mobility plans are under review this year.

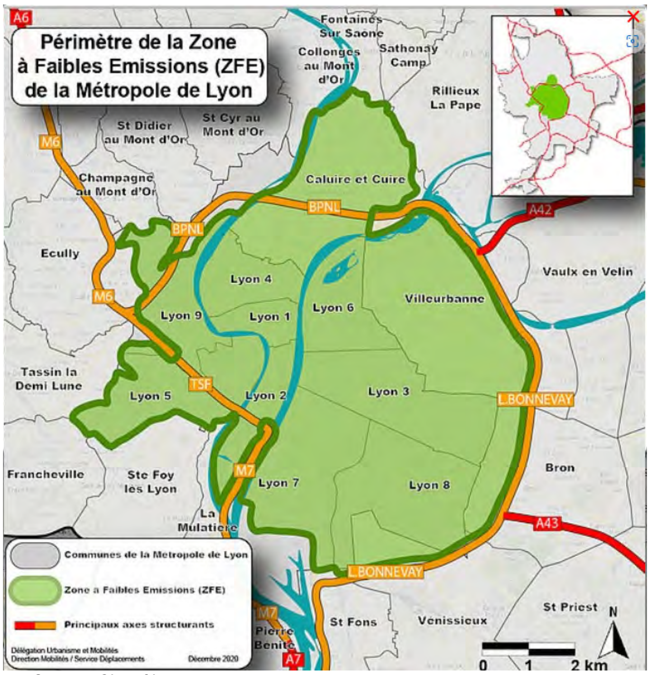
Urbalyon aggregates, cleans, and consolidates collected data, which allows them and their partners the easiest way to access a lot of indicators.

6) Mobility in Lyon

In 1997, Lyon was the first in France to adopt a Sustainable Urban Mobility Plan thanks to the continuous planning by SYTRAL, public authorities in the metropole, transport operators, and other partners. It was subsequently revised and updated in 2005. The development of the plan for the period 2017 to 2030 started in 2015 for the territory of 73 municipalities of the Métropole de Lyon, the 8 communes of the Community of Communes East Lyonnais and the 6 communes of the West Lyon, for which SYTRAL acts as transport authority.

The city of Lyon has chosen to address accessibility as a cross-cutting issue and to invest substantially in creating a barrier-free and inclusive environment. Promoting independent mobility is an important part of its overall strategy particularly considering that 30% of the public transport network users are affected by mobility issues.[12]

(1) Low emission zone (ZEF)



Vehicle Classification according to article L. 318-1 and R. 318-2 French road traffic act					
Class	Motor-cycles, trikes and quads	Cars and vans		Lorries	
		Diesel	Petrol	Diesel	Petrol
non classified	Without norm until 31.05.2000	Pre-Euro, Euro 1	Pre-Euro, Euro 1	Pre-Euro, Euro 1, 2	Pre-Euro, Euro 1, 2
CRIT'Air 5	-	Euro 2	-	Euro 3	-
CRIT'Air 4	Without norm 1.6.2000 to 30.6.04	Euro 3	-	Euro 4	-
CRIT'Air 3	Euro 2	Euro 4	Euro 2 and 3	Euro 5	Euro 3 & 4
CRIT'Air 2	Euro 3	Euro 5 and 6	Euro 4	Euro 6	Euro 5
CRIT'Air 1	Gas vehicles and PHEV (plug in hybrid)				
	Euro 4	-	Euro 5 and 6	-	Euro 6
CRIT'Air	Electric vehicles and hydrogen fuel cell vehicles				

Source: City of Lyon

Figure A5.4.1 Low Emission Zone in Lyon

Greater Lyon's low emission zone (ZFE) has started as of 1 January 2021.

As of 1 January 2023, the minimum standard for vehicles will be Crit'Air sticker 4.

As of 1 January 2024, the ZFE will be enlarged, including M6-M7, Ring Road North, and Boulevard Laurent Bonnevay. The minimum vehicle standard will be Crit'Air sticker 3.

Crit'Air stickers and "air quality certificates" are mandatory for French and foreign vehicles.

(2) SYTRAL

As of 1 January 2015, SYTRAL became the sole transport organizing authority for urban and interurban transport on the entire territory of the Lyon metropolis and the Rhône General Council.

As transport organizing authority, SYTRAL delegates the operation of networks to private transport operators in the framework of public service delegation agreements.

