Data Collection Survey on Improvement of Urban Transport Utilizing Conventional Railways in African Countries

Final Report

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Japan International Cooperation Agency (JICA)

Japan International Consultants for Transportation Co., Ltd.
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Table of Contents

List of Figures

List of Tables

Abbreviation List

Abbreviation	Definition
ACCT	Agence de Coopération Culturelle et Technique
AFC	Automated Fare Collection system
AFD	Agence Française de Développement(French Development Agency)
AfDB	African Development Bank
AFTU	Association de Financement des professionnels du Transport Urbain
AIBD	Aéroport International Blaise-Diagne
ANCF	Agence Nationale des Chemins de Fer
ANSD	Agence nationale de la Statistique et de la Démographique
APIX	Agence pour la promotion des investissements et des grands travaux
ATW/OBC	All Track Warranty / Onboard Computer System
AU	African Union
B3W	Build Back Better World
BCEAO	Banque centrale des États de l'Afrique de l'Ouest
BRT	Bus Rapid Transit
CAPEX	Capital Expenditure
CBD	Central Business District
CCC	Canadian Commercial Cooperation
CCD	Comité Communal de Développement
CETUD	Conseil Exécutif des Transports Urbains de Dakar
CFM	Portos e Caminhos de Ferro de Moçambique
CFS	Chemins de Fer du Sénégal
CLD	Comités Locaux de Développement
CO2	Carbon Dioxide
CRBC	China Road and Brdige Corporation
CSE	Compagnie Sahélienne d’Entreprises
DART	Dar Rapid Transit Agency
DBF	Dakar-Bamako Ferroviaire
DCRP	Dar es Salaam Commuter Rail Project
DDD	Dakar Dem Dikk
DEMU	Diesel Electric Multiple Unit
DMU	Diesel Multiple Unit
DUA	Direction de l’Urbanisme et de l’Architecture
E/N	Exchange of Notes
EAC	Ministry of East African Community
ECDPM	European Centre for Development Policy Management
ECOWAS	Economic Community of West African States
EMTASUD	Enquête-ménages sur la Mobilité, les Transports et l’Accès aux Services Urbains dans l’Agglomération de Dakar
EPC	Engineering Procurement Construction
EPSA	Enhanced Private Sector Assistance for Africa
E&S	Effective & Speedy Container Handling System
ETCS	European Train Control System
EU	European Union
FCFA	Franc de la Communauté Financière Africaine
F/S	Feasibility Study
G/A	Grant Agreement
GCO	Grande Côte Opérations
GDP	Gross Domestic Product
GNI	Gross National Income
GPS	Global Positioning System

GSM-R	Global System for Mobile communications - Railway
GTS	Grands Trains du Sénégal
ICC	International Criminal Court
ICS	Industries Chimiques du Sénégal
ICT	Ministry of Information, Communication and Technology
IMF	International Monetary Fund
INS	Institut National de la Statistique
JIC	Japan International Consultants for Transportation Co., Ltd.
JICA	Japan International Cooperation Agency
JICS	Japan International Cooperation System
JOCV	Japan Overseas Cooperation Volunteers
KBS	Kenya Bus Service
KeNHA	Kenya National Highways Authority
KRC	Kenya Railways Corporation
LRT	Light Rail Transit
LSCI	Liner Shipping Connectivity Index
LS-MFEZ	Lusaka South Multi Facility Economic Zone
MFDC	Mouvement des forces démocratiques de Casamance
MGR	Meter Gauge Railway
MITTD	Ministère des Infrastructures et des Transports Terrestres et du Désenclavement
MOT	Ministry of Transport
MoTIHUDP	Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works
MOU	Memorandum of Understanding
MP	Master Plan
MRT	Mass Rapid Transit
MTC	Ministry of Transports and Communications
MTL	Ministry of Transport and Logistics
NaMATA	Nairobi Metropolitan Area Transport Authority
NCR	Nairobi Commuter Rail
NCR MP	Nairobi Commuter Rail Master Plan
NCS	Nairobi Central Station
NEPAD	New Partnership for Africa’s Development
NGE	Nouvelles Générations d’Enterpreneurs
NIUPLAN	Nairobi Integrated Urban Deelopment Master Plan
NK	Nippon Koei Co., Ltd.
NMT	Non-Motorized Transport
NOx	Nitrogen Oxides
O&M	Operation and Maintenance
OCAJI	Overseas Construction Association of Japan, Inc.
OCC	Operation Control Center
OCG	Oriental Consultants Global Co., Ltd.
ODA	Official Development Assistance
OIC	Organisation of Islamic Cooperation
OIF	International Organization of La Francophonie
PAD	Port Autonome de Dakar
PAP	Plan d’Actions Prioritaires
PC	Pre-Stressed Concrete
PDS	Parti Démocratique Sénégalais
PDU	Plan Directeur d'Urbanisme de Dakar
PDUD	Plan de déplacements urbains pour l'agglomération de Dakar
PKO	United Nations Peacekeeping Operations

PMUD	Plan de Mobilité Urbaine Durable
PNSD	Plan National Stratégique de Développement
PPHPD	Passengers per hour per direction
PPP	Public-Private Partnership
P&R	Park and Ride
PSD	Platform Screen Doors
PSE	Plan Sénégal Emergent
PSS	Parti Socialiste du Sénégal
PTB	Petit Train de Banlieue
RAHCO	Rail Assets Holding Company
RCFS	Régie des Chemins de fer du Sénégal
REDD+	Reducing Emissions from Deforestation and Forest Degradation in developing countries
ROW	Right-of-Way
SACCO	Saving and Credit Co-Operative Society
SADC	Southern African Development Community
SCTP	Société Commerciale des Transports et des Ports
SDGs	Sustainable Development Goals
SEN-TER	Société Nationale de Gestion du Patrimoine du Train Express Régional
SERF	Secrétaire d’Etat chargé du Réseau Ferroviaire sénégalais
SETER	Société d'Exploitation et de maintenance de la ligne du TER
SGR	Standard Gauge Railway
SNCC	Société nationale des chemins de fer du Congo
SNCS	Société nationale des chemins de fer du Sénégal
SNS	Social Networking Service
SOSAK	Schéma d'Orientation Stratégique de l' Agglomérations de Kinshasa
SPM	Suspended Particulate Matter
STEP	Special Terms for Economic Partnership
TAZARA	Tanzania-Zambia Railway
TCC	Trans Connexion Congo SARL
TER	Train Express Régional
TEU	Twenty-foot Equivalent Unit
TIRP	Tanzania Intermodal and Rail Development Project
TOD	Transit Oriented Development
Transco	Transport au Congo
TRC	Tanzania Railways Corporation
TRL	Tanzania Railways Limited
TSO	Travaux du Sud-Ouest
UAE	United Arab Emirates
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UN-HABITAT	United Nations Human Settlements Programme
UPS	Union Progressiste Sénégalaise
USD	United States Dollar
WB	World Bank
YEC	Yachiyo Engineering Co., Ltd.
ZRL	Zambia Railways Limited

Chapter 1 Background and Purpose of the Study

1.1 Background of the Study

The urban population of Africa has grown continuously in recent years. It is expected to reach 1 billion people by 2040[1]. The cities are expected to play a vital role in the economic growth of African countries.

Among the large cities in Africa, Dar es Salaam in Tanzania, Nairobi in Kenya, Kinshasa in the Democratic Republic of the Congo, Maputo in Mozambique, and Lusaka in Zambia have not been able to develop transportation infrastructure to keep up with the fast concentration of population and constant traffic congestion in their city centers. Such situation brings huge economic loss to the countries. Dakar in Senegal is faced with similar problems. In addition, because heavy trucks are used to transport most of the goods between the port of Dakar, which is located in the central part of the city, and the hinterland, these trucks further exacerbate traffic congestion in the city.

In order to resolve these problems, JICA is assisting these cities in formulating urban master plans or urban transport master plans. The World Bank and the African Development Bank (AfDB) are also providing support for urban transport development in these countries.

Among the mass transportation systems, the railway is indispensable from the perspectives of its capacity for mass transportation, punctuality, safety, and energy efficiency. In the master plans of the cities mentioned above[2], the construction of new railways and the improvement of existing railways have been proposed frequently. Compared to the construction of a new railway, upgrading an existing one may be restricted to a certain extent by the existing infrastructure. However, it is a viable option to increase transportation capacity step by step and at a lower cost. Upgrading an existing railway also helps to develop human resources and strengthen management structure in the process, not to mention the progressive increase in transportation capacity. As of today, no concrete progress has been made in upgrading the existing railways, as has been proposed in the master plans of the cities mentioned above. It is necessary, therefore, to conduct an in-depth review of the proposals in each of these master plans and put forward actionable recommendations to help solve the transportation issues in these cities.

1.2 Purpose of Study

The purpose of this Study is to propose railway development plans through grant aid and technical cooperation projects, while reviewing proposals in the urban transport master plans, current state and issues of the railways, utilization of Japanese technologies, and collaboration with other donors. The objectives of this Study are as follows:

Objective 1: Proposition of improvement plans and roadmaps for the existing railways based on urban master plans and urban transport master plans

Objective 2: Proposition that addresses the current state and issues of the existing railways, utilization of Japanese technologies, and collaboration with other donors

Objective 3: Proposition for future grant aid and technical cooperation

[1] World Bank, "Africa’s Cities: Opening the Door to the World," 2017.
[2] JICA, "The project for revision of Dar Es Salaam urban transport master plan," 2018
JICA, "Project on Integrated Urban Development Master Plan for the City of Nairobi," 2014.
JICA, "Project for Urban Transport Master Plan in Kinshasa," 2018.
JICA, "Comprehensive Urban Transport Master Plan for the Greater Maputo," 2014.
JICA, "The study on comprehensive urban development plan for the City of Lusaka," 2009
JICA, " Project for Urban Master Plan of Dakar and Neighboring Area for 2035," 2016

1.3 Areas of Study

This Study covers six cities: Dar es Salaam (Tanzania), Nairobi (Kenya), Kinshasa (Democratic Republic of the Congo), Maputo (Mozambique), Lusaka (Zambia), and Dakar (Senegal). Figure 1-1 shows the locations of the countries surveyed and their railway networks.

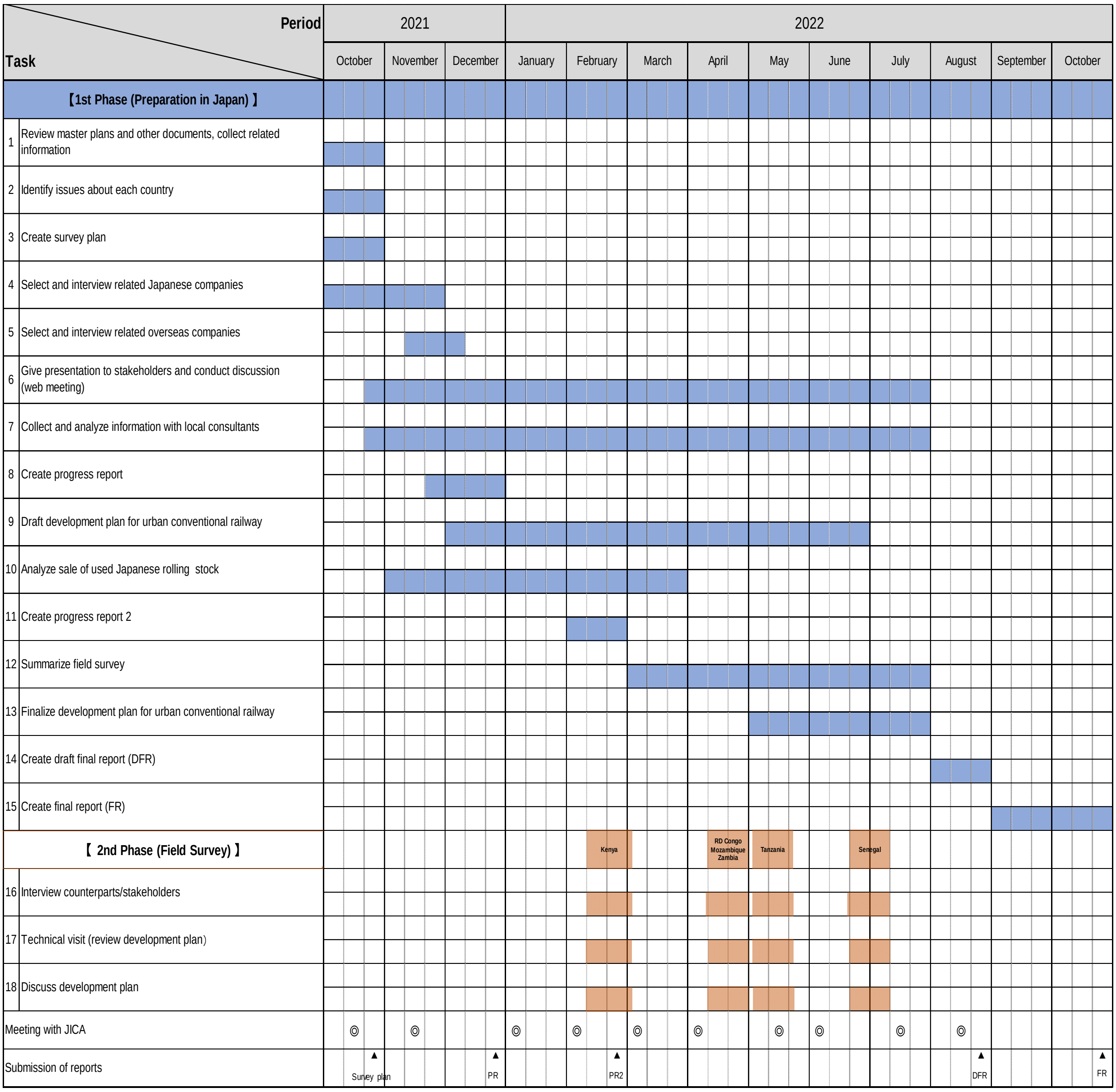
Source: Railways of the World, JARTS, 2015, and edited by JICA Study Team

