

**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 II**

**Improvement Plan of Organizational Capacity of  
Public Transport Operators**

**November 2023**

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## List of Abbreviations

CCTV	Closed-Circuit Television
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CIVITAS	City-Vitality-Sustainability
CMMS	Computerized Maintenance Management System
CNG	Compressed Natural Gas
COVID-19	Corona Virus Disease of 2019
CS	Canton Sarajevo
CSR	Corporate Social Responsibility
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
EU	European Union
EUR	Euro
FCEV	Fuel Cell Vehicle
GRAS	<i>Gradski Saobraćaj</i>
GTZ	German Technical Cooperation
HR	Human Resources
IC	Integrated Circuit
JCC	Joint Coordination Committee
JICA	Japan International Cooperation Agency
JPS	Public Transport Sarajevo ( <i>Javni prijevoz Sarajevo</i> )
KJKP	Cantonal Public Utility Company ( <i>Kantonalno Javno Komunalno Preduzeće</i> )
KM	Convertible Mark
NPV	Net Present Value
O&M	Operation and Maintenance
OJEU	Official Journal of the European Union
OPEX	Operating Expenditure
P&R	Park and Ride
PT	Public Transport
RAMS	Reliability, Availability, Maintainability & Safety
SIE	Sarajevo Institute of Economics
SPTC	Sarajevo Public Transport Company
TCO	Total Cost of Ownership
UITP	International Association of Public Transport ( <i>Union Internationale des Transports Publics</i> )
VAT	Value-Added Tax
ZFBiH	Federal Railway Company ( <i>Zeljeznice Federacije Bosne i Hercegovine</i> )







# 1 Actual Conditions of Public Transport Operators

## 1.1 Organizational Conditions

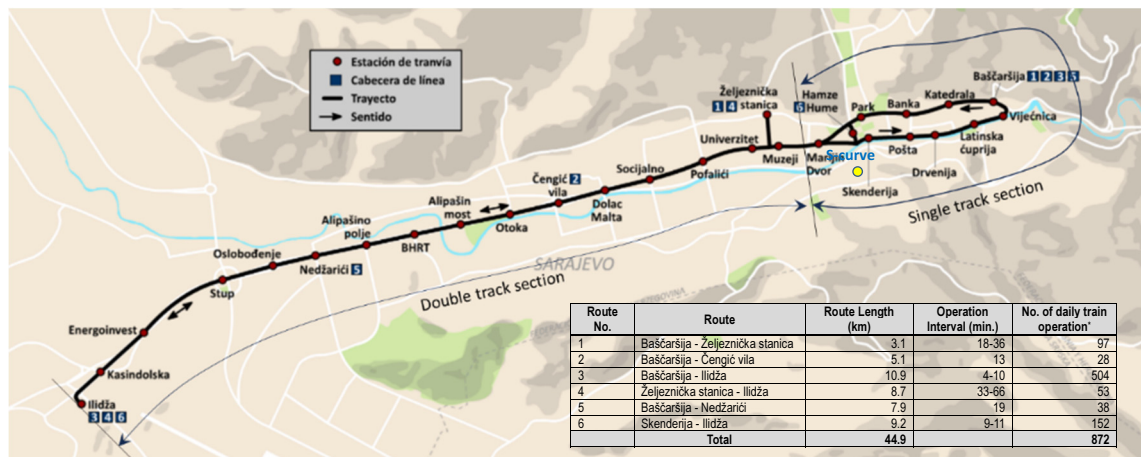
GRAS can be described as dysfunctional, facing financial challenges that would lead a regular company to bankruptcy. The company's bank accounts are frequently blocked due to excessive debt, making it difficult to purchase supplies like spare parts and fuel. Outdated equipment and an aging fleet result in significant energy and resource inefficiencies. Despite a high staff count, productivity is low, partly due to the large amount of labor input in the work system because complex legal procedures have made a significant layoff difficult, the need for resources to maintain obsolete vehicles and a lack of a clear vision for the company's future.

CENTROTRANS is a private company with a diverse portfolio, including urban, intercity, and international transport. Its operations are described as reliable, with a well-maintained fleet and state-of-the-art operation tools. The company adheres to high-quality standards, holding ISO 9001 and 14401 certifications. CENTROTRANS optimizes its investment policy by purchasing used buses from 6 to 8 years old from Germany, reducing costs while maintaining quality. Efforts have been made to increase wages and address the staffing shortage, including rehiring former drivers and recruiting more qualified personnel.

## 1.2 Fleet Conditions and Maintenance

### 1) Existing Conditions of Track Structure of Sarajevo Tram Line

The Sarajevo Tram Line runs East-West in Sarajevo, with six operational routes.



Source: JICA Expert Team based on online information, GRAS

**Figure 1 Sarajevo Tram Route Map with Operation Route Summary**

Tram tracks vary between single-track loop sections with embedded asphalt concrete and double-track sections. The western section, rehabilitated by EBRD fund, had significant track issues. An inspection in May-June 2021 found poor track conditions in the western section, leading to tram speed reduction.

After rehabilitation work, ballasted track sections now allow for appropriate tram speeds. Tracks embedded in slab track intersections have improved ride quality for trams and other vehicles. Due to both rehabilitation work for single-track loop line section in 2004-2005 and for road-center double-track section in 2021-2023, all the track condition are drastically improved and tram can be operated at typical speeds that the trams are capable of.

### 2) Existing Conditions of Tram Fleet

The tram fleet consists of 50 trams, but 30 are non-operational due to issues such as unplanned repairs, maintenance deficiencies, and wear and tear. Some trams are kept for further usage after repairs, while others are cannibalized for spare parts. The GRAS tram fleet includes trams of various types and sizes. Most of the non-operational trams belong to older production years.

**Table 1 Breakdown of the GRAS Tram Fleet**

R/No.	Type of tram	Tram size	Inventory number	Number of working trams	Number of defective trams	Production year of the vehicle
1.	CKD – K2	2 cars, 20,4 m	14 ( 5 )	9	(5)	1973
2.	KT8 – D5	3 cars, 30,3 m	3	1	2	1989
3.	SATRA 2	2 cars, 20,4 m	11	1	10	2004 - 2011
4.	SATRA 3	3 cars, 28,25 m	4	2	2	2005 - 2015
5.	E1	2 cars, 19,7 m	2	1	1	1961-1963
6.	GT8	3 cars, 30,8 m	16	6	10	1963
<b>TOTAL</b>			<b>50 (5)</b>	<b>20</b>	<b>30 (5)</b>	

Note 1: number in ( ) means five K2 trams which are planned to be modernized as Satra 2/3.

Source: GRAS

### 3) Existing Conditions of Trolleybus Fleet

Prior to the incorporation of the newly acquired Belkommunmash trolleybuses, the GRAS fleet comprised a mix of buses (125), minibuses (34) and trolleybuses (50), totaling 209 vehicles.

Similar to the trams, one out of every two or three buses in the GRAS fleet are typically non-operational, with the non-operational units sitting idle in the depots and are simply cannibalized and repair/service the operational units.

Whilst there is an obvious deficiency with respect to the maintenance regime due to the lack of spare parts, the principal cause of the issues faced by GRAS is the advanced age of their fleet, typically well beyond the average age in European cities. As such, many of the manufacturers who originally produced these vehicles simply do not stock the parts needed by GRAS as the technology has either moved on or been replaced with newer technology that is not backwards compatible with those vehicles still used by GRAS. The breakdown of the GRAS fleet of buses, minibuses and trolleybuses is listed in tables in the main report.

The Canton has ordered and received 25 new trolleybuses from the Belarussian manufacturer, Belkommunmash. The introduction of the new Belkommunmash trolleybuses greatly improved performance and will lower the median age of fleet to 15-16 years as of the end of 2023 when the last new unit arrives.

A more detailed breakdown of the trolleybus fleet is provided in the full report.

### 4) Existing Conditions of Bus and Minibus Fleet

The GRAS bus fleet comprises a mix of buses (125), and minibuses (34) from eight different manufacturers. From supplementary data provided by CENTROTRANS, their rolling stock fleet consists of 110 standard-sized 12-m buses and minibuses.

As with trolleybuses, the principal cause of the issues faced by GRAS is the advanced age of their fleet – the average age of the GRAS fleet is far beyond the typical useful life of rolling stock in exemplary European cities: bus (19.5 years vs 10-12) and, minibus (11.1 vs 8-10). Unlike the trolleybus fleet which now benefits from the incorporation of the newly acquired units, the problem of obsolete vehicles remain however for the bus and minibus fleet as there are no definitive plans to acquire new rolling stock to gradually replace and decommission the vehicles.

A more detailed breakdown of the bus and minibus fleet is provided in the full report.

## 1.3 Establishment of a New SPTC

The Canton Sarajevo (CS) Government has proposed the creation of a new company, KJKP JPS (SPTC), for trolleybuses and trams, awaiting approval from the Assembly of Canton Sarajevo. The decision to split operations between GRAS and SPTC could lead to duplicated administrative structures.

The organization of SPTC will be determined by the Management Board, but the Sarajevo Institute of Economics (SIE) study makes certain assumptions. The study suggests a certain number of vehicles, reserve percentages, and staffing levels, which are based on statements by GRAS but may not reflect best practices. JICA Expert Team has highlighted potential inaccuracies in the study's assumptions, such as overvaluation of fleet needs, reserve requirements, and driver needs. The proposed organization and staffing are listed.

**Table 2 Proposed Organization and Staffing**

General Management		HR Department		Administrative and finance	
General manager	1	HR director	1	Adm and financial director	1
Assistant / Receptionist	3	Secretary	1	Chief accountant	1
Legal Dpt	1	Training Dr	1	Accountants	2
Communication	1	Staff administration	2	Administration procurement	2
Security / Quality	1	Social worker	1	IT	3
<b>Total</b>	<b>7</b>	<b>Total</b>	<b>6</b>	<b>Total</b>	<b>9</b>
Operations Department		Commercial Department		Maintenance Department	
Operation director	1	Commercial director	1	Maintenance director	1
Secretary	1	Secretary	1	Secretary	1
Planification / Rostering	3	Marketing and studies	3	Planning and methods	2
PCC regulation	1	Control and inspection	20	Fixed installations mgt	3
Regulators	7	Sales	5	Fixed installations staff	15
Line management	12			Tram mgt	3
Tram drivers	65			Tram maintenance staff	15
Trolleybus drivers	65			Trolleybus mgt	3
<b>Total</b>	<b>155</b>	<b>Total</b>	<b>30</b>	Trolley maintenance staff	15
				Spare shop	2
				<b>Total</b>	<b>60</b>
<b>Grand total staff</b>	<b>267</b>				

Source: JICA Expert Team

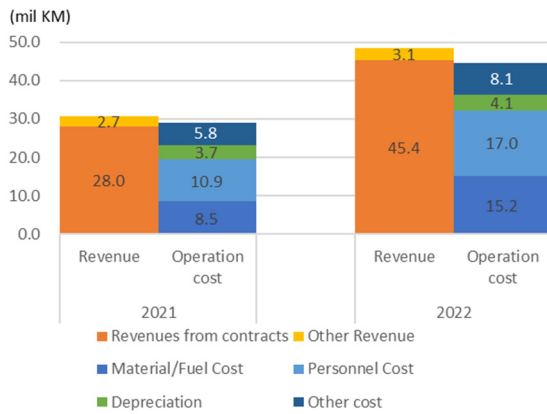
Recommendations include optimizing fleet requirements, reducing reserve needs, avoiding the transfer of vehicles from GRAS to SPTC, and increasing commercial speeds for trams and trolleybuses. A simplified organization for SPTC with fewer staff members is suggested. Consequences of setting up SPTC on GRAS are discussed, including the potential decline in GRAS's revenue and the need to address the future of bus operations within GRAS.

## 1.4 Financial Situation

### 1) CENTROTRANS

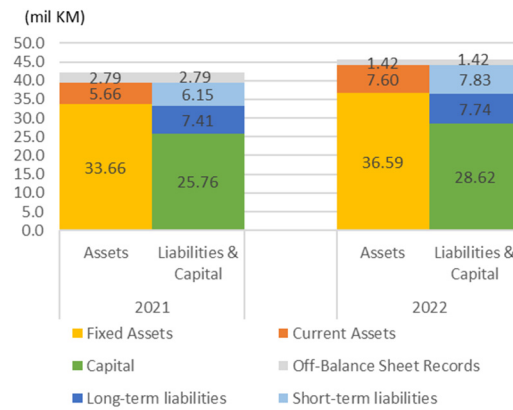
CENTROTRANS has not communicated financial statements for its activity in Canton Sarajevo, however JICA Expert Team had access to the public data regarding the whole company, "Financial statements for the year ended December 31, 2022 and independent auditor's report". As these statements regard the whole company, it is not representative of the sole Canton Sarajevo urban activity. It enables however to check the company delivered a net beneficiary margin around 6% in 2021 and around 9% in 2022. These results are good for the sector. Debt level is reasonable compared with asset value. CENTROTRANS is a sound company, with positive future perspectives.

In 2022, CENTROTRANS achieved revenues totally 48.4 million KM, while incurring operational costs of 44.5 million KM, which means that the profit was 3.9 million KM.



Source: JICA Expert Team based on the website

**Figure 2 Profit & Loss Statement of CENTROTRANS (2021 & 2022)**



Source: JICA Expert Team based on the website

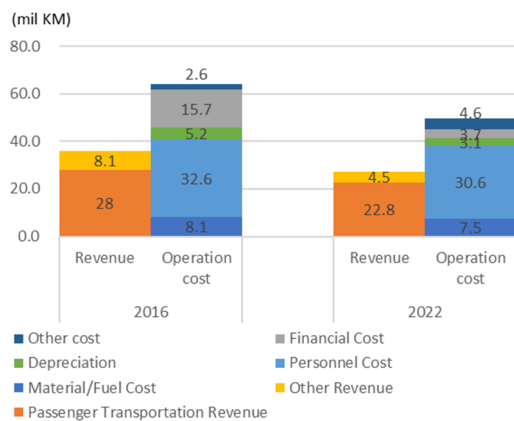
**Figure 3 Balance Sheet of CENTROTRANS (2021 & 2022)**

## 2) GRAS

The “Study on socio-economical justification of the establishment of a new cantonal public utility company for the provision of regular passenger public transport services” November 2021 published by Sarajevo Institute of Economics provides a comprehensive analysis of GRAS financial statements. Although this study has not been updated since its publication, the overall situation of GRAS has not evolved significantly since the publication of this study.

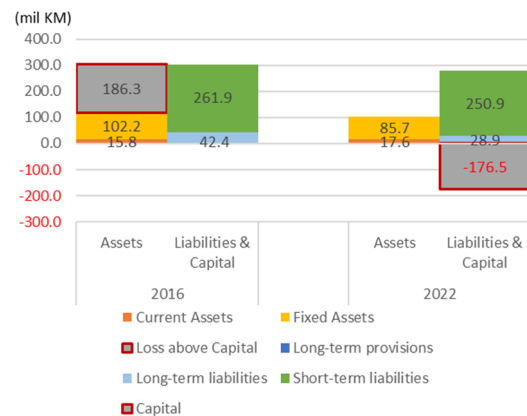
The study provides a clear vision of GRAS financial situation. Yearly losses of GRAS in the most recent years are in a range of 20 to 25 million KM, while in 2020, liabilities on salaries amounted to 92 million KM and tax liabilities were over 102 million KM.

The operating profit has been in deficit even before depreciation since 2011, and the negative trends have not been changed while restructuring plans were announced by the Government. The profit situation of GRAS is one where both revenue and cost are decreasing and ordinary loss continues to occur, and this is recurring on a regressive scale.



Source: GRAS

**Figure 4 Profit & Loss Statement of GRAS (2016 & 2022)**



Source: GRAS

**Figure 5 Balance Sheet of GRAS (2016 & 2022)<sup>1</sup>**

Should GRAS not be public, it should already have filed for bankruptcy. It has an urgent need for restructuring. GRAS has struggled with significant financial losses and accumulated debt. It has relied heavily on subsidies to cover its operating costs. The company has faced difficulties in maintaining fleet of buses, minibuses, trams, and trolleybuses, as well as providing regular and reliable services.

Although the funds received from Canton Sarajevo have helped GRAS in addressing its

<sup>1</sup> Since 2011, capital was allocated on the asset side as "loss above capital," but due to a change in accounting standards in 2022, capital was recorded on the liabilities and equity side as a negative value.

obligations and maintaining its operations, it's important to note that given the substantial accumulated loss of 263 million KM in 2022, only a fraction of these funds represent a temporary remedy rather than a lasting solution.

## 2 Vehicle Allocation and Personnel Plans of Public Transport Operators

### 2.1 Vehicle and Personnel Requirements from Operation Plan

The driver requirements are calculated from the vehicle requirements in the operation plan in Volume 1 Chapter 4. This is built up at the line level based on the present demand forecast which contains the public transport network information according to the current registered timetables of public transport services.

The peak and off-peak vehicle requirements from the Optimal Service Case are used to compute the driver requirements from the following main considerations.

- Requirement of 3 straight shifts to meet whole day vehicle requirement for trams and trolleybuses.
- Maximum of 2 straight shifts to meet the whole day vehicle requirement for bus and minibus.
- 1 split shift to meet peak vehicle requirement for all modes.
- Relief requirement is added to cater for off/rest days.
- Spare requirement to cater for annual leave, absenteeism, and training.

The above assumptions would produce a driver requirement of within 2.78 drivers per vehicle for the Optimal (recommended) case developed from the Operations plan.

#### Optimal (recommended) case

**Table 3 Driver Requirement: Optimal Service Case**

Mode	Peak Vehicle Requirement	Off-Peak Vehicle Requirement	Driver Requirement
Tram (GRAS)	42	36	151
Trolleybus (GRAS)	32	26	111
Bus (GRAS+CENTROTRANS)	106	86	255
Minibus (GRAS+CENTROTRANS)	45	37	109
<b>Total</b>	<b>225</b>	<b>185</b>	<b>626</b>

Source: JICA Expert Team

Drivers per vehicle = 2.78

As the current number of drivers per vehicle is expected to be 3.17 from MOT's estimates, it is recommended to work towards improving to between 2.80 – 3.00 drivers per vehicle by shortening late night operations on some lines where there is low demand. This will enable more lines to operate with a maximum of 2 straight shifts instead of 3 to reduce driver requirement.

### 2.2 Working Conditions and Labor Management

Working conditions and regulations governing work of drivers in Canton Sarajevo's public transportation system were studied as a follow-up to the 2020 JICA Data Collection Survey, discussing the role of the EU Rulebook and union intervention in protecting drivers' rights.

The Manual for Public Transport Planning and Operations in the Appendices of Volume I aims to suggest scheduling guidelines and service optimization methods to address working conditions with topics such as driver work hours, rest time, operational activities compliance

with regulations, balancing rest times and run times for driver safety and cost-effectiveness, creating efficient timetables, continuous improvement of scheduling guidelines, and methods for tracking and optimizing working hours. The manual also aims to address labor management with a focus on setting work schedule policies, identifying potential issues related to vehicle and personnel allocation, and promoting collaboration with unions. In summary, the manual aims to provide a framework for improving both the operational and labor management aspects of public transportation planning and operations.

## **2.3 Service Delivery**

Key weaknesses in public transport service delivery in Sarajevo, noted during experts' visits and supported by the 2020 JICA Data Collection Survey include limited availability of service information, public transport infrastructure that is lacking basic amenities, inconsistent cleaning practices, low interaction between drivers and passengers due to closed driver cabins leading to fare evasion, unfriendly public transport system for individuals with mobility challenges, inadequate measures to protect female passengers and inadequate number of staff.

To address service delivery weaknesses in Sarajevo's public transport, the Manual on Public Transport Planning and Operations in the Appendices of Volume I discusses user guidance, support for foreigners, cleanliness/greeting, support for the disabled and gender support.

## **2.4 Safety Management**

Bosnia and Herzegovina's road safety ranking is relatively low compared to regional peers, indicating a need for improvement despite lower motorization rates. During the project, it was observed that efforts to enhance traffic safety primarily focus on infrastructure improvements as part of ongoing road rehabilitation. Educational campaigns to improve traffic safety were not observed during the project. While there were some past educational campaigns in 2014 in collaboration with the Cantonal Ministry of Interior, it's unclear if these were followed up, and recent campaigns are not known.

Safety management is addressed in the Manual for Public Transport Planning and Operations in the Appendices of Volume I with measures such as accident rates analysis, identifying hotspots, education/training, and mitigating private vehicle impact. By implementing these safety measures, conducting ongoing monitoring and evaluation, and fostering a safety-conscious culture, public transport systems can reduce risks and enhance overall safety and security.

# **3 Management Improvement Plan for Public Transport Operators**

## **3.1 Fare and Ticket Management**

Both GRAS and CENTROTRANS operating public transportation in Canton Sarajevo, have different fare collection systems that are primarily paper based. Past plans to modernize and unify fare ticketing systems have never materialized. While CENTROTRANS buses have only one entrance door to make sure to collect the fare, GRAS faces more fare leakage due to trams/trolleybuses with multiple doors and advance ticket purchases allowing entry from all doors. These differences in fare collection systems and control strategies impact the revenue collection and management of both operators in Sarajevo.

To improve the current fares and ticketing system in Sarajevo, several recommendations have been made to facilitate interoperability between operators and intermodality across different modes, as well as ticket management and control measures. The Manual on Public Transport Operation Planning and Monitoring also covers general rules, fare/ticket handling, penalties, collected fare handling, and guidance to crew members, which aim to enhance

the efficiency and effectiveness of Sarajevo's public transportation fare and ticketing systems.

## **3.2 Fleet and Track Maintenance Plans**

### **1) Findings of Maintenance Plans of Existing Tram Fleet**

GRAS faces several challenges in maintaining their tram fleet due to a lack of investment in capital assets and rolling stock. These challenges include an unstable budget for asset renewal and maintenance, leading to:

- A shortage of spare parts, with many trams now obsolete and original manufacturers no longer producing parts.
- Dependency on donors for spare parts and equipment.
- Insufficient tools, repair halls, wheel lathes, gantry cranes, and skilled personnel.

GRAS has a fleet maintenance manual, but budget constraints have hindered proper maintenance.

New trams from Stadler Rail AG will be delivered from late 2023 to July 2024, along with maintenance manuals. Stadler Rail AG will maintain the new trams for three years, providing an opportunity for knowledge transfer to GRAS.

Workshop renewal, including new maintenance equipment, painting, electrical work, and lightning renovation, will be funded with a secured budget of 2 million EUR from MOT, as a part of the obligation of the client side for procurement of new tram fleet from Stadler Rail AG. The renewed facilities are expected to enhance tram fleet maintenance.

### **2) Findings of Maintenance Plans of Tram Track**

EBRD-funded rehabilitation drastically improved tram track conditions. Proper maintenance is essential for system reliability, including activities like ballast shifting, replacement, and tamping, as well as addressing track irregularities. Maintenance of slab tracks and surrounding asphalted areas is crucial. Special attention is needed for tracks at switches, and crossings, as these are prone to failure.

The Chinese contractor working on EBRD-funded rehabilitation will provide a maintenance manual for tracks and other facilities. Proper maintenance based on this manual is essential for maintaining the line effectively. However, GRAS lacks sufficient human resources, equipment, materials, and funding to maintain the track structure adequately. After the EBRD project's completion and full tram line rehabilitation, it's crucial to establish a robust maintenance regime for the fixed infrastructure. Among others, the following are important: regular preventive maintenance for tracks and facilities; continuous monitoring of track irregularities and data collection to assess repair quality; adhering to the maintenance manual provided by the EBRD project contractor; allocating a sufficient budget to address resource and equipment shortages; and developing technical training for specialized equipment use, etc.

### **3) Findings of Maintenance Plans of Bus**

Bus and minibus, as well as trolleybus depots, are overcrowded with inoperable vehicles, and the space is not adequately utilized. These inoperable vehicles cannot presently be written off nor consigned to the scrap yard as many are cannibalized for spare parts that can be utilized for maintenance and repair of operational vehicles.

GRAS, as with O&M for trams, faces a number of obstacles to improving their O&M (operation and maintenance) regime for buses. Many factors contribute to this situation, including difficulties in procuring spare parts, a lack of stability across senior management, employment restrictions and all this is reducing the number of trained engineers, and lack of reliability of buses that severely impacted on providing a reliable service.

Investment is needed not just to replace equipment but also to shore up the back-of-office functions such as the human resources. Lastly, the overarching maintenance regime also needs a step-change from one that is based on a corrective regime that merely reacts to

failures, to one that is preventative, meaning that the corrective measures are proactively taken in advance of failures.

#### **4) Concluding Remarks (Tram and Bus)**

In order to make specific recommendations pertaining to the improvement of the inventory and maintenance plans for the tram and bus fleet and infrastructure, there are two critical decisions that are a non-negotiable prerequisite: the first is whether or not the Canton intends to found the new organization (KJKP JPS) to be the successor to GRAS, and the second being the decision relating to the choice of divesting in buses to only focus on trams and trolleybuses.

Until such time when there is clarity regarding the new mandate for the organization, there are a number of more generic proposals by the JICA Expert Team, namely:

- The introduction of an updated maintenance regime that is premised upon the principles of preventative maintenance in lieu of corrective maintenance.
- Once the future of GRAS and the future legal entity KJKP JPS is determined, for the Canton to secure financing for investment in vehicles and depot upgrades, as well as institutionalize continuous training and development, and establish technical apprenticeships (possibly with local technical schools and universities). The approach to financing is contingent upon the decision of whether GRAS retains all its current operations or to separate electric transport to KJKP JPS because ultimately, the financing of projects through one or both legal entities depend upon its credit ratings and financial wellbeing.

### **3.3 Directions of Fleet and Track Renewal**

#### **1) Findings of the Renewal Plan of Fleet, Track and Depot (for Tram and Railway)**

##### **(1) Existing tram line improvement projects funded by EBRD**

The European Bank for Reconstruction and Development (EBRD) is funding the project for the rehabilitation, reconstruction, and modernization of the Sarajevo tram railway system. The project includes the reconstruction of tram tracks, drainage systems, electricity poles, and station facilities in phases. Phase 1 (Ilidza - Čengić Vila) of the reconstruction was completed in September 2022, and Phase 2 was completed in August 2023. After completion, all tram track structures in Sarajevo are renewed, resulting in improved operational speeds. The operational speed of Line 3, which is the most important line connecting Ilidža with Bašćarsija, was 15 km/h before EBRD project. After the reconstruction of the tracks, it is expected that the operational speed will be improved up to about 18 km/h. It should be noted that the rehabilitation work on tram tracks Ilidza-Bascarsija has been finished. However, the other parts, (Sarajevo railway station – Skenderija, access and inside the depot) are still ongoing and not completed yet as of 18<sup>th</sup> October 2023.

Sarajevo is procuring 15 low-floor trams (29-32 meters long) with an option for an additional 10 trams, Stadler Rail AG, a Swiss manufacturer, is the supplier, and delivery of the first prototype fleet is expected in November or December 2023, with the final set due in July 2024. Maintenance work for three years is included in the contract.

##### **(2) New tram line plans**

Feasibility studies are ongoing for new tram routes from Nedzarici to Dobrinja and from Main Railway Station to Sip. An extension of the tram route from Ilidza to Hrasnica is also in progress, with a Turkish contractor responsible for construction, track, station, signal, and power supply work.

##### **(3) ZfBiH commuter train services**

Commuter train services are planned with FBiH Railways lines to connect the city center with suburban areas, such as Sarajevo-Pazarić and Sarajevo-Visoko. The success of these services as user-friendly commuter modes will enhance the city's urban transport system.



## 2) Recommendations of the Renewal Plan of Fleet, Track and Depot (for Tram and Railway)

### (1) For Tram

One of the current problems is that the tram fleets are aging and spare parts for some fleets are not available, making it difficult to make progress in vehicle maintenance and repair. In addition, the maintenance and repair of these vehicles requires a large number of personnel to keep up with the various types of spare parts needed for each type of vehicle. In order to get out of this situation, it is desirable to shift from "minimizing initial investment and performing large-scale maintenance when necessary" to "reducing the types of spare parts needed and cutting maintenance costs by investing in the necessary renewal and standardizing the vehicles. In practice, it is recommended to gradually replace the vehicles with new ones, taking into account the budget allocations available. Canton Sarajevo has purchased 15 new low-floor trams, increasing the number of operational vehicles to 35, but an estimated 42-45 trams are needed to maintain the required operational frequency.

GRAS's idea is to provide 56 trams on inventory basis including 49 trams on workable basis by repairing some current defected fleets, scrapping some fleets which have no more spare parts, etc. after new 15 tram fleets are delivered.

After the 49 workable trams are secured, in order to realize the abovementioned shift, alternative scenarios for tram fleet replacement have been proposed, considering different timelines for additional tram purchases.

**Table 4 Alternative Tram Fleet Replacement Scenario**

	Alternative 1	Alternative 2	Alternative 3
Title	Minimum expenditure	Renewal gradually	Renewal soon
Additional trams to be purchased	<ul style="list-style-type: none"> <li>15 additional tram fleets are purchased in 2033*</li> <li>3 additional tram fleets are purchased in 2040.</li> <li>15 additional tram fleets are purchased in 2045.</li> </ul>	<ul style="list-style-type: none"> <li>15 additional tram fleets are purchased in 2028*</li> <li>3 additional tram fleets are purchased in 2040.</li> <li>15 additional tram fleets are purchased in 2045.</li> </ul>	<ul style="list-style-type: none"> <li>15 additional tram fleets are purchased soon*</li> <li>3 additional tram fleets are purchased in 2040.</li> <li>15 additional tram fleets are purchased in 2045.</li> </ul>

Note1: \*regarding 10 fleets in 15, call option of the current procurement from Stadler can be used.

Note2: Successor of GRAS may purchase the new tram fleet before the proposed year.

Source: JICA Expert Team

### (2) For ZfBiH Commuter Train Services

The followings are recommendation to improve the commuter train services of ZfBiH as "more convenient, more reliable, and more sustainable" urban transport means.

- Improve hospitality: by mind-set of all employees, high operation frequency, etc.
- Realize reliable operation: Just running trains according to the timetable
- Improve ticket selling system, a driving information notification service, etc.
- Improve information sharing: train operation information, etc.
- Improve safety: to prevent trespassing on the route.
- Put passenger service facilities at stations specially Sarajevo station. (tenants, restroom, roof of the platform and waiting chairs, etc.)
- Provide transfer facilities (ex, P&R (park and ride) space, bus stop, etc.) beside stations
- Conversion to automatic level crossing, and education on the need for "no entry" at the time of a level crossing warning (forward stop)

### 3) Findings of the Renewal Plan of Fleet, Track and Depot (for Bus)

The depots of bus, minibus and trolleybus are not utilized optimally due to the need for space to park a large number of inoperable vehicles that are cannibalized for spare parts.

Moreover, the site itself and buildings are in a poor state of repair with outdated equipment and poor working conditions, with the trolleybus depot being in slightly better condition. As an overall summary for the bus fleet, the principal issues can be described as follows:

- Difficulties in procuring spare parts and supply chain deficiencies (e.g., Turkish-manufacturer Isuzu minibuses);
- Lack of stability across senior management (e.g., short tenure for General Managers);
- Shortage of trained engineers/mechanics;
- Lack of reliability of buses that had been procured or donated (e.g., donated German brand MAN vehicles); and
- Outdated operations and maintenance regime that is corrective-based, instead of a preventative regime which is now practiced by all the best-in-industry public transport operators.