(3) Vélo'v or bicycle

The City of Lyon has a good cycling network as a response to seeking to reduce car usage and inciting people to use eco-friendly transport methods.

Vélo'v offers bicycles on self-service throughout the city (428 stations).

It is also possible to rent a bicycle for a single ride (1.8-euro ticket) for a day (4-euro ticket) or a year (16.5 Euros for annual membership for 14–25 year olds).

(4) Electric scooters

In Lyon, electric scooters on the street without locks are self-service electric scooters

[12] This includes people with "permanently reduced" mobility (wheelchair users, people with visual impairments, those who are deaf or hard of hearing, etc.) and "temporarily reduced" mobility (pregnant women, and people with pushchairs, shopping, luggage, etc.).

offered by different companies for rent through mobile apps. Fares differ from one company to another.

7) Public transport

The public transport network (TCL) is extensive, including four metro lines, two funicular lines, five tram lines, 1,000 buses, and 6,555 stops. All the vehicles used for public transport are equipped with low floors, retractable ramps, and wider entrance doors, while each has four seats reserved for people with reduced mobility.

All metro stations (except Croix-Paquet, where the configuration does not allow its redevelopment) are now accessible. They are equipped with sound-system lifts and embossed buttons and braille to enable easy access for people with low or no vision, as well as people in wheelchairs. Seven out of 10 bus stops are equipped for people with reduced mobility. In delivering the 2016–2022 Programmed Accessibility Agenda, SYTRAL plans to ensure accessibility at 812 priority stops spread over the TCL network.

The tram network comprises 76.7 km of tracks, 2 workshops, and 107 vehicles. They make more than 5 million km. There are 45 metro stations and some 80–100 tram stations, all installed with video cameras. A total of 960 buses in Lyon drive an average of 200 km daily.

SYTRAL's policy in terms of passenger information benefits everyone by making it easier for people with reduced mobility to travel. The geo-localized dynamic passenger information system, deployed on 118 panels on the underground transport network and the funicular, provides users with waiting times for the next two trains in real-time, as well as information on any delays and their anticipated resolution time.

The passenger information system is also connected to the new overall traffic management system in the Lyon urban area that provides real transport data, allowing for a 10% reduction in congestion and guaranteeing 100% travel time.

Visually impaired people can use an innovative remote-control device to receive travel information from buses, bus stops, and passenger information kiosks. It can also be used to activate sound boxes at pedestrian crossings automatically. Some 75 % of pedestrian crossings have been equipped with such sound devices.

SYSTRAL also organizes and finances the Optibus and Optiguide services. Optibus provides dedicated transport services for disabled people, facilitating over 100,000 trips per year. Optiguide provides information on door-to-door travel options and individual guidance to enable people to travel independently by public transport. Furthermore, 2,500 public transport drivers have been trained to provide better services for people with disabilities.

Implementing these actions is generally considered to have greatly improved accessibility for all within the entire metropolitan agglomeration of Lyon. In recognition of this achievement, Lyon not only received the Access City Award 2018 but was named European Capitals of Smart Tourism 2019 for exemplary achievements as a tourism destination in implementing innovative and intelligent solutions for accessibility, in addition to sustainability, digitalization, cultural heritage, and creativity.

Challenges, opportunities, and transferability

Lyon’s extensive and accessible network is the result of 30 years of continuous effort and investment. Since 2008 SYTRAL has committed more than Euro 100 million to ensure public transport is accessible to as many as possible. While for many cities it might not be easy to match similar levels of investment, Lyon’s approach to improving accessibility contains various elements that could be transferred to other cities.

Lyon’s approach is, in many ways, an example of an integrated planning and needs-based approach. Both principles are captured in the underlying objectives of the consecutive PDUs.

Lyon’s mobility system has been developing a network of door-to-door routes to key destinations. Accessibility barriers are gradually but steadily being eliminated with the support of user feedback. This encompasses implementing measures to improve access to information (e.g., itinerary planning), offer mobility services, and improve the physical accessibility of public space and public transport.

Even with smaller investment budgets to promote accessibility, the integrated and participatory way in which accessibility has been addressed in Lyon provides a useful example of how to promote accessibility effectively.

(1) KEOLIS Lyon

KEOLIS Lyon is a private operator, operating trams, metro, bus, trolleybus, and funicular on the TCL, the Lyon public transport network. The infrastructure and vehicles are owned by the authority. SYSTRAL is deciding on the offer, alignment of routes, and frequency of daily services. The operator is executing this decision. SYSTRAL decides about the tariff and is the only one that can make changes. Tariffs can be adjusted during the entire contractual period.