Figure 1-1 Locations of the Countries Surveyed and Their Railway Networks

1.4 Study Process and Related Organizations

(1) Study Process

Figure 1-2 shows the process of this Study. The Study was conducted in two phases: the first phase was conducted in Japan and the second phase was field surveys. In the first phase and the period after the field surveys in the second phase, the Study was conducted mainly online through interviews with local consultants and various JICA overseas offices.



Source: JICA Study Team

Figure 1-2 Study Process

1.5 Organizations related to the Study

Table 1-1 shows the major organizations related to this Study.

In Dar es Salaam (Tanzania), the railways are operated by two different operators: the Tanzania Railways Corporation (TRC) and the Tanzania–Zambia Railway Corporation (TAZARA). This Study focuses on the railway lines operated by TRC.

In Maputo (Mozambique), in addition to railway services provided by the Ports and Railways of Mozambique (CFM), Metrobus also operates passenger trains on the CFM railway network. It is also included in the review.

In Dakar (Senegal), since the development of freight lines within the port of Dakar is being considered, the Study will review the railway company and the port authority.

Table 1-1 List of Governmental Authorities in the Railway Sector, Railway Companies, and Other Donors

City (Country)	Type	Name of the organization concerned
Dar es Salaam (Tanzania)	Government Authority	Ministry of Work, Transport and Communications
	Railway company	Tanzania Railway Corporation (TRC)
Nairobi (Kenya)	Government Authority	Ministry of Transport and Infrastructure
	Railway company	Kenya Railways Corporation (KRC)
Kinshasa (Democratic Republic of the Congo)	Government Authority	Ministry of Transport and Communications
	Railway company	Société Commerciale des Transports et des Ports (SCTP, Commercial Society of Ports and Transports)
Maputo (Mozambique)	Government Authority	Ministry of Transports and Communications
	Railway company	Portos e Caminhos de Ferro de Moçambique (CFM, Ports and Railways of Mozambique)
		Metrobus
Lusaka (Zambia)	Government Authority	Ministry of Transport, Works, Supply and Communication
	Railway company	Zambia Railways Limited (ZRL)
Dakar (Senegal)	Government Authority	Agence nationale pour la Promotion des Investissements et des grands travaux (APIX, National Agency for the Promotion of Investments and Major Projects)
	Railway company	Chemins de Fer du Sénégal (CFS, Senegal Railways)
	Port Authority	Port Autonome de Dakar (PAD, Dakar Port Authority)
Others	Other donors	World Bank
		African Development Bank (AfDB)
		Agence Française de Développement (AFD, French Development Agency)

Source: JICA Study Team

1.6 Study Team Members

Table 1-2 shows members of the Study Team

Table 1-2 Study Team Members

Name	Assigned position	Company
AKIYAMA, Yoshihiro	Team leader/ Railway improvement planning 1 (Kinshasa, Democratic Republic of the Congo)/ Railway improvement planning 6 (Dakar, Senegal)	JIC
KIKUIRI, Takashi	Railway improvement planning 2 (Maputo, Mozambique)	OCG
KAWAI, Nobuyoshi	Railway improvement planning 3 (Dar es Salaam, Tanzania)	OCG
TANIMOTO, Shuichi	Railway improvement planning 4 (Nairobi, Kenya)	NK
FUJIWARA, Nobuyoshi	Railway improvement planning 5 (Lusaka, Zambia)	JIC (YEC)
MATSUO, Nobuyuki	Track	JIC
ABE, Yutaka	Track 2	JIC
TAKEMURA, Kiichi	Signal	JIC
WATAI, Keisuke	Rolling stock	JIC
NAKAO, Daiju	Station	JIC
SAKAMOTO, Yasutaka	Station plaza	JIC
TAKAHASHI, Yasuo	Transport planning	JIC
ASHITANI, Yusei	Logistics Analyst	JIC

Source: JICA Study Team

Chapter 2 Dar es Salaam (Tanzania)

2.1 Overview of Tanzania and Dar es Salaam

2.1.1 Tanzania

(1) Topographical Overview

The United Republic of Tanzania is situated in the eastern part of the African continent, bordering Kenya, Uganda, Rwanda, Burundi, Zambia, Malawi and Mozambique. To the west of Tanzania is the Democratic Republic of the Congo, which is on the west side of Lake Tanganyika, and to the east of Tanzania is the Indian Ocean. The Zanzibar Islands lie about 50 kilometers off the Indian Ocean. The plain extends several tens of kilometers from the coast of the Indian Ocean, but to the west of it lies a plateau 900–1,200 meters above sea level. There are major trenches running north to south in the west, and Mt. Kilimanjaro (5,895 meters above sea level), the highest mountain in Africa, is in the northeast.

The national land area of Tanzania is 945,000 square kilometers (about 2.5 times that of Japan) and the population is 59.73 million people (2020), which is on the rise. Most of the country's land areas have a Savannah climate, but the central region has a steppe climate, and the southern and northern highlands have mild winters.[3]

The official capital of Tanzania is Dodoma. Dar es Salaam, which is the economic center of the country, performs the actual capital functions. Dar es Salaam is located in eastern Tanzania and is the largest port city facing the Indian Ocean.

(2) Economic Overview

Tanzania pursued socialist economic policies after it became independent from the United Kingdom in 1961. However, Tanzania’s economy went into crisis in the 1980s. Since 1986, it shifted from a socialist economy to a market economy, with support from the World Bank and the IMF. Economic reforms were carried out through deregulation and other measures, but the economy stagnated in the 1990s. Since then, the economy has grown from around 2000, and industries such as mining, information and communications, transportation, and construction have grown steadily, maintaining a certain degree of balanced growth. Tanzania’s GDP increased from USD 13.38 billion in 2000 to USD 62.41 billion in 2020, an increase of about 4.7 times. Nearly 70% of the working population is engaged in agriculture, and the government is focusing on the growth and productivity of the agriculture sector.

Despite the progress of market liberalization in many industries, the government is still heavily involved in sectors such as telecommunications, banking, energy, and mining. Meanwhile, the financial sector has expanded in recent years, with foreign banks holding nearly half of the total assets in the banking sector. In a way, the increased competition from foreign banks has improved the efficiency and quality of the financial services.

(3) Political and Administrative Structure

Tanzania is a united republic made up of the Republic of Tanganyika (mainland) and Zanzibar (islands). The president of the United Republic of Tanzania is elected directly by voters on the mainland and the Zanzibar Islands. Zanzibar also has its own president, as well as autonomy of its judicial, legislative and administrative branches, which are separate from the Government of the United Republic. The mainland Tanganyika does not have an autonomous government of its own.

Tanzania has 31 provinces. Of these, 26 provinces are in Tanganyika and five provinces are in the Zanzibar Autonomous Region.

[3] Source: *Data Book of the World, World Directory and Latest Statistics,* Vol. 33, 2021 (Ninomiya Shoten)

(4) Japan's Assistance Policy

Japan's assistance to Tanzania is focused on three areas: 1: development of the sectors that drive economic growth; 2: infrastructure development to support economic and social development; and 3: improvement of governance and administrative services.

The agriculture sector in Tanzania is important for ensuring food security and maintaining a stable rural economy, with over 70% of the population engaged in agriculture. To date, grant aids or loan aids have been received, including the Zanzibar Malindi Fishing Port Market Rehabilitation Project and the Small-Scale Irrigation Development Project.

In terms of the development of infrastructure to support economic and social development, Japan has rendered support through "quality infrastructure" by developing basic infrastructure for transportation, power supply etc. To date, grant aids have been extended to the Tazara Intersection Improvement Project, the New Bagamoyo Road Widening Project, and the Dar es Salaam Power Transmission and Distribution Strengthening Project.

Amid growing concerns over the widening regional disparities and income disparities resulting from economic growth and urbanization, it is important to improve basic administrative services such as local administration, water, and health and medical services, from the perspective of equity. To date, grant aids have been provided to implement the Tabora Water Supply Project, the Mwanza and Mala Water Supply Projects, and the Metropolitan Area Water Supply Project.

2.1.2 Dar es Salaam

(1) Basic Data

At present, the official capital of Tanzania is Dodoma, but Dar es Salaam is the economic center that performs many of the functions of a capital. Dar es Salaam is the largest city in the United Republic of Tanzania, with 1,590 square kilometers and 5,116,000 people (2015).[4] Dar es Sallam has a tropical, coastal, and moist climate, with a maximum temperature around 30°C and a minimum temperature around 20°C throughout the year.

The population is projected to grow rapidly to 15.97 million by 2050, 37.49 million by 2075, and 73.68 million by 2100.

(2) Institutional Framework

Dar es Salaam is divided into five administrative districts: Ilala, Quinondoni, Temeke, Kiganboni and Ubungo, four of which are governed by city councils belonging to the suburbs or wards of the city.

2.2 Current State of Urban Transport Infrastructure

2.2.1 Rail

The railway network in Tanzania is operated by two different entities. The Tanzania Railways Corporation (TRC) operates a line that has a narrow-gauge of 1,000 mm and a total length of approximately 2,700 kilometers. The Tanzania Zambia Railway Company (TAZARA) operates a line that connects Dar es Salaam and Capilim Poshi in Zambia. It has a 1,067-mm gauge and a total length of 1,859 kilometers. As of June 2022, TRC has been constructing an electric railway line with a 1,435-mm gauge; the line is not in operation yet. Figure 2-1 shows the railway map of Tanzania.

[4] Source: *Data Book of the World, World Directory and Latest Statistics*, Vol.33, 2021 (Ninomiya Shoten)

Source: "Railways of the World", Japan Overseas Association for Railway Technical Cooperation (JARTS)

Figure 2-1 Railway Map of Tanzania

Dar es Salaam has two commuting lines operated by TRC, and lines operated by TAZARA. The Ubungo Line and Pugu Line operated by TRC are the subjects of this Study. Tables 2-1 shows the operating conditions of the two commuter lines and Figure 2-2 is a route map of the two lines.

A train operating on the Ubungo Line has one diesel locomotive and four to six passenger cars and a train operating on the Pugu Line has one diesel locomotive and 16 to 17 passenger cars. The average number of passengers per month, which is the 3-month average of July, August, and September of 2021, is approximately 38,000 passengers on the Ubungo Line and 179,000 passengers on the Pugu Line.