#### 4) Recommendation of the Renewal Plan of Fleet, and Depot (for Bus)

The JICA Expert Team proposes a renewal plan for the bus system comprising the following measures:

- The further expansion for bus and minibus operation of the new organization (SPTC) as a successor to GRAS.
- The Canton to establish investment and financing Plans for Fleet and Depot upgrades (considering a consolidated Depot) once there is clarity on the future of GRAS and SPTC as a separate legal entity.
- Develop a succession plan for Engineers/Mechanics by teaming with local Universities/Colleges to supply apprentices and trainees

In Volume 1, three operating Scenarios were discussed and agreed with the Canton. These Scenarios are as follows:

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

In respect of the bus fleet replacement plan, the same three alternatives were considered, therefore a Baseline or recommended bus fleet replacement plan is aligned with the Optimal case. The Recommended or Optimal option is summarized in the following table; the two other alternative scenarios (Hypothetical and Full-Service Cases) are described in detail in the main report and omitted from this summary:

The logic behind the proposed bus replacement strategy is to focus on purchasing the buses needed to deliver the operating plan included in Volume 1 for the Optimal Case. More specifically, the following acquisitions are recommended in respect of a fleet replacement strategy.

**Table 5 Alternative Bus Fleet Replacement Scenarios (Optimal Case)**

Description	Details	Additional buses to be made available
<b>Optimal Case: Bus Replacement Plan</b>	Buses: Invest in the purchase of 20 no. second-hand diesel buses (10 x 12-m and 10 x 18-m) if the financial resources are available (in 2024/2025).	+20 diesel buses +10 diesel minibuses to meet Optimal Case operational fleet requirements.

Description	Details	Additional buses to be made available
	Focus is on diesel fleet (i.e. lowest OpEx) until such time when new buses can be purchased  Minibuses: Invest in the purchase of 10 no. second-hand diesel minibuses if the financial resources are available (in 2024).  Trolleybuses: The deployment of the 25 new Belkommunmash trolleybuses already bought will provide GRAS with a surplus of 14 vehicles therefore they can choose to either decommission/ scrap these 14, or run them on new routes as a trial service.	

Source: JICA Expert Team

### 3.4 Improved Management and Business Plan

Permanent effort targeting reduction of expenditure is a fundamental aspect of an Operator's business. Best practices in public transport production and business plan improvement include actions in the fields of following 1) to 6).

#### 1) HR Management

These measures include qualitative measures and measures with a measurable impact on the company's results. Qualitative measures concern:

- Corporate Social Responsibility (CSR) plans encompass commitments in social, environmental, economic, and governance aspects, aiding in staff retention and motivation, particularly among younger employees who prioritize societal issues.
- The participatory implementation of CSR plans fosters communication between management and staff, addressing issues that can have serious consequences in public transport.
- Partnership contracts with local authorities aim to improve relations and transparency between the operator and the Public Transport Regulator.
- Fighting absenteeism involves organizing the company into smaller units, providing attention to absent employees, tracking absences statistically and financially, conducting medical checks, and managing a pool of replacement drivers.

#### 2) Network Productivity Improvement

Network productivity improvement consists in optimizing human resources (number of driving hours) and material resources (number of vehicles) to produce a given Operating Plan. This optimization utilizes specialized business tools, with Hastus being a well-known international tool. Regular checks are essential to ensure that production is fully optimized.

#### 3) Rational Driving and Consumption Checks

Rational driving and consumption checks involve training drivers in rational and anticipatory driving techniques. Benefits of this training include reduced fuel consumption, fewer accidents, less vehicle wear and tear, improved driver adherence to corporate values, and reduced absenteeism. Daily monitoring of production kilometers and fuel consumption, compared to the budget, helps identify discrepancies that may indicate internal resource misappropriation.

#### 4) Demand and Supply Optimization

The public transport offer should align with demand, necessitating constant monitoring of demand evolution. Precise attendance statistics categorized by different days and hours are crucial. Measures may include route redefinition, adjustments to service frequencies, and modifications to vehicle capacity. These measures reduce mileage production of buses and trams.

### 5) Targeted Marketing

Targeted marketing can enhance attendance by aligning supply with demand and understanding customer needs. As examples, digital tools, such as customer information development and social media communication, can significantly improve the attractiveness of public transport. Coordination of timetables between buses and trams, as well as major bus lines, can facilitate better connections. Targeted marketing efforts directed at universities, large companies, and administrations can attract new public transport users.

### 6) Diversification of Revenue Streams

Public transport operators can benefit from diversifying their sources of revenue, specifically by exploring non-fare revenue streams, such as leasing spaces within stations for retail establishments or developing commercial and residential buildings adjacent to stations; and other potential options for advertising and retail and services.

## 3.5 Recommendations for SPTC and Existing Public Transport Operators

### 1) Recommendations for Canton Sarajevo

Canton Sarajevo has a major shareholder responsibility with GRAS which is not exerted; past accumulated losses have turned GRAS into an indebted company. Canton Sarajevo should end the debt problem of GRAS and launch a strong restructuring to make human resources match with the rolling stock available to be operated. Compared to the issues of GRAS, the decision to create or not a new company to operate trams and trolleybuses is of secondary importance, as:

- Such creation will only worsen the problems of the remainder of GRAS with respect to bus and minibus operation;
- It will generate difficult legal problems of property transfer that will be much easier to solve once GRAS is restructured;
- It will double management and administrative costs (one structure for GRAS, one structure for the new company); and
- Its only interest is to separate trams and trolleybuses from indebted company GRAS, problem that will be solved once GRAS is restructured.

In addition to this main issue, CS should concentrate on:

- Infrastructure development to improve commercial speed, beginning with traffic light priority on the tram and trolleybus lines;
- Offer adaptation to actual demand, following the recommendations of the traffic surveys performed in this report and constant traffic monitoring; and
- Developing Public Service Contracts with its operators according to the JICA Expert Team's above recommendations.

The JICA Expert Team propose the following road map to address GRAS issues in priority. GRAS issues are mainly the responsibility of CS.

**Table 6 Roadmap to Address GRAS Issues in Priority**

No	Question to be addressed	Who should make the decision / take the lead	Remarks
1	Should GRAS be liquidated, maintained or split into other companies	Canton Sarajevo	If liquidated, alternative operator should be defined. In the following steps, the JICA Expert Team assume GRAS is maintained or split into other companies
2	Liberate operator(s) from the burden of debt they will never be able to reimburse.	Canton Sarajevo	The operator(s) should be able to deal with their current expenses. Operating profits should be limited and alternative solutions should be found for existing debt.

No	Question to be addressed	Who should make the decision / take the lead	Remarks
3	Decide transport plan and allocate it between operators Adapt fare structure.	Canton Sarajevo	
4	Establish business plan with investment and operation budget	Canton Sarajevo	Business plan should be prepared by GRAS and negotiated with Canton Sarajevo. If financial burden is not sustainable, then transport plan should be reduced (step 4 above)
5	Implement business plan. Adjust company resources and HR according to plan	GRAS	
6	Follow implementation of plan	Canton Sarajevo	

Source: JICA Expert Team

## 2) Recommendations for Existing Public Transport Operators

CENTROTRANS is managed according to state of the art procedures, with remarkable achievements in the fields of operational control and resource optimization. Amongst the JICA Expert Team's general recommendations above, the development of more ambitious CSR programs and a better cooperation with CS to implement transparent Public Service contracts should be advised.

The restructuring of GRAS is urgent. It first needs a solution to the debt issue, which cannot come from GRAS itself. In addition, the social and even political consequences of a complete restructuring of GRAS are such that only CS can manage them. For this reason, and until CS takes its responsibilities regarding GRAS, the current survival strategy of management probably is the worse option.

When the debt issue will have been solved by CS, GRAS structure needs to be adjusted to the modern rolling stock available for operation; it is extremely costly, uneconomical and dangerous to operate buses over 20 years and trams and trolleybuses over 30 years. These obsolete rolling stock should be pure and simply disposed. Staff and structure of the company should be adjusted to remaining operational fleet. A similar structure can be adjusted for a bus pure player if it should be the fate of a restructured GRAS.

## 3) Recommendations for SPTC

As a new company, KJKP JPS should follow all the above general recommendations. Splitting current GRAS into two operating companies will induce duplication of administrative structures. Based on the organigram proposal the JICA Expert Team made for the new company, the Team can evaluate this negative synergy to at least the whole GM department plus half of HR and half of finance departments, or around 15 additional staff.



***MAIN TEXT***

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## 0 Introduction

### 0.1 Background

Public regular passenger transport (public transport) comprises trams, trolleybuses, buses, and minibuses. Public transport in Canton Sarajevo is a utility service, and, as such, services were mainly provided by the Cantonal Public Utility Company, GRAS, with the support of private operator, CENTROTRANS.

Due to the old and insufficient fleet and infrastructure, GRAS started to fault timetables, provide irregular services, and even cease operation on certain lines. This caused dissatisfaction among citizens and an increase in the use of private cars which generates severe congestion and increased air pollution. As a result, the Canton Sarajevo Ministry of Traffic (MOT) revoked the decision for GRAS to operate some minibus and bus lines.

In 2018, upon the requests for regular service from local authorities and citizens, the MOT issued a public tender for 22 minibus and bus lines taken away from GRAS. In December of the same year, the tender was finished, and CENTROTRANS, a private operator, was selected as the new operator of the lines. On 24 January 2019, MOT informed the Canton Sarajevo Government of re-establishing services on those 22 lines. CENTROTRANS is one of the largest bus transport companies in Bosnia and Herzegovina with a rich history. It has been a provider of suburban and urban transport since 1973.

Currently, tram and trolleybus services are regulated by the public sector, GRAS, while buses and minibuses are operated by a combination of public and private sectors, namely, GRAS and CENTROTRANS. According to the transport survey result in this Project, in Canton Sarajevo, a public transport network of trams, trolleybuses, buses, and minibuses accounts for about 25% of person trips and is the basis of citizens' lives.

However, before the start of this Project, the average ages of tram, trolleybus, bus and minibus vehicles owned by the public operator, GRAS, which has yet to undergo sufficient renewal of the rolling stock, were 36, 30, 19 and 11 years, respectively. Due to financial difficulties, the service level of public transport dropped, such as the number of operations stipulated in the original timetable was reduced, and the number of passengers transported by GRAS per day decreased by approximately 20% from 311,000 in 2010 to 254,000 in 2015 (GRAS survey, 2015).

JICA conducted a Data Collection Survey (2020) intending to analyse the current situation and issues in Canton Sarajevo and improve public transport. The following issues and the necessary countermeasures were identified:

- The management capacity of GRAS is weak, and the number of services operated is less than the operation plan. GRAS is operating at a loss, and accrued interest is leads to a further increase in debt. Therefore, it is necessary to reorganize the company.
- The number of GRAS' operable vehicles decreased by more than 40% from 219 in 2011 to 126 in 2018, and the average age of tram vehicles is 36 years (respectively 18 years for bus and 20 years for trolleys before the arrival of new vehicles). Formulating a renewal plan for these rolling stock and infrastructure is necessary.

Based on the above situation, mainly through the two activities of this Project, namely,

Activity 2, "Improvement of management capacity of public transport operators," and Activity 3, "Development of renewal plan of tracks, depots and fleet," further analyses of the above issues were conducted and recommendations that contribute to improving the management capabilities of the public transport operators (namely, both GRAS and CENTROTRANS) are presented in Volume II.

## **0.2 Report Organization**

The JICA Expert Team first investigated and analysed the current operation status, staffing/working conditions, facility conditions, and financial structure. For this, since the collection of major indicators for daily operation and its quantitative analysis were conducted in the Data Collection Survey (2020) by JICA, the JICA Expert Team had a series of interviews with various departments and personnel of the two public transport operators and made overall analyses in Chapter 1, Inventory and maintenance conditions of tracks, depots and fleet and GRAS' plans as a cantonal public corporation were reviewed along with the financial conditions of the two operators. The latest information on the establishment of a new public operator, KJKP JPS, is also included in Chapter 1.

Then, detailed vehicle allocation and personnel plans for trams, trolleybuses, buses, and minibuses are formulated in Chapter 2, based on the operation plan proposed in Chapter 4 of Volume I. Issues of implementing the vehicle allocation and personnel plans are analysed, and a manual that clarifies various procedures related to the revision of the vehicle allocation and personnel plans has also been attached as an appendix (A3.1.4) to Volume I so that the operators could revise their vehicle allocation and personnel plans by themselves in future. The manual includes labor management (policy for setting work schedule (shift table)) (A3.2.2), working conditions (break time, continuous operation time, and resting environment) (A3.2.1), service delivery (user guidance, cleanliness, greeting, support for the disabled, gender support, foreigners support) (A3.3.2), and safety management (measures for accidents, education and training for preventing accidents, crime prevention on board) (A.3.2.3).

Finally, a management improvement plan for public transport operators is proposed in Chapter 3. The current situation in fare/ticket management has been updated on the findings from the Data Collection Survey (2020) by JICA, and recommendations for improvement are explained. A manual is also attached to Volume I consisting of "1: General rules, 2: Handling of fares/tickets, 3: Penalties, 4: Handling of collected fares, 5: Guidance to crew members" (A3.3.1). By reviewing the existing fleet's maintenance conditions and renewal plans and the public sector's (GRAS) tracks and depots, improvements are made to the fleet and track maintenance plans. Further directions for fleet and track renewal are also presented with detailed vehicle technology selection in the Appendix. For improved management and business plans, best practices in every aspect of public transport production are presented as recommended actions. Along with the existing public transport operators, recommendations for the new public operator, KJKP JPS, are also presented in Chapter 3.

# 1 Actual Conditions of Public Transport Operators

## 1.1 Organizational Conditions

### 1) List of Interviews

Data was collected through face-to-face interviews with management and staff and site visits. Interviews generally lasted between one and two hours and were conducted at the working place of the interviewee. The tables below summarize the interviews performed.

**Table 1.1.1 List of Interviews for GRAS**

No	Function of interviewee	Date
1	General Manager	12/10/2021
2	HR (Human Resource) Manager	13/10/2021
3	Union leader	13/10/2021
4	Bus maintenance executive	14/10/2021
5	Tram operations executive	14/10/2021
6	Bus driver	15/10/2021
7	Tram driver	16/11/2021
8	Central bus dispatcher	17/11/2021
9	Planner	17/11/2021
10	Tram mechanic	17/11/2021
11	Director trolleybus division	18/11/2021
12	Trolleybus driver	18/11/2021
13	Head of trolleybus maintenance	19/11/2021

Source: JICA Expert Team

**Table 1.1.2 List of Interviews for CENTROTRANS**

No	Function of interviewee	Date
1	General Manager	13/10/2021
2	Supervision center	15/10/2021
3	Director of Quality and Maintenance	24/03/2022
4	Urban and peri-urban operations Director	3/01/2023
5	Director of Quality and Maintenance and Deputy for Maintenance	3/01/2023
6	Legal Director and Company secretary	4/01/2023
7	Finance Director	4/01/2023
8	HR Director	4/01/2023
9	Driver	4/01/2023
10	Electrician + Head of shift mechanic	4/01/2023

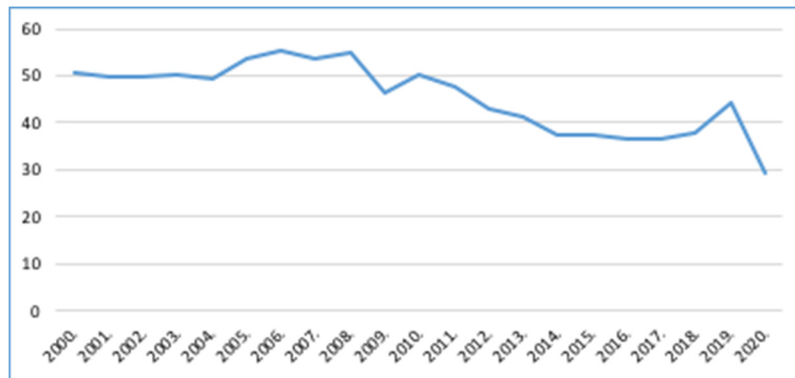
Source: JICA Expert Team

GRAS and CENTROTRANS have facilitated exchanges with staff and provided full transparency about operating conditions and staffing.

### 2) Overview of Operating Conditions in GRAS

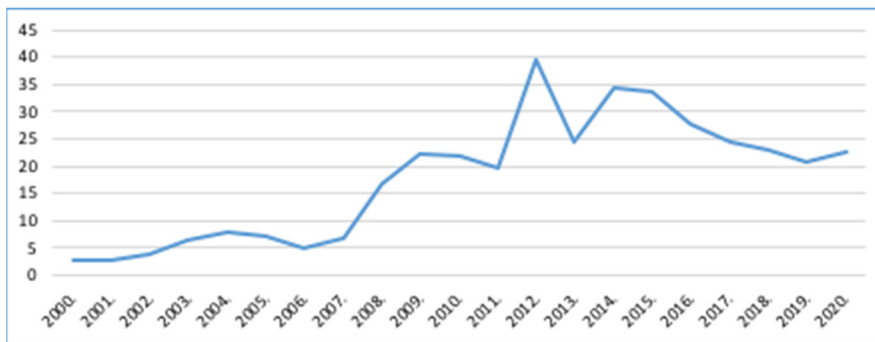
KJKP GRAS, a company owned by Canton Sarajevo, was established more than 138 years ago. Before the 1992 war, GRAS operated 92 trams, 86 trolleybuses, 220 buses, and 90 minibuses, and was the main operator of the public transport. War between 1992 and 1995 led to the destruction of almost the whole rolling stock, partially reconstituted thanks to foreign grants and loans, one of the first in 1995 being issued by the Japanese Government.

KJKP GRAS has not been managed efficiently since the war and is still inefficient. Since 2008, annual losses of the order of magnitude of half the yearly revenue or even more have occurred.



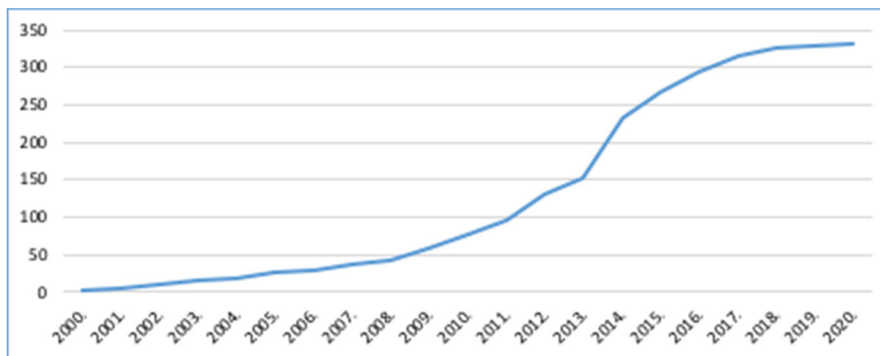
Source: Sarajevo Institute of Economics

**Figure 1.1.1 GRAS Revenue in Million KM**



Source: Sarajevo Institute of Economics

**Figure 1.1.2 GRAS Loss in Million KM**



Source: Sarajevo Institute of Economics

**Figure 1.1.3 Accumulated GRAS Debt in Million KM**

Such orders of magnitude of losses are usual every year in Europe, but this historical track record of GRAS is a serious concern for the following reasons:

- a. This profit and loss statement included the effect of subsidies on seasoned tickets and was, therefore, supposed to lead to a non-loss-making situation.
- b. As the company was not provided with new rolling stock by its founder and was not in a position to renew it through its own resources, it has operated older vehicles, which consumed more resources which aggravated even more the financial situation of the company.
- c. As the financial results of the company justify filing for a bankruptcy, banks made payments to suppliers more complicatedly and generated aggravation of the financial situation of the company.

- d. Number of staff was never adapted to actual rolling stock, which went declining. It resulted in poor productivity ratios in all domains.

Another consequence of this situation was the decline in the quality of service provided by GRAS. This led to the decision to tender the operation of bunches of lines and eventually resulted in transferring operations from GRAS to CENTROTRANS, a private company mainly operating in interurban transport, which definitively deprived GRAS from the potential revenue associated to these lines.

It was found that GRAS is not in a condition to be operated according to minimal standards. Should it be run like a regular company, it would already have filed for bankruptcy and stopped all operations.

GRAS bank accounts are usually blocked because of excessive debt, except for short periods when salaries and some suppliers can be paid. Purchasing current supplies like spare parts or fuel is a permanent challenge.

Depot equipment and tools are outdated, and the fleet is too old, as explained in the next section. Because of the lack of resources mentioned above, considerable energy is lost in maintaining outdated equipment and vehicles.

Total workforce was 1,229 at the time of the interviews. This figure is considerably too high compared with the operational fleet sizes and two main factors can explain this:

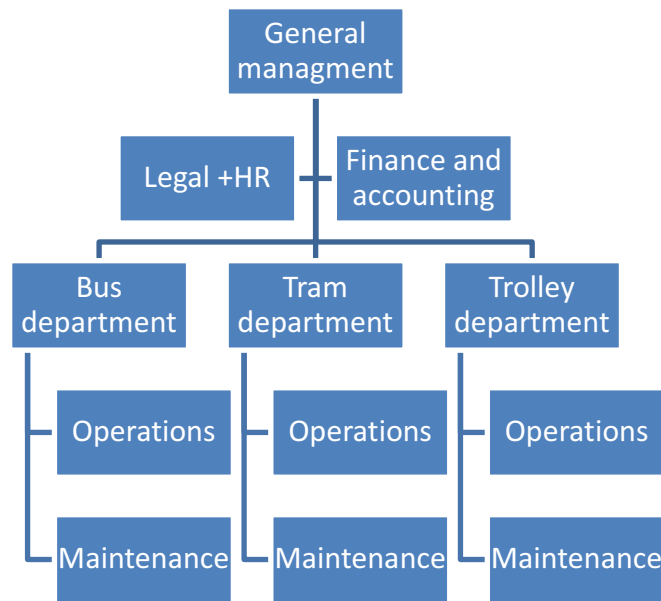
- Significant additional resources are required to maintain obsolete vehicles due to the insufficient supply of spare parts caused by poor financial situation.
- Company management is not incited to make productivity efforts, whereas there is no vision for the future of GRAS.

### **3) GRAS Human Resources**

The new 2007 labor agreement for utility companies has been extended to GRAS after a strike. It has increased wages from 20 million KM to 60 million KM while total revenues were 55 million KM. The rules changed in 2016 and reduced the cost of wages to 40 million KM. Most employees (around 1,200) have sued GRAS to obtain the incurred difference in pay due to the 2016 rules and won the case, inducing inappropriate differences between them and those who did not sue.

GRAS is also highly unionized, and the power and influence acquired by unions do not ease management tasks.

The JICA Expert Team believes that despite the conditions they are placed in, employees are GRAS's sole and most significant asset. Staff are qualified and know how to find solutions to impossible situations. At 54 years, average age of staff of tram maintenance department is high, and there are no recruits to benefit from the experience of older employees, most of whom will retire within one or two years. This situation will worsen with the possibility offered to citizens who participated in the war to retire earlier.



Source: JICA Expert Team

**Figure 1.1.4 GRAS Simplified organization chart**

#### **4) Overview of CENTROTRANS Operating Conditions**

CENTROTRANS is a private company that has been in suburban transport for several decades, and urban transport for more than 10 years. Today, urban transport accounts for roughly less than half the activity, whereas another half is shared between intercity (regular or occasional) and international. In urban transport, CENTROTRANS operates in 6 cities in addition to Sarajevo. It does not have to cope with the burden of past debts or unsustainable operations and can decide to invest in the best of its interests.

Operations are reliable, the fleet is in good condition, and operation tools (fleet supervision, fare collection) are state of the art, providing a strong contrast with GRAS. The JICA Expert Team checked that company procedures and processes (for instance, fuel consumption monitoring, accident follow-up, driver training, etc.) are state of the art. In addition, CENTROTRANS has acquired ISO 9001 and 14401 certifications.

An investment policy is optimized for urban services. CENTROTRANS purchases used buses from 6 to 8 years old from Germany, a large market that corresponds to the usual age when Stadtwerke (urban operators in Germany) renews its fleet. This enables it to contain investment costs and still benefit from quality rolling stock.

#### **5) CENTROTRANS HR: Strong Culture and Exemplarity**

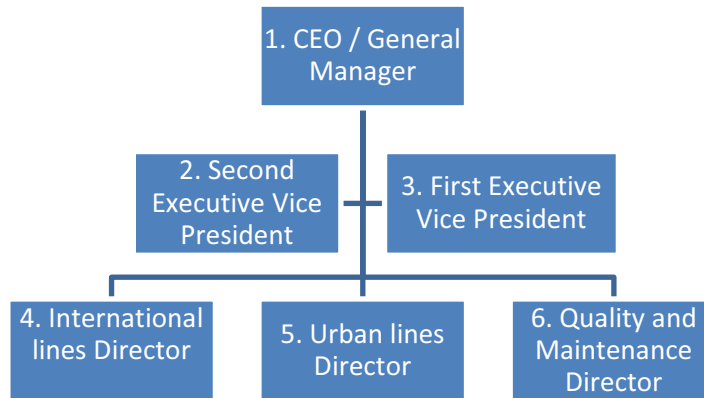
All personnel appear sensitized to the importance of permanent cost optimization and cost control. The abovementioned procedures are, therefore, understood and applied throughout all the hierarchic lines.

The organigrams are significantly simpler than in GRAS, with fewer resources better employed. Procedures for expenses are such that collegial decisions are required for the most significant expenses. This enables transparency regarding the use of the company resources. All employees are aware that no one is abusing the company's resources.

Unions are cleverly managed and do not interfere negatively with the management of the company. Although governance is balanced, the charisma and strong personality of the

general manager still give him a central role in the organization.

However, a real delegation effort is on its way. Recently, the top organization of the company has been changed, introducing three new managing positions (numbers 4, 5, and 6 in the figure below).



Source: JICA Expert Team

**Figure 1.1.5 New CENTROTRANS Top Management**

The former deputy general manager is now in position 3. Safety and Traffic Director. Three new director positions (numbers 4, 5, and 6) have been introduced. They previously had the same functional role but were not appointed directors and had less margin of maneuver.

These changes are justified because the general manager and his former deputy are close to retirement, and the company grew. The objective is to delegate more and prepare the next leading generation for the company. The three new directors are more responsible for hiring recruits and the evaluation/sanction process of their reports. These changes show a will to make the structures of the company evolve according to its needs and should enable talents to grow.

## 6) Challenges faced by CENTROTRANS

CENTROTRANS is faced with a shortage problem of qualified human resources, particularly drivers. The average wage in the company is estimated at around 1,070 KM, which is higher than in the Federation of Bosnia and Herzegovina. Significant efforts have been made in the recent period to increase wages, with an average of 25% increase in 2022 vs 2019.

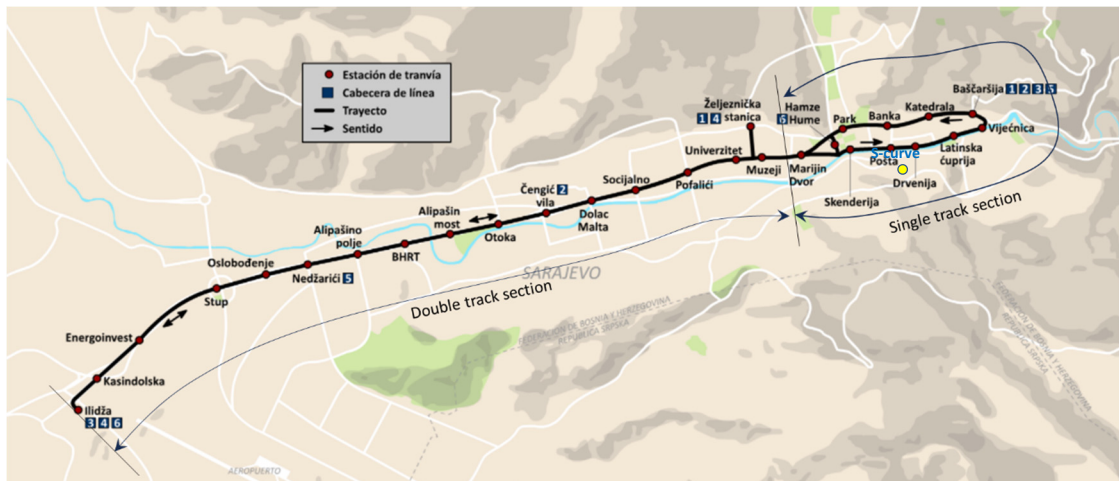
This shortage in resources leads, in turn, to more frequent overtime. The company is, however, making efforts to overcome this situation by (i) refusing to operate new services in the short term, (ii) trying to reemploy drivers who left the company during the COVID-19 lockdown period, and c) trying to employ more qualified drivers.

## 1.2 Fleet Conditions and Maintenance

### 1) Findings of Inventory of Existing Tram Track, Fleet, etc.

#### (1) Existing Conditions of Track Structure of Sarajevo Tram Line

Sarajevo Tram Line stretches in the east–west direction in Sarajevo city (refer to Figure 1.2.1).



Source: JICA Expert Team based on online information

**Figure 1.2.1 Sarajevo Tram Route Map**

Tram line consists of six operation routes. The section of each route is shown in Table 1.2.1, together with the route length, operation interval, and number of daily tram operations.

**Table 1.2.1 Route Summary of Sarajevo Tram**

Route No.	Route Name	Route Length (km)	Operation Interval (min.)	No. of daily train operation*
1	Baščaršija–Željeznička stanica	3.1	18-36	97
2	Baščaršija–Čengić vila	5.1	13	28
3	Baščaršija–Ilidža	10.9	4-10	504
4	Željeznička stanica–Ilidža	8.7	33-66	53
5	Baščaršija–Nedžarići	7.9	19	38
6	Skenderija–Ilidža	9.2	9-11	152
	<b>Total</b>	<b>44.9</b>		<b>872</b>

\*: before EBRD project

Source: GRAS

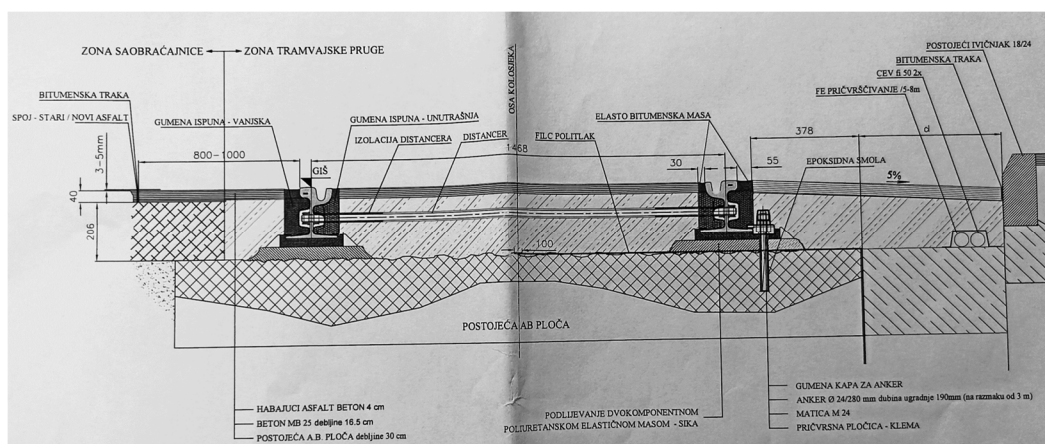
There are two typical track structures in the Sarajevo Tram. On the eastern section of the tram is a single-track loop line beginning from “S” curve in a counterclockwise direction. In this single-track section, the track structures are embedded in asphalt concrete in the far-right lane of the road, and vehicles can pass over the tram tracks when tram cars are not running the tram tracks.