Keolis has a 6-year contract, currently in its fourth year, with SYSTRAL to maintain rolling stock, keep buses for 15 years, and refurbish them at 7 years so they are always as new. It must increase the number of passengers annually; otherwise, it has to pay penalties to the authority. The contract stipulates the necessary kilometers to be driven for every bus route and targets the income, quality, and cleanliness of vehicles and stations. Everything must be clean, and Keolis must respect timetables.

Keolis additionally needs 300 drivers and 200 staff for maintenance. Usually, drivers remain in the company until retirement, but as of last year, they leave to work in Germany.

The contract defines income level. In case the realized income is below, Keolis has to pay the difference to the authority, but if the realized income is above the defined level, the difference is equally shared between Keolis and the authority.

Relations between Keolis and authority are very good, but they are sometimes strict. If there are extraordinary events when they need to hire additional drivers and a security agency, Keolis will be granted additional payment from the authority, but for events like football matches, the authority might decline and reply that they should have considered this during the negotiations.

The authorities give the operator a certain amount of money during the contract, and with this money, the operator must operate all network and, if possible, make benefit because it is a private company.

Two years ago, before the last elections, Keolis in Lyon had 60% of the costs covered by the ticket and 40% tax, but after the elections, the Green Party introduced a new tariff with free tickets for very low income, and it costs a lot to the city. At the end of the year, the calculation will show less income.

After the current contract expires, the authorities expect services to be separated. Tram and heavy lines would be given to Keolis and other companies will assume some parts of the service.

(2) Maintenance and parking centers for railway

There are two maintenance and parking centers. The biggest one was built in 2001. In those two workshops, they perform 15,000 maintenance operations annually, including bandaging. Electric parts are repaired at special parts of the workshop.

(3) Operational control center

The center is on two locations. Staff in the center are called regulators and each manages one tram line. In total there are 7 regulators, 2 are placed in the other control center. One staff is dedicated to travelers' information and there is one supervisor.

(4) Bus depot and maintenance

There are eight central bus facilities. Every night, buses return to the depot and fuel and are washed every other day, but not nowadays due to the water reduction. However, vehicles are cleaned inside manually every night. Every two months, they have a deep inside wash.

It is the driver's obligation after daily operations to return the vehicle, fuel it, and park it. There are spare drivers for absentees.

The maintenance team has a total of 13 staff in the workshop. Three shifts start at 4:00, and the last finishes at 2:00 the next morning. Each depot has a maintenance workshop to guarantee that buses will be operational the next day.

The central workshop has 35 staff. They are polyvalent. Mechanics and electricians have general maintenance training.

Body work maintenance/repair is in central workshop and subcontracted.

8) About Grenoble

Grenoble is in the Auvergne-Rhône-Alpes region in southeastern France along the riverbed of the Isère and has a relatively flat profile. It is known for its picturesque setting amidst the Alps. The Grenoble metro area population in 2022 is 534,000, with a 0.56% increase from 2021.

Grenoble is accessible by road and rail and well-connected to nearby regions and countries.

9) Low emission zone in Grenoble

Vehicle Classification according to article L. 318-1 and R. 318-2 French road traffic act					
Class	Motor-cycles, trikes and quads	Cars and vans		Lorries	
		Diesel	Petrol	Diesel	Petrol
non classified	Without norm until 31.05.2000	Pre-Euro, Euro 1	Pre-Euro, Euro 1	Pre-Euro, Euro 1, 2	Pre-Euro, Euro 1, 2
5	-	Euro 2	-	Euro 3	-
4	Without norm 1.6.2000 to 30.6.04	Euro 3	-	Euro 4	-
3	Euro 2	Euro 4	Euro 2 and 3	Euro 5	Euro 3 & 4
2	Euro 3	Euro 5 and 6	Euro 4	Euro 6	Euro 5
1	Gas vehicles and PHEV (plug in hybrid)				
	Euro 4	-	Euro 5 and 6	-	Euro 6
	Electric vehicles and hydrogen fuel cell vehicles				

Source: City of Grenoble

Figure A5.4.2 Low Emission Zone in Grenoble

Grenoble introduced a low-emissions zone on 1 November 2016. This is the so-called emergency low-emissions zone (ZPA), which comes into force in cases of exceptionally bad emissions conditions. As of 1 April 2017, on days with high air pollution, foreign drivers of passenger cars also need a valid environmental badge.