Table 2-1 Operation of TRC Commuter Lines

Name	Description of line	Total length	Number of trains in operation
Ubungo Line	Operates between Kamata and Ubungo Maziwa	Approx. 12 km	6 round trips per day (3 round trips in the morning and 3 round trips in the evening)
Pugu Line	Operates between Kamata and Pugu	Approx. 20 km	6 round trips per day (3 round trips in the morning and 3 round trips in the evening)

Source: JICA Study Team

Source: JICA Study Team

Figure 2-2 Route Map of TRC Commuter Lines

2.2.2 Non-rail Public Transportation

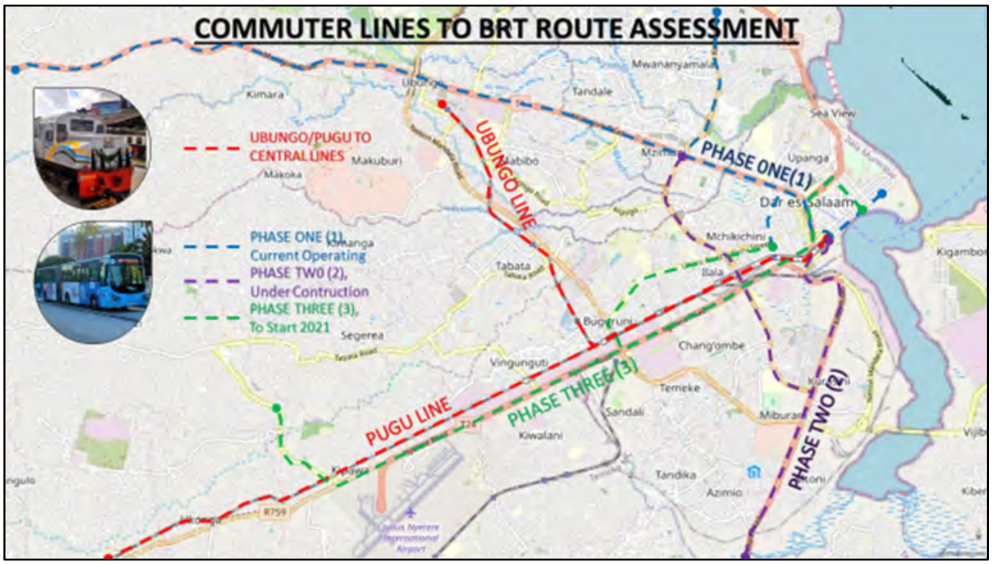
Minibus called dala dala are the primary means of public transportation for Dar es Salaam citizens. They operate mainly in the city of Dar es Salaam. There are many dala dala minibuses in operation and over 200 routes; some go as far as Bagamoyo.

As shown in Figure 2-4, the BRT is currently operating along Morogoro Road. The route along Kiwa Road is under construction as Phase 2 of the BRT project, and Phase-3 construction of the route along Nyerere Road is scheduled to start.

Source: JICA Study Team

Figure 2-3 Dala Dala Minibuses

There are also other types of transportation, such as the three-wheeled taxis called Bajaj and the motorcycles called pikipiki.



Source: JICA Study Team

Figure 2-4 BRT Route Map

2.3 Past JICA Aid Projects

Since the Study on Comprehensive Urban Transport System Development in Dar es Salaam in 2008, the Preparatory Study for the Improvement of Transport Function in Dar es Salaam City (2011) and the Project for Capacity Development for Urban Transport in Dar es Salaam (2013) have been carried out with JICA support. Table 2-2 shows the two projects sponsored by JICA that are largely related to this Study, and three projects sponsored by other donors.

Table 2-2 Related Projects

	Projects sponsored by JICA
1	The Project for Revision of Dar es Salaam Urban Transport Master Plan 2018
2	Data Collection Survey on Dar es Salaam Urban Transportation 2020
	Projects sponsored by other donors
1	BRT Projects
2	SGR Project
3	Tanzania Intermodal and Rail Project (TIRP)

Source: JICA Study Team

The projects shown in Table 2-2 above are summarized below.

2.3.1 The Project for Revision of Dar es Salaam Urban Transport Master Plan

(1) Background

The Project for Revision of Dar es Salaam Urban Transport Master Plan was carried out by JICA to revise the 2008 Dar es Salaam City Urban Transport Master Plan because ten years had passed since formulation of the 2008 master plan. The population and transportation demand in Dar es Salaam city were increasing rapidly and at paces much faster than the forecasts in the 2008 master plan. While the target year was 2030 in the 2008 master plan, it was reset to 2040 in the project for revising the master plan. The urban transport master plan was revised after a traffic survey, studies, and discussions with relevant Tanzanian organizations had been conducted.

(2) Rail-based Public Transportation

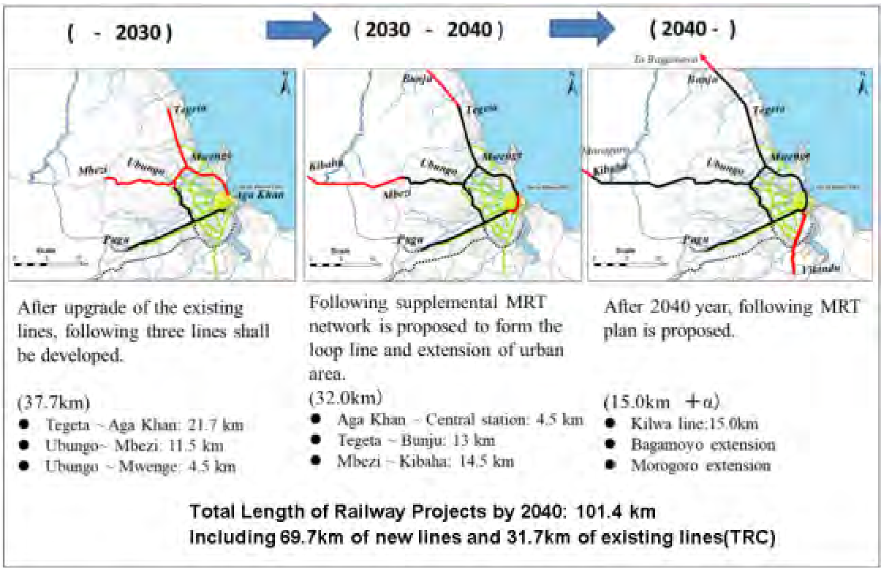
While the railway requires large investment and long construction time, the BRT can start services in a relatively short period of time, especially by linking its development with a road-widening project. The revised master plan aims at creating a transportation network capable of covering both short and long distances.

The revised master plan identified BRT as the main public transportation means for its short- and medium-term plans. From the medium term onwards, the BRT and railway would provide public transport services in coordination with each other.

The existing railway lines include the Pugu Line, Ubungo Line, and lines operated by the Tazara Railway, as mentioned above. The Pugu Line and the Ubungo Line each offers six round trips per day, providing highly punctual commuter train services. However, upgrading the aging railway infrastructure, electrification, and doubling of track are necessary to further improve services.

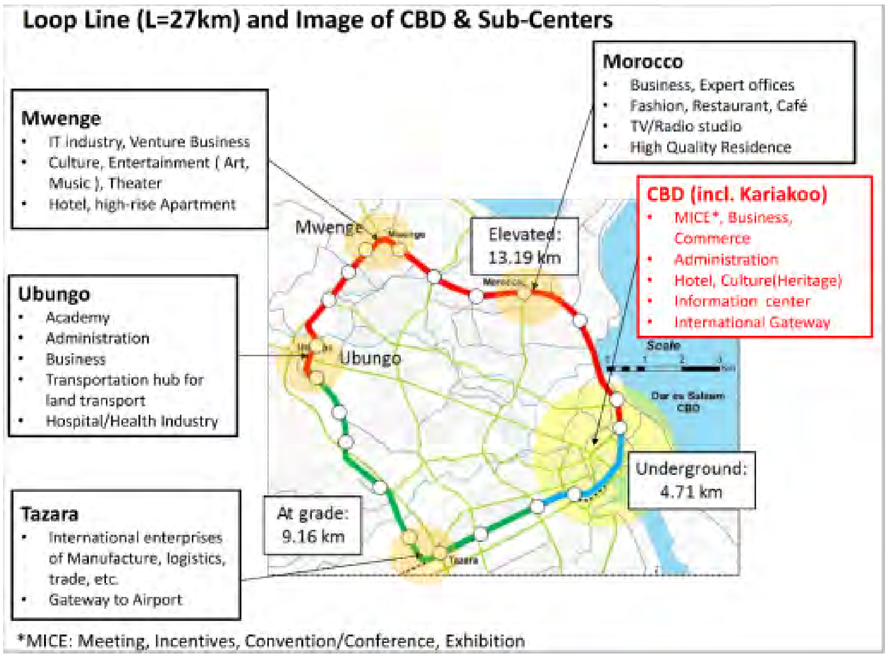
(3) Priority Project for Railway Modernization

It has been proposed that the existing lines be improved by 2025 to make more effective use of them, and new railway lines such as the Tegeta Line, Morogoro Line, and a loop line be developed by 2030 to create a railway network with a radius of 20 km from the center of Dar es Salaam. Furthermore, the existing lines and the new lines shall be connected by 2040 to increase the radius of the railway network to 30 km in order to cover most of the areas in the city.



Source: The Project for Revision of Dar es Salaam Urban Transport Master Plan

Figure 2-5 Railway Development Plan in Phases



Source: The Project for Revision of Dar es Salaam Urban Transport Master Plan

Figure 2-6 Railway Loop Line Development Plan

2.3.2 Data Collection Study on Dar es Salaam Urban Transportation

The 2018 revised master plan proposed adoption of ITS (intelligent transportation system), improvement of intersections, development of public transportation terminals, and construction of urban railways in Dar es Salaam to mitigate chronic traffic congestion and to utilize the existing road infrastructure more efficiently. In order to implement these recommendations, the government of Tanzania is conducting related research. This Study was carried out in 2020 to enable JICA to conduct a preliminary review on the technical feasibility and priority of each project, and the feasibility of utilizing Japanese technologies, as well as to determine the financial cooperation policy for strengthening the urban transportation capacity of Dar es Salaam city.

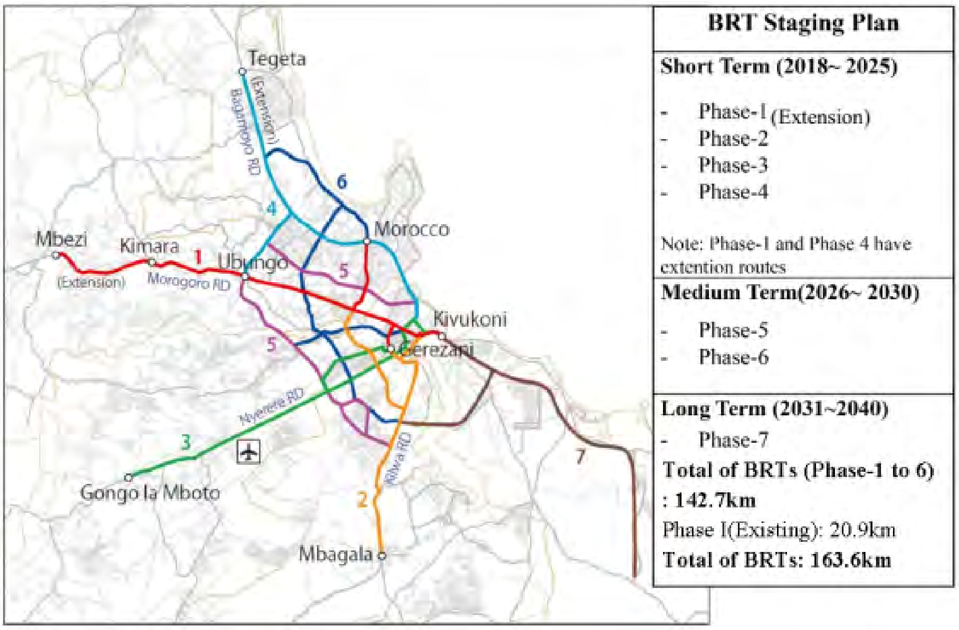
As for the railway, this Study reviewed the issues and solutions relating to the organizational structure, capacity, and technology of TRC, as well as the Dar es Salaam Community Rail Project (DCRP) Feasibility Study, which was implemented by TRC in June 2019. Issues such as "restructuring of the old system," "elimination of personnel shortage," "understanding of the risks involving land acquisition" "acquisition of basic knowledge for planning an electric railway," and "acquisition of knowledge for the operation and maintenance of an urban railway" were identified. As solutions, the "Establishment of a new technical department and strengthening of management system," "recruitment of experienced personnel with knowledge of transportation," and "capability-building with the help of railway experts" were proposed.