Source: JICA Expert Team

**Figure 1.2.2 Track Structure in Single-track Loop Line Section**





Source: GRAS

**Figure 1.2.3 Typical Track Structure Section in Single Loop Line Section**

On the other hand, the western section of the tram, which is a so-called S-curve where the track becomes double track from the single-loop, and most of the tram line between Ilidža station and “S” curve runs as double track line in the middle of the wide median of the road. The western section was rehabilitated by the EBRD fund.

The track inspection report in May–June 2021, before the commencement of the EBRD track rehabilitation project, mentions many issues in the western section, as listed below; however, it reported only a few issues in the eastern section (single-track section).

- The general condition in the section was very bad prior to the track rehabilitation.
- The section from Čengić Vila to the “S” curve was in the worst condition.
- Due to the lack of quality connection between the rail and the base, the upper surface of the rail head was very wrinkled, which causes uneven tram travel with bumps.
- Tram drivers were warned to reduce the speed for the safety of tram operation due to the very poor condition of the railway on some sections.

It should be noted that the reasons for “very bad,” “the worst condition,” etc. are not clear as the evaluations described in the track inspection report prepared by GRAS are without reasons. According to the interview with GRAS, there are compounded reasons, including deteriorated material, lack of regular maintenance, etc. It is usually required to maintain a certain extent of track quality to implement track maintenance work. The track condition before the EBRD project was too bad to conduct maintenance work.

On the other hand, after the rehabilitation work of the western section, some obvious lessons can be drawn from the observations made, namely:

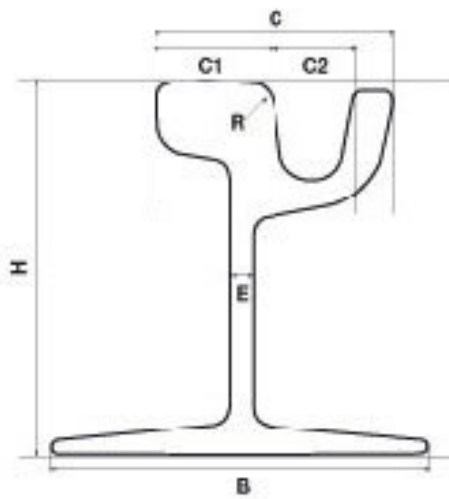
- Ballasted track sections were previously maintained only irregularly. Following the latest rehabilitation effort, the tram fleet can now operate at the appropriate speeds.
- Tracks embedded in slab tracks through the intersections have been paved with good quality. As such, cars and other rubber-tired vehicles can also run smoothly, thereby reaping benefits as well as the trams.



Source: JICA Expert Team

**Figure 1.2.4 Track Structure after Rehabilitation in the Western Section**

In both sections, groove rail, used for tram track, has been applied. The rail type and details of the groove rail applied to the Sarajevo Tram are shown below.

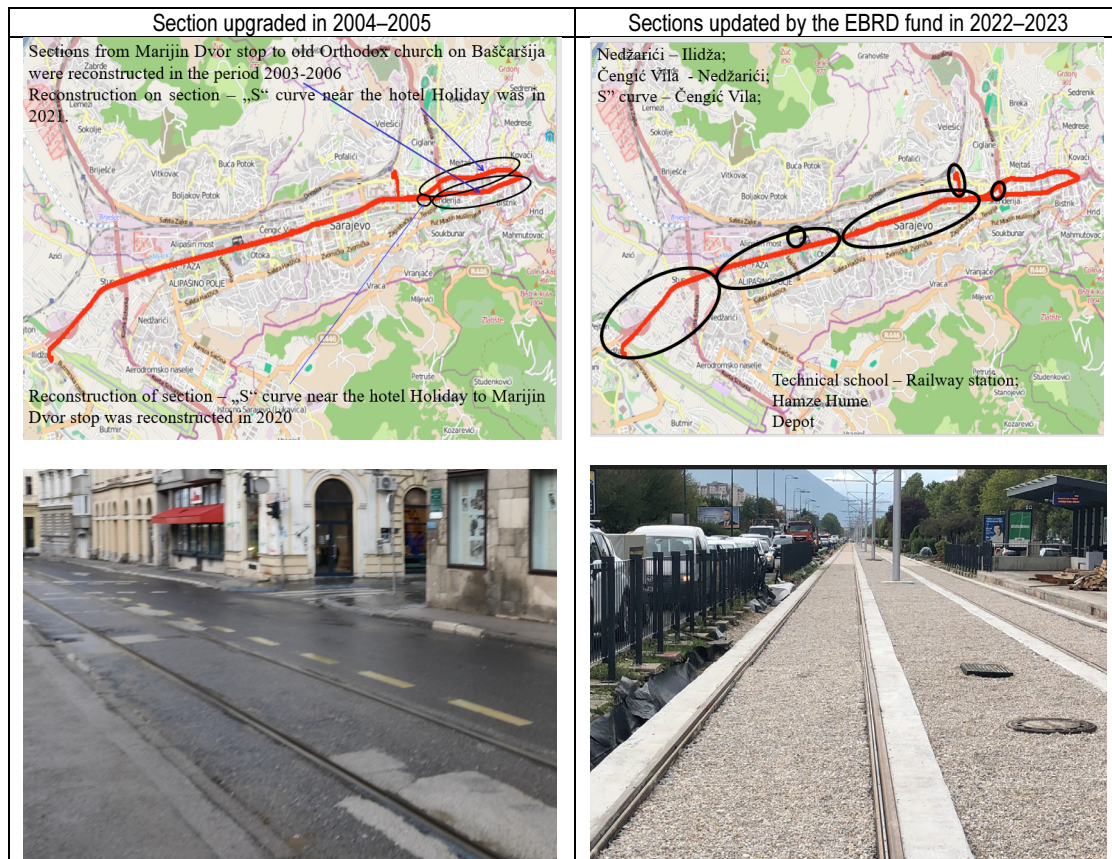


Rail Profile	:	60 R1
Standard	:	EN14811
Dimension (mm)	H	:180
	B	:180
	C	:113
	C1	:55
	C2	:36
	E	:12
	R	:10/225
weight	Kg/m	60.59

Source: JICA Expert Team based on the data by GRAS, etc.

**Figure 1.2.5 Typical Section of Groove Rail**

A comparison of the conditions in these two sections is shown in the following figure.



Source: JICA Expert Team

**Figure 1.2.6 Comparison of Track Condition of the Upgraded Section in 2004–2005 (left) and the Section Rehabilitated with the EBRD Fund (right)**

From this comparison of the single-track loop line section rehabilitated in 2004 and 2005 and the rehabilitated road-center double-track section, track conditions have become drastically better, and the tram can operate at typical speeds it is supposedly capable of.

## (2) Existing Conditions of Tram Fleet

Following an in-depth review of the existing tram fleet, the JICA Expert Team has ascertained a total fleet of 50 trams.<sup>1</sup> However, 30 trams are not operational due to various issues related to unplanned repairs (i.e., damage from collisions), deficiencies in the preventative maintenance regime (e.g., lack of spare parts and/or in-house capability to repair), and/or merely from wear and tear due to the advanced age of the trams themselves which result in systemic breakdowns. A detailed breakdown of the GRAS tram fleet is attached. A large number of defective trams is one of the reasons for low frequency, slow speed, etc. Some trams are kept for further usage after repair work, but others are kept for cannibalization to service the operational units due to a lack of spare parts.

<sup>1</sup> As of 27 July 2023.

**Table 1.2.2 Breakdown of the GRAS Tram Fleet**

R/No.	Type of tram	Tram size	Inventory number	Number of working trams	Number of defective trams	Production year of the vehicle
1.	CKD – K2	2 cars, 20,4 m	14 ( 5 )	9	(5)	1973
2.	KT8 – D5	3 cars, 30,3 m	3	1	2	1989
3.	SATRA 2	2 cars, 20,4 m	11	1	10	2004–2011
4.	SATRA 3	3 cars, 28,25 m	4	2	2	2005–2015
5.	E1	2 cars, 19,7 m	2	1	1	1961–1963
6.	GT8	3 cars, 30,8 m	16	6	10	1963
<b>TOTAL</b>			<b>50 (5)</b>	<b>20</b>	<b>30 (5)</b>	

Note: "(5)" means five K2 trams are planned to be modernized as Satra 2/3.  
Source: GRAS

### (3) Existing Conditions of Trolleybus Fleet

Prior to the incorporation of the newly acquired Belkommunmash trolleybuses, the GRAS fleet (omitting buses, minibuses and trams as these are described in the preceding and following sections) comprised a fleet of 50 trolleybuses, of which 24 were ascertained to be operational with the remainder deemed to be inoperative for a variety of reasons ranging from the lack of spare parts or obsolete technology thereby rendering these inoperative units unrepairable. In similar fashion to the buses and minibuses, the trolleybus fleet was exceedingly old (averaging 30.7 years vs 12-18 for exemplar peer systems). CENTROTRANS does not operate any trolleybuses.

The Canton has since acquired and taken receipt of new trolleybuses following a protracted procurement process which resulted in the award of the supply contract to the Belarussian manufacturer, Belkommunmash. The introduction of the new Belkommunmash trolleybuses has greatly improved performance and lowered the median age of fleet to 15-16 years as of the end of 2023 following the incorporation of the last new unit (25 in total).

Those vehicles that are listed as "Operational" form part of the daily operational fleet being used to deliver the planned services as described in the planned service schedules, whilst the "Inoperative" vehicles are those that are not currently operable due to defects, damage or need for repair. Due to the very advanced age of the trolleybuses (omitting the new units), there are no units deemed to be "serviceable" (unlike the buses and minibuses).

A more detailed summary of the trolleybus fleet, including the 25 newly delivered Belkommunmash trolleybuses is attached below.

**Table 1.2.3 Breakdown of the GRAS Trolleybus Fleet**

Trolleybus Manufacturer	Model	Total	Operational	Inoperative	Average Age (years)
<b>HESS</b>	NAW BGT-N	14	14	-	36.0
	NAW BGT-25	22	9	13	
<b>MAN</b>	SG 200 HO	3	-	3	28.7
	SL 172 HO	11	1	10	
<b>Belkommunmash (New)</b>	<b>BKM 43300D</b>	<b>25</b>	<b>25</b>	-	1.0
<b>TOTAL</b>		75	49	26	

Source: GRAS

### (4) Existing Conditions of Bus Fleet

The GRAS fleet (omitting trolleybuses and trams as these are described in the preceding

section) comprise a mix of buses (125), and minibuses (34) from eight different manufacturers. From supplementary data provided by CENTROTRANS, their rolling stock fleet consists of 110 standard-sized 12-m buses and minibuses.

Similar to the trams, one out of every two or three buses in the GRAS fleet are typically non-operational, with the non-operational units sitting idle in the depots due to a lack of spare parts or are simply cannibalized to service the operational units.

Whilst there is an obvious deficiency with respect to the maintenance regime due to the lack of spare parts, the principal cause of the issues faced by GRAS is the advanced age of their fleet – the average age of the GRAS fleet is far beyond the typical useful life of rolling stock in exemplary European cities: bus (19.5 years vs 10-12) and minibus (11.1 vs 8-10). As such, many of the manufacturers who originally produced these vehicles simply do not stock the parts needed by GRAS as the technology has either moved on or been replaced with newer technology that is not backwards compatible with those vehicles still used by GRAS. The breakdown of the GRAS fleet of buses and minibuses is listed below. Unlike the trolleybus fleet which now benefits from the incorporation of the newly acquired units, the problem of obsolete vehicles remain however for the bus and minibus fleet as there are no definitive plans to acquire new rolling stock to gradually replace and decommission the vehicles.

In similar fashion to the trolleybuses, those vehicles that are listed as “Operational” form part of the daily operational fleet being used to deliver the planned services as described in the planned service schedules, whilst the “Inoperative” vehicles are those that are not currently operable due to defects, damage or need for repair. For the buses and minibuses, the primary distinction between the “Serviceable” and “Inoperative” units are that the former are those buses that can be brought back to operable conditions if spare parts and tools/machinery were available, whilst the “Inoperative” units are those that are considered as obsolete and beyond repair – these units are effectively those vehicles being stripped down as spare parts to service either Operational or Serviceable vehicles.

**Table 1.2.4 Breakdown of the GRAS Bus Fleet**

Bus Manufacturer	Model	Total	Operational	Serviceable	Inoperative	Average Age (years)
FAP	A 757	1	-	-	1	17.3
	OM 442	2	-	-	2	
IKARBUS	IK 201 (Articulated)	4	-	-	4	14.2
	IK 206 (Articulated)	9	-	3	6	
MAN	A 20 CNG	6	2	1	3	18.3
	A 21 CNG	2	-	-	2	
	A 23	2	1	1	-	
	A 23 CNG	13	4	1	8	
	G A 23 LPG	10	7	2	1	
	RO 2	1	-	1	-	
	SG 313	4	1	1	2	
Mercedes-Benz	O 345	44	19	7	18	24.5
	O 530 G	3	2	-	1	
NEOPLAN	4413 CNG	1	-	-	1	17.2
	4416 CNG	2	-	-	2	

Bus Manufacturer	Model	Total	Operational	Serviceable	Inoperative	Average Age (years)
	G.AUWAERTER STGT N 116	1	1	-	-	
	N 122 L	2	1	1	-	
	N 213 S	1	-	1	-	
	N 4421/3	4	2	1	1	
	PD 4 CNG	10	2	-	8	
<b>TOTAL</b>		125	43	22	60	

Source: GRAS

**Table 1.2.5 Breakdown of the GRAS Minibus Fleet**

Minibus Manufacturer	Model	Total	Operational	Inoperative	Average Age (years)
<b>ISUZU</b>	NOVOCITY S801	10	-	10	6.2
	NOVOCITY S801-2	9	9	-	
	Q31	1	1	-	
<b>IVECO</b>	100 E 18	1	1	-	18.5
	OTOYOL M23	1	-	1	
	OTOYOL M50.14	9	1	8	
<b>MAN</b>	10.220	2	1	1	23.0
<b>TEMSA</b>	OPALIN M3	1	-	1	4.0
<b>TOTAL</b>		34	13	21	

Source: GRAS

### 1.3 Establishment of a New SPTC

Canton Sarajevo has purchased 25 new trolleybus units (delivery to be completed by the end of 2023) and 15 sets of new trams (delivery to be completed in 2025) which if given to GRAS would be ceased for settlement of its debt. Therefore, Canton Sarajevo was considering the establishment of a new Sarajevo Public Transport Company (SPTC), or KJKP JPS, dedicated to these two modes. The Canton Sarajevo Government resolved to that purpose and on 10 March 2022, put it forward to the Assembly of Canton Sarajevo for approval.

The JICA Expert Team highlights that the decision to split the current operations of GRAS will have the consequence of duplicating the management and administrative structures, thus generating a negative synergy evaluated below.

Apart from this initial remark and a public transport management perspective, the decision to establish a new company raises two questions, which are partially addressed in the study prepared by the Sarajevo Institute of Economics in November 2021<sup>2</sup> (referred to below as the SIE study) and annexed to the decision submitted to the Assembly of Canton Sarajevo:

- What should be the organization of the new company?
- What should be done with the remaining organization in GRAS?

#### 1) Organization of the New Company

##### (1) Assumptions and Statements of the SIE Study

The decision submitted to the assembly of Canton Sarajevo states in Article 14 a special

<sup>2</sup> Prof Izudin Kešetović, MSc Armin Avdić, Study on the socio-economic justification of the establishment of a new cantonal public utility company for the provision of regular passenger public transport services, Sarajevo Institute of Economics, November 2021.

act of the Management Board will decide the organization of the new company.

However, the SIE study annexed to this decision makes the following statements:

- The number of vehicles required to perform the service according to the timetables approved in 2006 is 33 trolleybuses and 42 trams (p. 24).
- The reserve vehicles ratio is 20% (p. 24).
- The number of drivers per operated vehicle is 3.17 (p. 26).
- The number of indirect employees (besides drivers) is 200 (82% of drivers) to 215 (p.31).
- The SIE study also provides an organizational chart of the new company (p. 32) but does detail about how the total number of employees is calculated.

The statements and assumptions made by the SIE study are based on statements made by GRAS and do not reflect best practices in the field of public transport.

(a) Overestimation of the necessary number of fleets

Timetables approved in 2006 are based on an average commercial speed of 14 km/h for trams. The tram line is 10 km long with an average distance between stops of 350 m. Commercial speed must be higher for such an infrastructure. It can be increased relatively easily through:

- Installing traffic light priority for trams and trolleybuses
- Analyze the number of passengers in all tram stations and suppress the three to six stations (10 to 20%) with fewer passengers if an alternative station exists less than 400 m away.

The reasonable commercial speed objective for trams (as this value is in the low range of the average commercial speeds reached by tramways in Europe) should be 22 km/h. In the first analysis, the number of required trams can vary in direct proportion to the commercial speed increase,<sup>3</sup> which reduces the number of necessary trams to perform the 2006 timetables to 27 instead of 42. The JICA Expert Team provides a thorough analysis of demand and offer scenarios in another section of this report. This section only highlights the fact that present commercial speed is very low compared with other networks, and that reasonable optimization can bring significant gains. Commercial speed increase should therefore be considered as a priority objective.

GRAS provided the JICA Expert Team with a speed observed for one day for trolleybuses (23.95 km/h). Commercial speed gains should be lesser than for trams. To be conservative, the JICA Expert Team will retain half the gains of the trams, bringing the number of required trolleybuses down from 33 to 27. The JICA Expert Team also believes there is room for additional productivity in the timetables approved in 2006 but will not retain it as the JICA Expert Team has yet to do an in-depth analysis.

(b) Overvaluation of reserve needs

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<sup>3</sup> It does not vary as this direct proportion because waiting times at the end of lines might remain constant. However, as the tram is often from a dedicated lane, travel time variations are limited; thus, waiting time can also be shortened and represents a negligible fraction of total travel time in the first analysis.

Twenty percent reserve might be good for the current obsolete fleet of GRAS, but 10% or even 8% is more than enough for properly maintained vehicles. Therefore, the JICA Expert Team re-estimated the maximum need of trams and trolleybuses to 27 and 2 vehicles.

(c) Wrong appraisal of fleet transfer needs

CS's current fleet procurement plans are:

- Between February and July 2022, there are 25 new trolleybuses and an additional 10, totaling 35.
- Between August and December 2023, there have been 15 new trams and an additional 10, totaling 25.

CS procurement strategy should be revised according to the following steps:

- Install traffic light priority for trams and trolleybuses.
- Suppress redundant stops on all lines, which may lead to the attitude of stop-skipping operational. From the transport survey result on Bus Line 16B, for example, three consecutive stops within the area of Antuna Hangija may be considered as one only.
- Implement a commercial speed-focused policy (monitor driving times, identify and treat black spots).
- Re-calculate and optimize timetables considering commercial speed increase and actual demand.<sup>4</sup>
- Fine tune vehicle needs:
  - Decide if the purchase of additional trolleybuses is necessary.
  - Adjust the number of additional trams required.

Based on the above reevaluations, the transfer of defined vehicles proposed by the SIE study from GRAS to KJKP JPS appears useless since the proposal may have been obsolete. However, avoiding such transfers will also have the following upsides:

- Dismantle all current trams (average age of 38 years) and trolleybuses (average age of 20 years) with costly maintenance and requires obsolete practices and organizations (for instance, cannibalization of vehicles to use spares that are not available on the market anymore or focusing more on corrective than preventive maintenance).
- Avoid the transfer of obsolete spare parts stock from GRAS to KJKP JPS and avoid the attached legal complications.
- Avoid very expansive maintenance of obsolete rolling stock.
- Maintain, according to state-of-the-art practices, only new trams and trolleybuses of the same type and brand, increasing maintenance productivity and organizing the workshop properly.

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<sup>4</sup> Demand should also increase significantly following the increase in commercial speed. However, this will be delayed by build-up phenomena, leaving enough time to adjust the number of vehicles through the following step of the proposed process.



(d) Overvaluation of driver needs

SIE retains the ratio of 3.17 drivers per vehicle as compliant with “professional experience standards.” However, the current 3.17 ratio is the consequence of the present work organization in GRAS in 3 shifts (morning, afternoon, and night) rather than its compliance. This is close to the ratio of operations 7/7 x 24/24 as in airports. In cities like Sarajevo, peak hours occur in the morning and the afternoon, and driver work schedules should be organized so that a significant share of the drivers is mobilized on the same day during the morning and afternoon peaks. This will significantly decrease the 3.17 ratio. JICA Expert Team made an estimate in the Optimal Service Case in Section 2.1.

Objections have been formulated to these orders of magnitude because tram operations range from 5am to 12pm, drivers are submitted to safety regulations and spend time for resting, annual leave, training etc. The JICA Expert Team confirms these orders of magnitude even taking into account all these constraints, which are not different from the usual conditions in most public transport networks in the world.

Based on the above considerations, the JICA Expert Team revised the estimates of SIE regarding the need for drivers, as follows.

**Table 1.3.1 Driver Estimate**

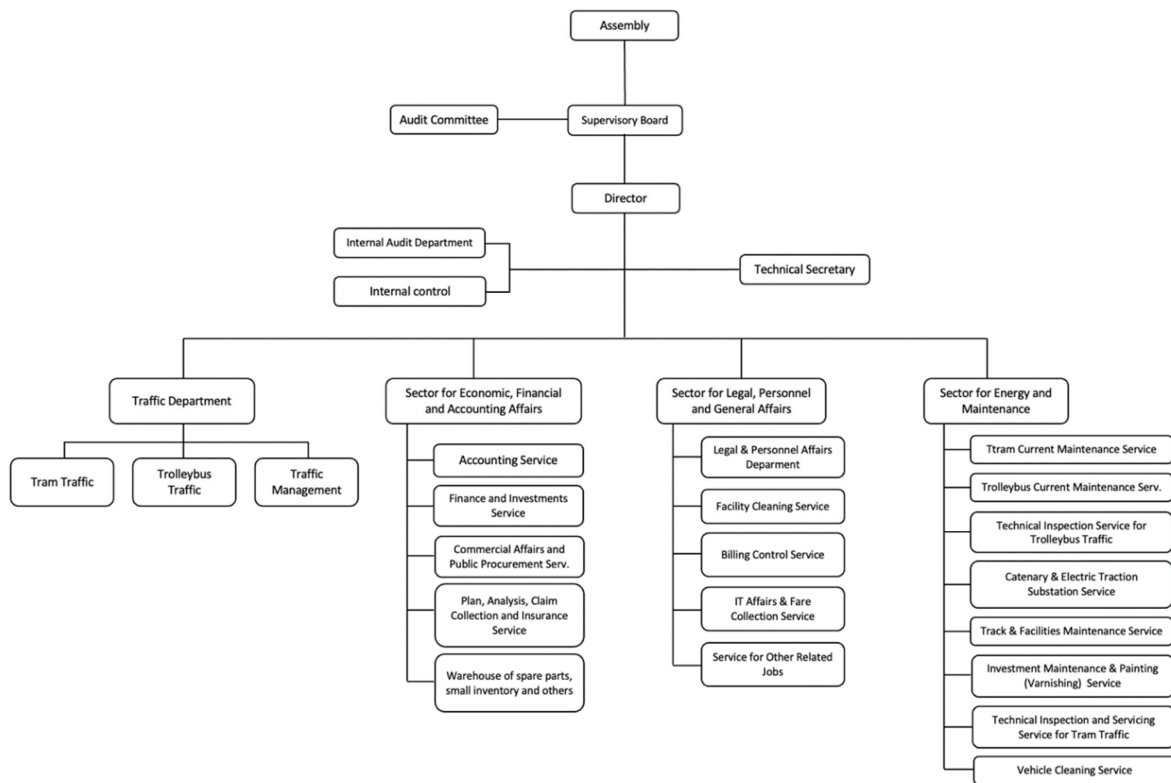
Driver estimate (revised)	2022	2023	2024	2025	2026	2027	2028	2029	2030
Number of trams		15	27	27	27	27	27	27	27
Number of trolleybuses	25	27	27	27	27	27	27	27	27
Max tram drivers	0	36	65	65	65	65	65	65	65
Max trolleybus drivers	60	65	65	65	65	65	65	65	65
Max total drivers	60	101	130	130	130	130	130	130	130
Total drivers (according to SIE study)	200	200	248	263	263	263	263	263	263

Note: Rows of “Max tram drivers” and “Max trolleybus drivers” are multiplication of “Number of trams” and “Number of trolleybuses” to 2.4. Same calculation is applied but to ratio of 3.17 and values in row “Total drivers (according to SIE study)” is resulted.  
Source: JICA Expert Team

The JICA Expert Team highlights that this is an estimate and that only a proper scheduling calculation will determine the required number of drivers.

**(2) Organization of KJKP JPS**

SIE study estimates the number of employees other than drivers to be 200–215 (without giving details about the number of staff) and proposes the following organigram for KJKP JPS.



Source: SIE study

**Figure 1.3.1 Proposed KJKP JPS Organigram**

This organigram is acceptable in principle but does not explicitly provide assumptions about the number of necessary staff. Based on the experience of the JICA Expert Team and existing similar operations, it proposes the following organization and staffing. The practice in the Canton of Sarajevo, MOT determines the timetables and the operator executes it. In European practice, the transport authority decides the transport plan (i.e., which frequency and type of service per type of day and time in the day) and usually leaves the determination of the timetables to the operator. Of course, timetables should be in line with the transport plan. This enables the operator to identify possible optimizations (for example, use the same bus on two different lines with close terminals to reduce waiting times of one bus and eventually reduce the total number of mobilized buses) by changing the bus schedules without affecting the overall offer (which is characterized by the transport plan). Investment in the research and determination of such potential optimizations is advisable. It could be performed directly at the Canton level or alternatively by the operators. The software best known internationally to help proceed to such optimizations is HASTUS. In the case of Sarajevo, the main problem in the execution of the timetables determined by Canton Sarajevo is that the GRAS fleet suffers from many breakdowns, and when a scheduled bus is unavailable, the services are not performed. In addition, the operator is supposed to propose changes to the transport plan if it sees that demand is not matching the offer (for instance, nobody takes the bus after 8 P.M., but some large buses still operate after that hour). In Sarajevo, operators are supposed to directly propose changes to the timetables instead of the transport plan.

The JICA expert team believes that implementing a transport plan / timetable organization as described above in Sarajevo could bring the following benefits:

- Ease the work of the commission in charge of optimizing and revising the transport plan.
- Facilitate the optimization of the timetables by the operators.

**Table 1.3.2 Proposed Organization and Staffing**

General Management		HR Department		Administrative and finance	
General manager	1	HR director	1	Adm and financial director	1
Assistant / Receptionist	3	Secretary	1	Chief accountant	1
Legal Department	1	Training Dr	1	Accountants	2
Communication	1	Staff administration	2	Administration procurement	2
Security / Quality	1	Social worker	1	IT	3
<b>Total</b>	<b>7</b>	<b>Total</b>	<b>6</b>	<b>Total</b>	<b>9</b>
Operations Department		Commercial Department		Maintenance Department	
Operation director	1	Commercial director	1	Maintenance director	1
Secretary	1	Secretary	1	Secretary	1
Planification / Rostering	3	Marketing and studies	3	Planning and methods	2
PCC regulation	1	Control and inspection	20	Fixed installations mgt	3
Regulators	7	Sales	5	Fixed installations staff	15
Line management	12			Tram mgt	3
Tram drivers	65			Tram maintenance staff	15
Trolleybus drivers	65			Trolleybus mgt	3
<b>Total</b>	<b>155</b>	<b>Total</b>	<b>30</b>	Trolley maintenance staff	15
				Spare shop	2
				<b>Total</b>	<b>60</b>
<b>Grand total staff</b>	<b>267</b>				

Source: JICA Expert Team

The responsibilities of the human resources (HR) department vary across the staffing administration, training of new staff, annual training, and payrolls. The administration department is responsible for legal, finance, and information technology (IT). The operational department is responsible for operational planning based on rule adjustment to actual conditions and day-to-day operational matters (i.e., line management and drivers' performance). The commercial department is responsible for marketing matters, including publication, sales, and control and inspection. The maintenance department maintains the rolling stocks and installation works, including reparation.

The total size of KJKP JPS should be less than 300 instead of close to 500 proposed in the SIE study.

### **(3) Procurement of Tram and Trolleybus Services**

KJKP JPS will be an "in-house" operator according to the EU definition. As such, tendering processes would not be required as per EU rules.

However, the JICA Expert Team recommends establishing a gross cost contract with the same structure as the one described in this report for bus lines. This will enable CS to follow the costs more accurately and benefit from more transparency from its new operator.

## **2) Consequences of Setting-up of KJKP JPS on GRAS**

As stated by the SIE study, trams and trolleybuses represent close to 65% of the current revenues of GRAS. If these resources are allocated to KJKP JPS, GRAS will be left with the same debts, organization, obsolete bus fleet, and 35% of its current revenue. Not only will it never be able to recover, but it's a situation that will significantly worsen.

The staff count of GRAS in October 2021 was 1,229. It will have to operate around 30 buses,

averaging 18 years.

Bus operations are structurally less profitable than trams and trolleybuses, which drain more passengers and have a smaller per-passenger operating cost. Bus operations usually serve areas with less demand (or less accessible because of strong slopes) and serve as feeders to tram and trolleybus operations. These are very easy to visualize in the case of Sarajevo, where trams operate in the valley, and buses drain passengers from the surrounding hills.

This is why buses, trams, and trolleybuses should be organized as a network, and intermodality should be promoted. Allowing connections between all modes increases the overall demand (the network effect), and buses and mini buses are an essential part of such a network.

Setting up KJKP JPS is a management act. It strongly signals that new rolling stock should be managed according to international productivity standards and sets a new frame from that. However, it does not solve the bus operations issue, which GRAS cannot perform efficiently.

The Canton of Sarajevo must make a clear decision regarding the future of what will remain of GRAS. Two options are possible:

- Bankruptcy and ending all bus operations (will not make a significant difference with current operations, limited to 30 buses) while laying off all employees not transferred to KJKP JPS.
- Recapitalization, solving the issue of past debt, purchase of a limited fleet of acceptable buses (they could be used like the ones purchased by CENTROTRANS but with an average age of 6 years, not 18), discarding all current buses, strong restructuring of the company with significant layoffs to adapt staff count to actual fleet and participating in tenders along with the other competitors to operate urban services.