In the event of declining air quality lasting for 5 days or more, only cars with a valid Crit'Air environmental badge are allowed entry at a limited speed. After 7 days, rules are tightened, and only vehicles with the Crit'Air E, 1, 2, and 3 may enter the city.

A new low-emission zone will come into force in the city center of Grenoble on 1 July 2023. Cars and motor homes, as well as motorized two-wheelers, tricycles, and quads, will need a number 4 sticker or higher to enter the zone.

Since the introduction of a permanent low-emission zone in 2019, entry into Grenoble has been prohibited for HGVs and vans (N1, N2, N3) without a sticker, as well as those with class 5, 4, and 3 stickers. A new ZFE is being set up in the city center. Its rules are intended to complement the existing ZFEs and lanes and ensure lower emissions from 1 July 2022.

This second, smaller environmental zone is located within the first and covers 13 municipalities. In this zone, vehicle owners need at least four stickers to enter the zone with their car or motor home. In addition to class M1 vehicles, class L vehicles are also affected by the driving ban, i.e., all motorized two-wheelers, three-wheelers, and quads (four-wheelers).

It is currently unclear whether the new ZFE in Grenoble will be extended further. However, the city has already presented a plan to tighten the environmental zone regulations around 2030. Then, all vehicles with the French sticker 2 should no longer be allowed to drive.

10) Mobility and public transport in Grenoble

Grenoble, one of the largest metropolitan regions of the European Alps, offers a great mobility mix between public transport, including trams and buses, and a good cycling infrastructure. While there are several different options for navigating the city, the trams are the most widely used.

The Grenoble Central Train Station (Gare de Grenoble) is conveniently located near the city center of Grenoble, France.

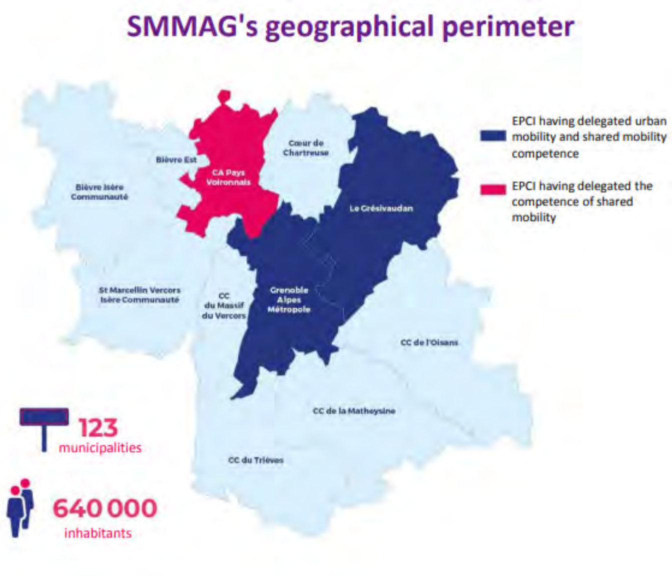
In efforts to reduce air pollution, an extensive cycling strategy has been the basis for the SUMP since the 1990s. Currently, Grenoble has 300 km of cycling paths.

Grenoble, the industrial metropolitan region in the heart of the Alps, tackled its locational disadvantages, as it suffered from high air pollution. This led to the decision to build a tramway, which was inaugurated in 1987 and subsequently extended in several steps to today’s 35 kilometers of tramway. Since its opening, the Grenoble tramway has been fully accessible and is the world’s first completely low-floor tramway.

In transport and mobility, Grenoble’s urban planning projects include successfully implementing a 30 km/h speed limit throughout the city in 2016. The lower speed limit has allowed the city to reduce air and noise pollution and, in turn, make the city more pedestrian-friendly. This outcome has been seen in the impressive cycling rates throughout the city, which have meant that Grenoble has become France's top city for bicycle commuting. The high levels of cycling in the city have been attributed to incentives, reimbursements, and the pedestrianization of the city.

By altering the modal split and increasing the proportion of bicycle trips by 33% between 2009 and 2016, Grenoble reduced pollution levels between 2007 and 2018, both for large particles (-41%) and fine particles (-60%). Based on these successes, the second SUMP was approved in 2019, which includes long-term plans until the end of this decade.