2.4 Initiatives by Other Donors

2.4.1 BRT Projects

According to the 2018 revised master plan, BRT can be introduced in a relatively short period of time when carried out in conjunction with a road-widening project. For this reason, the BRT is expected to be the main public transportation means for a short- to medium-term, especially until around 2025. From 2030 onward, the BRT and the railway are expected to provide public transport services in a concerted manner to create a transportation network capable of covering short to long distances. The BRT will cover demand within a radius of 20 km from the CBD, while the railway will cover long-distance demand within 30 km inside the city limits, and also beyond in the long term. The railway, BRT, as well as feeder bus services, shall coordinate their operations and shoulder their shares of the demand within the transportation network.

As shown in Figure 2-7, the Phase 4 of the BRT development will be completed by 2025. Thereafter, Phases 5 and 6 are expected to be completed by 2030, and Phase 7 be completed by 2040. The construction of Phase 1 was financed by the African Development Bank, the World Bank, and the government of Tanzania. The BRT first started operation in 2016.



Source: The Project for Revision of Dar es Salaam Urban Transport Master Plan

Figure 2-7 BRT Development in Phases

The TRC commuter lines include the Pugu Line, which runs parallel to the planned Phase-3 BRT line on Njerele Road, and the Ubungo Line, which runs roughly parallel to the planned Phase-5 BRT line on Nelson Mandela Road (see Figures 2-30 and 2-31). The commuter rail lines and the BRT lines are about 300 m to 500 m apart. They will complement each other by sharing the demand, which is expected to increase over time. The Ubungo Line is part of the future extension to Mbeji and Mwenge/Tegeta proposed in the revised master plan and the TRC FS.

2.4.2 SGR Project

This project plans to construct an electrified, standard-gauge (1,435 mm) railway from Dar es Salaam on the east coast to Mwanza on the north coast. The line will be 1,219 km in length, with a design maximum speed of 160 km/h for passenger trains and 120 km/h for freight trains. The project is financed by Nippon Export and Investment Insurance, Danish Export Credit Fund, Swedish export credit agencies, African Export and Import Bank, Southern Africa Development Bank, and Eastern and Southern Africa Trade and Development Bank. The 201-km section from Dar es Salaam to Morogoro is Phase 1 and the 426-km section from Morogoro to Machupola is Phase 2. They are currently under construction. Both sections are using rails manufactured by Nippon Steel Corporation and exported by Mitsui & Co. The standard gauge railway (SGR) is designed for high-speed transportation. The trip between Dar es Salaam and Morogoro takes four hours and thirty minutes by bus but only an hour and thirty minutes by SGR. The transportation cost for freight on the SGR can be reduced by 40%. This SGR is designed to transport long distance passengers and long distance freight in a short period of time. Information on the opening date of the SGR varies. As of May 2022, the passenger line section ending at the Dar es Salaam Central Station was seen being constructed but construction of the branch line from the vicinity of the Ilala Yard to the Dar es Salaam Port has not started yet. According to the latest information from TRC, Phase 1 between Dar es Salaam and Morogoro will open in 2023/2024 and Phase 2 between Morogoro and Machupola will open in 2024/2025.

2.4.3 TIRP

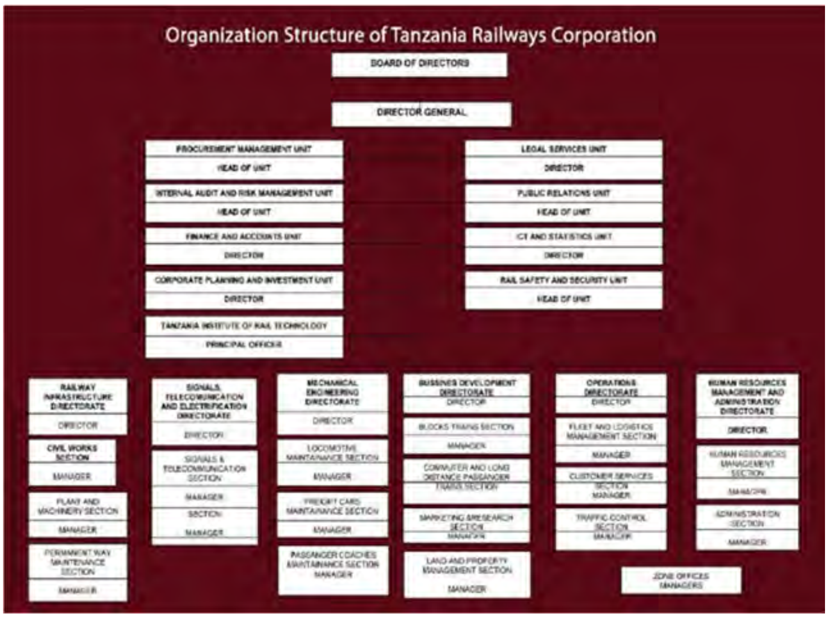
The Tanzania Intermodal and Rail Project (TIRP) is a project financed by the World Bank to upgrade the tracks of the TRC Central Line (a trunk line that crosses the central part of Tanzania), which is a conventional railway. The project began in 2018 and was completed in 2021. The total cost of the project was $300 million, which included the procurement of locomotives and freight cars. In order to increase the freight transport volume on the Central Line and reduce speed limitation, the tracks were upgraded (from 13 tons of axial weight to 18.5 tons of axial weight), the 56-pound rail and 60-pound rail were replaced with the 80-pound long rails, and the obsolete rails were also replaced. The bridges were reinforced or replaced to enable them to withstand the change of axial load from 13 tons to 18.5 tons. As is shown in Fig. 2-9, the section between Pugu Station and Ilala Yard on the Pugu Line was part of TIRP. Improvement of this section has been completed.

2.5 Current State of TRC and Commuter Lines, and Issues

Both the Pugu Line and the Ubungo Line are important lines for TRC, making it difficult for TRC to prioritize them. Despite repeated requests to TRC regarding which line should be prioritized for improvement, there was no reply. Therefore, this Study has summarized the current conditions of both lines, highlighted their issues, made recommendation for a priority line, and determined the scope of improvement necessary.

2.5.1 Current State of TRC

The current TRC was established by merging TRL (Tanzania Railways Limited) and RAHCO (Rail Assets Holding Company), which were divided into two organizations by the Railway Act No. 10 enacted in 2017. Figure 2-7 shows the TRC organizational chart. TRC has approximately 3,300 employees and approximately 78 employees are assigned to the commuter line services. Under the current ticket inspection system, two crewmembers are assigned to each passenger car to inspect tickets. A commuter train on the Pugu Line, which has from 16 to 17 passenger cars in the train set, will have 32 to 34 crewmembers on board, excluding the driver. It is understandable, therefore, that about 78 crewmembers are needed for the commuter lines.



Source: TRC Website

Figure 2-8 Organizational Chart of TRC

The TRC and the government of Tanzania have indicated their intention to develop SGR while continuing operation of the existing meter-gauge railways. This policy is evident in the Tanzania Intermodal and Rail Project (TIRP), a project designed to upgrade the tracks of an existing line (the meter-gauge Central Line). With assistance from the World Bank, the project has been carried out to improve freight transport. However, TRC has not stated clearly its policy for the commuting lines in the greater Dar es Salaam area.

There are plans to develop the commuter lines in the greater Dar es Salaam area. The existing Pugu and Ubungo commuter lines are operated on meter-gauge tracks. However, the Dar es Salaam Commuter Rail Project (DCRP) FS completed in 2019 and the Pre-FS of the Tegeta Line carried out under the JICA revised master plan in 2018 were both proposed based on standard gauge. Therefore, it is not clear whether the urban railways in the greater Dar es Salaam area is moving toward standard gauge in the future or not. To our inquiry on what gauge that TRC plans to use for its commuter lines in the future, TRC’s reply was "The Dar es Salaam SGR commuter railway is a mega project. The first route is scheduled to be completed in 2024 and the project as a whole is scheduled to be completed in 2056. Since the project has not started yet, the Dar es Salaam commuter rail services will continue to be provided on meter gauge."

2.5.2 TRC Budget Status

Table 2-3 shows TRC budgets for the last three years.

Table 2-3 TRC Budgets for Last Three Years

	2018/19		2019/20		2020/21	
	Target	Actual	Target	Actual	Target	Actual
Budget (TZS billion)	2,219	1,539	3,064	1,960	2,628	1,957

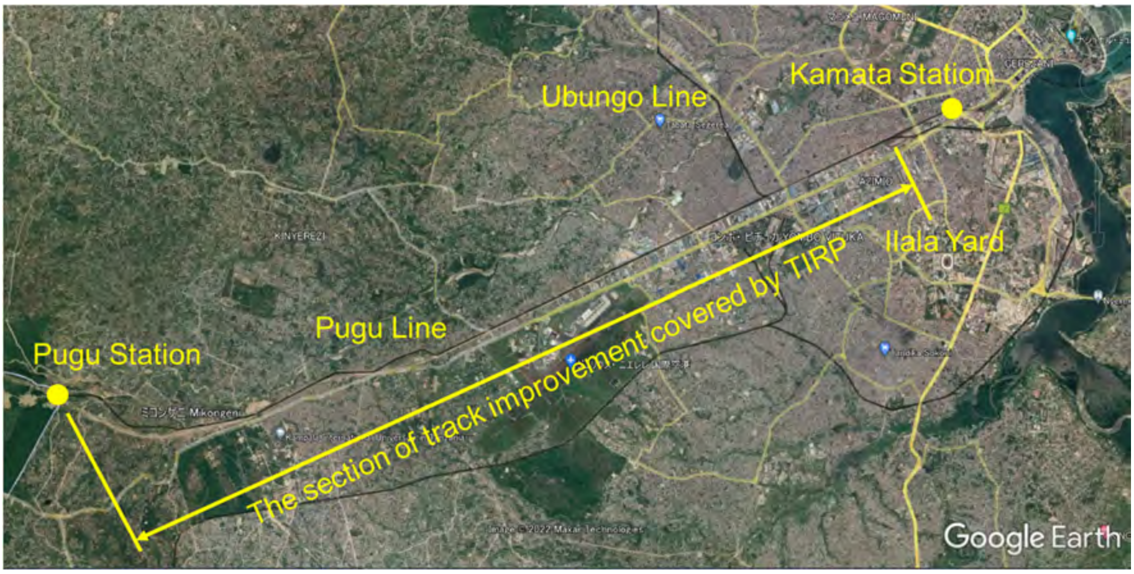
Source: 14th Joint Transport Sector Review (JTSR 2021) July, 2021

Data obtained from TRC show that the unit mentioned in the table above was TZS trillion. If the unit is indeed trillion, TRC will have a scale of 100 trillion yen, which is too high. For this reason, the unit of the budget is assumed to be billion, not trillion. Based on this assumption, the scale of TRC is similar to that of JR Hokkaido, among the railway companies in Japan, although a simple comparison is not possible. There is a difference, however, a large proportion of the TRC operations is freight transport, whereas JR Hokkaido only provides passenger transport.

2.5.3 Tracks

(1) Current State

As mentioned earlier, the "Tanzania Intermodal and Rail Project (TIRP)," a project financed by the World Bank to upgrade the tracks of the Central Line (a mainline that traverses the central part of Tanzania), has been completed. Since Phase I of TIRP is between Isaka and Dar es Salaam Port (details about the targeted areas in the Ilala Yard and Dar es Salaam Port are not known), track improvement has been completed in the section from Pugu Station on the Pugu Line to the entrance of the Ilala Yard, where the Pugu Line branches into the Port Line.



Source: JICA Study Team

Figure 2-9 Track Improvement of TIRP

The tracks between Pugu Station and Ilala Yard were confirmed to be in good condition during our field survey. There is no need to make any adjustments at this time because operation of the commuter trains is not interfered in any way. The section between Ilala Yard and Kamata Station was outside the scope of TIRP. It is not necessary to upgrade the tracks of this section because it does not have any freight transport. It is necessary, however, to repair the ballast, including replacing the existing ballast, replenishing with new ballast, and compacting the ballast.