## **1.4 Financial Situation**

### **1) CENTROTRANS**

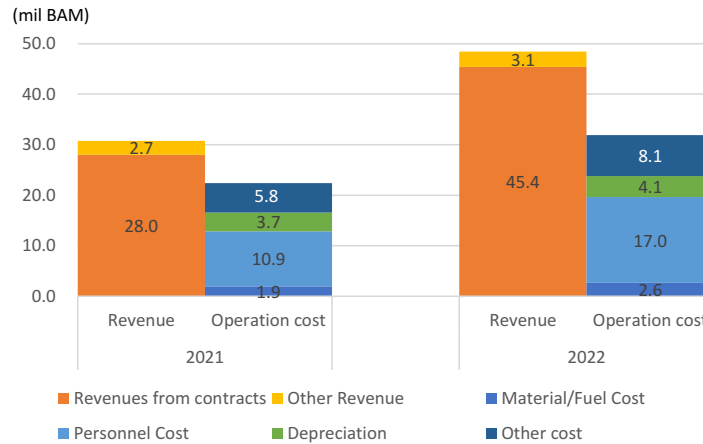
CENTROTRANS has not communicated its financial statements for its activities in Canton Sarajevo. However, the JICA Expert Team had access to the public data regarding the whole company, "Financial statements for the year ending 31 December 2022 and independent auditor's report." The financial statements do not represent the sole Canton of Sarajevo urban activity. It enables, however, to check the company delivered a net beneficiary margin of around 6% in 2021 and about 8% in 2022. These results are good for the sector.

The debt level is reasonable compared with asset value. CENTROTRANS is a sound company with positive future perspectives.

#### **(1) Profit and loss statement**

In 2022, CENTROTRANS achieved a total revenue of 48.4 million KM, while incurring operational costs amounted to 44.5 million KM, which means that the profit was 3.9 million KM. This extra profit and revenue are probably the consequence of the bus transport

replacement contract because of the works on the tram track and is thus probably non-recurring. Overall, CENTROTRANS experienced significant revenue growth in revenues, demonstrating its ability to secure contracts and diversify income sources. While costs increased as the company expanded operations, efficient cost management allowed for healthy profit growth in 2022.



Source: Financial Statements of CENTROTRANS

**Figure 1.4.1 Profit and Loss Statement of CENTROTRANS (2021 and 2022)**

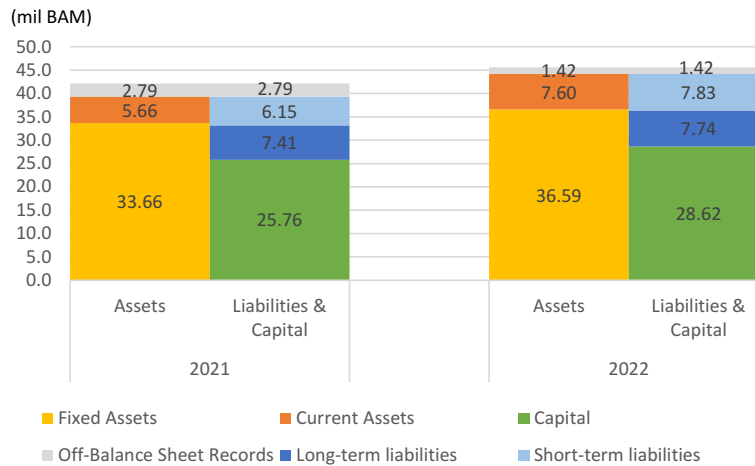
Among the 583 employees, the revenue per employee for 2022 is calculated at 82.7 thousand KM. In contrast, at GRAS, with 1,229 employees, the revenue per employee stood at 22.2 thousand KM—approximately four times lower than that of CENTROTRANS.

## (2) Balance Sheet

CENTROTRANS’s balance sheet indicates a positive trend in assets and liabilities over two years. The increase in current assets could signify improved liquidity and better management of short-term resources. The growth in fixed assets highlights its commitment to investment and expansion.

Liabilities have also grown, both in the short- and long-term categories. This was led by an increase in reservations in the short-term liabilities and financial liabilities in the long-term liabilities.

The capital has also shown growth, reflecting the accumulated retained earnings. The overall picture suggests that CENTROTRANS is investing in its operations, potentially expanding its asset base, and managing its liabilities.



Source: Financial Statements of CENTROTRANS

**Figure 1.4.2 Balance Sheet of CENTROTRANS (2021 and 2022)**

## 2) GRAS

The “Study on socio-economic justification of the establishment of a new cantonal public utility company for the provision of regular passenger public transport services” published by the Sarajevo Institute of Economics in November 2021, provides a comprehensive analysis of GRAS financial statements. Although this study has not been updated since its publication, the overall situation of GRAS has not evolved significantly since the publication of this study.

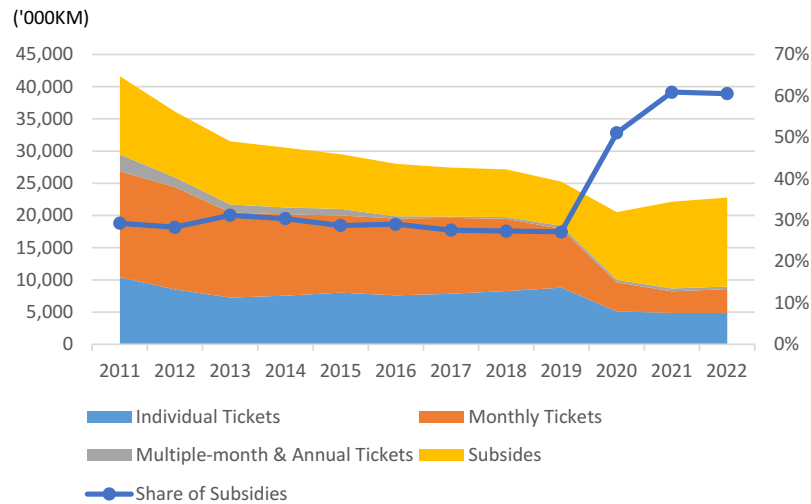
The study provides a clear vision of GRAS’s financial situation. The yearly losses of GRAS in recent years have been somewhere between 20 to 25 million KM. At the same time, in 2020, the liabilities on salaries amounted to 92 million KM, and tax liabilities were over 102 million KM. GRAS would have already filed for bankruptcy if it was not public company. It has an urgent need for restructuring.

GRAS has struggled with significant financial losses and accumulated debt. It has relied heavily on subsidies from the CS Government to cover its operating costs and sustain its operations. The company has faced difficulties in maintaining its fleet of buses, minibuses, trams, and trolleybuses, as well as providing regular and reliable services to the citizens of Sarajevo. The analysis was made based on the provided financial statements of GRAS in November 2021.

### (1) Profit and Loss Statement

#### (a) Revenue

The business revenue from passenger transport in 2020 was significantly reduced due to the epidemiological situation or reduced mobility of passengers, which continued in 2021. It recovered in 2022 to 22.7 million KM, but still lower than pre-COVID-19 in 2019 at 25.2 million KM despite the increase in shares of subsidies.



Source: GRAS

**Figure 1.4.3 Passenger Transport Revenue of GRAS (2011–2023)**

The subsidies, composing 61% of total transport revenue in 2022, cover the following beneficiaries: pupils, students, pensioners, visually impaired persons, war invalids, and family members of fallen soldiers, and from September 2020, unemployed persons.

Within these categories, specific criteria that determine the individual amount of subsidy per user, leading to some users being fully subsidized while others receiving partial subsidies. The subsidized monthly card is valid for unlimited rides in all forms of transportation. Since CENTROTRANS is also an operator of public transport, an agreement has been reached for the mutual acceptance of monthly cards between both operators (regardless of which operator the user purchased the card from). A Commission has been established within the MOT to distribute the revenue between the two operators. The structure of passenger transport revenue in 2022 by users is in the following table:

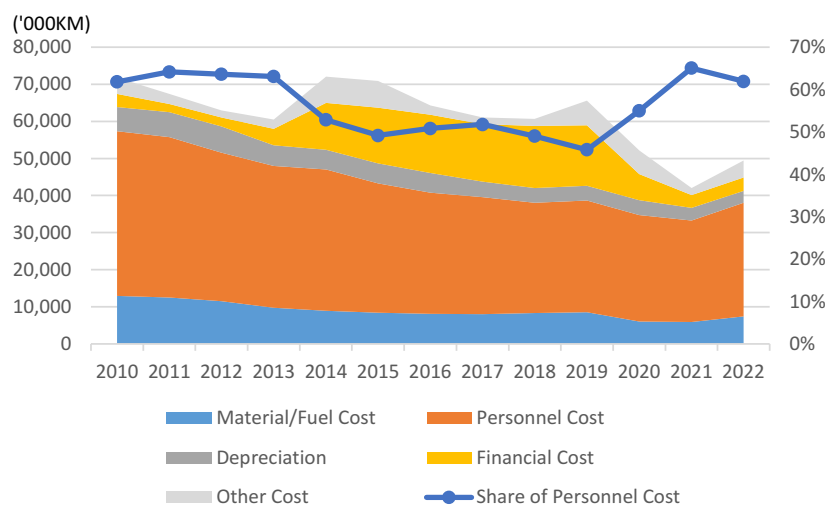
**Table 1.4.1 Structure of Passenger Transport Revenue in 2022 by Category of Users ('000)**

	Personal Contribution of Users	Subsidy Revenue	Total Passenger Transport Revenue	Share
Single tickets	4,859.7	673.7	5,533.4	24%
Citizens (monthly, multi-monthly, and yearly tickets)	2,962.6	229.9	3,192.5	14%
Pensioners	171.2	7,471.4	7,642.6	34%
Primary and secondary school students	14.1	3,314.9	3,329.0	15%
College students	46.7	1,457.0	1,503.7	7%
Unemployed individuals	884.8	472.7	1,357.5	6%
Persons with disabilities and war veterans	0.0	142.6	142.6	1%
Other pensioners, war-disabled civilians, disabled individuals	40.6	0.0	40.6	0%
Visually impaired individuals	0.0	22.4	22.4	0%
<b>Total for the year 2022</b>	<b>8,979.7</b>	<b>13,784.6</b>	<b>22,764.3</b>	<b>100%</b>
<b>% participation in income transportation passengers</b>	<b>39%</b>	<b>61%</b>	<b>100%</b>	

Source: GRAS

(b) Operating cost

In terms of operating costs, the personnel cost takes the largest portion, averaging 56% from 2010 to 2022. The total workforce of GRAS was 1,229 at the time of interviews in November 2021, and a significant layoff has been difficult due to relations with the labor unions. The material / fuel cost and depreciation decreased due to the unavailability of spare parts, new vehicles were not introduced, older vehicles were depreciated, etc.; however, as the number of employees remained, the share of personnel cost increased to more than 60% in 2021 and 2022.

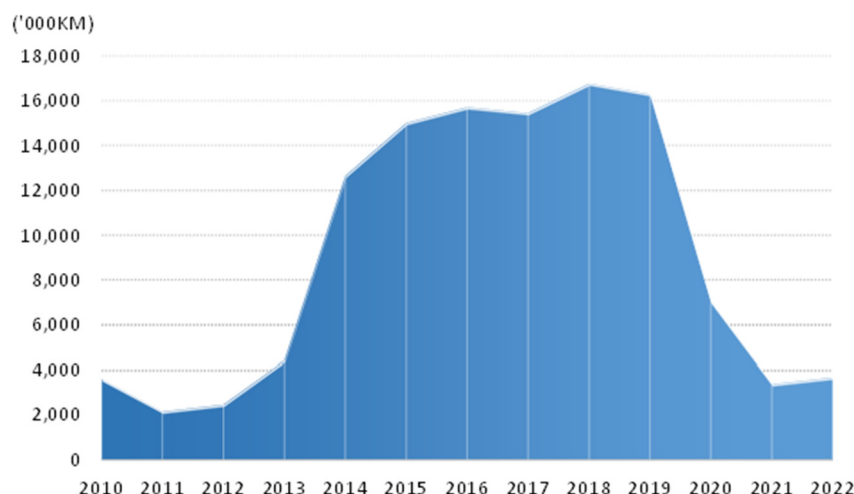


Source: GRAS

**Figure 1.4.4 Operating Cost of GRAS (2010–2022)**

In terms of the financial cost, there was a significant increase in 2014 by 184% and a decrease in 2020 by 56% due to a rise in penalty interest for taxes and a cancellation of penalty interest after changing a law.





Source: GRAS

**Figure 1.4.5 Financial Cost of GRAS (2010–2022)**

The financial cost amounted to 12,650,754 KM in 2014, which is higher by 8,201,614 KM compared to 2013. Most of the increase in financial cost is due to accrued penalty interest for overdue and unpaid obligations related to taxes, contributions on wages, interest, and costs of reminders for overdue and unpaid VAT liabilities.

**Table 1.4.2 Breakdown of Financial Cost of GRAS in 2013 and 2014 (KM)**

No.	Item	2014	2013	+/- compared to 2013.
1.	Regular and intercalary interest on bank loans and leasing for asset transportation	819,923	1,084,973	-265,050
2.	Penalty interest on loans and leasing	-	2.202	-2.202
3.	Penalty interest from suppliers	436.425	122.232	+314.193
4.	Penalty interest for taxes and contributions based on wages / PU FBiH (Public Revenue Office of BiH)	10.198.125	1,884,632	+8.313.493
5.	Interest and costs of reminders for VAT	1,196,281	1,355,101	-158,820
	<b>TOTAL</b>	<b>12,650,754</b>	<b>4,449,140</b>	<b>+8.201.614</b>

Source: GRAS

The total financial cost in 2020 was reported at 7.0 million KM. Compared to the same period of the previous year, financial costs decreased by 9.2 million KM, primarily due to a reduction in interest on direct taxes based on wages to the Public Revenue Office of the Federation of Bosnia and Herzegovina (PU FBiH).

With the enactment of the Law on the Rate of Penalty Interest (Official Gazette of the Federation of Bosnia and Herzegovina, No. 18/2020), the calculation of penalty interest on unpaid obligations to PU FBiH ceased, as the calculated interest cannot exceed the principal debt (Article 4 of the Law).

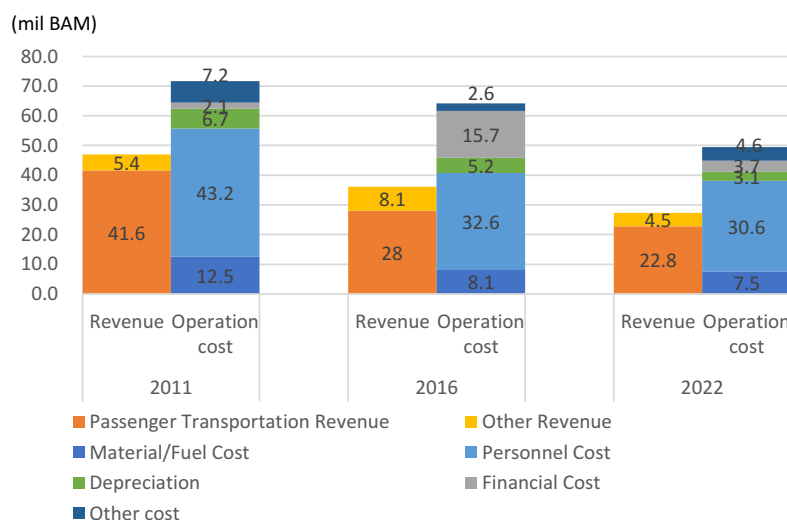
**Table 1.4.3 Breakdown of Financial Cost of GRAS in 2019 and 2020 (KM)**

	Item	2020	in 2019	+/- compared to 2019
1.	Interest and reminders costs for VAT	3,217,564	2,969,719	247,845
2.	Interest / PU FBiH	3,711,414	13,313,020	-9,601,606
3.	Interest / suppliers	92,106	23,108	68,998
4.	Interest / court executions for individuals	13,433	-	13,433
	<b>Total</b>	<b>7,034,517</b>	<b>16,305,847</b>	<b>9,271,330</b>

Source: GRAS

(c) Operating profit

The operating profit has been in deficit even before depreciation since 2011, and the negative trends have remained the same while the government announced restructuring plans. The profit situation of GRAS is one where both revenue, and cost are decreasing and ordinary loss continues to occur, and this recurs on a regressive scale.



Source: Provided by GRAS

**Figure 1.4.6 Profit and Loss of GRAS, 2011, 2016, and 2022 (Unit: million KM)**

**(2) Balance Sheet**

(a) Overall Condition

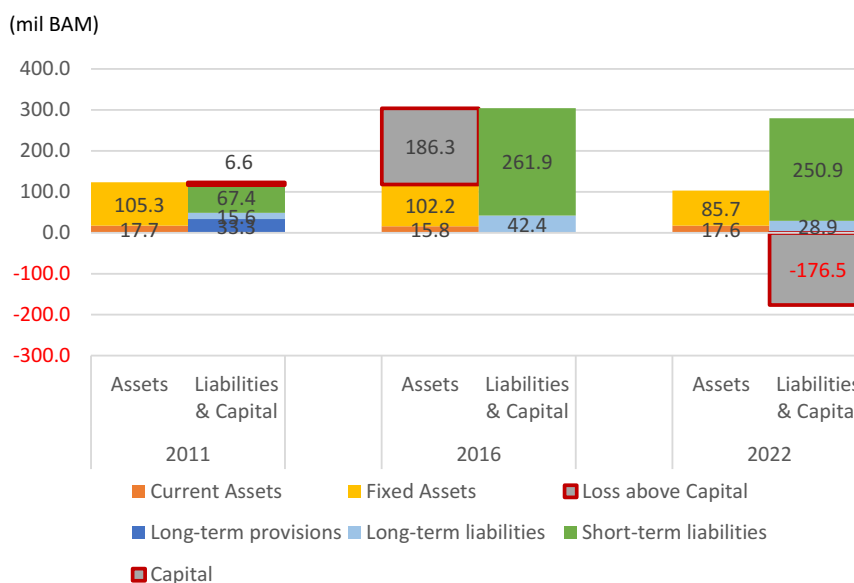
The balance sheet of GRAS shows that it is already in a state of bankruptcy. The debt ratio (total liabilities / [fixed assets + current assets]) in 2019 was 215%, much above the threshold of 50%.

The item "Loss above capital" on the asset side of the balance sheet deviates from the standard practice. In accounting principles, losses are typically recorded on the liability side of the balance sheet, reducing the shareholders' equity or capital.

According to an interview with GRAS, when the loss exceeds the amount of capital, it is moved to the asset side to achieve balance sheet equilibrium.

The reporting of "Loss above capital" began after 2012. In 2011, as the total capital exceeded the accumulated loss, there was no need to record it. In fact, in 2011, a court expert conducted a land valuation, resulting in an increase in land value and a corresponding increase in revaluation reserves.

Nevertheless, in 2022, a shift in accounting standards at GRAS led to the allocation of "loss above capital" on the liabilities and capital side, resulting in a negative figure. This alteration doesn't signify any adjustment in the loss values relative to the capital amount.



Source: Provided by GRAS

**Figure 1.4.7 Balance Sheet of GRAS, 2011, 2016 and 2022 (Unit: million KM)**

(b) Short-Term Liabilities

The short-term liabilities comprise around 90% of total liabilities and accounted for 251 million KM in 2022, a decrease of 11 million KM compared to the previous year. The largest shares of the short-term liabilities in 2022 were “Liabilities for interest to PU FBiH” (41.0%), “Liabilities for wages and salary compensations” (33.5%), and “Liabilities for VAT” (14.8%).

**Table 1.4.4 Structure of Short-term Liabilities of GRAS in 2022 and 2021 (KM)**

No.	Short-Term Liabilities	31.12.2022	31.12.2021	+/- differences	% of Total (2022)
<b>1</b>	<b>Financial liabilities at amortized cost</b>	<b>107,075,687</b>	<b>109,542,601</b>	<b>-2,466,914</b>	<b>42.7%</b>
1.1	Liabilities to suppliers	2,578,378	4,598,416	-2,020,038	1.0%
1.2	Contractual liabilities (advances received from customers)	765	0	765	0.0%
1.3	Liabilities from loans taken:	102,797,284	103,116,232	-318,948	41.0%
	-Short-term domestic loans / insurance	40,000	40,000	0	0.0%
	-Liabilities for interest to PU FBiH	102,757,284	103,076,232	-318,948	41.0%
1.4	Other financial liabilities at amortized cost	1,699,260	1,827,953	-128,693	0.7%
1.5	Derivative financial instruments / commission sales printing	0	1,694	-1,694	0.0%
<b>2</b>	<b>Deferred income</b>	<b>15,977,777</b>	<b>0</b>	<b>15,977,777</b>	<b>6.4%</b>
2.1	Deferred income for received donations - short-term	757,014	0	757,014	0.3%
2.2	Other short-term accruals / employee lawsuits	15,220,763	0	15,220,763	6.1%
<b>3</b>	<b>Short-term provisions under account 492</b>	<b>17,100</b>	<b>0</b>	<b>17,100</b>	<b>0.0%</b>
<b>4</b>	<b>Other liabilities, including accruals</b>	<b>127,830,168</b>	<b>152,927,874</b>	<b>-25,097,706</b>	<b>50.9%</b>
4.1	Other operating liabilities	1,209,149	2,871,878	-1,662,729	0.5%
4.2	Liabilities related to wages, compensations, and other earnings:	84,285,630	85,449,300	-1,163,670	33.6%
4.2.1	- Liabilities for wages and salary compensations	84,015,986	85,206,314	-1,190,328	33.5%
4.2.2	- Liabilities for other employee benefits	269,644	242,986	26,658	0.1%

No.	Short-Term Liabilities	31.12.2022	31.12.2021	+/- differences	% of Total (2022)
4.3	Liabilities for remuneration to board members and other individuals	35,798	33,760	2,038	0.0%
4.4	Other liabilities (membership fees for Tourism Association, special forest contributions)	303,174	281,702	21,472	0.1%
4.5	Liabilities for VAT	37,146,191	35,236,279	1,909,912	14.8%
4.6	Liabilities for other taxes, contributions, and fees	4,850,226	4,782,451	67,775	1.9%
4.7	Other short-term accruals / employee lawsuits	0	24,247,777	-24,247,777	0.0%
4.8	Advance payment for income of the next period	0	24,727	-24,727	0.0%
	<b>Short-term liabilities / total 1+2+3+4</b>	<b>250,900,732</b>	<b>262,472,169</b>	<b>-11,571,437</b>	<b>100.0%</b>

Source: GRAS

### (c) Funds from Canton Sarajevo

In accordance with the obligations assumed by the Agreement for Resolving the Issues in the Operations of GRAS, Canton Sarajevo has provided significant financial support through its budget since 2000.

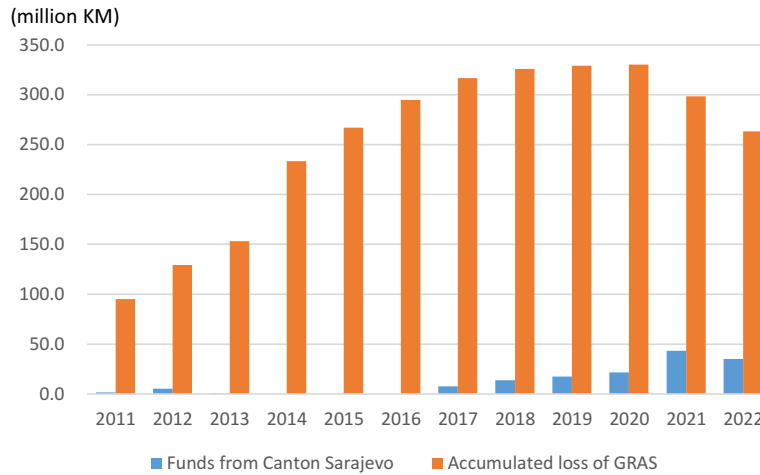
In 2022, a total of 52 million KM was provided to GRAS. "Subsidy for transportation" is described in the revenue section, and funds transferred to GRAS's bank account for covering a portion of the accumulated loss (35.1 million KM) have been used explicitly for salary payments, settling a portion of obligations to UIO (The Indirect Taxation Authority), pension settlement payments, and other obligations (suppliers, etc.).

**Table 1.4.5 Funds from Canton Sarajevo in 2022**

No	Description	KM	Notes
1.	Subsidizing transportation costs	16,127,974	Amount reduced for VAT - subsidy income / 13,784,593 KM
2.	To cover a portion of the accumulated loss of GRAS / Canton's Budget	35,128,455	Directly on capital / balance condition
3.	Contribution payment for the 2021 Employee Disposal Program / Employment Service of the Canton Sarajevo	742,312	other operating income

Source: GRAS

Although the funds received from Canton Sarajevo have helped GRAS in addressing its obligations and maintaining its operations, it's important to note that given the substantial accumulated loss of 263 million KM in 2022, only a fraction of these funds represent a temporary remedy rather than a lasting solution.



Source: GRAS

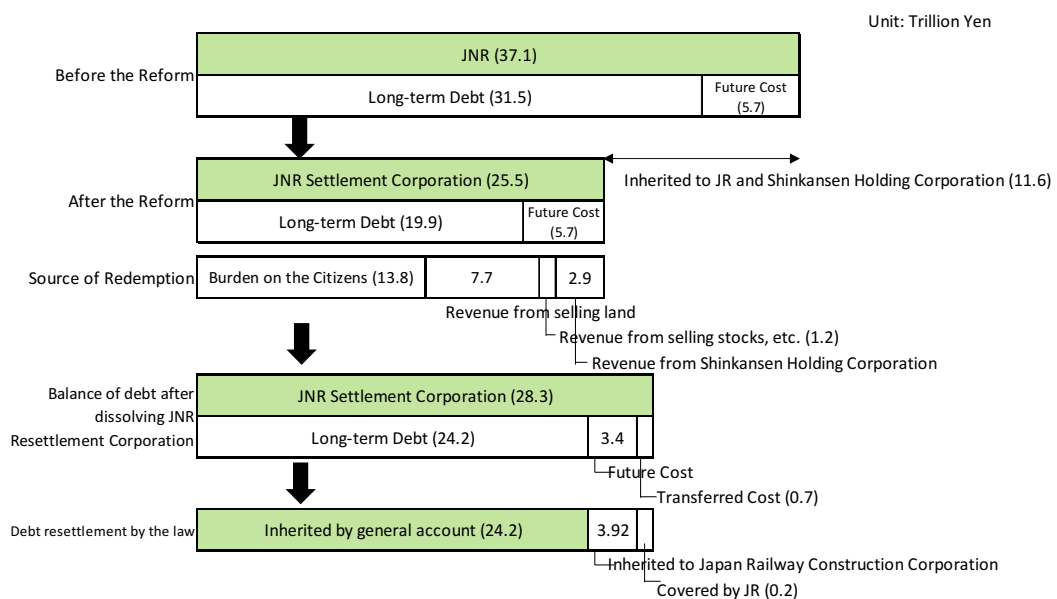
**Figure 1.4.8 Funds from Canton Sarajevo and Accumulated Loss of GRAS**

**BOX: Debt Restructuring of Japanese National Railways (JNR)**

Established in 1949 as a government-owned entity, the Japanese National Railways (JNR) managed Japan's nationwide railway network until 1987. Initially, it operated a vast network of 19,756.8 km of narrow-gauge railways, spanning all 46 prefectures of the country.

However, financial challenges arose, with the income statement slipping into deficit by 1964. By 1986, JNR found itself on the brink of bankruptcy, grappling with an operating loss of 1.4 trillion yen against a transportation income of 3.2 trillion yen, accompanied by a substantial loss of 15.5 trillion yen. In response, a comprehensive reform was initiated in 1987 to alleviate the government's financial burden, enhance efficiency within the railway sector, and provide enhanced services to the public.

In 1987, the Japanese government established the Japan National Railway Settlement Corporation (JNRSC) as a special public corporation. The primary purpose of JNRSC was to take over the massive debt of the state-owned JNR and facilitate its restructuring.



Source: JICA Expert Team

**Figure 1.4.9 Debt Restructuring of Japanese National Railways (JNR)**

There were several methods of debt restructuring:

- **Debt Write-Off:** A significant portion of JNR's debt was written off by converting it into government bonds. This reduced the immediate financial burden on JNRSC and provided a way to manage the debt over a longer period.
- **Issuance of JNR Settlement Bonds:** The government issued JNR Settlement Bonds to finance the debt repayment to JNRSC. These government backed these bonds, and their issuance helped fund the debt restructuring process.
- **Asset Sales and Revenue Generation:** The privatized JR companies focused on improving efficiency, increasing ridership, and generating revenue through various means, including land and real estate development near railway stations.
- **Long-Term Debt Repayment:** The privatized JR companies took over the responsibility of repaying the JNR Settlement Bonds and gradually repaid the government through their improved financial performance and revenue generation.

The debt restructuring of the JNR after the establishment of the JNR Settlement Corporation was a complex process, but the process led to the successful privatization of the Japanese National Railways and the establishment of a more sustainable railway industry in Japan.

## **2 Vehicle Allocation and Personnel Plans of Public Transport Operators**

### **2.1 Vehicle and Personnel Requirements from Operation Plan**

#### **1) Model Outputs Used**

From the headways of each line specified in the Operations Plan, the following information is taken from the model to compute the Vehicle Allocation Plan.

- Distance and Average Speed to derive journey time.
- 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.

The resultant turnaround time and Headway are used to compute the number of vehicles for each line during the AM peak and Off-peak periods.

#### **2) Using Peak and Off-Peak Vehicles to Compute Driver Duties**

Off-peak vehicle requirement forms the base of whole day driver duty requirement to be catered for with at 3 straight shifts for tram/trolleybus, and 2 straight (AM/PM) shifts for bus/minibus.

Peak vehicle requirement then forms the additional driver duty requirement to be catered for with a single (split or day) shift.

#### **3) Using Driver Duties to Compute Driver Requirements**

It is to be qualified that determining actual driver requirements require proper rostering processes to assign drivers to their duties. Without such tools for this project, this is calculated using a set of ratios practical enough for forward manpower planning in anticipation of the coming months' fleet requirement.

Relief requirement is added to cater for off/rest days. A six-day driver work week is assumed to cover seven days of operations, with the relief requirement incorporated by taking several duties multiplied by 7/6.

Spare requirement is added by considering an additional buffer. This is calculated to be about 16% to cater for annual leave, absenteeism, and training per year.

The above assumptions would produce a driver requirement of within 2.78 drivers per vehicle for the Optimal (recommended) case developed from the Operations plan in Volume I Chapter 4.1 Service Specifications of Public Transport Modes

Optimal (recommended) case

**Table 2.1.1 Driver Requirement: Optimal Service Case**

Mode	Peak Vehicle Requirement	Off-Peak Vehicle Requirement	Driver Requirement
Tram (GRAS)	42	36	151
Trolleybus (GRAS)	32	26	111
Bus (GRAS+CENTROTRANS)	106	86	255
Minibus (GRAS+CENTROTRANS)	45	37	109
<b>Total</b>	<b>225</b>	<b>185</b>	<b>626</b>

Drivers per vehicle = 2.78

Source: JICA Expert Team

As the current number of drivers per vehicle is expected to be 3.17 from MOT's estimates, it is recommended to work towards improving to between 2.80 – 3.00 drivers per vehicle by shortening late night operations on some lines where there is low demand.

## 2.2 Working Conditions and Labor Management

### 1) Working Conditions

#### (1) Current Situation

From the “Data Collection Survey on Public Transportation in Canton Sarajevo, Bosnia and Herzegovina” (2020) by JICA, the working week based on interviews with GRAS was 40-hour work/week and six-day per week based on the laws and regulations concerning traffic safety and labor.