(1) SMMAG – Urban public transport authority



Source: SMMAG

Figure A5.4.3 SMMAG’s Geographical Perimeter

SMMAG's territory extends beyond the borders of the Grenoble metropolis and includes the Grésivaudan and Pays Voironnais intercommunities, i.e.,123 municipalities concerned by the same mobility syndicate.

Intermodality remains essential for SMMAG and the Grenoble-Alpes Area.

SMMAG has simplified the multimodal ticketing structure and tariffs and, together with various mobility providers, created Pass Mobilité. It will allow users to combine different modes of (public-) transport and mobility services in several networks, as well as car-sharing or -pooling. Based on this project, a multimodal tariff will be set up by 2030 to ensure fair prices.

The public transport network has 5 tram lines, 7 chrono bus lines, 12 proximo bus lines, 27 flexo line i sacado school transport service 1 flexo+PRM service dedicated to persons with reduced mobility, and 22 park & ride facilities.

Grenoble opened its first tramway in 1987. With the opening of Line D in October 2007, the system had grown to four lines with a combined length of 34.2 km.

Grenoble ordered surveillance cameras to increase safety and security for both passengers and operational staff. New York-based Verint Systems was chosen to supply the networked video camera, which assists organizations in preventing incidents and allows improvements in response times. Onboard and tram stop information systems are also fitted.

As with other French tramway systems, trams in Grenoble receive priority at road junctions to assist in maintaining timetables.

(2) M TAG, Public operator of Grenoble

M TAG, a local public company owned by Grenoble Metropole by 33% and SMAAG by 67%, has a public service obligation contract from 1 January 2022 until 31 December 2023.

M TAG provides daily public transport services (bus and tram), proposes quantitative and qualitative improvements to the transport offer, and develops revenues.

It has three depots: Sassenage for buses, Eybens for bus and trams, and Gières for trams. Its fleet comprises 103 trams and 259 standard and articulated buses. The bus fleet is 75% on green energy.

In 2021, M TAG had 1,455 employees, of which 902 drivers covered 16.67 million km, made 32,400 journeys, and had an income of 27.5 million EUR.

According to the data collected in 2019, 92.6% of users were satisfied with the provided services.

A5.5 Third Country Training in Germany (Bonn)

1) Training Program

Table A5.5.1 Training Program in Germany (Bonn)

Day		Time	Activities
1	15 Mar 2022	AM	Sarajevo–Frankfurt
		PM	Frankfurt–Bonn by train
2	16 Mar 2022	AM	Site visit: SWB tram depot and workshop for tram refurbishment
		PM	Presentation & Discussion: tram refurbishment project
3	17 Mar 2022	AM	Presentation & Discussion: SWB organization, Fare collection system and Innovative tariff
		PM	Site visit: Traffic control center
4	18 Mar 2022		Site Visit: Stadtbahn Light Rail, Tram, Bus
5	19 Mar 2022	AM	Bonn–Frankfurt by train
		PM	Frankfurt–Sarajevo

Source: JICA Expert Team

2) Participants

Table A5.5.2 Participants in Germany (Bonn)

No	Name	Position
1	Mr. Emir Hota	Assistant Minister of Traffic, Canton Sarajevo, BiH
2	Mr. Muamer Kukan	Assistant Minister of Traffic, Canton Sarajevo, BiH
3	Mr. Tarik Basović	Advisor for Public Relations and Promotion, Canton Sarajevo, BiH
4	Mrs. Lejla Imamović	GRAS, Head of Traffic Management Sector
5	Mr. Vedad Smailhodzić	Director of department for urban and sub-urban transport, CENTROTRANS
6	Mr. Elmin Škulj	Director of department for maintenance, technology, and quality, CENTROTRANS
7	Ms. Aida Kalem	Faculty of Traffic and Communication, University of Sarajevo
8	Mr. Ajdin Džananović	Faculty of Traffic and Communication, University of Sarajevo

Source: JICA Expert Team

3) About Bonn

The federal city of Bonn is in western Germany, on the banks of the Rhine River. It is the former capital of West Germany (1949–1990). After the reunification of Germany, the capital was moved back to Berlin. Due to a political compromise (Berlin-Bonn Act) following the reunification, the German federal government maintained a substantial presence in Bonn. Roughly a third of all ministerial jobs are in Bonn as of 2019. It is the secondary seat of the President, the Chancellor, and the Bundesrat and the primary seat of six federal government ministries and twenty federal authorities. Bonn is also the seat of many UN organizations and over 150 NGOs.