On the other hand, the track condition of the Ubungo Line is not good (chattering of track circuit, rolling, etc.), based on findings from our train ride and field survey. Besides replacing or replenishing the ballast, track irregularities in "cross level," "longitudinal level," and "alignment" must be corrected. Figure 2-10 shows the track conditions of the Pugu Line and Ubungo Line.

	
	
Track Condition of Pugu Line	Track Condition of Ubungo Line

Source: JICA Study Team

Figure 2-10 Track Conditions of Pugu Line and Ubungo Line

Table 2-4 Track Specifications

Type	Specifications
Gauge	Narrow gauge (1,000 mm)
Track structure	Ballast track
Rail	56 lb/yd, 60 lb/yd, 80 lb/yd
Sleeper	Steel sleeper
Fastening device	Pandrol (PR clips)

Source: JICA Study Team

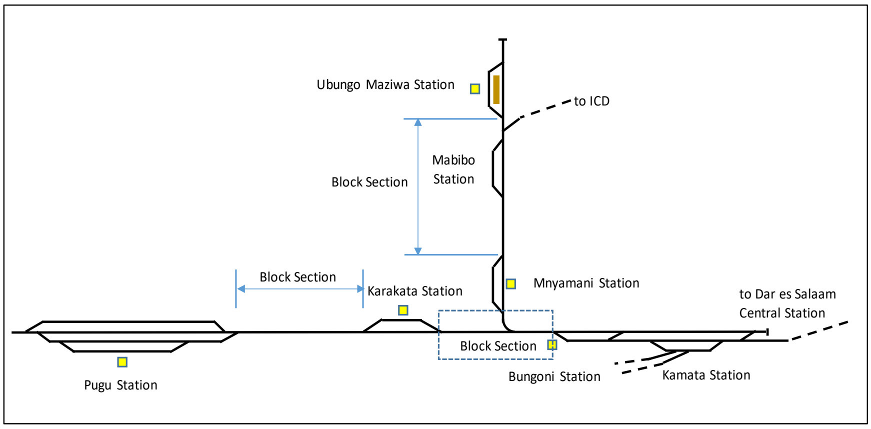
(2) Issues

As mentioned earlier, the Ubungo Line has not only insufficient ballast but also track misalignment, which causes the train to shake severely. Even if the tracks are not replaced, the ballast should be replaced or replenished and the track irregularities in "cross level," "longitudinal level," and "alignment" should be corrected.

2.5.4 Signaling System

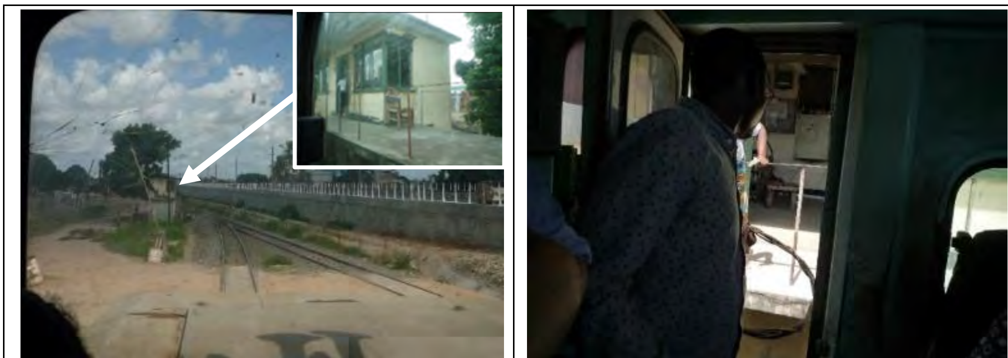
(1) Current State

Figure 2-11 is a track layout diagram of the Pugu Line and Ubungo line. The staff and ticket block system seems to have been used as a non-automatic block system in the TRC single-track sections. Areas surrounding Bungoni Station, Karakata Station, and Muyamani Station, which are single-track sections branching off from the Pugu Line and Ubungo Line, use the staff and ticket block system at the signal operating room of the stations to safeguard the block. Figure 2-12 shows the ticket being transferred at the signal operating room of Bungoni Station.



Source: JICA Study Team

Figure 2-11 Track Layout Diagram of Pugu Line and Ubungo Line



Signal Operating Room (Bungoni)	Transfer of Ticket (Bungoni)

Source: JICA Study Team

Figure 2-12 Signal Operating Room

The turnouts are switched manually. Figure 2-13 shows switching of the turnout for the Pugu Line and Ubungo Line.

Changing to the Direction toward Pugu Station	Changing to the Direction toward Ubungo Station

Source: JICA Study Team

Figure 2-13 Switching the Turnouts

The information of a train's approach is transmitted by radio from the OCC to the guard at the railway crossing. The level crossing guard uses hand signals. Figure 2-14 shows the conditions of level crossings.

Level crossing on the Ubungo Line	Level crossing on the Pugu line

Source: JICA Study Team

Figure 2-14 Conditions of Level Crossings

(2) Issues

The signaling equipment shall be upgraded step-by-step as the number of trains in operation increases. For the time being, level crossing warning devices shall be installed to enhance safety for the railways and road traffic at level crossings, interlocking equipment shall be installed to ensure safe and smooth train operation, and the block system shall be upgraded gradually to increase train frequency. In tandem with the installation of improved equipment and devices, education and training for level crossing personnel and maintenance staff (including failure recovery, etc.) shall be provided.

2.5.5 Rolling Stock

(1) Current State

Table 2-5 lists the rolling stock that TRC owned and operated in the three months of January, February, and March of this year. From this table, it can be said that only about 60% of the locomotives and passenger cars were in working condition. Such an operating rate seems to be the result of aging rolling stock and shortage of spare parts. Due to the mostly old and aging rolling stock, TRC does not have enough cars for operation. New rolling stock shall be procured and the existing freight cars, passenger cars, and locomotives shall be rehabilitated.

Table 2-5 TRC Rolling Stock

INDICATORS FOR REGULATORY PURPOSES: JANUARY, FEBRUARY, MARCH, 2021/22				
Year 2021/22				
	JANUARY	FEBRUARY	MARCH	Total/Avr.
No. of Serviceable Locomotives				
Shunting	14	14	14	14
Mainline	40	40	43	41
Total	**54**	**54**	**57**	**55**
Actual No. of Locomotives Available for Use				
Shunting	10	12	10	11
Mainline	25	24	25	25
Total	**35**	**36**	**35**	**35**
Overall Mainline Locomotive Availability (%)	**58**	**59**	**60**	**60**
Overall Motive Power Availability (%)	**65**	**67**	**61**	**64**
Shunting Engines	20,345	19,670	18,677	19,564
Overall Reliability of Mainline Locomotives (km/failure)	15,760	17,880	17,565	17,068
Total Wagon Holding Fleet (No.)	1240	1284	1284	1269
No. of Wagons Available for Use	645	654	663	654
Overall Wagon Availability (%)	**52**	**51**	**52**	**52**
Passenger Coaches Holding Fleet:				
Passenger Coaches	105	105	105	105
Restaurant Cars	7	7	7	7
Brake Van	18	18	18	18
Total	**130**	**130**	**130**	**130**
Actual Number Available for Use:				
Passenger Coaches	62	64	66	64
Restaurant Cars	4	4	4	4
Brake Vans	11	11	11	11
Total Number of Coaches Made Available	77	79	81	79
Overall Coach Availability (%)	59	61	62	61

Source: TRC

In Table 2-5, the mainline locomotives are allocated for the freight trains, long-distance trains, and commuter trains, and the passenger cars are allocated for the long-distance trains and commuter trains. A commuter train on the Pugu Line has 16-17 passenger cars and a commuter train on the Ubungo Line has 4-6 passenger cars.

Under the Tanzania Intermodal and Rail Project (TIRP), the Malaysian-made Series H10 locomotives (meter gauge) for freight transport were delivered to TRC in November 2021.

Pugu Line Locomotive

Ugungo Line Locomotive


Pugu Line Passenger Cars


Locomotive and Passenger Cars for Ubungo Line

Pugu Line Passenger Cars


Ubungo Line Passenger Cars

Source: JICA Study Team

Figure 2-15 Locomotives and Passenger Cars used for the Two Commuter Lines

For maintenance, the locomotives are inspected and repaired on a weekly, monthly, every three months, and yearly basis, while the diesel cars are inspected and repaired every month, every three months, every six months, every year, and every three years. The locomotives are inspected at the Gerezani DSM and Morogoro Workshop, and the diesel cars are inspected at the DSM Workshop and Kamata Depot. Education and training for inspection work are provided as needed.

(2) Issues

While new locomotives are used in operation, the old passenger cars in use appear to be deteriorating. If these trains are maintained and inspected properly, they may not pose danger to the safety of train operation. Unfortunately, the Study Team was not able to confirm the level of maintenance during the field survey. For the comfort of the users, some modifications to the car interior are necessary.

2.5.6 Station

(1) Current State

The Pugu Line and Ubungo Line, which are the two commuter lines currently in operation, share three stations. They are the Kamata Station, Ilala Bungoni Station, and Bakhresa Station. Besides these three common stations, the Pugu Line has eight other stations and the Ubungo Line has six other stations. Most of these stations do not have platforms or other station facilities. Passengers get on and off the train at the so-called station location where the train stops.

①	Dar es Salaam Central	⑪	Vingunguti
②	Kamata	⑫	Kipawa
③	Ilala Bungoni	⑬	Karakata
④	Bakhresa	⑭	Banana
⑤	Buguruni	⑮	Mombasa
⑥	Tandale	⑯	Gongola Mboto
⑦	Tabata Matumbi	⑰	Pugu Kwala
⑧	Relini	⑱	Pugu
⑨	Mabibo		
⑩	Ubungo Maziwa		

Source: JICA Study Team

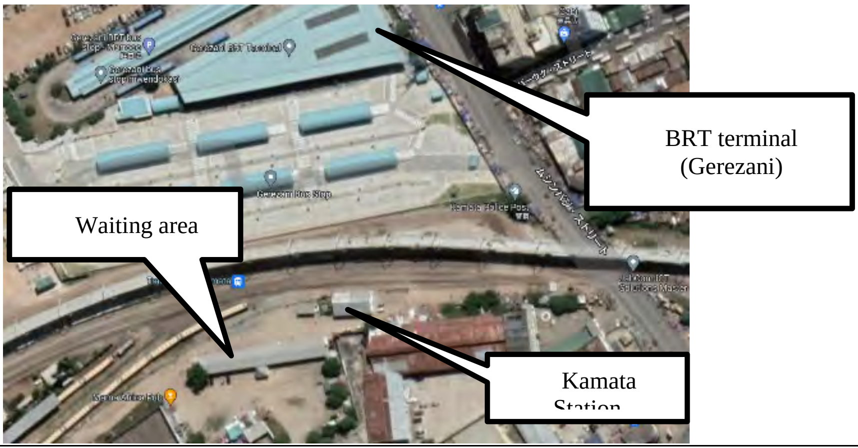
Figure 2-16 List of Existing Stations on the Ubungo and Pugu Lines

Kamata Station is currently a temporary terminal station with a large waiting area. Since the station does not have a platform, many passengers have to climb onto the train. Only the Relini Station and Ubungo Maziwa Station on the Ubungo Line have a platform.