In addition, the following information on working conditions was gathered during depot visits and driver interviews throughout this project:

**Table 2.2.1 Working Conditions**

Parameter	GRAS	CENTROTRANS
Shift hours	<ul style="list-style-type: none"> <li>1<sup>st</sup> shift: 5:00 AM– 12:00 PM</li> <li>2<sup>nd</sup> shift: 12:00 PM – 5:30 PM</li> <li>3<sup>rd</sup> shift: 5:30 PM – 10:30 PM + after checking, refuelling, and cleaning.</li> <li>Split shifts: during peak hours in the morning (6:00/7:00 AM – 9:00/9:30 AM) and afternoon (12:00/12:30PM – 5:00 PM)</li> </ul>	<ul style="list-style-type: none"> <li>1<sup>st</sup> shift: 5:00 AM –3:00 PM</li> <li>2<sup>nd</sup> shift: 3:00 PM until end of operations.</li> <li>Split shifts during peak hours and can be interlined with other routes.</li> </ul>
Continuous operation time for a workday	<ul style="list-style-type: none"> <li>Average 6h30m to 7h00m per day and 6 shifts per week.</li> </ul>	<ul style="list-style-type: none"> <li>Average 8h00m to 8h30m per day and 6 shifts per week.</li> </ul>
Continuous operation time before taking a break	<ul style="list-style-type: none"> <li>Not more than 4 hours from start of a driving trip.</li> </ul>	<ul style="list-style-type: none"> <li>Same as GRAS</li> </ul>
Rest time	<ul style="list-style-type: none"> <li>Minimum of 30 minutes for every 7 hours of continuous driving.</li> </ul>	<ul style="list-style-type: none"> <li>Same as GRAS</li> </ul>

Note: A split shift is a driver duty separated into two pieces of work which are typically during the peak periods.

Source: JICA Expert Team

These were consistent with the observations made during the Data Collection Survey (2020) by JICA, which showed CENTROTRANS to be more efficient than GRAS regarding



drivers per vehicle.

The above rest times are believed to already include all operational activities before and after each trip, such as vehicle inspection/cleaning, walking between terminals and meal places, and between parking spots to rest area.

Given that the above activities may be specific to a route or location where it terminates or passes, these should be accounted for separately from run time and minimum rest time as these could change over time.

Unions are apparently not involved in the operators' determination of drivers working hours, mealtimes, rest times, and run times in preparing timetables since the EU issued the rulebook covering all these accepted on the state level with which they must comply.

Therefore, based on working hours for drivers defined in the rulebook, unions only react if a driver is assigned to work more than what is legally required as part of fighting to protect their workers' rights.

## **(2) Recommendations to Improve**

Taking the above review into account, the Manual for Public Transport Planning and Operations, as part of the of Volume I, attempts to impart a set of scheduling guidelines and service optimization methods as follows so that the operator can organize it in a way that is economically justified and viable.

- Driver work hours and continuous operation time
- Driver rest time and meal breaks
- Operational activities respecting regulations.
- Trade-offs between rest times and run times to balance the cost of service and operational safety for drivers to have sufficient rest.
- Creating cost effective and implementable timetables
- Continuous improvement of scheduling guidelines
- Methods to track and optimize the working hours of drivers.

A model for optimal scheduling of drivers based on passenger flow in the peak hour and the constraint in working hours is needed to minimize situations of uneven work hours among drivers. This can be best implemented and modeled with proper scheduling and rostering tools.

## **2) Labor Management**

### **(1) Current Situation**

From the Workgroup 2 discussions in September 2022 on the lecture materials for labor management, it is understood that:

- A common union covers all utility companies, and each utility company also has its union; therefore, the GRAS has a union on the operator level.
- GRAS communicates with unions in a way that informs them about changes in certain work regulations in the rulebook and gets the union's feedback after it is finalized.

- GRAS tries to assign drivers' shifts according to where they live, as well as strives for every driver to have a split shift at least once a year so shifts are fairly distributed among all drivers.

Other characteristics of Labor Management are described in Section 1.1, 3) GRAS human resources and Section 1.1, 5) CENTROTRANS human resources.

## **(2) Recommendations to Improve**

Taking the above review into account, the Manual for Public Transport Planning and Operations, as part of the Appendices of Volume I, attempts to impart the following topics to improve labor management:

- objectives and setting the Work Schedule Policy,
- possible Issues with Vehicle / Personnel Allocation, and
- collaboration with unions.

## **2.3 Service Delivery**

### **1) Current Situation**

Some of the following key weaknesses in service delivery of public transport in Sarajevo were observed during the experts' visits for this project, which were also similar to what the Data Collection Survey (2020) by JICA observed:

#### Service Information

There is limited information for timetables and route maps to transfer at bus stops or terminals. Though most buses have a display of the route number (usually GRAS) and route origin-destination (usually CENTROTRANS), it is necessary to provide a more user-friendly environment where public transportation users can quickly obtain operation information such as route maps, service frequencies, or timetables before and during travel.

#### Public Transportation Infrastructure

Shelters with benches are installed at all stops along the tram line and at major bus stops. However, some bus stops do not even have a bus stop pole. Bus stop names are also not indicated at most stops. This greatly deters spontaneous use of public transport unless a potential user does prior research on operators' websites or mobile apps.

#### Cleanliness

While COVID-19 necessitated regular disinfection of public transport vehicles and infrastructure, this was no longer consistently practiced as the effects of the pandemic gradually wore out.

#### Greeting

Interaction between driver and passengers is limited due to the closed design of the driver's cabin on most public transport vehicles. Least interaction occurs on trams due to the possibility of entering/exiting the vehicles via their many doors. This partly contributes to the high fare leaking on trams.

### Support for the Disabled

Public transport still remains unfriendly to those with mobility challenges, thus forcing them away from public modes. Though recent minibus models are wheelchair accessible, it takes complete conversion of all other public transport modes as well as supporting infrastructure such as bus stops and terminals to be likewise wheelchair accessible for this group of users to be able to use the public transport system for an entire journey.

### Gender Support

While sexual harassment on public transport was not observed to be prevalent, it is not conclusive as to whether there is general avoidance of public transport among females who are not represented. Therefore, some measures to enhance gender support on the public transport system can be included.

### Other service problems caused by inadequate number of staff

- Slow response times lead customers to perceive that their feedback as unimportant.
- Compromised service quality from the need to rush through interactions leading to inaccurate information and misunderstandings.
- Negative reputation as a perception of poor customer service spreads by word-of-mouth and social media, deterring potential customers.
- Decreased productivity and employee satisfaction due to the need to multitask or handle tasks outside their usual roles.

All the above factors lead to general frustration and dissatisfaction among customers who give up on public transport over time. Likewise, public transport workers leave the industry for better career opportunities.

## **2) Recommendations to Improve**

It is necessary to recognize that service delivery is an important public transportation component that users can trust. If users' needs, such as regular and high-quality services, are addressed, the users would undoubtedly pay fares, and as a result, the revenue would increase.

Good service delivery starts at the organizational and staffing levels, discussed in more detail in Section 3.4, Improved Business Plan. Assuming all these are in place, it is then possible to address the following weaknesses in the service delivery of public transport in Sarajevo through the topic of User Services for the Manual on Public Transport Planning and Operations in the Appendices of Volume I for these reasons:

- User guidance
  - Suggest the necessary information to guide users throughout their experience before, during, and after the trip made on public transport.
- Foreigners support
  - Special information in English and common foreign languages in Sarajevo as part of making the public transport system friendly to tourists and foreign users.
- Cleaning and greeting

It is maintaining a clean environment that makes public transport comfortable and hygienic and fosters a social culture that improves interaction between passengers and drivers.

- Support for the disabled

Guidelines to make public transport accessible to potential passengers with impaired mobility as part of creating inclusive public transport for all.

- Gender support

Another part of creating public transport inclusive for all is to make public transport safe for more vulnerable users, including women.

Ultimately, operators influence the image of public transport, which should be well delivered to improve users' impression of Sarajevo city. Service Delivery is also closely linked to the Promotion of Public Transport, described in more detail under Volume III: Public Transport Convenience Enhancement Plan.

## 2.4 Safety Management

### 1) Current Situation

Transportation in Sarajevo city must be fundamentally safe for all users. According to a joint study in 2016 between the World Bank Group and the Global Road Safety Facility, Bosnia and Herzegovina ranks low compared to its regional peers regarding road safety. Extracts of comparison are as follows:

**Table 2.4.1 Comparison of Road Fatalities in Region and Globally**

	2016 Estimated Road Fatalities	2016 Estimated Fatality Rate per 100,000 population	Motorization Registered Vehicles per 100,000 population
Bosnia and Herzegovina	552	15.7	27,816
<b>Best Performing Countries in Region</b>			
Macedonia	134	6.4	21,284
Serbia	649	7.4	25,877
<b>Best Performing Countries Globally</b>			
Switzerland	223	2.65	71,182
Singapore	155	2.76	16,604
Norway	143	2.72	75,544
Sweden	278	2.83	62,037

Source: Road Safety in Bosnia and Herzegovina

The above statistics suggest a relatively poor safety culture in BiH despite low motorization rates compared to its peers.

During this project, it was observed that measures to improve traffic safety are largely infrastructural and usually part of ongoing road rehabilitation. Figure 2.4.1 shows some notable examples of these that were reported in Canton Sarajevo's social media channels.

A traffic control center, as shown in Figure 2.4.2, has also been set up for the MOT to have visibility of public transport vehicles, and this has been complemented by the progressive installation of CCTV cameras on public transport vehicles for better visibility of traffic situation and safety. However, the capability of this facility still needs to be fully realized.



**Figure 2.4.1 Notable Road Improvements in Sarajevo**



**Figure 2.4.2 Traffic Control Center in Sarajevo**

Educational campaigns to improve traffic safety were not observed during this project, with the ongoing emphasis on road infrastructural improvements, which are more visible to the public. Some past attempts at educational campaigns back in 2014 in collaboration with the Cantonal Ministry of Interior are shown in the next figures.



Source: JICA Expert Team

Figure 2.4.3 “Watch How You're Driving” Campaign



Source: [https://www.researchgate.net/publication/279243807\\_The\\_strategy\\_of\\_traffic\\_safety\\_in\\_Bosnia\\_and\\_Herzegovina\\_Police\\_aspects](https://www.researchgate.net/publication/279243807_The_strategy_of_traffic_safety_in_Bosnia_and_Herzegovina_Police_aspects)

Figure 2.4.4 “Love Life Respect Rules” Campaign

However, it is unknown whether the results of these campaigns have been actively followed up and whether any similar campaigns have been conducted in more recent years.

From the Workgroup 2 discussions in September 2022 on the lecture materials for Safety management, the following key issues were brought up by the participants:

- As there are no legal regulations on additional schools that provide driver education and training, there was resistance from union representatives of drivers. Refresher and corrective training practices have been discontinued until an internal act is on regulating this area in detail is adopted.
- In traffic accidents involving GRAS vehicles, the cause of the accident is recorded by the traffic safety unit which informs the competent sector, which may or may not hold an interview with the driver within the scope of its competency. Therefore, the security unit does not receive feedback on the measures and activities taken.
- The above complexities have resulted in a lack of safety management, especially among junior drivers.

- Since there is no legal act that contains a part related to additional training of the operator's driving crew, the operator should, with an internal act, prescribe and define obligation to have regular periodic training for the driving crew, which would include safety, safe participation in traffic and behavior of drivers as well as other driving crew and staff directly in contact with passengers.

## 2) Recommendations to Improve

The aim of public transport safety management is to minimize the likelihood and severity of collisions and security threats. This is to create a safe and reliable transportation experience for passengers while ensuring the well-being of employees.

While it is true that road infrastructure and design play the most important role in enhancing road safety ahead of education and enforcement, these complementary measures should co-exist to reinforce the importance of the collective responsibility of road users.

Therefore, this project attempts to address the following areas of Safety Management in the Manual for Public Transport Planning and Operations in the Appendices of Volume I for these reasons:

- **Accident rates and Analysis**  
Breaking down accidents into a wider range of indicators beyond just the number of incidents and fatalities. This can facilitate root-cause analysis and more meaningful investigation and prevention of most non-fatal cases.
- **Identifying hotspots at route and corridor level**  
Such study methods have significant benefit of helping to prioritize enforcement personnel, emergency responders, and infrastructure improvements to minimize wastage of limited funds and manpower on more widespread improvements. It also allows data-driven decision-making that could shape important policy and regulation changes if required.
- **Education and Training for Preventing Accidents**  
An important complementary measure to road design on the proactive side, these measures foster shared responsibilities between drivers and other road users. Enforcement, a reactive approach, should be minimized for better outcomes.
- **Mitigating Negative Impacts of Private Vehicles on Safety Management**  
As most public transport vehicles navigate in mixed traffic, operators have little control over incidents involving private vehicles. Therefore, more comprehensive strategies must be developed in public transport safety management, such as priority measures, real-time management, and sustainable transport options.

By implementing these safety measures, conducting ongoing monitoring and evaluation, and promoting a safety-conscious culture, public transport systems can minimize risks and enhance their operations' overall safety and security. Additional aspects of Safety Management are also outlined in Section 3.4 on Rational Driving and Consumption Checks.





## **3 Management Improvement Plan for Public Transport Operators**

### **3.1 Fare and Ticket Management**

#### **1) Current Situation**

It is understood from the “Data Collection Survey on Public Transportation in Canton Sarajevo, Bosnia and Herzegovina” (2020) by JICA, as well as observations made during this project, that both GRAS and CENTROTRANS have different fare systems.

Nonsubsidized tickets are only valid on the lines of the operator who emitted the ticket. Subsidized electronic tickets are delivered by any operator and are valid on all lines.

#### **(1) GRAS**

For tram and trolleybus, tickets are available both onboard the vehicle and at kiosks near the stops. The tickets bought at kiosks are about 0.2 KM cheaper than onboard the vehicle.

GRAS ticketing system is based on paper tickets. The tram ticket is a magnetic card that records the tram stops validated by the passenger on the validator. However, this has not been an accurate source of passenger counts as many passengers do not validate their tickets, especially when the vehicle is crowded. Moreover, the many doors on the tram allow passengers to get on/off easily without being detected.

A large share of passengers uses seasoned tickets as well as monthly coupons for groups entitled to subsidized ticket prices, such as students, pensioners, and the unemployed. For these tickets, Canton Sarajevo also operates a complex but arbitrary revenue allocation system between GRAS and CENTROTRANS based on the addresses of the beneficiaries and who use by the closest bus stop (to be elaborated in further sections). GRAS has a plan for outsourcing e-ticketing, but it has not been enforced to date.

#### **(2) CENTROTRANS**

CENTROTRANS bus/minibus ticketing system is based on the use of a company-owned IC-card system (Centrocard) for regular users, as well as QR code tickets for occasional users either on paper or on a company-owned smartphone app developed by Turkish vendor Kentkart accepting Mastercard payments. Ticketing statistics are directly interfaced with the accounting systems of CENTROTRANS.

#### **(3) Fare Collection through IC Card**

Canton Sarajevo launched an IC card system for subsidized tickets with GRAS only. The plan is to include CENTROTRANS after the test period of the electronic system is finished. As of 13 May 2022, they started issuing subsidized IC cards to pupils and currently all entitled users have an IC card. Although IC card systems of GRAS and CENTROTRANS are incompatible, the operators worked out an arrangement of mutually accepting subsidized IC tickets.

#### **(4) Fare Leakage**

GRAS, being the sole operator of trams and trolleybuses, has a more serious issue with fare leakage since trams/trolleybuses have several doors. Moreover, with tickets that can be purchased in advance at a kiosk, passengers can enter from every door instead of the

front, which facilitates non-payment of fares. Even fare enforcement by the limited number of inspectors is not strict with passengers allowed to get off the tram upon the inspectors getting on. On the other hand, CENTROTRANS only operates buses where passengers all board from the front door.

### **(5) Control Strategy**

According to both operators, fraud is not a big issue. Fraud surveys are performed by independent auditors, who, unlike controllers, do not inflict fines on violators. A fraud survey aims to have the clearest view about actual fraud practices and figures and deploy a control strategy accordingly.

## **2) Recommendations to Improve Current Situation**

To improve the current fares and ticketing system, the new regime is recommended to be inter-operable and inter-modal.

### **(1) Interoperability**

Ticketing systems for both GRAS and CENTROTRANS are recommended to be interoperable, i.e., that information generated by the operators is based on the same set of standards, which can be compatible throughout both systems. One way is for the validators used by CENTROTRANS to be deployed in the GRAS fleet so GRAS can also leverage the new electronic pass system currently under development by Canton of Sarajevo. By using the same validators as CENTROTRANS, GRAS can immediately adopt the same functionalities designed for use with the new electronic ticketing system. Currently, CENTROTRANS is using Kenkart validators. As most European validators are compatible with A and B standards (Mifare and Calypso), this objective should be easy to reach. It will, therefore, fulfill the interoperability objective between GRAS and CENTROTRANS.

### **(2) Intermodality**

Developing intermodal tickets, i.e., tickets valid for use with both operators, is recommended. As interoperability will happen as soon as Canton of Sarajevo deploys its new electronic pass system, the main issue is how to share revenue between both operators.

Presently, the only intermodal ticket available is the subsidized monthly pass. The development of new intermodal tickets should eventually encompass all types not only the subsidized ones. Such development should take place under the responsibility of the PT regulator.

Introducing of such tickets will be an advantage to users who connect between the two operators (for example, GRAS tram/trolleybus + CENTROTRANS bus) and will only pay once. However, the operator's revenues will drop and only be partly compensated by a possible increase in ridership from better convenience for intermodal trips. It is then reasonable to compensate for this drop by increasing the ticket price (which can be accepted by users because the ticket will enable them to do more) and adding a PT regulator subsidy.

Unification of the fare scale, for GRAS and CENTROTRANS to charge the same fares, is necessary to allow simpler implementation of an interoperable and intermodal fare system. It will also enable less complex revenue-sharing arrangements when both operators

operate on the same fare scale. Under the unified fare scale, the two operators could consider some of the following revenue-sharing principles:

- Proportion of number of passengers by operator in each zone
- Proportion of passenger distance travelled by each passenger by each service
- Proportion of operated distance by each service by operator

Although the introduction of an electronic pass system might enable the complex yet arbitrary revenue allocation rules to be simplified by using actual validated passenger travel data, the following issues must be anticipated when proposing any changes to revenue-sharing rules:

- No revenue-sharing rules are perfectly fair: Even if validation takes place after boarding and alighting every vehicle (which is rarely the case, as validations in most countries take place only after boarding) and such that every trip segment can be identified, it could be argued that revenue sharing could be based on time spent inside each vehicle; or by number of kilometers run in each vehicle; or by nature of the vehicle.
- The introduction of new revenue-sharing rules always disrupts the previous financial equilibriums and, therefore, needs to be assessed accordingly to such disruption. This comes from the fact that the revenue from subsidized tickets is a substitute for equilibrium subsidies to all operators. Changing the rules will benefit one operator and affect the other. The operator who benefits will make an extra profit that will not benefit the PT Regulator; the operator who loses will need additional financial support from the PT Regulator because it has no other means of balancing its accounts. Hence, the consequences of such a change should be analyzed in advance so that the current financial equilibriums between both operators are not changed significantly or that a remedial financial compensation system is set up in that case.

### **(3) Ticket Management and Controls**

An independent party is recommended act as the central clearing house for fare revenue sharing. This organization shall be in charge of the distribution, sales, fare collection, and fare sharing of the intermodal ticket. The PT regulator and operators can engage independent auditors to audit their processes for fraudulent practices.

Operators should assign more ticket inspectors to check for fare evasion onboard vehicles. A penalty fare regime can be imposed on fare evaders. Based on international standards and networks of comparable sizes, it is recommended that an order of magnitude of a maximum of 40 ticket inspectors for Canton of Sarajevo. This figure should be adjusted according to more accurate data about fraud practices. A suggested practice to calculate the required number of ticket inspectors is to set a sample size representative of the observed fare evasion rate. Assuming, in Sarajevo's case, it is at least 10%. Taking the estimated average daily ridership of about 200,000 for all public transport modes translates to about 20,000 rides to be checked daily. For a maximum of 40 ticket inspectors, each will be required to check 500 passengers daily, which is a reasonable volume within a working day.

Alternatively, ticket inspectors could be redeployed as conductors issuing tickets so they could act as a source of fare enforcement, failing which drivers will also need to be trained in fare enforcement as in the case with major developed cities using one-person operations for public transport vehicles worldwide.

Taking the above review into account, a chapter on fares and ticket management in the Manual on Public Transport Operation Planning and Monitoring will attempt to address current issues in fare/ticket management, with these topics: 1: General rules, 2: Handling of fares/tickets, 3: Penalties, 4: Handling of collected fares, and 5: Guidance to crew members.

## **3.2 Fleet and Track Maintenance Plans**

### **1) For Tram**

#### **(1) Findings of Maintenance Plans of Existing Fleet**

Regarding its plans to maintain its fleet of trams, GRAS faces some challenges, primarily originating from a general lack of investment in its capital assets and rolling stock. As there is no guaranteed and/or stable budget allocation for the renewal of these assets and regular maintenance (both daily maintenance and periodic maintenance, including overhaul), GRAS has had to face the challenges as follows:

- No stable supply of spare parts and maintenance materials, with many trams being obsolete to the point where even the original manufacturers no longer produce the spare parts. Therefore, those essential spare parts are cannibalized from the defective trams and installed in some other trams. (Note: spare parts which are no longer manufactured may be produced by 3D printer technology. There is an example of a Japanese firm<sup>5</sup>, although there is a size limitation within 400 mm x 400 mm x 400 mm in the case of aluminum alloy or 250 mm x 250 mm x 250 mm in the case of the other metal powder)
- Further to the above point, the Canton must rely on donors to keep the system going. The City of Konya in Turkey has expressed its willingness to donate another tram to add to its original donation and has generously provided some spare parts, which are no longer sold on the market.
- Lack of tools and equipment, some of which are specialist equipment that are bespoke to the obsolete rolling stock.
- Lack of repair halls and workshop space.
- Lack of a modern wheel lathe.
- Lack of new gantry cranes for trams.
- Lack of the requisite skilled personnel in the proper maintenance of trams.

On the other hand, GRAS has its fleet maintenance manual. If GRAS strictly conducted their maintenance work based on the manual, these fleets could be worked properly.

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<sup>5</sup> <https://newswitch.jp/p/26946>

One of the main reasons these fleets have not been maintained properly is the lack of budget for maintenance work. With proper budget allocation, GRAS or the successor of GRAS may do their maintenance work properly based on the existing manual, and the thought of “Preventative Maintenance” will be introduced smoothly.

Furthermore, new tram fleets purchased from Stadler Rail AG will be continuously delivered from (the end of) 2023 to July 2024. The maintenance manual will be delivered together.

Stadler Rail AG will maintain new fleet for 3 years after the delivery. During this period, GRAS or the successor of GRAS can learn from Stadler Rail AG about the proper maintenance method.

In addition, MOT, as a part of the obligation of the client side for procurement of new tram fleet from Stadler Rail AG, secured budget (2 million EUR) for the upgrade of workshop and installation of new equipment (purchasing new equipment for maintenance, painting, electrical work with lightning renovation) for proper fleet maintenance. It is expected to conduct proper maintenance work for the tram fleet by introducing these renewed facilities.

## **(2) Findings of Maintenance Plans of Tram Track**

After the rehabilitation work by the EBRD fund, the track condition improved drastically.

So, it is important to continue undertaking the appropriate maintenance activities to maintain the system’s reliability. These activities would typically include shifting, replacing, and tamping of ballast, in addition to maintaining the tracks against track irregularity (composed of gauge irregularity, cross-level irregularity, longitudinal level irregularity, alignment irregularity, compound irregularity) due to daily operation.

It is also important to conduct proper maintenance to maintain the quality of the slab tracks and the surrounding asphalted areas. Moreover, the tracks at crossing points, as well as the switches and crossings, have been improved with new materials and, therefore, will require proper maintenance as these are typically more prone to failure, being moving parts such as the points themselves.

The scope of the Chinese contractor, which is conducting the rehabilitation work with the EBRD fund, includes providing a maintenance manual for the track and the other facilities. If GRAS (or the successor of GRAS) properly conducts the maintenance work based on the manual, the line will be maintained appropriately.

However, GRAS does not have enough human resources in addition to facility, equipment, and materials to maintain the track structure appropriately. According to “Track inspection report in May-June 2021,” “With the current number of workers, it is not possible to organize some works, such as replacement of rails longer than 8 m and tightening of track accessories along the entire tram track.” There are only 16 permanent employees under the tram track maintenance department in GRAS, and considering GRAS’s financial situation, where most of the revenue is allocated for the salary of the staff and the persistent deficit, it will be difficult to keep the rehabilitated infrastructure properly.

## **(3) Recommendations**

Following the completion of the EBRD project, the existing tram line is rehabilitated completely, and the tram line condition in Sarajevo improved drastically. In order to ensure that the system remains optimal, there is naturally a need to ensure that there is also a

robust and proper maintenance regime in place for the fixed infrastructure. To this end, the JICA Expert Team recommends the following:

- To conduct maintenance work for the track and the other facilities at regular intervals as part of a preventive maintenance regime.
- To regularly monitor for the track irregularity and collect the appropriate data to continuously assess the quality of periodic repair work.
- To conduct the maintenance work based on the manual provided by the contractor in the EBRD project.
- To achieve the above, to ringfence the budget needed to mitigate any lack of human resources, materials (spare parts), equipment, etc.

Figure 3.2.1 shows specialist equipment examples needed to undertake proper track preventive maintenance. (It is recommended to develop any technical training/knowledge transfer for a proper use of this equipment.)



Source: JICA Expert Team

**Figure 3.2.1 Specialist Equipment**

## 2) For Trolleybus and Bus

Bus, minibus, and trolleybus depots are not utilized optimally due to the many parked defective vehicles. As previously mentioned, these inoperable vehicles cannot presently be consigned to the scrap yard as many are being cannibalized for spare parts to be used in the vehicles that are operational/ serviceable.

Buildings on the current bus depot include a dispatching office, administration office, single access building with a ramp for vehicle servicing, and a maintenance building with “drive over” inspection pits. The site and buildings are in a poor state of repair, with outdated equipment and poor working conditions.

From the visits undertaken by the JICA Expert Team, observations indicate that the trolleybus depot is in better condition than the bus depot. Although slightly dated, the workshop is well-maintained, clean and organized. Equipment, tools, and other parts are

organized, and inventories are kept in an orderly fashion, demonstrating that the work culture and systems in place are still of a reasonable standard. One major deficiency is in the area dedicated to overhauling and half-life repairs. Workshops and maintenance staff do not overhaul systems and assemblies of old trolleybuses, primarily due to the lack of expertise in undertaking the repair of the more sophisticated electronic components and parts.



Source: JICA Expert Team

**Figure 3.2.2 Trolleybus and Bus Depots**

In a similar fashion to the trams, GRAS faces obstacles in improving its operation and maintenance (O&M) regime for buses. The combination of many factors, including difficulties in procuring spare parts, a lack of stability across senior management, employment restrictions reducing the number of trained engineers, and lack of reliability of buses that had been procured or donated following the war, have severely impacted on their ability to operate a reliable service.

As evidenced in the pictures below, vehicle investment is evident, but maintenance facilities dedicated to buses are also needed.



Source: JICA Expert Team

**Figure 3.2.3 Bus Depots (CENTROTRANS, GRAS)**

Investment is needed not just to replace equipment but also to shore up the back-of-office functions, such as human resources, including manpower and training for the technical staff members.

Lastly, the overarching maintenance regime also needs a step-change from one based on a corrective regime that merely reacts to failures to one that is preventative, meaning that the corrective measures are proactively taken in advance of failures.

As an overall summary of trams and the bus fleet, the principal issues faced by GRAS can



be described as follows:

- difficulties in procuring spare parts and supply chain deficiencies (e.g., Turkish-manufacturer Isuzu minibuses),
- lack of stability across senior management (e.g., short tenure for General Managers),
- shortage of trained engineers/mechanics,
- lack of reliability of buses that had been procured or donated (e.g., donated German brand MAN vehicles)
- outdated operations and maintenance regime that is corrective-based instead of a preventative regime, which all the best-in-industry public transport operators now practice.

Whilst there is a possibility of outsourcing the maintenance activities to private companies, the JICA Expert Team understands this is an unlikely option as GRAS remains one of the largest public sector employers in the Canton. Therefore, there is a vested interest in keeping these jobs in-house.

### **3) Concluding remarks (Tram, Trolleybus and Bus)**

In order to make specific recommendations pertaining to improving the inventory and maintenance plans for the tram and bus fleet and infrastructure, two critical non-negotiable decisions are a prerequisite. The first is whether or not the Canton intends to establish the new organization (KJKP JPS) to be the successor to GRAS, and the second is the decision to divest in buses to only focus on trams and trolleybuses, as described in Activity 2.

Once there was clarity with respect to these two key decisions and following the establishment of the new organization, more specific recommendations would be prepared by the JICA Expert Team.

Until such time when there is clarity regarding the new mandate for the organization, there are several more generic proposals by the JICA Expert Team, namely:

- The introduction of an updated maintenance regime premised upon preventative maintenance principles in lieu of corrective maintenance. This means that infrastructure rehabilitation (e.g., tracks, overhead catenary systems, etc.) is done on a fixed, periodic basis that is in line with best practices, so as to ensure the resilience and reliability of the overall tram and bus system.
- Once the future of GRAS and the future legal entity KJKP JPS is determined, the Canton will secure financing for investment in vehicles and depot upgrades, as well as institutionalize continuous training and development and establish technical apprenticeships (possibly with local technical schools and universities). The approach to financing is contingent upon the decision of whether GRAS retains all its current operations or separate electric transport to KJKP JPS because, ultimately, the financing of projects through one or both legal entities depends upon its credit ratings and financial well-being.

Similar to trolleybus upgrades through the introduction of the new Belkommunmash vehicles, the next immediate focus should be minibuses to serve the surrounding hilly areas

- larger (i.e., standard 12 m or articulated 18 m) buses cannot serve surrounding areas due to gradients and twisting, winding and narrow hilly roads. These are the fastest-growing and developing areas. Therefore, a significant modal shift to public transport relies on minibus improvement. The future decision on whether to invest in and further expand minibus services or completely divest in this business area and step away from the minibus market altogether is dependent upon the Canton. Nevertheless, there is clearly a latent demand to consider similarly expanding this market to the trolleybus network, which has enjoyed substantial investment in the last few years.

### 3.3 Directions of Fleet and Track Renewal

#### 1) Findings of the renewal plan of fleet, track and depot (for Tram and Railway)

##### (1) Existing tram line improvement projects funded by EBRD.

As part of the due diligence and analysis undertaken by the JICA Expert Team, it was confirmed that the EBRD is undertaking the following projects related to the renewal of the Sarajevo tram system.

- Reconstruction of Tram Line

The rehabilitation project of the tram line is financed by EBRD, called “The Project for Rehabilitation, Reconstruction and Modernization of the Tram Railway in Sarajevo.” In this project, the track structure, drainage system, electricity pole, and station facility were reconstructed. The reconstruction works were carried out phase by phase (lot by lot), and this project two phases (four lots). The section covered by this project is indicated in the following table.

**Table 3.3.1 Section to be Covered by Each Lot**

Phase	Lot No	Section
Phase 1	1	Iliđža - Nedžarići
	2	Nedžarići - Čengić Vila
Phase 2	3	Čengić Vila - "S" Curve
	4	Tehnička škola - Sarajevo train station

Source: JICA Expert Team based on the interview to GRAS, etc.