It had 320,182 citizens in 2022, with a 0% increase since 2019.

The local road and public transportation networks are very well developed. Bonn is, in fact, a city of short distances. Residential areas are well connected to the city center.

4) Mobility

In October 2019, SWB announced that the modal split improved significantly from 14% for public transport in 2018 to 17% in 2019.

There is a high percentage of commuters in Bonn. In addition to its inhabitants, more than 135,000 commute to Bonn and more than 57,000 from Bonn.

(1) Sharing

The City of Bonn is expanding its car-sharing service: In addition to the numerous parking spaces already rented by car-sharing organizations on private property, 155 new car-sharing spaces will be set up in the future in public street space at 73 locations throughout the city.

Nine hundred bicycles are available at stations all over town. Users must register in advance with Nextbike for an annual fee of 3 EUR. The cost of renting a bike is 1EUR per 30 minutes and a maximum of 8 EUR per day.

(2) Low-emission zone

Source: City of Bonn

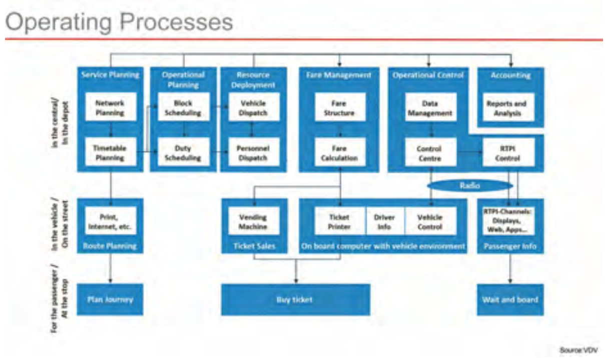
Figure A5.5.1 Low Emission Zone in Bonn

The city of Bonn introduced its first environmental zones in January 2010, where only vehicles with a valid red, yellow, or green badge are allowed to enter the city. About two and a half years later, the city authorized entry only to vehicles with a yellow or green sticker, and since July 2014, access has been possible only with a green badge.

The city council set itself the goal of achieving climate neutrality by 2035.

5) Public transport

Description:
This map shows streets, roads, S-Bahn, U-Bahn, bus and railways lines and stations in Bonn



Source: City of Bonn

Figure A5.5.2 Public Transport in Bonn

The City of Bonn has an excellent public transportation system with trams, subways (metro), trains, buses, and several Rhine River ferries. The network of lines and timetables are available at every stop and in many places inside the vehicles.

Bus and tram stops are marked with a green H, and underground (U-Bahn) stops have a blue U.

Bonn's main railway station and the Siegburg/Bonn ICE station are directly connected via public transportation, with trams operating at 10-minute intervals.

SWB, a public transport provider that operates the entire network, is responsible for the organization, planning, and management of public transport in the city. SWB bus, rail, and tram in the city and the Rhein-Sieg-Kreis (SSB) transport about 92 million passengers each year.

There are approximately 800 stations (36 tram stations, 51 metro stations, and 700 bus stations), 126 km of railway, six city railway lines, three tram lines, 600 km bus network, 50 bus lines, 106 solo, 12 m buses, 88 articulated, and 7 electric buses.

There are 8.7 million rail km and 12.9 million bus km annually.

(1) Tickets

Tickets are available from vending machines on trams, underground trains and stations, and ticket offices in Bonn. There are single, multiple travel, weekly, and monthly tickets, as well as a large variety of special offer tickets, such as a 24-hour ticket, mini group ticket, 3-day ticket (3-Tage-Karte), and Junior ticket.

Tickets must be validated on all buses, trams, and underground trains. Public transport in Germany operates on a system of trust, but periodic spot checks are made. The fine for traveling without a valid ticket is EUR 60.

Following a national 9-euro monthly ticket for all public transport introduced for the summer, Bonn authorities announced they would introduce their version of a heavily subsidized public transport monthly ticket from 1 September to everyone with a Bonn ID card. The price is 19 EUR.

The BONNsmart contactless ticketing system is being introduced for passengers to check their contactless or mobile card on boarding and alighting and pay the cheapest available fare for their journey.

Following the test phase on the first two routes, SWB Bus und Bahn will equip its 230 buses and 99 light rail vehicles with the system and roll it out across its citywide network.