Source: JICA Study Team

Figure 2-17 Passenger Jumping onto a Train at an Intermediate Station without Platform

Table 2-6 Stations on the Pugu Line and Ubungo Line

Pugu Line		Ubungo Line	
Kamata	･The station has a station building and a large waiting area (with a roof). ・The station has no platform. 		
Ilala Bungoni	･Trains stop at this station because it is a signal handling station, but the number of users is small. ・The station does not have platform or other station facilities.		
Bakhresa	･This is a junction station of the Pugu Line and the Ubungo Line. It intersects with Nelson Mandela Road, but the station does not have many users. ・The station does not have platform or other station facilities.		
Vingunguti	･The station does not have platform or other station facilities.	Buguruni	･The station has a passing siding. ･The station does not have platform or other station facilities.
Kipawa	･The station does not have platform or other station facilities.	Tandale (Matumbi)	･The station does not have platform or other station facilities.
Karakata (Airport)	･The station has a passing siding. ･The station does not have platform or other station facilities.	Tabata Matumbi	･The station does not have platform or other station facilities.
Banana	･The station does not have platform or other station facilities.	Relini	・The station has a platform.
Mombasa	･The station does not have platform or other station facilities.	Mabibo	･The station does not have platform or other station facilities. ・The station has a passing siding.
Gongola Mboto	･The station does not have platform or other station facilities.	Ubungo Maziwa	･The surrounding areas are urbanized. ･The location of the current station is quite far from the main road, and only local residents know about it. ･There is an access road from the main road, Morogoro Road, but it is difficult to enter the station. ・It is possible to construct a station adjacent to Morogoro Road, but there is no space for a terminal in front of the station, making future northward expansion difficult (need to be demolished for elevation).
Pugu Kwalala	･The station does not have platform or other station facilities.		
Pugu	･The station is located in a remote area and has few users. ･It has a station master's room and a waiting area (with a roof). ･Of the four tracks, only two tracks in the middle are being used currently. ・The station is located considerably away from the main road. Development of an access road will be a large-scale construction.		

Source: JICA Study Team

Dar es Salaam Central Station	Kamata Station	Pugu Station	Ubungo Maziwa Station
			

Source: JICA Study Team

Figure 2-18 Major Stations on the Ubungo Line and Pugu Line

TRC has previously proposed constructing stations for the commuter lines (Figure 2-19 Proposal for Construction of Dar es Salaam Commuter Train Stations for Pugu Line and Ubungo Line). Upon completion of the F/S, TRC will secure the budget for the construction in the next fiscal year 2022/23 (the next fiscal year begins July 2022 and ends June 2023); however, no specific details or forecasts have been disclosed.

Source: TRC

Figure 2-19 Image of Station Development Proposed by TRC

(2) Issues

Since most stations do not have station facilities, people walk freely in areas where the trains stop, posing great danger to safety and causing accidents. Passengers have to climb up the trains in order to board, making it very difficult for the elderly and users with disabilities. Due to the lack of roofs or covers, passengers have to wait for the trains in the hot blazing sun. The lack of fences around stations also cause security concerns.

Fare collection and ticket inspection are carried out by crewmembers onboard. This practice is similar to the one used by route buses and minibuses in developing countries. Manual fare collection and inspection in times of congestion makes it impossible to prevent fare cheating. The TRC "14th Joint Transport Sector Review (JTSR 2021) Jury, 2021" promoted the use of an ICT (information and communication technology) system. After the stations for commuter rail services have been developed, IC card and automated ticket gates shall be introduced in the future.

2.5.7 Station Plaza

(1) Current State

Of the 15 stations on the two commuter lines (Ubungo Line and Pugu Line), only Kamata Station and Pugu Station have station buildings. The other stations have hardly any station facilities.

Because these stations are in such poor conditions, the areas in front of the stations also lack facilities. The notion of a station plaza with facilities has not gained attention.

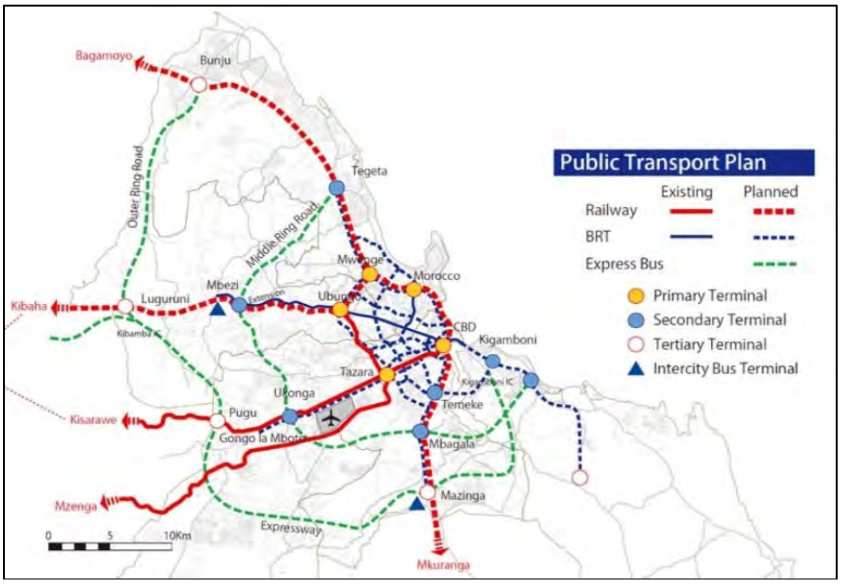
There is no separation between the station and the so-called “station plaza” space in front of the station. Some stations have parking spaces in front but they are mostly not maintained, and their boundaries with the station are not well defined. According to TRC, the land width (ROW) is 60 m (30 m on both sides from the center of the track) on the Pugu Line, and 30 to 60 m (15 m to 30 m on both sides from the center of the track) on the Ubungo Line.

Source: JICA Study Team

Figure 2-20 Parking lot

(2) Planning

The Urban Traffic Master Plan envisages an interval of about 2 to 3 km between railway stations, and also connection with the BRT (about 0.5 to 1 km between BRT stations) or a feeder bus service. The objective of the master plan is to improve the convenience of public transportation by distributing transportation demand and providing stations with transit facilities to create a public transportation network.



Source: Dar es Salaam Urban Transportation Master Plan Revision Project

Figure 2-21 Network Diagram of the Public Transportation Plan (Future Plan)

(3) Issues

Connectivity between the railway and other modes of transportation is vital for Dar es Salaam but currently there is a lack of facilities in front of stations.

A study shall be conducted to find out the level of station plaza functions needed based on the transportation demand specific to the station locations. Connection/competition with the BRT, and connectivity with buses, cars, and other public transportation means shall be considered in order to facilitate the shift from other transportation modes to the railway. A station plaza development plan with a scale suitable for future use shall be formulated.

2.5.8 Car Depot and Workshops

(1) Current State

The locomotives are inspected weekly, monthly, every three months, and yearly, while non-locomotive rolling stock is inspected monthly, every three months, every six months, yearly, and every three years. The locomotives are inspected at the Gerezani DSM and Morogoro workshops. The other rail cars are inspected at the DSM Workshop and at the car depot in Kamata.

The Study Team inspected the DSM Workshop and confirmed that the wheel lathes were in working order. Although the workshop has overhead cranes and test equipment for air brakes, it does not have enough equipment to perform maintenance.

Wheel Lathe

Wheel Lathe

Source: JICA Study Team

Figure 2-22 Wheel Lathes at the Workshop

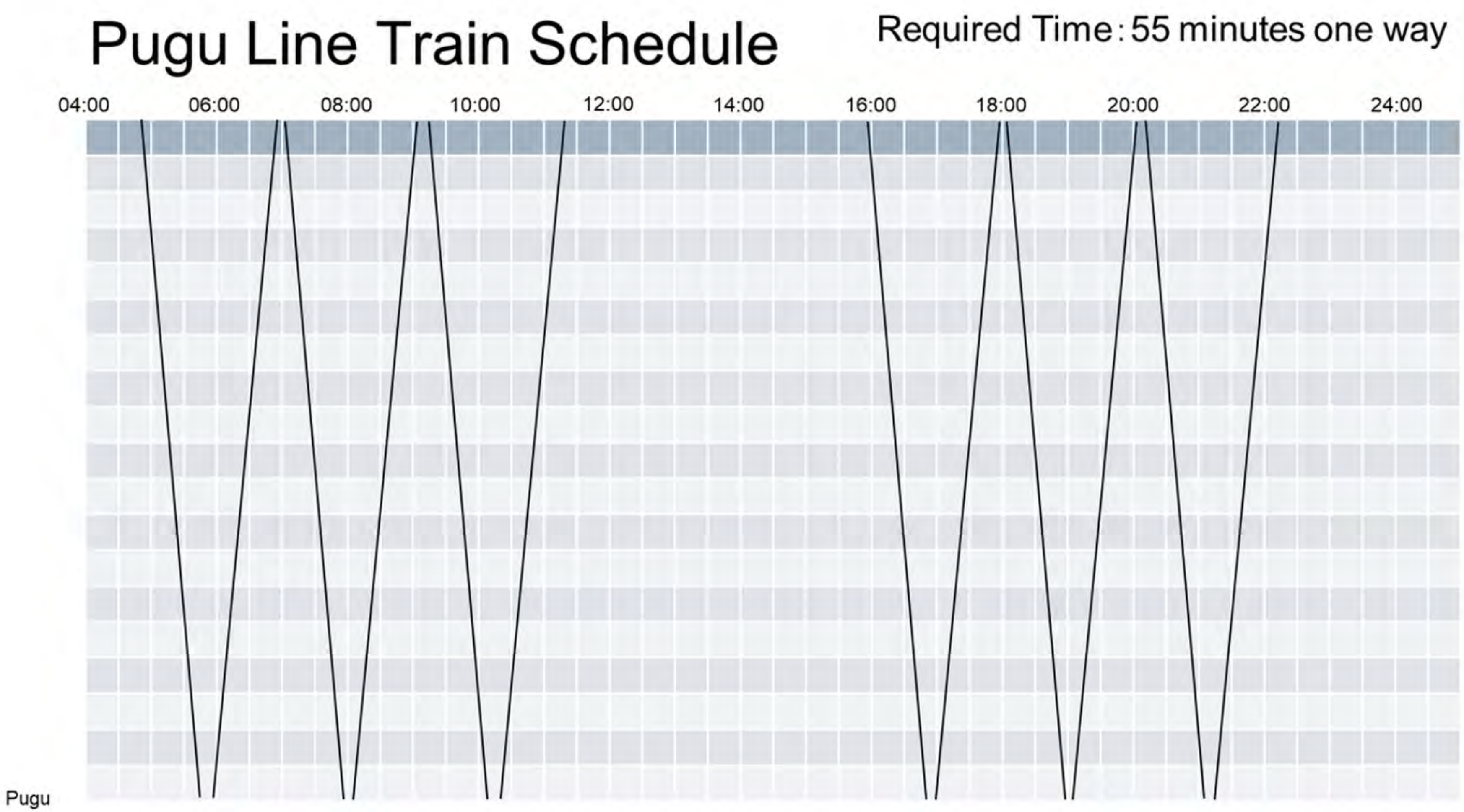
(2) Issues

The lack of maintenance machinery, aging equipment, and difficulty in obtaining spare parts make it necessary to upgrade the car depot and workshops to ensure that the rolling stock can be scheduled for operation reliably.