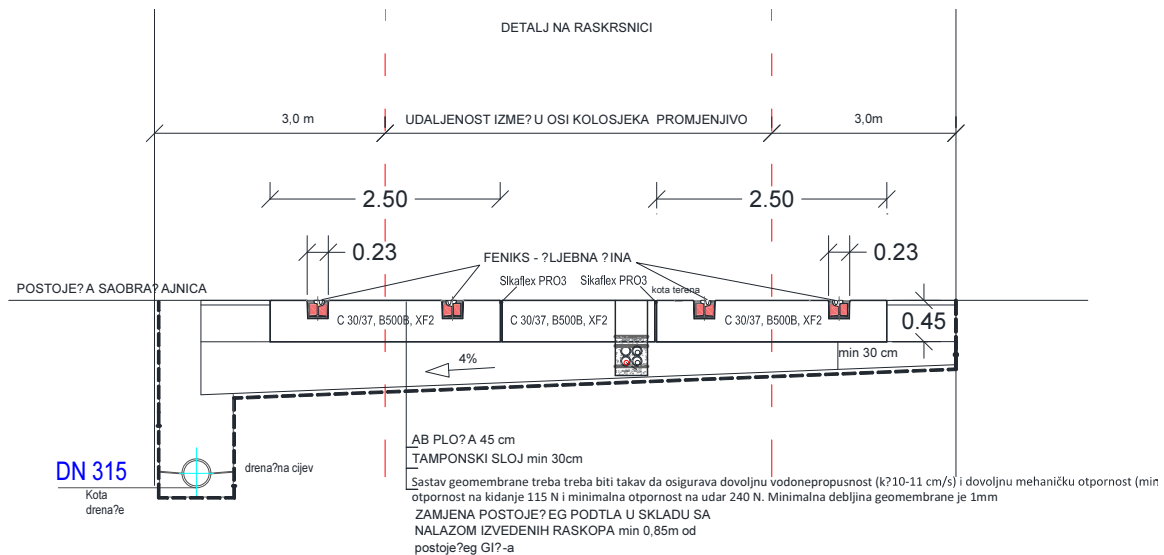


Source: JICA Expert Team

**Figure 3.3.1 Location Map for EBRD Fund's Project and Example of the Rehabilitated Track (Before / After)**

Five bids were evaluated, with a consortium comprising two Chinese firms selected as the preferred contractor. Track rehabilitation of Phase 1 (Ilidža - Čengić Villa) was completed in September 2022. The, and Phase 2 was completed in August 2023. The completion date is two years following the signing of the contract.

Since the section to be covered by the EBRD reconstruction project includes all tram line routes, except for the single-track loop line section, which has already been reconstructed before, all the track structures of the Sarajevo Tram Line are reconstructed with the completion of EBRD project.



Source: Design Report of “The Project for Rehabilitation, Reconstruction and Modernization of the Tram Railway in Sarajevo”, Lot 2, Construction Phase, 2019 by IPSA Institut

**Figure 3.3.2 Typical Section of Track Structure after Reconstruction Project**

In those rehabilitated sections, the track condition have become drastically better, and the tram can operate at typical speeds it is supposedly capable of. (According to the data and interview with GRAS, the average operational speed before the rehabilitation work was 13 to 18 km/h—varying speeds based on the operational routes). Line 3, which is the most important line connecting Ilidža with Bašćaršija, operating speed was 15 km/h before the EBRD project. After the reconstruction of the tracks, it is expected to be improved up to about 18 km/h. (It notes that as of 20<sup>th</sup> October 2023, the rehabilitation work is on tram tracks Ilidža - Bašćaršija has been finished and the operational speed is improved, according to GRAS. However, the other parts, (Sarajevo railway station – Skenderija, access and inside the depot) are still ongoing and not completed yet. Also, tram line has a lot of crossings and traffic lights and these crossings decrease the speed of the tram. If any proper traffic control system is installed for crossing the intersection, the speed will improve.)

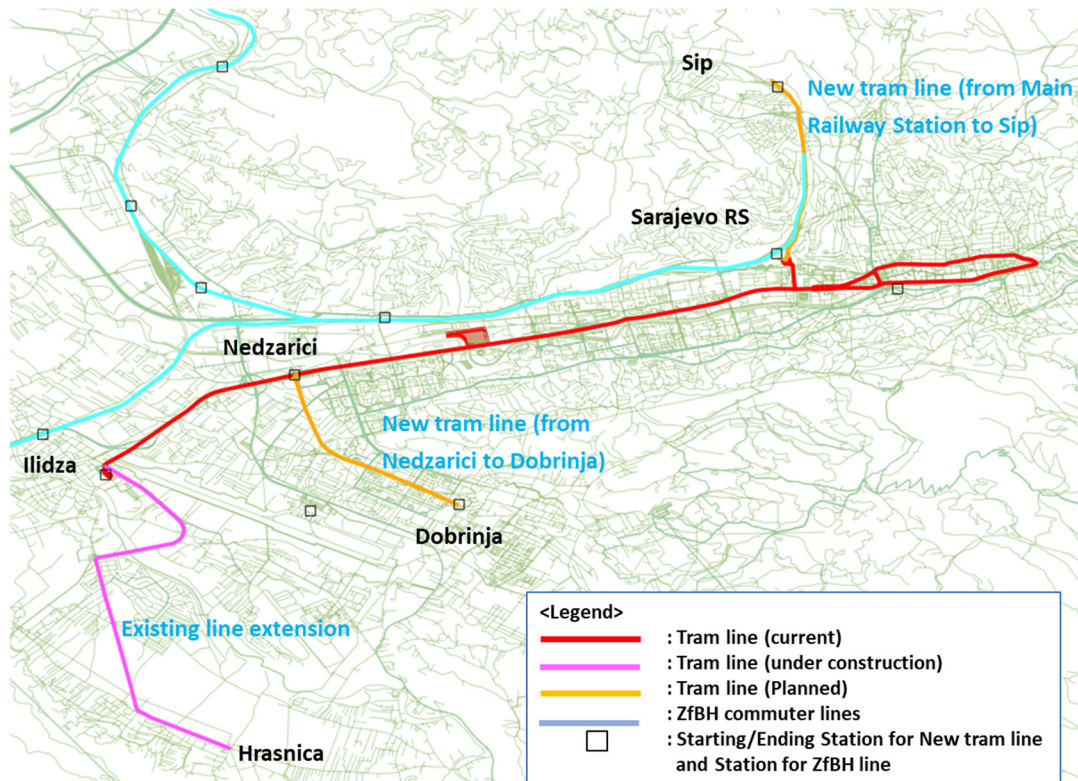
- Purchase of new trams

The tender carried out in accordance with EBRD’s procurement rules has been announced for the procurement of 15 low-floor trams measuring 29–32 m long, with a call option for the order of 10 additional trams. Canton of Sarajevo conducts the procurement by using an EBRD loan. The project is in progress, and the supply contract has been signed with Swiss manufacturer Stadler Rail AG. The prototype fleet will be delivered to Sarajevo in November or December 2023, and the final set will be delivered in July 2024. The contract of Stadler Rail AG includes the maintenance work for three years. (GRAS or the successor will do daily inspection work.)

## (2) New tram line plans

In addition to the above initiatives, other projects are underway. The study ascertains the feasibility of new tram routes from Nedžarići to Dobrinja and from Main railway station to Sip (depicted as orange lines in the figure below), as well as an ongoing tram route extension from Ilidža to Hrasnica (depicted as pink lines in the figure below).

Regarding the extension from Ilidža to Hrasnica, a Turkish contractor signed a contract and will conduct their construction work, including track, station, signal, and power supply with two traction substations, whose contract period is 18 months from the contract date (within the year 2024).



Note: RS means Railway Station  
Source: JICA Expert Team based on the interview to GRAS, etc.

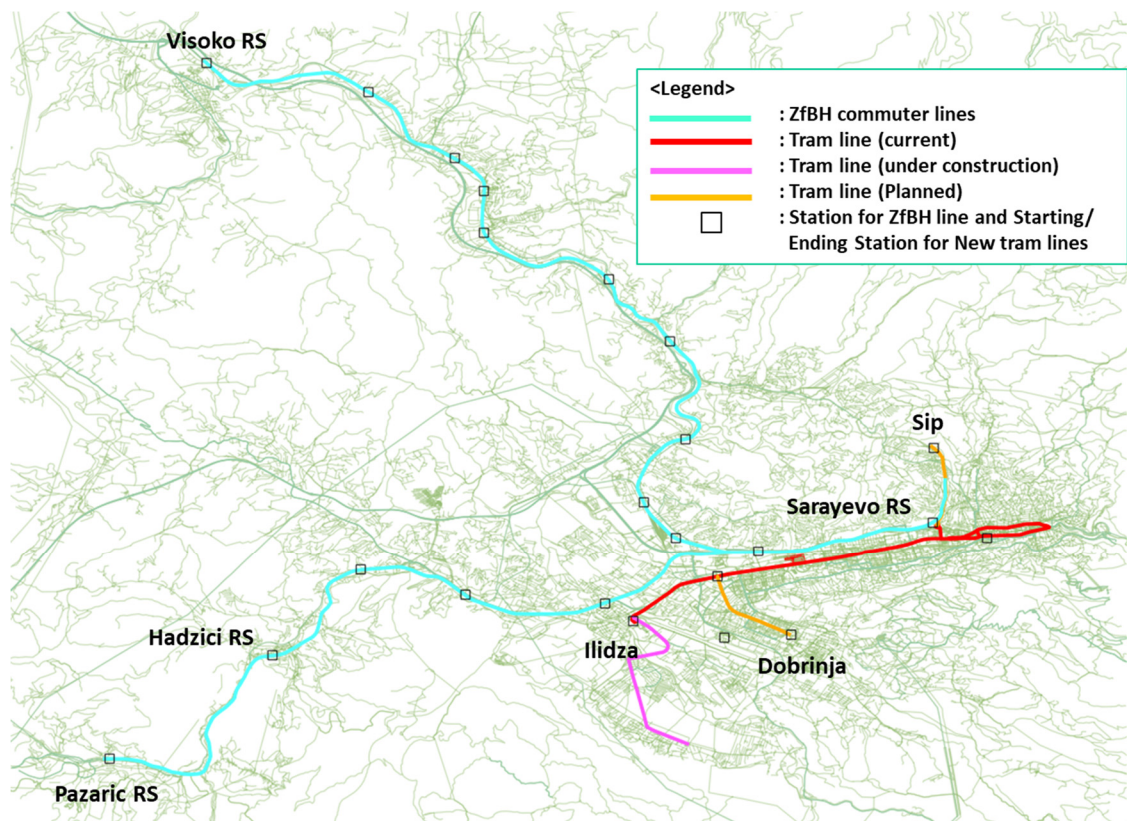
**Figure 3.3.3 Route Map for Planned/Ongoing Tram Line Project**

### (3) ZFBiH commuter train services

After EBRD project, the service level of the existing tram improved drastically, and the tram will be enough as the key urban transport mode in Sarajevo, subject to proper maintenance and adding some facilities to enhance the service.

On the other hand, some federal railway lines are planned in Sarajevo. Although mainly for intercity railway services, it is provided as commuter train services to connect the city center with the suburban area (Sarajevo–Pazarić and Sarajevo–Visoko; see Figure 3.3.4) based on the agreement between Canton Sarajevo and ZFBiH. If Sarajevo succeeds in using this commuter train service as a more user-friendly commuter mode, it will be a great additional urban transportation system in Sarajevo.

Many findings include issues/problems to be improved according to the site investigation (trial ride). Hence, future commuter train services in and around Sarajevo will be tested in the demand forecast (though any organizations on the Sarajevo side do not commit to these plans).





Note: RS means Railway Station  
 Source: JICA Expert Team based on the site survey







**Figure 3.3.4 Route Map for Tram and ZFBiH Commuter Lines in Sarajevo**

The following is a summary of awareness by the expert on the trial ride. (The *italicized & underlined sentences* are recommendations by the expert.)

**Table 3.3.2 Summary of Awareness for ZFBiH Commuter Train Services on the Trial Ride**

Category	Item	Description
General Issues	Poor hospitality	<ul style="list-style-type: none"> <li>Not clean infrastructure such as station facilities and rolling stocks.</li> <li>Poor attitude of station staff (ticket seller) → <u>ZFBiH needs to start improving its fundamental customer service mindset. Improvement cost for hospitality is free.</u></li> <li>Although many ticketing counters are inside Sarajevo railway station lobby, only one to two counters have staff.</li> <li>No announcements at the station or in the car at all → <u>The mindset of all employees (especially those who are in contact with passengers) needs to be changed.</u></li> <li>Low train operation frequency: between Sarajevo and Pazaric:12 trains/day (6trains/day for each direction), between Sarajevo and Visoko:12 trains/day (6trains/day for each direction) → <u>If the frequency with a train/30 min is realized, the convenience will be improved drastically, and the passenger number may be increased. It may be physically possible.</u></li> </ul>
	Not reliable operation	<ul style="list-style-type: none"> <li>Train operation is not punctual. → <u>Just running trains according to the timetable will increase reliability and become a “usable means of transportation.”</u></li> <li>Sudden suspension of operation without any announcement/explanation. (User should confirm by phone whether a train will be operated as scheduled before the departure time shown in the timetable.)</li> </ul>
	Poor passenger convenience	<ul style="list-style-type: none"> <li>Only paper tickets are available. (No IC card type, QR code ticket, etc.) → <u>The convenience will be increased by adding (1) a payment system and (2) a driving information notification service to the smartphone app.</u></li> </ul>
	Poor information sharing	<ul style="list-style-type: none"> <li>Actual train operation plan information is not shared at all up to the station counter level. → <u>It is necessary to build an information platform that enables centralized sharing of train operation information, etc.</u></li> </ul>
	Poor safety	<ul style="list-style-type: none"> <li>When the expert observed ahead from the driver cabin’s window, he saw several instances of unauthorized entry (crossing) in the track, and each time an alarm was sounded, and the train</li> </ul>

Category	Item	Description																		
		<p>was forced to operate with caution. ⇒ This would hinder the increase in the number of trains and speed and could lead to accidents resulting in death or injury of residents. → <u>Reinforcement of educational activities and PR to residents along the route, is necessary to prevent trespassing on the route.</u></p>																		
Location Specific	Sarajevo railway station	<ul style="list-style-type: none"> <li>Sarajevo station has high potential as a transportation node, with a station square + Tram station + parking lot in front of the station.</li> <li>The parking lot costs 2 KM (≈140 yen) for 2 hours. The parking lot was almost full.</li> <li>Tram station and railway station entrance/exit are close to each other (approx. 70m), so the distance is easy to access, but there is no roof, so it is inconvenient in bad weather. → <u>If they were connected by a roofed corridor, the number of people using the station would increase.</u></li> <li>There are stores inside the station, but they are run down and lack vitality. → <u>It is recommended to invite tenants that can attract customers.</u></li> <li>The platforms are connected by an underground passageway, but it is dark and cold. → <u>How about making the atmosphere a little brighter and more pleasant?</u></li> <li>Payable restroom. → <u>How about making the restrooms free for those who have train tickets and those who buy things from the tenants?</u></li> <li>The roof of the platform is shabby. There are no waiting chairs. → <u>Need to be installed.</u></li> </ul> <div style="display: flex; justify-content: space-around;">   </div> <p style="text-align: center;">Railway station (left) and tram station (right) <span style="margin-left: 200px;">Platform</span></p>																		
	For Sarajevo–Pazarić	<ul style="list-style-type: none"> <li>Single track, electrified section.</li> <li>The trial ride train: electric train composed of three cars with AC.</li> <li>Maximum speed: approximately 75 km/h.</li> <li>Smooth and comfortable ride. The track between Alipašin Most and Pazarić has been improved by changing to a new rail, welded as long rail, installing PC sleeper in 2015. Although the remaining section (Sarajevo to Alipašin Most) is still with wooden sleeper and non-welded rail, it is no uncomfortable ride.</li> <li>Many stations put only one temporary small ramp for boarding/alighting. → <u>It is better to put more ramps for convenient boarding/alighting.</u></li> <li>There is enough land which can be used for P&amp;R (park and ride), bus stop, etc. beside many stations. → <u>it is recommended to provide such facilities in order to increase the number of railway users for commuting.</u></li> </ul> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Station name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Sarajevo</td> <td>• N/A</td> </tr> <tr> <td>Alipašin Most</td> <td>• Small land beside the station which can be used for bus stop.</td> </tr> <tr> <td>Iliđža</td> <td>• Hut (no siding) • Some land beside the station which can be used for small P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Blažuj</td> <td>• With siding • Some land between station and road which can be used for small P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Binježevo</td> <td>• Hut (no siding) • Some land between station and road which can be used for small P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Hadžići</td> <td>• Comparatively large station with sidings • Many cars are parked at the northern side of the station. The land can be used for P&amp;R, bus stop, etc.</td> </tr> <tr> <td></td> <td>Four tunnels</td> </tr> <tr> <td>Pazarić</td> <td>• Comparatively large station with sidings • Some land at the southern side of the station which can be used for P&amp;R, bus stop, etc.</td> </tr> </tbody> </table>	Station name	Description	Sarajevo	• N/A	Alipašin Most	• Small land beside the station which can be used for bus stop.	Iliđža	• Hut (no siding) • Some land beside the station which can be used for small P&R, bus stop, etc.	Blažuj	• With siding • Some land between station and road which can be used for small P&R, bus stop, etc.	Binježevo	• Hut (no siding) • Some land between station and road which can be used for small P&R, bus stop, etc.	Hadžići	• Comparatively large station with sidings • Many cars are parked at the northern side of the station. The land can be used for P&R, bus stop, etc.		Four tunnels	Pazarić	• Comparatively large station with sidings • Some land at the southern side of the station which can be used for P&R, bus stop, etc.
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Category	Item	Description																										
		<ul style="list-style-type: none"> <li>Situation about the possibility to allocate transfer facilities beside existing stations is below.</li> </ul> <div style="display: flex; justify-content: space-around;">    </div> <p style="text-align: center;"> <span>Typical intermittent station</span>      <span>Small ramp</span>      <span>Vacant land at Pazaric station</span> </p>																										
	For Sarajevo–Visoko	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">Station name</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Sarajevo</td> <td>• N/A</td> </tr> <tr> <td>Alipašin Most</td> <td>• Small land beside the station which can be used for bus stop.</td> </tr> <tr> <td>Briješće</td> <td>• Stopped regardless of no station facility.</td> </tr> <tr> <td>Rajilovac</td> <td>• Stopped regardless of no station facility.</td> </tr> <tr> <td>Reljevo</td> <td>• N/A</td> </tr> <tr> <td>Semizovac</td> <td>• Comparatively large station with sidings • Some land between station and road which can be used for small park &amp; ride (P&amp;R), bus stop, etc.</td> </tr> <tr> <td>Vogošća</td> <td>• Some land beside the station which can be used for small P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Stari Ilijaš</td> <td>• Stopped regardless of no station facility. • Some land beside the station which can be used for small P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Ilijaš</td> <td>• Some land beside the station which can be used for small P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Podlugovi</td> <td>• Comparatively large station with many sidings • Some land beside the station which can be used for P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Lješevo</td> <td>• Some land beside the station which can be used for small P&amp;R, bus stop, etc.</td> </tr> <tr> <td>Visoko</td> <td>• Comparatively large station with many sidings • Some land beside the station which can be used for P&amp;R, bus stop, etc.</td> </tr> </tbody> </table> <ul style="list-style-type: none"> <li>Single track, electrified section.</li> <li>The trial ride train: Talgo is composed of nine cars with AC.</li> <li>Driving speed: 40 to 60 km/h.</li> <li>No uncomfortable ride, although the track condition is worse than Sarajevo – Pazaric. It may be due to the excellent rolling stock.</li> <li>Many stations put only one temporary small ramp for boarding/alighting. → <u>It is better to put more ramps for convenient boarding/alighting.</u></li> <li>There is enough land to use for P&amp;R (park and ride), bus stops, etc., besides many stations. → <u>it is recommended to provide such facilities to increase the number of railway users for commuting.</u></li> <li>There are several level crossings (with an automatic warning, without automatic gate open/close) in this section, and trains slow down considerably (almost stopping) whenever they pass through them, possibly due to unauthorized entry of cars. This increases the time required and also makes it difficult to increase the number of trains (more trains would result in level crossings that would not be open). → <u>Conversion to automatic level crossing and education on the need for "no entry" when a level crossing warning (forward stop) are needed.</u></li> <li>No signs on the road near the Visoko station indicate its location. This means that no one knows where the station is. → <u>PR of the station location is necessary.</u></li> <li>Situation about the possibility of allocating transfer facilities beside existing stations is below.</li> </ul> <div style="display: flex; justify-content: space-around;">    </div> <p style="text-align: center;"> <span>Inside Talgo</span>      <span>Example of Intermittent station</span>      <span>Visoko station</span> </p>	Station name	Description	Sarajevo	• N/A	Alipašin Most	• Small land beside the station which can be used for bus stop.	Briješće	• Stopped regardless of no station facility.	Rajilovac	• Stopped regardless of no station facility.	Reljevo	• N/A	Semizovac	• Comparatively large station with sidings • Some land between station and road which can be used for small park & ride (P&R), bus stop, etc.	Vogošća	• Some land beside the station which can be used for small P&R, bus stop, etc.	Stari Ilijaš	• Stopped regardless of no station facility. • Some land beside the station which can be used for small P&R, bus stop, etc.	Ilijaš	• Some land beside the station which can be used for small P&R, bus stop, etc.	Podlugovi	• Comparatively large station with many sidings • Some land beside the station which can be used for P&R, bus stop, etc.	Lješevo	• Some land beside the station which can be used for small P&R, bus stop, etc.	Visoko	• Comparatively large station with many sidings • Some land beside the station which can be used for P&R, bus stop, etc.
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Source: JICA Expert Team



## 2) Recommendations of the renewal plan of fleet, track and depot (for tram and Railway)

### (1) For Tram

#### < Tram fleet replacement plan>

Section 1.2 mentions there are 50 trams as of 26 July 2023; however, operations are only conducted by 20 workable trams. Thirty trams are out of service due to defects. Among the 30 out-of-service trams, some cars are so old that spare parts are not produced anymore, and some are scheduled for repairs and putting back into service. Spare parts are cannibalized from fleets that are no longer usable because they are too old and spare parts are not available for purchase.

In this matter, one of the current problems is that the tram fleets are aging and spare parts for some fleets are not available, making it difficult to make progress in vehicle maintenance and repair. In addition, the maintenance and repair of these vehicles requires a large number of personnel to keep up with the various types of spare parts needed for each type of vehicle. In order to get out of this situation, it is desirable to shift from “minimizing initial investment and performing large-scale maintenance when necessary” to “reducing the types of spare parts needed and cutting maintenance costs by investing in the necessary renewal and standardizing the vehicles”. Therefore, within financial constraints, it is desirable to gradually replace them with new vehicles for which spare parts can be purchased from the manufacturer.<sup>6</sup>

Canton Sarajevo has been aware of the necessity. Fifteen new low-floor tram fleets (29–32 m long per set) have been purchased from Stadler Rail AG using EBRD funds and will be delivered from the end of 2023 to July 2024. The contract includes the article for a call option for the order of 10 additional trams.

After delivering the new 15 tram fleets, the number of workable trams will be increased from 20 to 35, as shown in the table below. However, GRAS has observed that 42–45 workable trams are required to keep the required operation frequency. It means that 7–10 workable trams are still short. (Note that GRAS’s estimated required 42–45 workable trams is evaluated as appropriate as approximately 20 trams are required to realize 4 minutes interval operation for Line 3 and approximately 20 trams for other lines in rush hour.)

**Table 3.3.3 List of Tram Fleet after Delivering 15 New Trams**

R/ No.	A type of tram	Tram size	Inventory number	No. Of working trams	No. of defective trams			Age of the vehicle	Remarks
					Total	For disposal	Re-run after repair		
1.	CKD – K2	2 cars, 20,4 m	14 ( 5 )	9	(5)	-	-	1973	No more spare parts are produced.
2.	KT8 – D5	3 cars, 30,3 m	3	1	2	-	2	1989	No more spare parts are produced.
3.	SATR A2	2 cars, 20,4 m	11	1	10	-	10	2004 to 2011.	All defect causes broken converter. After

<sup>6</sup> The typical lifetime of a tram fleet is approximately 50 years.

R/ No.	A type of tram	Tram size	Inventory number	No. Of working trams	No. of defective trams			Age of the vehicle	Remarks
					Tota l	For dispo sal	Re- run after repair		
4.	SATR A 3	3 cars, 28,25 m	4	2	2	-	2	2005 to 2015.	purchasing the converter, all fleets will be fixed.
5.	E1	2 cars, 19,7 m	2	1	1	1	-	1961/ 63	Not used for passenger tram, but for push tram during snow.
6.	GT8	3 cars, 30,8 m	16	6	10	-	10	1963	Although no more spare parts are produced, spare parts for at least 5 years are retained by donated from Konya, Turkey.
<b>New</b>		<b>29-32m</b>	<b>15</b>	<b>15</b>				<b>2023- 2024</b>	
<b>TOTAL</b>			65 (5)	<u>35</u>	30 (5)	1	24		

Note: Five K2 trams need to be modernized in Satra 2/3  
Source: JICA Expert Team

GRAS's ideas for tram fleet replacement idea are as follows.

- Proper number of trams is 50-55 on an inventory basis and 42–45 on a workable basis.
- 12 defective SATRA2/SATRA3 are repaired and used for operation as soon as possible.
- There are 32 trams over 50 years old: (i)14 trams of CKD-K2 in 1973, (ii) 2 trams of E1 in 1961, and (iii)16 trams of GT8 in 1963.
  - In the 14 trams of CKD-K2 in 1973, five were defective planned to be modernized as Satra2/3. However, it is not officially decided because all five defective trams had been cannibalized to take spare parts for other fleets. Among the nine working trams, two may be used for another five years, but seven will be disposed of and deleted from the inventory. Two trams of E1 in 1961 were used for maintenance/rescue purposes only.
  - On the other hand, 16 trams of GT8 in 1963 can be used more after fixing due to the tough body, simple system, and enough spare parts for five years or more.

The following table shows the summarized idea of GRAS.

**Table 3.3.4 Summarized Idea of GRAS**

R/ No.	A type of tram	Tram size	Inventory number	No. of working trams	Age of the vehicle	Remarks
1.	CKD – K2	2 cars, 20,4 m	7 ( 5 )	2	1973	Used until 2028 or retired soon.
2.	KT8 – D5	3 cars, 30,3 m	3	1	1989	Used until 2039
3.	SATRA 2	2 cars, 20,4 m	11	11	2004 to 2011.	Used until 2044
4.	SATRA 3	3 cars, 28,25 m	4	4	2005 to 2015.	

R/ No.	A type of tram	Tram size	Inventory number	No. of working trams	Age of the vehicle	Remarks
6.	GT8	3 cars, 30,8 m	16	16	1963	Used until 2033, or until 2028
New		29-32m	15	15	2023-2024	Used until 2053 or more
<b>TOTAL</b>			56 (5)	49		

Source: JICA Expert Team

After the 49 workable trams are secured, in order to realize the abovementioned shift, alternative scenarios for tram fleet replacement have been proposed, considering different timelines for additional tram purchases.

**Table 3.3.5 Alternative Tram Fleet Replacement Scenario**

	Alternative 1	Alternative 2	Alternative 3
Title	Minimum expenditure	Gradual renewal	Renewal soon
Description	<ul style="list-style-type: none"> <li>15 new trams are operated.</li> <li>All GT8s in 1963 are repaired and will be used until 2033.</li> <li>2 fleets of CKD-K2 in 1973 will be used until 2028 under the assumption that the lifetime is extended up to 55 years.</li> <li>18 defective trams of KT8-D5, Satra2, and Satra3 are repaired and will be used until 2044.</li> </ul>	<ul style="list-style-type: none"> <li>15 new trams are operated.</li> <li>All GT8 in 1963 are repaired and will be used until 2028.</li> <li>All CKD-K2 in 1973 are retired soon.</li> <li>18 defective trams of KT8-D5, Satra2, and Satra3 are repaired and used for operation.</li> <li>10 additional trams (for lack of 9 trams and 1 spare) are purchased in 2028 by using the call option for the order.</li> </ul>	<ul style="list-style-type: none"> <li>15 new trams are operated.</li> <li>All GT8 in 1963 and CKD-K2 in 1973 are retired soon.</li> <li>18 defective trams of KT8-D5, Satra2, and Satra3 are repaired and used for operation capacity enhancement.</li> <li>10 additional trams for lack of 9 trams and 1 spare) are purchased soon by using the call option for the order.</li> </ul>
Additional trams to be purchased	<ul style="list-style-type: none"> <li>15 additional tram fleets are purchased in 2033*</li> <li>3 additional tram fleets will be purchased in 2040.</li> <li>15 additional tram fleets will be purchased in 2045.</li> </ul>	<ul style="list-style-type: none"> <li>15 additional tram fleets are purchased in 2028*</li> <li>3 additional tram fleets will be purchased in 2040.</li> <li>15 additional tram fleets will be purchased in 2045.</li> </ul>	<ul style="list-style-type: none"> <li>15 additional tram fleets will be purchased soon*</li> <li>3 additional tram fleets will be purchased in 2040.</li> <li>15 additional tram fleets will be purchased in 2045.</li> </ul>

Note1: \*Regarding 10 fleets in 15, call option of the current procurement from Stadler can be used.

Note2: Successor of GRAS may purchase the new tram fleet before the proposed year.

Source: JICA Expert Team

The yearly changing of the number of tram fleet for each alternative are shown in the table below.

**Table 3.3.6 Yearly Charging of Tram Fleet Number for Alternative 1**

Alternative 1(Minimum expenditure)										
Year	Type of Tram Fleet (Manufactured year)					[f] Total no. of fleet alive in [a]+[b]+[c]+[d]+[e]	[g] Minimum requirement no. of fleet	[h] Lack of fleet no. from [f]	[j] No. of new fleet to be purchased	[k] Total no. of fleet alive+new
	[a] CKD-K2 (1973)	[b] KT8-D5 (1989)	[c] SATRA2/3 (2004-2015)	[d] GT8 (1963)	[e] New (2023-2024)					
2023	2	3	15	16		36	app. 45-50	12		36
2024	2	3	15	16	15	51	app. 45-50	0		51
2025	2	3	15	16	15	51	app. 45-50	0		51
2026	2	3	15	16	15	51	app. 45-50	0		51
2027	2	3	15	16	15	51	app. 45-50	0		51
2028	2	3	15	16	15	51	app. 45-50	0		51
2029		3	15	16	15	49	app. 45-50	0		49
2030		3	15	16	15	49	app. 45-50	0		49
2031		3	15	16	15	49	app. 45-50	0		49
2032		3	15	16	15	49	app. 45-50	0		49
2033		3	15	16	15	49	app. 45-50	0		49
2034		3	15		15	33	app. 45-50	15	15	48
2035		3	15		15	33	app. 45-50	15		48
2036		3	15		15	33	app. 45-50	15		48
2037		3	15		15	33	app. 45-50	15		48
2038		3	15		15	33	app. 45-50	15		48
2039		3	15		15	33	app. 45-50	15		48
2040			15		15	30	app. 45-50	18	3	48
2041			15		15	30	app. 45-50	18		48
2042			15		15	30	app. 45-50	18		48
2043			15		15	30	app. 45-50	18		48
2044			15		15	30	app. 45-50	18		48
2045					15	15	app. 45-50	33	15	48
2046					15	15	app. 45-50	33		48
2047					15	15	app. 45-50	33		48
2048					15	15	app. 45-50	33		48
2049					15	15	app. 45-50	33		48
2050					15	15	app. 45-50	33		48
2051					15	15	app. 45-50	33		48
2052					15	15	app. 45-50	33		48
2053					15	15	app. 45-50	33		48

note: [h] Lack of fleet no. is basically calculated as difference from 48, which is intermediate 45-50 shown nn [g] Minimum requirement no. of fleet.