(2) Stadtwerke Bonn (SWB)

With its subsidiaries, SWB, a wholly-owned subsidiary of the City of Bonn, has a secure supply of electricity, natural gas, drinking water, district heating, and energy services in Bonn and the region. SWB actively shapes mobility in public transport with buses, light rail vehicles, and trams, using innovative technologies, and promotes the expansion of electro-mobility. In 2021, the company generated sales of over 526 million Euros.

SWB offers mobility for the last mile and contributes to sharing mobility with a fleet of 900 rental bicycles, 1,000 e-scooters, and 12 e-scooters.

When it comes to digitization, we are pioneers. With the BONNsmart pilot project, citizens can make contactless and smart payments on our buses and trains.

(3) Trams and Light rail vehicles

On 19 December 2019, SWB signed a contract to purchase 28 new low-floor trams type Skoda for City Smart T 41(Tw 2251) as a replacement for the existing 24 low-floor trams dating from 1994 (9451 to 9474 series) to increase frequency on the tram lines. Trams are designed with three carriage sections; the first and the last run on two bogies in which each axle is driven to ensure trouble-free passage through the south subway that has the tightest curve radii in the Bonn rail network and a veritable S-curve to boot.

It is also investing in the light rail fleet by purchasing 22 new light rail vehicles for frequency increases and extension of the existing light rail lines, which connect to the nearby Cologne system via routes 16 and 18.

The extensive retrofit and refurbishing project of 76 older light rail vehicles type “Düwag B-Wagen” is in its final stage. The analysis indicated that restoration of these trams would be profitable, but due to the increasing difficulty in obtaining necessary parts, it was decided to discontinue restoration work but procure new trams.

(4) Buses

SWB purchased 15 solo and 15 articulated MAN Euro 6D buses, which is the last purchase of such type of buses. The procurement process of 10 electric buses, which should be delivered by the end of 2024, is underway.

The plan is to purchase 200 electric buses by 2035, with an estimated investment for the buses and the complete reconstruction of the depot, including a new charging infrastructure of around 80 million EUR to comply with the city council’s goal of achieving climate neutrality by 2035.

(5) Eco-friendly buses

In 1995, SWB tested two MAN natural gas buses, but due to the lack of a filling station in Bonn, they agreed with RSVG operator in Troisdorf (Rhein–Sieg Verkehrs–Gesellschaft) to a swap deal. RSVG received the two natural gas buses from Bonn, while SWB got two diesel buses of the same age from RSVG, which had a much higher mileage than the natural gas buses.

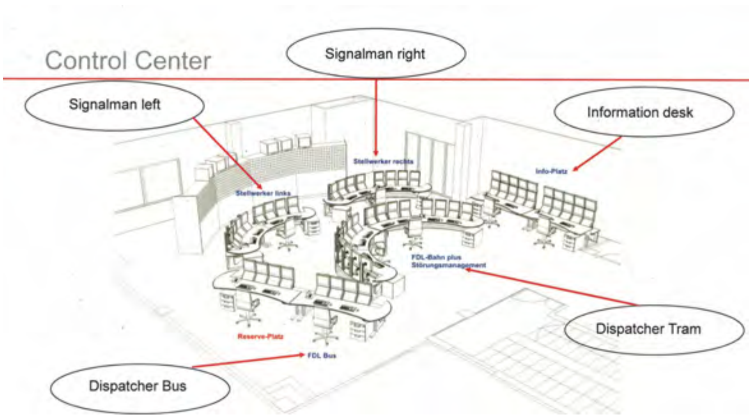
During the summer of 2013, SWB tested the first battery-electric buses from Chinese manufacturer BYD but was dissatisfied with the performance.

SWB bought six Sileo S 12s buses at the beginning of 2016, but since they could not cover 200 km before recharging, as promised, SWB returned the buses to the manufacturer.

As of March 2021, three articulated electric buses type, “Solaris Urbino 18 electric,” operate in Bonn and an additional four 12-metre-long solo vehicle, Ebusco 2.2, since April 2021.

SWB installed a charging infrastructure at the Friesdorf depot for overnight charging. The system design allows all electric buses, regardless of their respective manufacturers, to be charged with direct current.

(6) Control Center



Source: City of Bonn

Figure A5.5.3 Control Center in Bonn

The center operates 24 hours a day in three shifts, with 8 employees per shift. Video surveillance is available at all stops, as well as in vehicles. It also manages the entire network of roads and the displays at stops at all times.