2.5.9 Operation of Commuter Trains

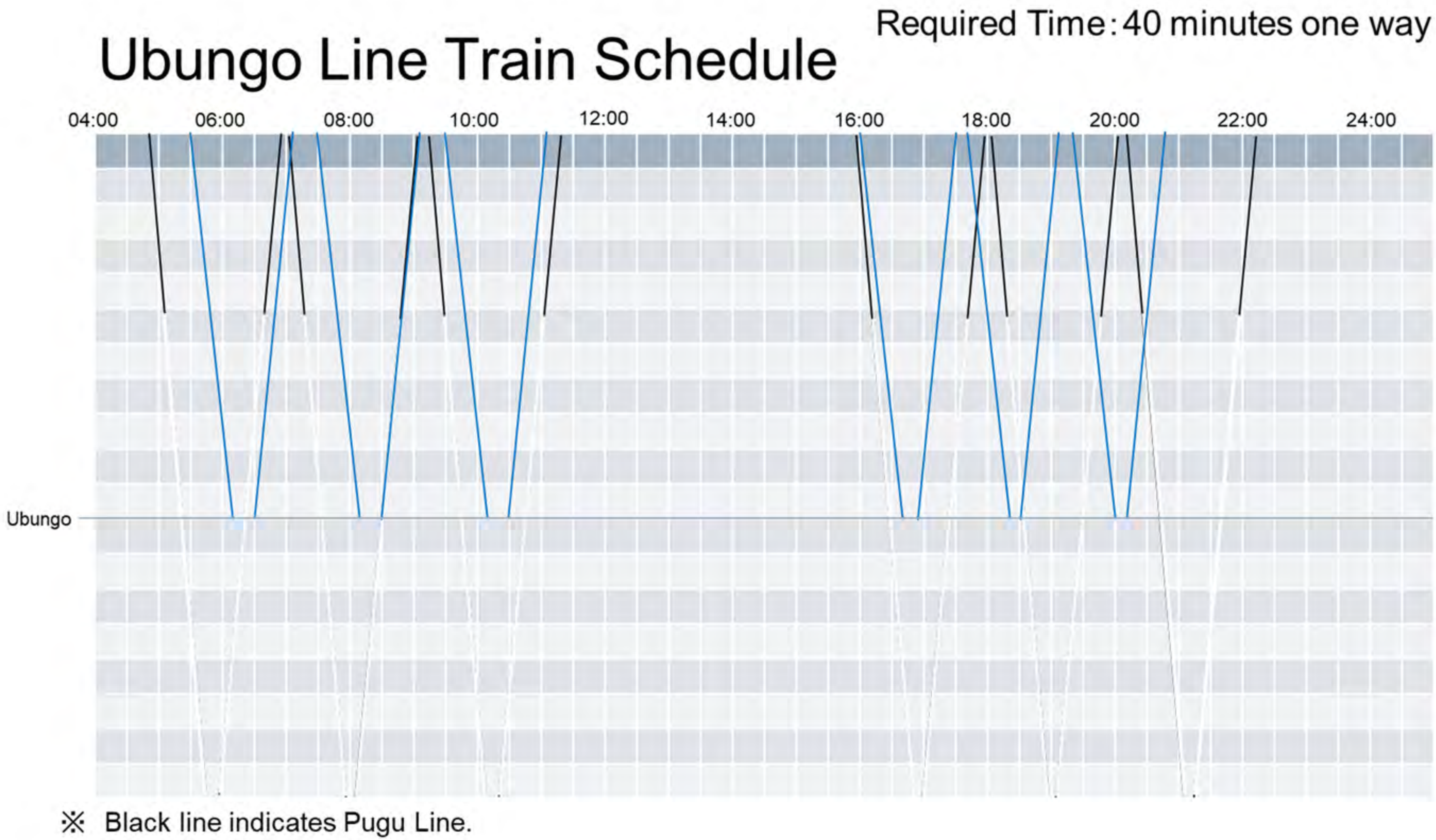
(1) Current State

The Pugu Line and the Ubungo Line both offer six round trips per day, three round trips in the morning and three round trips in the evening. Figures 2-23 and 2-24 are their operation schedules.



Source: JICA Study Team

Figure 2-23 Pugu Line Operation Schedule



Source: JICA Study Team

Figure 2-24 Ubungo Line Operation Schedule

Kamata Station, which is currently used as a terminal station, is temporary. The Pugu Line and Ubungo Line are scheduled to be extended to Dar es Salaam Central Station in the future. Our on-site survey confirmed that the meter-gauge rail (MGR) line is extending from Kamata Station to the direction of the Central Station and crossing under a standard-gauge rail (SGR) viaduct. A single track is not sufficient for the operation of commuter trains for both the Pugu Line and Ubungo Line. In the future extension plan to the Dar es Salaam Central Station (see Figure 2-25), a detailed track layout plan shall be worked out and the station location shall be examined. Figure 2-26 shows the track layout and a photograph of Kamata Station.

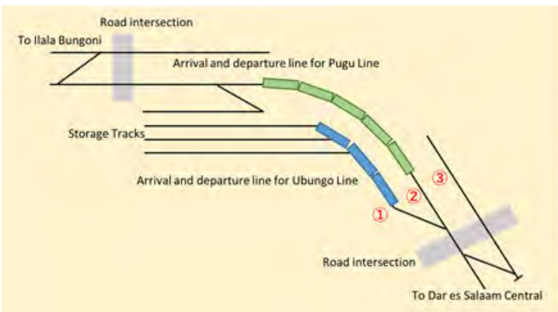
There are three tracks (excluding the siding track) at Kamata Station. Of these, two tracks are used for the Pugu Line and Ubungo Line, respectively. The other one is an escape track for shunting locomotives. In the future, the two lines will be extended to Dar es Sallam Central Station, making it a terminal station. The track layout at the Central Station shall have functions exceeding those at the Kamata Station currently, taking into consideration the proposed increase in train frequency.

MGR Line Crossing Under SGR Viaduct

View from Kamata Station toward Central Station

Source: JICA Study Team

Figure 2-25 MGR Track Crossing Under SGR Viaduct and Dar es Salaam Central Station



Track Layout at Kamata Station

Trains at Kamata Station

Source: JICA Study Team

Figure 2-26 Track Layout of Kamata Station and Trains at Kamata Station

In terms of train configuration, a train operating on the Pugu Line has a locomotive and 16 to 17 passenger cars, and a train operating on the Ubungo Line has a locomotive and 4 to 6 passenger cars. Since the locomotives currently in use on the Pugu Line and Ubungo Line are capable of hauling 20 passenger cars (2,200 BHP), TRC recognizes that the current locomotive use wastes fuel.

TRC explained that the lack of demand was the reason why it did not operate during the daytime. However, the train was seen being used for transporting sleepers during this time period.

The fares are 600 TSh for the Pugu Line, 400 TSh for the Ubungo Line, and 100 TSh for students. The fare has a flat rate, regardless of distance. As for fare collection, crewmembers sell tickets on the train and passengers purchase the tickets in cash. At the time of sale, the ticket is date-stamped on the back and punched at the same time. The ticket is collected when the passenger gets off the train. If a passenger does not have a ticket, the passenger will be asked to pay back the fare.

(2) Issues

Although the train operating on the Pugu Line has 16 to 17 passenger cars, the train can be temporarily congested, as described in "Use of Commuter Trains" in the next section. Currently, there is only one train running every two hours, even at the peak of commuting hours when people are going to work, going to school, coming home, or coming back from school. Since a high congestion rate is inevitable, train frequency must be increased.

2.5.10 Use of Commuter Trains

(1) Current State

Tables 2-8 to 2-10 show the number of passengers on the Ubungo Line and Pugu Line in January, February, and March 2022, respectively. These tables show that the number of passengers on the Pugu Line is 9 to 12 times higher than the number of passengers on the Ubungo Line. In the January table, since the numbers of students on the Pugu Line and the Ubungo Line are extremely small, the schools were probably closed during this period. Therefore, the numbers of passengers in February and March should be used as indicators for the numbers of passengers of the two lines in normal times. According to the February and March data, the ratio of regular customers to students was about 70% regular customers to 30% students on the Pugu Line, and 65% to 70% regular customers to 30% to 35% students on the Ubungo Line, showing no significant difference in the ratios of regular customers to students between the two lines. There is no significant difference in the number of passengers in terms of the day of the week; however, Wednesday has fewer passengers than the other days during the week. Table 2-7 summarizes the number of passengers using the commuter lines in the last three years.

Table 2-7 Number of Passengers Using the Commuter Lines in the Last Three Years

	2018/19		2019/20		2020/21	
	Target	Actual results	Target	Actual results	Target	Actual results
Number of passengers using the commuter lines (thousands)	6,847	4,231	4,444	3,218	5,000	3,044

Source: 14th Joint Transport Sector Review (JTSR 2021) July, 2021

Table 2-8 Number of Passengers (January 2022)

FOR THE MONTH OF JANUARY, 2022									
		UBUNGO LINE				PUGU LINE			
S/N	DATE	ADULTS	AMOUNT	STUDENTS	AMOUNT	ADULTS	AMOUNT	STUDENTS	AMOUNT
1	3.1.2022	973	389,200	0	-	8,668	4,053,300	382	38,200
2	4.1.2022	1115	446,000	0	−	8328	4,138,700	457	45,700
3	5.1.2022	1405	562,000	0	−	8079	4,189,800	380	38,000
4	6.1.2022	1493	597,200	129	12,900	8482	4,410,300	663	66,300
5	7.1.2022	1107	442,800	0	−	8899	4,058,500	730	73,000
6	10.1.2022	1151	460,400	63	6,300	8747	4,266,900	314	31,400
7	11.1.2022	1127	450,800	44	4,400	8872	4,325,700	475	47,500
8	13.1.2022	1188	475,200	0	−	7406	3,688,600	471	74,100
9	14.1.2022	1217	486,800	0	−	8719	4,035,000	437	43,700
10	17.1.2022	950	380,000	305	30,500	9870	4,584,500	3089	308,900
11	18.1.2022	1094	438,000	248	24,800	8525	4,079,500	3862	386,200
12	19.1.2022	962	384,800	264	26,400	9243	4,132,800	4788	478,800
13	20.1.2022	1093	437,200	333	33,300	8248	3,970,700	4449	444,900
14	21.1.2022	1035	414,000	284	28,400	8268	3,778,101	3366	336,600
15	24.2.2022	1047	418,800	335	33,500	8674	4,149,200	3757	375,700
16	25.1.2022	1069	427,600	432	43,200	10264	4,419,100	4297	429,700
17	26.1.2022	1123	449,200	455	45,500	10828	4,206,900	3667	366,700
18	27.1.2022	1173	469,200	336	33,600	11202	4,307,100	2782	278,200
19	28.1.2022	1163	465,200	266	26,600	11207	4,329,400	3228	322,800
20	31.1.2022	1048	419,200	201	20,100	13141	5,153,400	4054	405,400
	TOTAL	22,533	9,013,600	3,695	369,500	185,670	84,277,501	45,648	4,591,800

Source: TRC

Table 2-9 Number of Passengers (February 2022)

FOR THE MONTH OF FEBRUARY, 2022									
		UGO				PUG			
S/N	DATE	ADULTS	AMOUNT	STUDENTS	AMOUNT	ADULTS	AMOUNT	STUDENTS	AMOUNT
1	1.2.2022	1,214	485,600	492	49,200	8,512	4,316,700	3,065	306,500
2	2.2.2022	840	336,000	253	25,300	8365	4,261,700	3359	335,900
3	3.2.2022	919	367,600	467	46,700	8318	4,597,700	3166	316,600
4	4.2.2022	945	378,000	482	48,200	8153	4,027,300	2915	291,500
5	7.2.2022	705	282,000	357	35,700	7877	4,269,100	2589	258,900
6	8.2.2022	875	350,000	524	52,400	8270	4,312,100	3087	308,700
7	9.2.2022	485	194,000	333	33,300	8946	4,633,000	3583	358,300
8	10.2.2022	541	216,400	392	39,200	7807	4,320,300	3858	385,800
9	11.2.2022	567	326,800	375	37,500	6884	4,068,300	4549	454,900
10	14.2.2022	498	199,200	579	57,900	8145	4,744,500	3959	395,900
11	15.2.2022	677	270,800	323	32,300	6518	3,864,800	4806	480,600
12	16.2.2022	665	266,000	364	36,400	7761	4,156,800	3429	342,900
13	17.2.2022	526	210,400	328	32,800	5794	3,003,100	2724	272,400
14	18.2.2022	614	245,600	317	31,700	7009	3,772,800	4068	406,800
15	21.2.2022	710	284,000	337	33,700	8740	4,548,700	2559	255,900
16	22.2.2022	622	248,800	275	27,500	8270	4,320,400	3799	379,900
17	23.2.2022	539	215,600	260	26,000	5932	4,536,100	3929	392,900
18	24.2.2022	639	255,600	277	27,700	7175	3,945,800	3278	327,800
19	25.2.2022	587	234,800	407	40,700	9042	4,721,200	3386	338,600
20	28.2.2022	645	258,000	412	41,200	10302	5,182,100	3206	320,600
	TOTAL	13,813	5,625,200	7,554	755,400	157,820	85,602,500	69,314	6,931,400

Source: TRC

Table 2-10 Number of Passengers (March 2022)