Source: JICA Expert Team

**Table 3.3.7 Yearly Charging of Tram Fleet Number for Alternative 2**

Alternative 2(Renewal gradually)										
Year	Type of Tram Fleet (Manufactured year)					[f] Total no. of fleet alive in [a]+[b]+[c]+[d]+[e]	[g] Minimum requirement no. of fleet	[h] Lack of fleet no. from [f]	[j] No. of new fleet to be purchased	[k] Total no. of fleet alive+new
	[a] CKD-K2 (1973)	[b] KT8-D5 (1989)	[c] SATRA2/3 (2004-2015)	[d] GT8 (1963)	[e] New (2023-2024)					
2023	2	3	15	16		36	app. 45-50	12		36
2024		3	15	16	15	49	app. 45-50	0		49
2025		3	15	16	15	49	app. 45-50	0		49
2026		3	15	16	15	49	app. 45-50	0		49
2027		3	15	16	15	49	app. 45-50	0		49
2028		3	15	16	15	49	app. 45-50	0		49
2029		3	15		15	33	app. 45-50	15	15	48
2030		3	15		15	33	app. 45-50	15		48
2031		3	15		15	33	app. 45-50	15		48
2032		3	15		15	33	app. 45-50	15		48
2033		3	15		15	33	app. 45-50	15		48
2034		3	15		15	33	app. 45-50	15		48
2035		3	15		15	33	app. 45-50	15		48
2036		3	15		15	33	app. 45-50	15		48
2037		3	15		15	33	app. 45-50	15		48
2038		3	15		15	33	app. 45-50	15		48
2039		3	15		15	33	app. 45-50	15		48
2040			15		15	30	app. 45-50	18	3	48
2041			15		15	30	app. 45-50	18		48
2042			15		15	30	app. 45-50	18		48
2043			15		15	30	app. 45-50	18		48
2044			15		15	30	app. 45-50	18		48
2045					15	15	app. 45-50	33	15	48
2046					15	15	app. 45-50	33		48
2047					15	15	app. 45-50	33		48
2048					15	15	app. 45-50	33		48
2049					15	15	app. 45-50	33		48
2050					15	15	app. 45-50	33		48
2051					15	15	app. 45-50	33		48
2052					15	15	app. 45-50	33		48
2053					15	15	app. 45-50	33		48

note: [h] Lack of fleet no. is basically calculated as difference from 48, which is intermediate 45-50 shown nn [g] Minimum requirement no. of fleet.

Source: JICA Expert Team

**Table 3.3.8 Yearly Charging of Tram Fleet Number for Alternative 3**

Alternative 3(Renewal soon)										
Year	Type of Tram Fleet (Manufactured year)					[f] Total no. of fleet alive in [a]+[b]+[c]+[d]+[e]	[g] Minimum requirement no. of fleet	[h] Lack of fleet no. from [f]	[j] No. of new fleet to be purchased	[k] Total no. of fleet alive+new
	[a] CKD-K2 (1973)	[b] KT8-D5 (1989)	[c] SATRA2/3 (2004-2015)	[d] GT8 (1963)	[e] New (2023-2024)					
2023	2	3	15	16		36	app. 45-50	12		36
2024		3	15		15	33	app. 45-50	15	15	48
2025		3	15		15	33	app. 45-50	15		48
2026		3	15		15	33	app. 45-50	15		48
2027		3	15		15	33	app. 45-50	15		48
2028		3	15		15	33	app. 45-50	15		48
2029		3	15		15	33	app. 45-50	15		48
2030		3	15		15	33	app. 45-50	15		48
2031		3	15		15	33	app. 45-50	15		48
2032		3	15		15	33	app. 45-50	15		48
2033		3	15		15	33	app. 45-50	15		48
2034		3	15		15	33	app. 45-50	15		48
2035		3	15		15	33	app. 45-50	15		48
2036		3	15		15	33	app. 45-50	15		48
2037		3	15		15	33	app. 45-50	15		48
2038		3	15		15	33	app. 45-50	15		48
2039		3	15		15	33	app. 45-50	15		48
2040			15		15	30	app. 45-50	18	3	48
2041			15		15	30	app. 45-50	18		48
2042			15		15	30	app. 45-50	18		48
2043			15		15	30	app. 45-50	18		48
2044			15		15	30	app. 45-50	18		48
2045					15	15	app. 45-50	33	15	48
2046					15	15	app. 45-50	33		48
2047					15	15	app. 45-50	33		48
2048					15	15	app. 45-50	33		48
2049					15	15	app. 45-50	33		48
2050					15	15	app. 45-50	33		48
2051					15	15	app. 45-50	33		48
2052					15	15	app. 45-50	33		48
2053					15	15	app. 45-50	33		48

note: [h] Lack of fleet no. is basically calculated as difference from 48, which is intermediate 45-50 shown nn [g] Minimum requirement no. of fleet.

Source: JICA Expert Team

### < Other issues to improve the passenger service level >

Lastly, with respect to customer services, the following operational needs to be resolved to provide better services to passengers.

Observations made by the JICA Expert Team show that at some occasions several trams arrive at the same time at a station (pile-up), while, at other times, there is a longer waiting time for any tram to arrive at a station. In order to avoid the unpredictability of tram arrivals, the tram dispatching system needs to be leveraged to adequately space out the vehicles by using existing tram location monitoring (GPS).

- Currently, there is little to no information about tram location, tram arrival time, etc., for passengers. To improve the situation, it is recommended that the dispatching system and vehicle location system working in tandem should be coupled with an improved (dynamic) Passenger Information System to provide passengers with real-time (or near real-time) tram operation and status information at each station. (Although many aspects should be improved, one of the important aspects is education/training for site staff such as dispatchers, drivers, etc.)
- Many trams appear fully occupied by passengers, especially during peak hours. This suggests a need to match service with better actual demand and increase service frequencies (i.e., minimize headways) to improve passenger convenience and comfort. According to the estimation in Volume 1 by JCT, 50–54 trams are required. According to GRAS's estimates, the proper number of trams is 50–55 on an inventory basis and 42–45 on a workable basis. On the other hand, the current

number of tram fleets is 50 on an inventory basis and 20 on a workable basis. The difference should be compensated for as soon as possible.

- At present, anyone can enter the tram stations without checking. Passengers can enter without a ticket through any door, and passengers who attempt to ride for free are only occasionally caught when inspectors check their tickets. As a potential corrective measure, consideration should be given to installing turnstiles/gates and barriers or fencing around stations to prevent persons without tickets from boarding the trams.
- Converting Ilidža station to an enhanced interchange and multimodal hub to facilitate transfers from/to tram to/from the other modes like bus will attract more passengers.

## (2) For ZFBiH Commuter Train Services

The following recommendations will improve the commuter train services of ZFBiH to a “more convenient, more reliable, and more sustainable” urban transport means.

**Table 3.3.9 Recommendation for ZFBiH**

Category	Item	Description
General Issues	Poor hospitality	<ul style="list-style-type: none"> <li>• ZFBiH needs to start improving its fundamental customer service mindset. Improvement cost for hospitality is free.</li> <li>• The mindset of all employees (especially those who are in contact with passengers) needs to be changed.</li> <li>• If the frequency with a train/30 min is realized, the convenience will be improved drastically, and the passenger number may be increased.</li> </ul>
	Not reliable operation	<ul style="list-style-type: none"> <li>• Just running trains according to the timetable will increase reliability and become a “usable means of transportation.”</li> </ul>
	Poor passenger convenience	<ul style="list-style-type: none"> <li>• The convenience will be increased by adding (i) a payment system and (ii) a driving information notification service to the smartphone app.</li> </ul>
	Poor information sharing	<ul style="list-style-type: none"> <li>• Building an information platform that enables centralized sharing of train operation information, etc., is necessary.</li> </ul>
	Poor safety	<ul style="list-style-type: none"> <li>• Reinforcement of educational activities and PR to residents along the route, is necessary to prevent trespassing on the route.</li> </ul>
Location Specific	Sarajevo railway station	<ul style="list-style-type: none"> <li>• If a roofed corridor connects the Sarajevo railway station and tram station, the number of people using the station would increase.</li> <li>• Inviting tenants that can attract customers is recommended.</li> <li>• How about making the atmosphere a little brighter and more pleasant?</li> <li>• How about making the restrooms free for those with train tickets and buying things from the tenants?</li> <li>• The roof of the platform and waiting chairs need to be installed.</li> </ul>
	For Sarajevo-Pazaric	<ul style="list-style-type: none"> <li>• Putting more ramps at station platforms for more convenient boarding/alighting is better.</li> <li>• Providing transfer facilities (e.g., P&amp;R space, bus stop, etc.) beside stations to increase the number of railway users commuting is recommended.</li> </ul>
	For Sarajevo-Visoko	<ul style="list-style-type: none"> <li>• Putting more ramps at station platforms for more convenient boarding/alighting is better.</li> <li>• Providing transfer facilities (e.g., P&amp;R space, bus stop, etc.) beside stations to increase the number of railway users commuting is recommended.</li> <li>• Converting to automatic level crossing and education on the need for “no entry” at the time of a level crossing warning (forward stop) are needed.</li> <li>• P&amp;R of the station location is necessary.</li> </ul>

Source: JICA Expert Team

## 3) Findings of the renewal plan of fleet, track, and depot (for Bus)

In this section, the first focus is identifying the key deficiencies in the bus and tram facilities,

particularly from a top-down (strategic) policy framework perspective, and the current maintenance mindset, before proceeding to describe in Volume 3 what the proposed mitigation measures and actionable steps are to rectify the situation, from a bottom-up (tactical) perspective.

Following the last JCC, a recommendation was made to consider consolidating the bus and minibus depot (with supporting satellite facilities at the ends of bus/minibus routes such as Hošin brijeg and Mahmutovac, amongst others). Further work carried out by the JICA Expert Team has resulted in the following additional proposals and recommendations, namely:

- Develop the Investment and Financing Plan to upgrade the depot of bus and minibus to ensure that the facilities have adequate provisions for the regular, preventative maintenance and also the specialist repairs needed over the life of the vehicles (e.g., electronic components).
- The installation of a computerized maintenance management system (CMMS)).
- Depot sites are large enough to accommodate all the required facilities to operate new buses. Specifically:
  - The workshops should be cleaned and upgraded with the supply of tools and equipment in preparation for the delivery of the new buses.
  - Components of new buses are different from existing ones, presenting challenges to a skilled engineer when considering routine maintenance. However, on-site training for more complex procedures and newer electronic systems would need to be included in future bus procurement packages to ensure knowledge transfer and business continuity.
  - The above needs to be complemented with a succession plan for retiring mechanics and engineers through an influx of apprentices and trainees. This is critical to start with safeguarding the trolleybus personnel and facilities since it is in better shape than the bus/minibus facility and is needed to accommodate the new Belkommunmash trolleybuses.

#### **4) Recommendation of the renewal plan of fleet, track, and depot (for bus)**

In respect of next steps, the JICA Expert Team proposes the following:

- Further development of the new organization (KPKJ JPS) as a successor to GRAS. The actual mandate of the new organization will directly impact the operational and institutional issues relating to trams and buses. Therefore, more detailed recommendations can only be made after establishing this new entity.
- The Canton established investment and financing plans for fleet and depot upgrades (considering a consolidated Depot) once there is clarity on the future of GRAS and the potential establishment of KJKP JPS as a separate legal entity. Investment should include a CMMS system and a sufficient stockpile of spare parts. This should be done in tandem with the introduction of proper Reliability, Availability, Maintainability, and Safety (RAMs) targets so that progress is measurable.
- Develop a succession plan for Engineers/Mechanics by teaming with local Universities/Colleges to supply apprentices and trainees.

### < Bus fleet replacement plan>

In Volume I, three operating Scenarios were discussed and agreed upon with the Canton. These Scenarios are as follows:

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

The same three alternatives were considered regarding the bus fleet replacement plan; therefore, a baseline or recommended bus fleet replacement plan is aligned with the Optimal case.

Similarly, Alternative 1 considers further investment in the purchase of additional buses to deliver the full GRAS timetabled service, which aligns with the Full-service case listed above.

Lastly, Alternative 2, which is the bus fleet replacement plan, is the more capital-intensive among the three options as it aligns with the Hypothetical (oversupply) case that considers the purchase of even more buses than the Baseline or Alternative 1 to deliver a greatly enhanced public transportation service in the Canton. The details of the three bus fleet replacement plans are detailed as follows:

#### **Baseline (Optimal):**

The logic behind the proposed Baseline bus replacement strategy focuses on purchasing the buses needed to deliver the operating plan included in Volume 1 for the Optimal Case. More specifically, the following acquisitions are recommended in respect of a fleet replacement strategy:

- 10 no. 12-m and another 10 no. articulated 15-m buses to supplement the existing operational bus fleet (thereby representing c. 25% of the total GRAS fleet needed to deliver the Optimal operating plan). The JICA Expert team proposes that the bus investment is focused on 12-m diesel buses due to their low operating costs.
- No further need for replacement trolleybuses after the incorporation of the 25 new Belkommunmash trolleybuses that the Canton is already committed to purchasing and taking delivery of.
- 10 no. 8- or 9-m minibuses to supplement the existing operational minibus fleet (thereby representing c. 50% of the total GRAS fleet needed to deliver the Optimal operating plan).

#### **Alternative 1 (Full-Service):**

Alternative 1 is an enhanced replacement strategy which aligns with the Full-Service operating plan, and which advocates a more aggressive investment and fleet replacement strategy in order to fulfil the integral GRAS timetable.

In this scenario, the JICA Expert Team also proposes investing in the purchase of additional second-hand vehicles since there is an easily available pool of used buses, trolleybuses



and minibuses throughout Europe, so long as the finances are in place to do so.

More specifically, the following acquisitions are recommended in respect of a fleet replacement strategy:

- 15 no. 12-m and another 15 no. articulated 15-m buses to supplement the existing operational bus fleet (thereby representing nearly 100% of the total GRAS fleet needed to deliver the Full-Service operating plan). Again, the JICA Expert team proposes that the investment for buses is focused on 12-m diesel buses due to their low operating costs.
- No further need for replacement trolleybuses after the incorporation of the 25 new Belkommunmash trolleybuses that the Canton is already committed to purchasing and taking delivery of.
- 15 no. 8- or 9-m minibuses to supplement the existing operational minibus fleet (thereby representing about 50% of the total GRAS fleet needed to deliver the Optimal operating plan).

#### **Alternative 2 (Hypothetical):**

Alternative 2 is also an enhanced replacement strategy that advocates the most ambitious fleet replacement strategy that is aligned with the Hypothetical Case.

More specifically, the following acquisitions are recommended in respect of a fleet replacement strategy:

- 23 no. 12-m and another 22 no. articulated 15-m buses to supplement the existing operational bus fleet (thereby representing nearly 67% of the total GRAS fleet needed to deliver the Hypothetical operating plan). Again, the JICA Expert team proposes that the investment for buses is focused on 12-m diesel buses due to their low operating costs.
- 10 no. additional trolleybuses to follow the incorporation of the 25 new Belkommunmash trolleybuses that the Canton is already committed to purchasing and taking delivery of (in addition to the existing 24). This would GRAS to reach the required fleet size to deliver the more ambitious Hypothetical operating plan which would require 55 trolleybuses (excluding spares) in the peak hour.
- 20 no. 8- or 9-m minibuses to supplement the existing operational minibus fleet (thereby representing about 33% of the total GRAS fleet needed to deliver the Optimal operating plan).

**Table 3.3.10 Alternative Bus Fleet Replacement Scenarios (Baseline)**

Description	Details	Additional buses to be made available
<b>Optimal Case: Bus Replacement Plan</b>	Buses: Invest in the purchase of 20 no. second-hand diesel buses (10 x 12-m and 10 x 18-m) if the financial resources are available (in 2024/2025).  Focus is on diesel fleet (i.e. lowest OpEx) until such time when new buses can be purchased.	+20 diesel buses +10 diesel minibuses to meet Optimal Case operational fleet requirements.

Description	Details	Additional buses to be made available
	<p>Minibuses: Invest in the purchase of 10 no. second-hand diesel minibuses if the financial resources are available (in 2024).</p> <p>Trolleybuses: The deployment of the 25 new Belkommunmash Trolleybuses will provide GRAS with a surplus of 14 vehicles. They can either decommission/scrap these 14 or run them on new routes as a trial service.</p>	

Bus Manufacturer	Model	Total	Operational	Serviceable	Inoperative
FAP	A 757	1	-	-	1
	OM 442	2	-	-	2
IKARBUS	IK 201 (ZGLOBNI)	4	-	-	4
	IK 206 (ZGLOBNI)	9	-	3	6
MAN	A 20 CNG	6	2	1	3
	A 21 CNG	2	-	-	2
	A 23	2	1	1	-
	A 23 CNG	13	4	1	8
	G A 23 LPG	10	7	2	1
	RO 2	1	-	1	-
	SG 313	4	1	1	2
	SL 283	3	1	2	-
MERCEDES-BENZ	O 345	44	19	7	18
	O 530 G	3	2	-	1
NEOPLAN	4413 CNG	1	-	-	1
	4416 CNG	2	-	-	2
	G. AUWAERTER STGT N 116	1	1	-	-
	N 122 L	2	1	1	-
	N 213 S	1	-	1	-
	N 4421/3	4	2	1	1
	PD 4 CNG	10	2	-	8
<b>TOTAL</b>		<b>125</b>	<b>43</b>	<b>22</b>	<b>60</b>
<b>Second-hand Bus Purchase</b>	12-m standard		<b>10</b>		
	18-m articulated		<b>10</b>		
<b>TOTAL Revised Fleet</b>			<b>63</b>		

Trolleybus Manufacturer	Model	Total	Operational	Inoperative
HESS	NAW BGT-N	14	14	-
	NAW BGT-25	22	9	13
MAN	SG 200 HO	3	-	3
	SL 172 HO	11	1	10
<b>TOTAL</b>		<b>50</b>	<b>24<sup>a</sup></b>	<b>26</b>
<b>Belkommunmash (New)</b>	<b>BKM 43300D</b>	<b>25</b>	<b>25</b>	<b>-</b>
<b>Second-hand Trolleybus Purchase</b>	<b>TBC</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>TOTAL Revised Fleet</b>			<b>49<sup>a</sup></b>	

Footnotes: <sup>a</sup> Out of the 24 old trolleybuses, 14 can be gradually decommissioned since the operational peak fleet requirement is only 35 (32 + 3 spares).

Minibus Manufacturer	Model	Total	Operational	Inoperative	Average Age (years)
ISUZU	NOVOCITY S801	10	-	10	6.2
	NOVOCITY S801-2	9	9	-	
	Q31	1	1	-	
IVECO	100 E 18	1	1	-	18.5
	OTOYOL M23	1	-	1	
	OTOYOL M50.14	9	1	8	
MAN	10.220	2	1	1	23.0
TEMSA	OPALIN M3	1	-	1	4.0
<b>TOTAL</b>		34	13	21	
<b>Second-hand Minibus Purchase</b>	TBC		10		
<b>TOTAL Revised Fleet</b>			<b>23</b>		

Source: JICA Expert Team

**Table 3.3.11 Alternative Bus Fleet Replacement Scenarios (Alternative 1)**

Description	Details	Additional buses to be made available
<b>Full-Service Case: Bus Replacement Plan</b>	<p>Buses: Invest in the purchase of 30 no. second-hand diesel buses (15 x 12-m and 15 x 18-m) if the financial resources are available. This scenario is aligned with GRAS' aspirations in respect of their bus fleet decommissioning plan (in 2024/2025).</p> <p>Focus on diesel fleet (i.e. lowest OpEx) until such time when new buses can be purchased.</p> <p>Minibuses: Invest in the purchase of 15 no. second-hand diesel minibuses if the financial resources are available (in 2024).</p> <p>Trolleybuses: The deployment of the 25 new Belkommunmash trolleybuses already bought will provide GRAS with a surplus of 15 vehicles therefore they can choose to either decommission/scrap these 15, or run them on new routes as a trial service.</p>	+30 second-hand diesel buses and +15 second-hand minibuses to meet the Full-Service Case operational fleet requirements.

Bus Manufacturer	Model	Total	Operational	Serviceable	Inoperative
FAP	A 757	1	-	-	1
	OM 442	2	-	-	2
IKARBUS	IK 201 (ZGLOBNI)	4	-	-	4
	IK 206 (ZGLOBNI)	9	-	3	6
MAN	A 20 CNG	6	2	1	3
	A 21 CNG	2	-	-	2
	A 23	2	1	1	-
	A 23 CNG	13	4	1	8
	G A 23 LPG	10	7	2	1
	RO 2	1	-	1	-
	SG 313	4	1	1	2
MERCEDES-BENZ	SL 283	3	1	2	-
	O 345	44	19	7	18
NEOPLAN	O 530 G	3	2	-	1
	4413 CNG	1	-	-	1
	4416 CNG	2	-	-	2
	G.AUWAERTER STGT N 116	1	1	-	-
	N 122 L	2	1	1	-

Bus Manufacturer	Model	Total	Operational	Serviceable	Inoperative
	N 213 S	1	-	1	-
	N 4421/3	4	2	1	1
	PD 4 CNG	10	2	-	8
<b>TOTAL</b>		<b>125</b>	<b>43</b>	<b>22</b>	<b>60</b>
<b>Second-hand Bus Purchase</b>	12-m standard		<b>15</b>		
	18-m articulated		<b>15</b>		
<b>TOTAL Revised Fleet</b>			<b>73</b>		

Manufacturer	Model	Total	Operational	Inoperative
<b>HESS</b>	NAW BGT-N	14	14	-
	NAW BGT-25	22	9	13
<b>MAN</b>	SG 200 HO	3	-	3
	SL 172 HO	11	1	10
<b>TOTAL</b>		<b>50</b>	<b>24</b>	<b>26</b>
<b>Belkommunmash (New)</b>	<b>BKM 43300D</b>	<b>25</b>	<b>25</b>	<b>-</b>
<b>Second-hand Trolleybus Purchase</b>	<b>TBC</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>TOTAL Revised Fleet</b>			<b>49<sup>a</sup></b>	

Footnotes: a - Out of the 24 old trolleybuses, 15 can be gradually decommissioned since the operational peak fleet requirement is only 34 (31 + 3 spares)

Minibus Manufacturer	Model	Total	Operational	Inoperative	Average Age (years)
<b>ISUZU</b>	NOVOCITY S801	10	-	10	6.2
	NOVOCITY S801-2	9	9	-	
	Q31	1	1	-	
<b>IVECO</b>	100 E 18	1	1	-	18.5
	OTOYOL M23	1	-	1	
	OTOYOL M50.14	9	1	8	
<b>MAN</b>	10.220	2	1	1	23.0
<b>TEMSA</b>	OPALIN M3	1	-	1	4.0
<b>TOTAL</b>		<b>34</b>	<b>13</b>	<b>21</b>	
<b>Second-hand Minibus Purchase</b>	<b>TBC</b>		<b>15</b>		
<b>TOTAL Revised Fleet</b>			<b>28</b>		

Source: JICA Expert Team

**Table 3.3.12 Alternative Bus Fleet Replacement Scenarios (Alternative 2)**

Description	Details	Additional buses to be made available
<b>Hypothetical Case: Bus Replacement Plan</b>	<p>Buses: Invest in the purchase of 45 no. (23 x 12-m and 22 x 18-m) second-hand diesel buses if the financial resources are available (in 2024/2025).</p> <p>Focus on diesel fleet (i.e. lowest OpEx) until such time when new buses can be purchased.</p> <p>Minibuses: Invest in the purchase of 20 no. second-hand diesel minibuses if the financial resources are available (in 2024).</p> <p>Trolleybuses: Invest in the purchase of 10 no. second-hand trolleybuses to allow the enhancement of trolleybus services.</p>	+45 second-hand diesel buses, +20 diesel minibuses and +10 second-hand trolleybuses to meet the Hypothetical Case operational fleet requirements.

Bus Manufacturer	Model	Total	Operational	Serviceable	Inoperative
FAP	A 757	1	-	-	1
	OM 442	2	-	-	2
IKARBUS	IK 201 (ZGLOBNI)	4	-	-	4
	IK 206 (ZGLOBNI)	9	-	3	6
MAN	A 20 CNG	6	2	1	3
	A 21 CNG	2	-	-	2
	A 23	2	1	1	-
	A 23 CNG	13	4	1	8
	G A 23 LPG	10	7	2	1
	RO 2	1	-	1	-
	SG 313	4	1	1	2
	SL 283	3	1	2	-
MERCEDES-BENZ	O 345	44	19	7	18
	O 530 G	3	2	-	1
NEOPLAN	4413 CNG	1	-	-	1
	4416 CNG	2	-	-	2
	G.AUWAERTER STGT N 116	1	1	-	-
	N 122 L	2	1	1	-
	N 213 S	1	-	1	-
	N 4421/3	4	2	1	1
	PD 4 CNG	10	2	-	8
<b>TOTAL</b>		<b>125</b>	<b>43</b>	<b>22</b>	<b>60</b>
Second-hand Bus Purchase	12-m standard		<b>23</b>		
	18-m articulated		<b>22</b>		
<b>TOTAL Revised Fleet</b>			<b>88</b>		

Trolleybus Manufacturer	Model	Total	Operational	Inoperative
HESS	NAW BGT-N	14	14	-
	NAW BGT-25	22	9	13
MAN	SG 200 HO	3	-	3
	SL 172 HO	11	1	10
<b>TOTAL</b>		<b>50</b>	<b>24</b>	<b>26</b>
Belkommunmash (New)	BKM 43300D	25	25	-
Second-hand Trolleybus Purchase	(TBC)	18	10	-
<b>TOTAL Revised Fleet</b>			<b>59</b>	

Minibus Manufacturer	Model	Total	Operational	Inoperative	Average Age (years)
ISUZU	NOVOCITY S801	10	-	10	6.2
	NOVOCITY S801-2	9	9	-	
	Q31	1	1	-	
IVECO	100 E 18	1	1	-	18.5
	OTOYOL M23	1	-	1	
	OTOYOL M50.14	9	1	8	
MAN	10.220	2	1	1	23.0
TEMSA	OPALIN M3	1	-	1	4.0
<b>TOTAL</b>		<b>34</b>	<b>13</b>	<b>21</b>	
Second-hand Minibus Purchase	TBC		20		
<b>TOTAL Revised Fleet</b>			<b>33</b>		

Source: JICA Expert Team

### 3.4 Improved Management and Business Plan

Permanent effort targeting reduction of expenditure is a fundamental aspect of an Operator's business. Best practices in public transport production and business plan improvement include actions in the following:

- HR management,
- network productivity improvement,
- rational driving and consumption checks,
- demand and supply optimization, and
- targeted marketing.

#### 1) HR Management

These measures include qualitative measures and measures with a measurable impact on the company's results. Qualitative measures concern:

- The development of a Corporate Social Responsibility (CSR) plan.
- Implementing a management of this CSR project to improve the operator's performance.
- The establishment of a partnership contract with Canton Sarajevo.
- Measures with measurable impact concern the fight against absenteeism.

CSR plan consists of formalizing concrete and measurable commitments in the areas of:

- social,
- environmental,
- relations with other local economic actors, and
- governance.

CSR plans facilitate retaining and motivating staff, especially the youngest, who attach greater importance to societal issues.

Implementing a participatory approach to this project to improve an Operator's performance will have comparable managerial consequences. The issue of participatory management in public transport is particular because drivers are essentially isolated from the company. This characteristic has strong implications for managerial methods, so it is essential to review the analysis of the social groups at the center of collective transport, particularly the drivers of vehicles to conceive and implement mechanisms contributing to less brutal corporate regulation. In this respect, the experience of more than fifteen years of mainly psychosociological work within transport companies (urban and intercity road, rail, and air transport) would reveal much relevant material on the subject of collective conflict.<sup>7</sup>

On the operational level, the CSR plan's participative implementation enables creating spaces for exchanges between management and its staff and fighting against "irritants," often derisory facts, but which, because of the specificities of public transport, can have

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<sup>7</sup> <https://transformation.fr/publications/etudes.php>

very serious consequences.

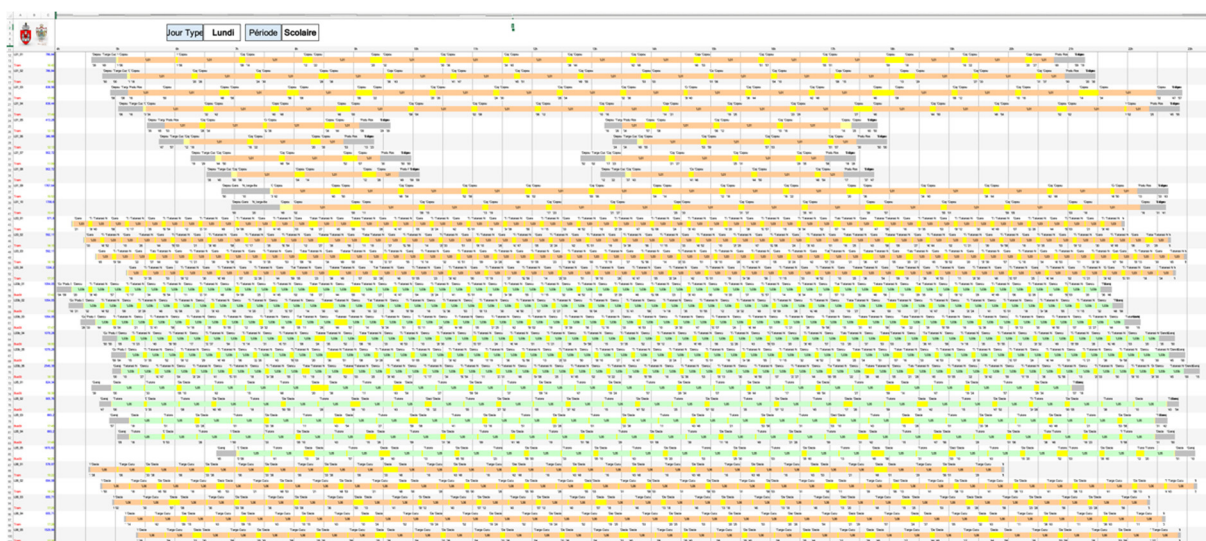
Establishing a partnership contract with the Canton of Sarajevo aims at the same objectives and the appeasement and transparency of relations between the operator and PT regulator.

The fight against absenteeism requires the implementation of the following measures:

- Organize the company into human-sized units in which individuals feel dependent on each other to carry out their missions (for example, forming a team of drivers of the same line to generate additional motivation to be present to avoid disrupting the functioning of the rest of the team).
- Special attention from management in case of absence (for example, call, send flowers, or come to their home to get some news in case of absence).
- Organize a precise statistical follow-up of absences, quantify their financial consequences for the company, and disseminate it widely.
- Organize regular and random medical checks of sick leave.
- Reduce the size of the pool of “insurer” drivers assigned to the replacement of sick drivers according to the results obtained.

## 2) Network Productivity Improvement

Network productivity improvement involves optimizing human resources (number of driving hours) and material resources (number of vehicles) to produce a given operating plan.



Source: JICA Expert Team

**Figure 3.4.1 Example of Modeling of the Production of an Urban Network**

Optimization work uses dedicated business tools, HASTUS being best-known internationally. It must be performed after the offer perfectly matches the actual demand. Regular checks to ensure that production is optimized should be performed.

However, HASTUS is not advisable for Sarajevo for its complexity reason. Instead, a rostering tool in order to do the optimization of public transport performance is needed.

The main benefits of such a tool are the following:

- Rostering: Optimizing work schedules for drivers and staff while adhering to labor

regulations and preferences.

- Service Planning: Efficiently designing routes, timetables, and service patterns to meet passenger demand cost-effectively.
- Resource Allocation: Effectively assigning vehicles and other assets, ensuring proper distribution on routes.
- Employee Communication: Facilitating electronic communication with employees, granting access to schedules and request submissions.
- Performance Analytics: Offering data analysis and reporting tools for performance evaluation and data-driven decision-making.
- Compliance: Ensuring adherence to labor laws, regulations, and collective bargaining agreements.
- Optimal Vehicle Utilization: Maximizing vehicle usage and minimizing downtime.
- Reduced Emissions: Supporting environmental sustainability by minimizing fuel consumption and emissions.
- Cost Control: Optimizing resources to manage operational costs and promote economic sustainability in public transit.

### **3) Rational Driving and Consumption Checks**

More detailed documentation on rational driving can be found in EcoDriving, Sustainable Transport: A Sourcebook for Policymakers in Developing Cities. Module 4f. GTZ, German Technical Cooperation, 2005.<sup>8</sup>

Consumption checks here mean that the number of kilometers driven daily must be compared with what is modeled or calculated in theory. In case of discrepancy, it means the bus is used to perform other things than what is planned. In addition, after every tank refill, bus consumption per km must be checked and compared with the budget and similar buses doing similar jobs. In case of discrepancy, drivers should be trained in eco-driving, the bus must be checked for malfunctioning, and investigations have to be made about possible fuel robbery (which happens often).

Systematic and regular training of drivers in rational and anticipatory driving has the following positive effects:

- reduced fuel consumption,
- reduction of accidents,
- less wear and tear on vehicles,
- less conflict (strikes, lack of adhesion to corporate values) among drivers, and
- reduced absenteeism.

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<sup>8</sup> Available for free on the internet: <https://sutp.org/publications/sutp-module-4f-eco-driving/>





Source: [www.liris.cnrs.fr](http://www.liris.cnrs.fr)

**Figure 3.4.2 Rational Driving and Consumption Checks**

In addition, all kilometers and fuel consumption productions should be checked daily and compared to the budget to identify divergences that might indicate internal misappropriation of resources.

#### **4) Demand and Supply Optimization**

The offer of public transport is always the consequence of demand. Therefore, constant monitoring of the evolution of demand and changing the supply of public transport services accordingly are necessary. While the methodology and comprehensive demand analysis are summarized in the technical note of Volume 1, the JICA Expert Team remind that it is necessary to rely on precise attendance statistics at the operation level, according to the hours and types of day. The days generally used are normal week, week period of short school holidays, week period of long school holidays, Saturday, and Sunday. Other typologies can be introduced, such as a particular day of the week when school habits are very different (for example, in France, Wednesday is the day of less school enrolment, or in many Muslim countries, Ramadan, which significantly changes mobility).

Measures to be taken may include:

- redefinition of lines (change of routes, extensions, interruptions, partial services, etc.),
- adaptation of service frequencies, and
- adaptation of means (modification of vehicle capacity).

They will result in a net reduction in the mileage production of buses and trams.

#### **5) Targeted Marketing**

Implementing a targeted marketing policy will improve attendance. Priority must be given to match better the supply to demand and improve knowledge of attendance and customer needs. The attractiveness of the offer can be greatly improved at reduced costs through:

- digital development of customer information and
- communication via social networks.

The development of digital technologies opens new perspectives for public transport marketing, which could follow the following guidelines:

### ACQUIRE NEW CLIENTS

- Attract attention (advertising, internet site)
- Raise interest (image, commercial actions, exchanges)
- Make buy (distant or contact sales)

### KEEP CLIENTS

- Interact (inquiries, claims follow-up)
- Increase loyalty (loyalty programs and product improvements and updates)

### INCREASE CUSTOMER BASE

- Find new revenues (special offers, value for clients)
- Develop sponsorship (crossed sales and partnerships)

The development of digital technology opens real prospects for public transport. These new opportunities must be seized.<sup>9</sup>

Better consideration of connections between lines (via the coordination of timetables between buses and trams and between main bus lines) also seems possible and desirable. It can easily be implemented through the improved rostering tools mentioned above.

Finally, targeted marketing actions on major destinations potentially generating customers such as universities, large companies, and administrations, should attract new customers to public transport. An example of a communication campaign highlighting the positive effects of bus use on the environment is shown below, translating to “For you, we sniff pollution in the district,” is a mix of communication and “nudge management.”<sup>10</sup>



Source: [www.nudgeme.fr](http://www.nudgeme.fr)

**Figure 3.4.3 Example of a Communication Campaign**

## **6) Diversification of Revenue Streams**

Public transport operators can benefit from diversifying their sources of revenue, specifically by exploring non-fare revenue streams. While the practice of leasing spaces within stations for retail establishments or developing commercial and residential

<sup>9</sup> <https://fr.slideshare.net/15marches/le-marketing-des-transport-publics-nest-pas-un-gros-mot>

<sup>10</sup> Described on <https://www.nudgeme.fr/portfolio/valoriser-les-usagers-de-transport-publics/>

buildings adjacent to stations is prevalent in Asian countries where private operators own available land or space, it has been acknowledged that suitable land for such purposes is not readily accessible, as indicated in discussions with MOT and GRAS. Despite this constraint, there are two potential options for consideration:

- **Advertising:** Transport operators can collaborate with advertisers to showcase advertisements on various transport components, including vehicles and stations.
- **Retail and Services:** While this approach might not be immediately viable given the current circumstances, the potential for incorporating commercial ventures alongside ticket sales could be explored while developing new lines. Additionally, as mentioned in section 3.3, optimizing stores at the Sarajevo railway station for ZFBiH commuter train services presents a possibility for enhancing commercial operations to attract a greater customer base.



Source: Hankyu Bus



Source: Tokyo Metro

**Figure 3.4.4 Example of Advertising and Retail Shop in a Station**

### 3.5 Recommendations for SPTC and Existing Public Transport Operators

#### 1) Recommendations for Canton of Sarajevo

Although not an operator, Canton of Sarajevo has a major shareholder responsibility with GRAS, which is not exerted. Past accumulated losses have turned GRAS into an indebted company, where considerable energy is allocated to solving insolvency issues. This situation should be addressed as a priority. Canton of Sarajevo should end the debt problem of GRAS and launch a strong restructuring to match human resources with the rolling stock available to operate.

Compared to the issues of GRAS, the decision to establish or not a new company to operate trams and trolleybuses is of secondary importance, as:

- Such establishment will only worsen the problems of the remainder of GRAS with respect to bus and minibus operation.
- It will generate difficult legal problems of property transfer that will be much easier to solve once GRAS is restructured.
- It will double management and administrative costs (one structure for GRAS and another for the new company).

- Its only interest is to separate trams and trolleybuses from indebted company GRAS, a problem that will be solved once GRAS is restructured.

In addition to this main issue, CS should concentrate on:

- infrastructure development to improve commercial speed, beginning with traffic light priority on the tram and trolleybus lines,
- offer adaptation to actual demand, following the recommendations of the traffic surveys performed in this report and constant traffic monitoring, and
- develop public service contracts with its operators according to the JICA Expert Team's recommendations.

The JICA Expert Team propose the following road map to address GRAS issues by priority. GRAS issues are the responsibility mainly by the CS.

**Table 3.5.1 Roadmap to Address GRAS Issues in Priority**

No	Question to be addressed	Who should make the decision / take the lead	Remarks
1	Should GRAS be liquidated, maintained, or split into other companies	Canton Sarajevo	If liquidated, an alternative operator should be defined. JICA Expert Team assumes GRAS is maintained or split into other companies.
2	Liberate operator(s) from the burden of debt they will never be able to reimburse.	Canton Sarajevo	The operator(s) should be able to deal with their current expenses. Operating profits should be limited, and alternative solutions should be found for existing debt.
3	Decide transport plan and allocate it between operators. Adapt fare structure.	Canton Sarajevo	
4	Establish business plan with investment and operation budget	Canton Sarajevo	Business plan should be prepared by GRAS and negotiated with Canton Sarajevo. If the financial burden is not sustainable, then the transport plan should be reduced (step 4 above)
5	Implement business plan. Adjust company resources and HR according to plan	GRAS	
6	Follow implementation of plan.	Canton Sarajevo	

Source: JICA Expert Team

## 2) Recommendations for CENTROTRANS

The data collection has enabled the JICA Expert Team to determine that CENTROTRANS is managed according to state-of-the-art procedures, with remarkable achievements in operational control and resource optimization.

Among the JICA Expert Team's general recommendations, developing more ambitious Corporate Social Responsibility programs (in particular with more employee participation) and better cooperation with CS to implement transparent Public Service contracts (in particular with more cost transparency) should be advised.

## 3) Recommendations for GRAS

The restructuring of GRAS is urgent. It first needs a solution to the debt issue, which cannot come from GRAS itself. In addition, the social and even political consequences of a complete restructuring of GRAS are such that only CS can manage them.

For this reason, and until CS takes its responsibilities regarding GRAS, the current survival strategy (i.e., do not make any move and try to survive on a day-to-day basis struggling with unpaid providers) of management probably is the bad option.

When the debt issue has been solved by CS, the GRAS structure needs to be adjusted to the modern rolling stock available for operation; It is extremely costly, uneconomical, and dangerous to operate buses over 20 years and trams and trolleybuses over 30 years. These obsolete rolling stock should be pure and simply disposed of. The staff and structure of the company should be adjusted to the remaining operational fleet; The JICA Expert Team has made detailed organigram proposals for the new KJKP JPS. A similar structure can be adjusted for a bus pure operator if it should be the fate of a restructured GRAS.

#### **4) Recommendations for SPTC**

As a new company, KJKP JPS should follow all the above general recommendations.

Splitting current GRAS into two operating companies will induce duplication of administrative structures. Based on the organigram proposal the JICA Expert Team made for the new company, the Team can evaluate this negative synergy to at least the whole GM department plus half of HR and half of finance departments, or around 15 additional staff.

#### **5) Financial Model of GRAS and SPTC**

The financial model of GRAS and SPTC was developed to estimate the financial performance of each entity until 2036 to evaluate the feasibility and profitability of each entity's operations. The financial model includes the operations of tram and trolley bus for GRAS, and tram, trolleybus, bus, and minibus for SPTC.

##### **(1) Assumptions**

###### Basic assumptions

- The base year of 2022 was considered in KM with an annual inflation rate of 1.4%<sup>11</sup>.
- The capital expenditure (CAPEX) is assumed to be covered by the Canton Sarajevo; therefore, revenue and operation, maintenance (OPEX) and financial costs were examined, and the depreciation costs were not included.

###### Revenue

- The number of passengers was derived from the demand forecast model and was adjusted based on the information from MOT about the number of monthly tickets sold.
- A weighted average single ticket fee was calculated based on four factors: 1) the ratio of single tickets (10%) and monthly tickets (90%), 2) the fees for single tickets (1.6 KM) and monthly tickets (0.67 KM), 3) the exclusion of VAT (17%), and 4) the inclusion of free riders (15%). The weighted average single ticket fee was 0.5543162 KM.

###### Personnel cost

- As for GRAS, the number of employees of 1,220 and the average gross monthly

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<sup>11</sup> 10 years average; data from the World Bank

salary of 1,893 KM in 2022 were applied, and the number of employees would be estimated to be reduced to 900 by 2036.

- As for SPTC, the number of employees would be estimated to be 267 for incorporation as shown in “1.3 Establishment of a New SPTC”.

#### Maintenance and fuel cost

- The GRAS profit & loss statement of 2019 was used as a benchmark as the figure of 2022 included some exceptional cases such as a temporary suspension of tram operations, etc.
- As for SPTC, the ratio of vehicle-km per year was derived from the demand forecast model (tram for 33% and trolleybus for 22%). Based on an internal benchmarking exercise undertaken by the JICA Expert team using datasets from previous EBRD and European tram and trolleybus projects, the introduction of new rolling stock is expected to reduce the maintenance and fuel cost by 50% for trolleybus and 24% for tram respectively, in reflection of the more energy efficient and newer rolling stock. Our financial model assumes that the new rolling stock would be introduced in 2024 for trolleybus and 2025 for tram.

#### Financial cost

- The debt repayment would continue to be a burden on either GRAS or Canton Sarajevo, and the current outstanding debt was assumed to be included in the financial cost of GRAS.

## (2) Results

The results of the financial model of both GRAS and SPTC are shown in the following table. As forecasted, the continuation of the current GRAS management would not provide any positive outcome; however, the financial forecast of SPTC showed positive figures. In order to achieve the scenario of establishing a new SPTC, a reduction of the number of employees as well as the introduction of new rolling stock to reduce the maintenance and fuel cost would be essential.

**Table 3.5.2 Financial Forecast of GRAS and SPTC**

Unit: '000 KM

GRAS Financial Forecast	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
1 Ticket revenue	26,769	26,640	26,512	26,384	26,257	26,130	26,004	25,878	25,754	25,629	25,506	25,383	25,260
2 Cost	57,933	57,843	57,757	57,673	57,594	57,518	57,445	57,376	57,310	57,248	57,189	57,134	57,083
2.1 OPEX	36,642	36,552	36,465	36,382	36,302	36,226	36,154	36,084	36,019	35,957	35,898	35,843	35,792
Personnel cost	27,665	27,449	27,235	27,023	26,812	26,603	26,396	26,190	25,986	25,783	25,582	25,383	25,185
Maintenance & fuel cost	8,977	9,102	9,230	9,359	9,490	9,623	9,758	9,894	10,033	10,173	10,316	10,460	10,607
2.2 Financial cost	21,291	21,291	21,291	21,291	21,291	21,291	21,291	21,291	21,291	21,291	21,291	21,291	21,291
3 Profit & Loss	-31,164	-31,203	-31,245	-31,290	-31,337	-31,388	-31,441	-31,497	-31,557	-31,619	-31,684	-31,752	-31,823

SPTC Financial Forecast	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
1 Ticket revenue	15,215	15,246	15,278	15,309	15,340	15,372	15,403	15,435	15,466	15,498	15,530	15,562	15,593
2 Cost	10,247	9,674	9,809	9,947	10,086	10,227	10,370	10,516	10,663	10,812	10,963	11,117	11,273
2 OPEX	10,247	9,674	9,809	9,947	10,086	10,227	10,370	10,516	10,663	10,812	10,963	11,117	11,273
Personnel cost	6,323	6,412	6,502	6,593	6,685	6,779	6,874	6,970	7,067	7,166	7,267	7,368	7,472
Maintenance & fuel cost	3,923	3,262	3,308	3,354	3,401	3,449	3,497	3,546	3,595	3,646	3,697	3,749	3,801
3 Profit & Loss	4,968	5,572	5,468	5,362	5,254	5,144	5,033	4,919	4,804	4,686	4,566	4,445	4,321

Source: JICA Expert Team

***APPENDIX***

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## A1 Vehicle Technology Selection: Total Cost of Ownership Comparisons

From the discussions held with the Canton to date, it has become evident that for public transport to flourish, there needs to be further investment in the system regarding rolling stock replacement and refurbishments to the infrastructure. The infrastructure pertinent to this particular scope of work includes but is not limited to the depots, traction power supply network (where applicable), and stops.

Against these and other institutional issues, the Canton is also considering the type of bus propulsion technology to invest in moving forward, as there are obvious incentives for introducing more electric-based mobility. However, given the higher upfront and unit costs for these technologies in comparison to traditional internal combustion engine-based vehicles, there is a trade-off between the maximum number of vehicles that the Canton can afford to purchase vis-à-vis the urgent need to replace the entire operating fleet and its ancillary infrastructure, and newer and more environmentally-friendly technology that requires higher upfront costs but may have lower operating & maintenance costs over the asset lifetime.

For the purposes of selecting the most appropriate vehicle technology for Sarajevo amongst the myriad choices, especially for buses, the JICA Expert team has undertaken a Total Cost of Ownership (TCO) analysis to facilitate an informed decision-making process.

For TCO comparisons, a bespoke Excel-based model has been developed to allow all the parameters to be automatically incorporated into the calculation and allow for the parallel assessment of multiple scenarios as required.

The model allows for both the financial and economic analysis of the TCO:

- Financial analysis: actual out-of-pocket costs, including investment costs in the form of rolling stock purchase and the construction of facilities, as well as operation and maintenance (O&M) costs (i.e. operating expenditure or OPEX).
- Economic analysis: Costs included in the financial analysis plus social cost, i.e. emissions and noise costs.

The following vehicle type options were assessed:

- Standard (12-m) bus – Diesel Euro VI
- Standard (12-m) bus – CNG
- Standard (12-m) bus – Battery Electric
- Standard (12-m) bus – Fuel Cell Electric Vehicle (Hydrogen)
- Standard (12-m) trolleybus – new (i.e., replacing the old trolleybuses but utilizing existing overhead line equipment and depot facilities already in place)
- Standard off-the-shelf Light Rail Vehicles or Trams with a carrying capacity (seated and standing of 200 passengers)

For consistency with the approach typically used by the European Investment Bank (EIB) and other European Union institutions when undertaking a cost-benefit analysis, the model

calculates the TCO per year over a 30-year time horizon based on the following parameters:

- vehicle purchase cost,
- vehicle lifetime,
- energy cost,
- maintenance cost,
- social cost, and
- infrastructure cost (capital and operational expenditures)

### A1.1 Vehicle Purchase Cost

For the vehicle purchase cost, a combination of actual tender prices taken from recent bus tenders as published in the Official Journal of the European Union (OJEU), EBRD tenders that the JICA Expert team has had access to, and the 2016 CIVITAS policy note.

For CNG buses the purchase price includes one replacement of the gas tanks within the vehicle's lifetime. In contrast, for battery electric buses, the purchase price consists of two replacements of the batteries within the vehicle's lifetime.

For trams, we have assumed a standard, modern low-floor 200-passenger (seated and standing at four passengers per m<sup>2</sup>) tram of similar configuration and performance as the ones in the City of Belgrade manufactured by the Spanish manufacturer, CAF.

The vehicle prices used are listed in the table below.

**Table A1.1.1 Vehicle Purchase Cost**

Engine Type	Cost [EUR]
Standard bus – Diesel Euro VI	220,000
Standard bus – CNG	270,000
Standard bus – Battery Electric	600,000
Standard bus - FCEV	645,000
Standard trolleybus	425,000
Standard low-floor tram	2,000,000

Source: JICA Expert Team

### A1.2 Vehicle Lifetime

For the vehicle lifetime duration, UITP and 2016 CIVITAS policy note figures for buses and trolleybuses were used. The assumptions used on the useful / serviceable life of the vehicles are summarized.

**Table A1.2.1 Vehicle Lifetime**

Engine Type	Lifetime [years]
Standard bus – Diesel Euro VI	12
Standard bus – CNG	12
Standard bus – Battery Electric	13.5
Standard bus - FCEV	13.5
Standard trolleybus (new)	20
Standard low-floor tram	30

Source: JICA Expert Team

### A1.3 Energy Cost

The energy cost was calculated based on EuroStat and historic Bosnian fuel data from the last 3–5 years (depending on the available data per fuel type). More specifically, local data from [www.ba.fuelo.net](http://www.ba.fuelo.net) estimates the price per liter (diesel) or kg (Hydrogen). The costs used in euros per km are shown in the following table.

**Table A1.3.1 Vehicle Lifetime**

Engine Type	Energy Cost [EUR/ km]
Standard bus - Diesel Euro VI	0.8262
Standard bus – CNG	0.7638
Standard bus – Battery Electric	0.1170
Standard bus – FCEV	0.7000
Standard trolleybus – New	0.1170
Standard Low-floor tram	0.2508

Source: JICA Expert Team

### A1.4 O&M Cost

For O&M costs, a blend of data from UITP and 2013 CIVITAS policy note prices for Euro VI diesel and CNG engines were used with historical data from GRAS and indicative market prices. The maintenance cost per km prices used are illustrated.

In the larger European cities, there is typically the option of outsourcing various aspects of operational and maintenance activities, such as heavy maintenance, to external service providers as there are usually many quality suppliers. For many of the larger systems in Europe, there are two general approaches to O&M. Cities, such as Madrid, tend to opt for vertical integration and doing everything in-house, while UK cities seek the best value-for-money option and outsource various O&M activities.

However, in the case of Sarajevo, few external service providers can step in and take over these responsibilities; therefore, in the case of GRAS and CENTROTRANS, their modus operandi requires all repairs to be undertaken internally.

**Table A1.4.1 Maintenance Cost**

Engine Type	O&M Cost [EUR/ km]
Standard bus - Diesel Euro VI	0.125
Standard bus – CNG	0.150
Standard bus – Battery Electric	0.075
Standard bus – FCEV	0.075
Standard trolleybus – New	0.175
Standard Low-Floor tram	1.510

Source: JICA Expert Team

### A1.5 Social Cost

Social costs include the cost of emissions and noise. More importantly, the analysis adopts a “Wells-to-Wheels” TCO approach in which emissions produced in the supply chain are also accounted for, not just at the exhaust pipe. Emissions costs are calculated based on engine emissions for combustion engines, while electric engines are based on electricity production emissions. The parameter values for emissions (g/vehkm) and noise (dB) are from the CIVITAS policy notes (2013 and 2016), while emissions and noise costs are from

the European Directive 2099/33/EC and the Mayeres et al. report (1997) respectively. The total social cost per vehicle type is illustrated in the table below.

**Table A1.5.1 Social Cost**

Engine Type	Social Cost [EUR/ km]
Standard bus - Diesel Euro VI	0.13
Standard bus – CNG	0.13
Standard bus – Battery Electric	0.08
Standard bus – FCEV	0.27
Standard trolleybus – New	0.08
Standard Low-Floor tram	0.22

Source: JICA Expert Team

## A1.6 Infrastructure Cost

The infrastructure cost (capital and operational expenditure) was calculated for decision-making if new infrastructure would be required, as illustrated in the following table.

**Table A1.6.1 Infrastructure Cost**

Engine Type	New Infrastructure required?	Infrastructure Type	Cost [EUR]
Standard bus – Diesel Euro VI	No		
Standard bus – CNG	Yes	CNF Refueling station	750,000
Standard bus – Battery Electric	Yes	Recharging Stations	(per station) 300,000 (in total) 4,500,000
Standard bus – FCEV	Yes	H2 Refueling station	950,000
Standard trolleybus – New	No		
Standard Low-Floor tram	No*		

Note: \*The use of new low-floor trams would however require the strict maintenance of tracks as described in the Fleet and Track Maintenance recommendations as the low-floor and bogies for the modern low-floor trams are more susceptible to damage if the track smoothness is not maintained.  
Source: JICA Expert Team

## A1.7 Summary Results

Using the TCO approach, the Economic or Financial Net Present Value (NPV) determines whether a particular technology is more cost-effective for the Canton of Sarajevo. A higher NPV, therefore, means a particular technology generally has a higher total cost of ownership and is more expensive to operate over its lifetime. Conversely, a lower NPV technology is cheaper and more cost-effective to operate. The TCO approach focuses on buses and omits any further consideration for trams, as the TCO analysis was at the behest of the Canton to look at buses only.

This model has limitations as operational considerations are not accounted for, such as the viability of operating a specific technology in specific locations in the Canton (e.g., the surrounding hillside with narrow streets and constrained turning radii, which limit the use of longer buses). That said, this TCO approach is still useful to inform the general direction for the Canton to take with respect to the type of technology to invest in over the longer term. More specific operational considerations can then be used to refine the choice of bus lengths (e.g., using shorter 10-m minibuses in lieu of the standard 12-m or articulated 18-m vehicle) for specific bus routes and lines.

For buses, the TCO analysis results illustrated in the figures below suggest that for GRAS's

current operations with 120–200 departures per day per vehicle (highlighted area in graph), trolleybuses and EURO VI Diesel buses are the two most cost-effective technologies to operate.

Evidently, the different technologies have different cost components, with electric, CNG, and hydrogen (FCEV) requiring heavy upfront investment for the refueling facilities as these have not previously been used in the Canton. However, electric, CNG, and hydrogen have lower OPEX and become more cost-effective as the system gets larger (economies of scale) since their cost curves are flatter. Conversely, diesel has a very low start-up cost but higher OPEX as the cost curve is steep.

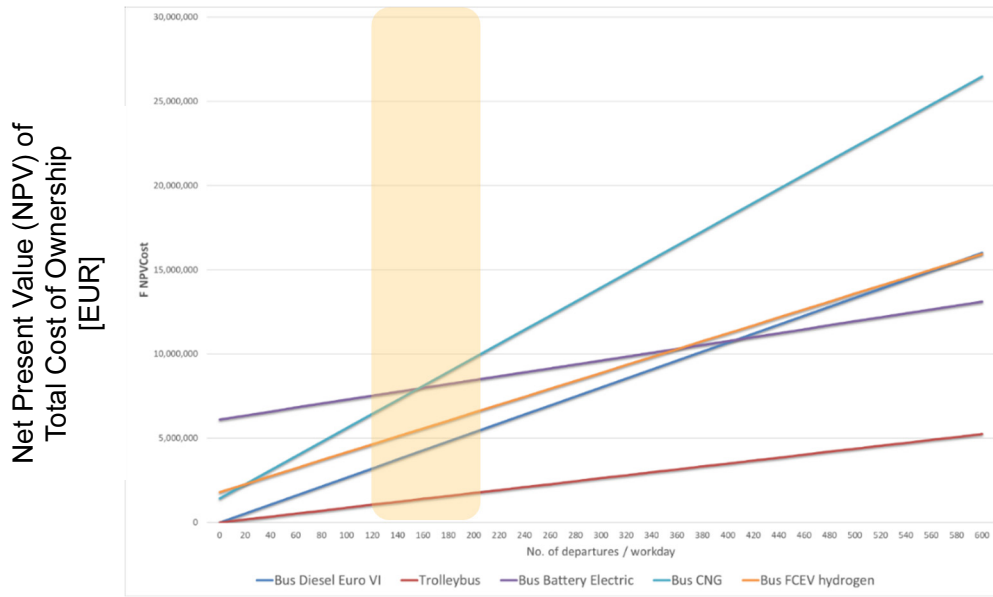
In short, the newer and more environmentally friendly technologies become increasingly cheaper per Veh-KM as the size of the public transport system gets larger in terms of service span and range.

Lastly, as depicted in the TCO curves plotted against Vehicle-km in the figure for 100 trips and 200 trips per day, the model also reveals that Diesel and CNG technologies are highly vulnerable to fuel price volatility since the energy cost has the biggest weight (omitting salaries since these would be the same across all technologies). As the number of trips and vehicle-km increase (see the graph for 200 trips per day), CNG buses become the most expensive technology while the trolleybus remains the most cost-effective. Between these two extremes, the JICA Expert Team notes that the hydrogen (FCEV) buses become more attractive for consideration as their cost curve approximates that of the Diesel EURO VI buses.

To conclude, these results suggest that the baseline recommendation would be to continue to invest in trolleybuses and EURO VI diesel buses if finance remains the determining factor behind the technology choice. However, if the Canton can obtain grants from donor countries to offset the high upfront capital costs of buying electric and hydrogen buses (in addition to assuring the supply chain for spare parts and green or blue hydrogen supply), these technologies become more attractive for consideration, especially for their busier and longer trunk routes which produce higher vehicle-km and daily trips. Opting to adopt electric and hydrogen buses, however, would also likely require the Canton to stipulate the need for knowledge transfer and maintenance for the initial few years. Since, in the view of the JICA Expert Team, GRAS and CENTROTRANS do not presently have the requisite expertise to operate and maintain these types of vehicles at this time since:

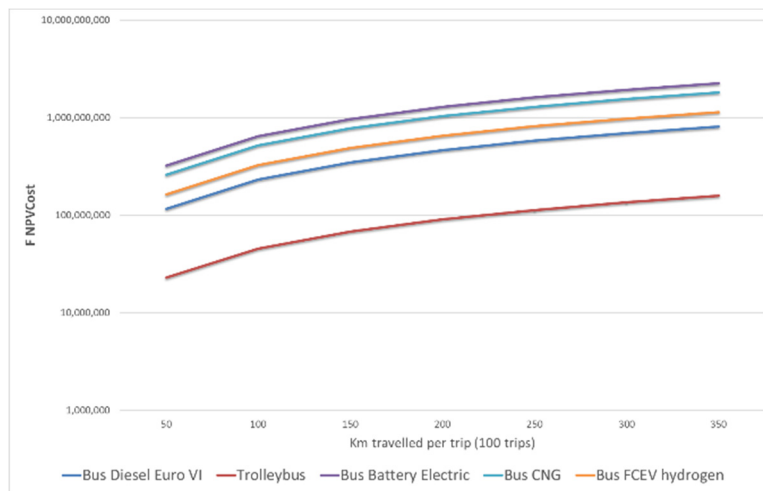
- (i) the sophisticated electronic systems are a step change from those of the trolleybuses and GRAS already struggles with this issue as described previously,
- (ii) without knowledge or history of dealing with lithium batteries and safety implications of charging, handling, and disposing of these hazardous materials, and
- (iii) the charging facilities for electric and hydrogen require significant investment and upgrades to the depots beyond those much-needed upgrades previously described.

Lastly, whilst trolleybuses remain the most cost-effective solution by some margin, there may be locations where the operation of electric and hydrogen buses without overhead wires will provide the Canton with greater operational flexibility and resilience.

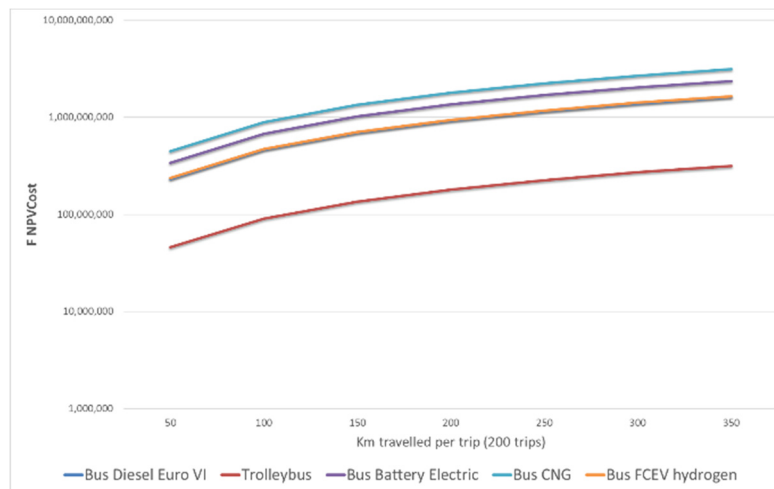


Source: JICA Expert Team

**Figure A1.7.1 TCO Results – Standard 12-m Buses (Financial Net Present Value vs Number of Departures per Day)**



TCO Curves for 100 Daily Trips



Source: JICA Expert Team

TCO Curves for 200 Daily Trips

**Figure A1.7.2 TCO Results – Standard 12-m Buses (Financial Net Present Value of Costs vs Vehicle-Kilometers per Day)**