FOR THE MONTH OF MARCH 2022									
		UGO				PUG			
S/N	DATE	ADULTS	AMOUNT	STUDENTS	AMOUNT	ADULTS	AMOUNT	STUDENTS	AMOUNT
1	1.3.2022	645	261,600	297	29,700	8,254	4,835,900	4,425	442,500
2	2.3.2022	633	253,200	321	32,100	7894	4,634,400	4850	485,000
3	3.3.2022	674	269,600	283	28,300	8237	4,869,900	4200	420,000
4	4.3.2022	529	211,600	286	28,600	8246	4,747,400	4232	423,200
5	7.3.2022	709	283,600	310	31,000	8117	4,803,100	4245	424,500
6	8.3.2022	633	253,200	413	41,300	8754	4,707,800	3111	311,100
7	9.3.2022	563	225,200	185	18,500	8868	4,567,700	4474	447,400
8	10.3.2022	510	204,000	315	31,500	8557	4,549,700	3427	342,700
9	11.3.2022	583	233,200	388	38,800	8447	4,490,300	3509	350,900
10	14.3.2022	704	281,600	215	21,500	10482	5,284,100	3270	327,000
11	15.3.2022	826	330,400	237	23,700	8574	4,458,200	3034	303,400
12	16.3.2022	685	274,000	254	25,400	8737	4,581,000	3539	353,900
13	17.3.2022	857	342,800	253	25,300	8434	4,471,400	3209	320,900
14	18.3.2022	803	321,200	471	47,100	7483	4,320,000	2658	265,800
15	21.3.2022	747	298,800	139	13,900	7696	4,410,300	4036	403,600
16	22.3.2022	792	316,800	371	37,100	10306	5,369,500	3080	308,000
17	23.3.2022	730	292,000	242	24,200	9257	4,696,400	3343	334,300
18	24.3.2022	818	327,200	244	24,400	9701	5,062,300	2844	284,400
19	25.3.2022	827	330,800	223	22,300	9117	4,946,100	3244	324,400
20	28.3.2022	785	314,000	275	27,500	11120	5,929,000	3922	392,200
21	29.3.2022	750	300,000	266	26,600	10142	5,352,100	3510	351,000
22	30.3.2022	691	276,400	342	34,200	8215	4,417,400	2416	241,600
23	31.3.2022	720	288,000	193	19,300	9595	5,193,700	2843	284,300
	TOTAL	16,214	6,489,200	6,523	652,300	204,233	110,697,700	81,421	8,142,100

Source: TRC

The Study Team also asked TRC for data on the number of passengers at each station, but no data were provided. Since the current onboard ticketing system cannot track the number of passengers at each station, TRC probably did not have the data. Table 2-11 shows the number of passengers estimated based on the number of passengers counted on the train. The busiest stations are Tabata Matumbi and Relini stations on the Ubungo Line, and Kamata, Kipawa and Gongola Mboto stations on the Pugu Line.

Table 2-11 Estimated Number of Passengers on Ubungo Line and Pugu Line

Survey date 2022/5/12
Line TRC Ubungo Line

	Departure/ Arrival Time	Number of passengers per car	Number of passengers per train (5 cars)	Remarks
Kamata	16:52			Student 20%, regular passenger 80%
		40	200	
Bungoni	16:55			Very few passengers boarded, except at Bungoni Station
		42	210	
Bakhresa	17:00			
		42	210	
Buguruni	17:06			
		33	165	
Tandale	17:12			
		30	150	
Tabata	17:14			
		25	125	
Relini	17:21			
		15	75	
Mabibo	17:25			
		13	65	
Ubungo Maziwa	17:31			

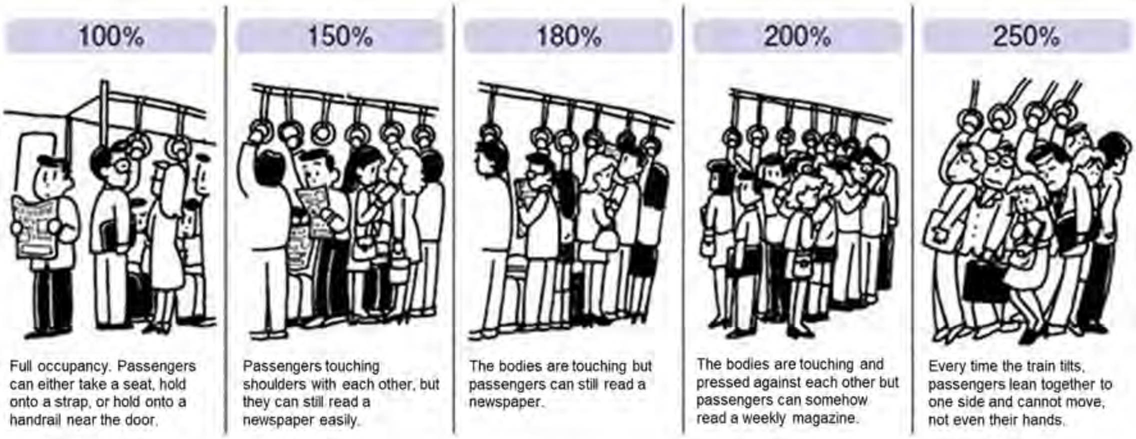
Survey date 2022/5/16
Line TRC Pugu line

	Departure/ Arrival Time	Number of passengers per car	Number of passengers per train (16 cars)	Remarks
Kamata	16:00			All the seats were occupied but no standees. Student 80%, regular passenger 20%
		44	704	
Bungoni	16:05			
		60	960	
Bakhresa	16:08			
		64	1024	
Vingunguti	16:13			
		68	1088	
Kipawa	16:20			There is probably a big school nearby. Many elementary and junior high school students boarded the train. The scene was like the morning rush hours in Tokyo before the Covid-19 pandemic.
		200	3200	
Airport	16:26			Conductor had to push through the crowd to sell tickets
		180	2880	
Banaa	16:31			
		120	1920	
Mombasa	16:36			
		90	1440	
Gongola Mboto	16:43			Close to a residential area, many passengers alighted here.
		21	336	
Pugu Kwalala	16:46			
		15	240	
Pugu	16:51			Few passengers

Source: JICA Study Team

(2) Issues

The Pugu Line is used by many students. It is very crowded when students are going to school or coming back from school. At peak hours, the most crowded car on the train probably has a congestion rate up to 180%. Therefore, the number of trains on the Pugu Line shall be increased during this time period to alleviate congestion.



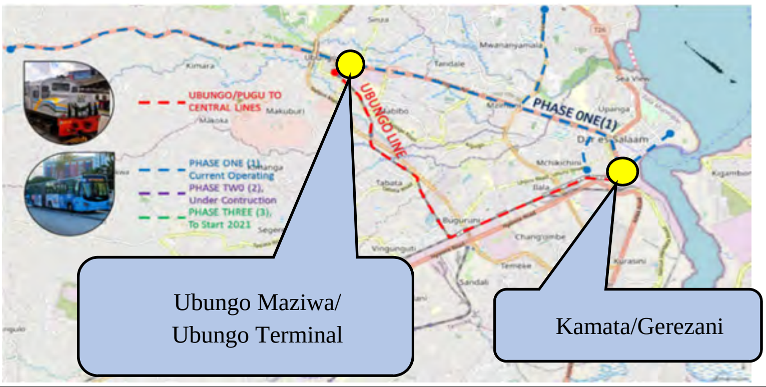
Source: Changes in Congestion Rates, Ministry of Land, Infrastructure, Transport and Tourism (mlit.go.jp)

Figure 2-27 Congestion Indicator

2.5.11 Comparison of the TRC Ubungo Line and BRT along Morogoro Road

Because the TRC Ubungo commuter line and the BRT along Morogoro Road divide the traffic between Kamata/Gerezani and Ubungo stations, this section was used to compare the two. Table 2-12 shows the comparison.

Table 2-12 Comparison of the TRC Ubungo Line and BRT along Morogoro Road

	TRC Ubungo commuter line	BRT
Route map		
Kamata/ Gerezani	 Kamata Station	 Gerezani Bus Terminal

Ubungo	 Ubungo Maziwa Station	 Ubungo Terminal
Fare	 400 TSh (flat rate)/100 TSh (student)	 650 TSh (flat rate)/200 TSh (student)
Total time required	39 minutes	21 minutes
Condition inside car	Passenger cars for students are crowded, but cars for regular passengers are not so crowded.	The cars are very crowded.

Source: JICA Study Team

The Study Team actually rode the TRC train and BRT to measure the travel time. The Ubungo commuter line took 39 minutes and the BRT took 21 minutes, confirming the18-minute difference between the two. How to evaluate this time difference depends on the individual. The Ubungo commuter line charges 400 TSh and the BRT charges 650 TSh, a difference of 250 TSh. This fare difference must be important to people who use the transportation means daily. Since the routes of the TRC train and BRT are different in the first place, many people living in the demand zones along the routes will probably choose the means of transportation that is more convenient.

2.5.12 Passenger Services (Fare Collection)

(1) Current State of Fare Collection

The fare collection methods of the target lines in this Study and the connecting public transportation means are shown below.

Table 2-13 Fare Collection Methods Used by the Conventional Railways and Connecting Public Transportation Means in Dar es Salaam

Item	Name of public transportation	Method of fare collection
1	Tanzania Railway Public Corporation (Meter Gauge Lines)	Purchase ticket in cash
2	Tanzania Railway Public Corporation (Standard Gauge Line)	Not announced yet
3	Dar es Salaam BRT	Purchase ticket in cash or by mobile app
4	Dala dala (minibus)	Cash, IC cards

* There are also taxis and motorcycles.

Source: JICA Study Team

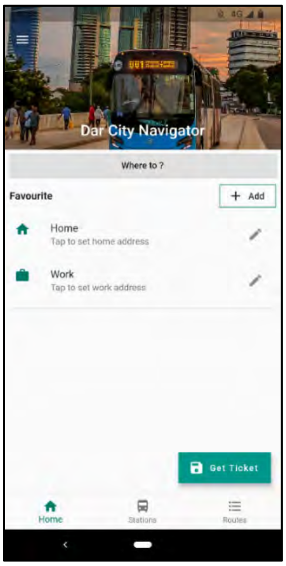
The TRC plan to construct a standard gauge electrified (SGR) railway in Tanzania is underway. The SGR is located between Dar es Salaam Central Station and Pugu Station, in approximately the same section as the conventional railway. The SGR stations will be newly constructed at locations far from the stations of the conventional railway and BRT. They are not expected to have connectivity with the conventional railway or BRT. It cannot be denied, however, that the fare collection system to be installed at the SGR stations will probably become the standard system for TRC. Some SGR stations have already been completed. Video images made public confirmed that a fare collection system with automated ticket gates has been installed.

Source: Yap ı Merkezi Tanzania YouTube channel
"DSM September 2021 Progress Video Standard Gauge Railway Line From Dar Es Salaam to Morogoro"
https://www.youtube.com/watch?v=--FAUPuOkd0

Figure 2-28 Automatic Ticket Gates at SGR Dar es Salaam Passenger Station

(2) Standardization of Fare Collection Methods between Dar es Salaam BRT and Tanzania Railways Corporation

While railways are being constructed between cities, BRT is being developed in Dar es Salaam, sponsored by the World Bank and the African Development Bank. The Dar Rapid Transit Agency (DART), which operates the BRT, has its own mobile application called Dar City Navigator for purchasing tickets, in addition to paper tickets.



Source: DART

Figure 2-29 Homepage Screen of Dar es Salaam BRT Mobile Application

There are many stakeholders in public transport management, such as the railway and BRT. Participation of the national and municipal governments is also vital to policy implementation. Therefore, it may take time to coordinate the various stakeholders when introducing a comprehensive policy for promoting public transportation use.

2.6 Improvement Plan

2.6.1 Priority Line

As mentioned earlier, the Pugu Line has about 10 times more demand than the Ubungo Line. The congestion rate of Pugu Line is extremely high. In Phase 3, the BRT is scheduled to open along Nyerere Road. However, it is about 300 m away from the Pugu Line. The transport capacity of Pugu Line shall be increased in order to meet the rising demand every year. This is explained in the next section "Need for Improvement." On the other hand, the demand for the Ubungo Line is not as high as for the Pugu Line. Although there is an interest in extending the Ubungo Line to Mwenge, Tegeta, and even Bagamoyo, construction of a multi-level crossing above Morogoro Road will require considerable investment. To meet the demand in the Tegeta area, construction of a Tegeta line should be given priority. In the TRC F/S conducted in 2019, while Pugu Line was proposed as Route B along the existing Pugu commuter line, the existing Ubungo commuter line was positioned as a section of the inner ring line Route A, and Route H would connect the CBD and Ubungo along the Morogoro Road.

The Study Team asked TRC about the priority of the lines several times during its stay in Dar es Salaam, but did not get any clear answers. According to TRC, both lines were deemed important and both would need improvement. Based on our conversation with TRC members, their preference seemed to be track improvement for the Ubungo Line.

Although TRC did not give any clear answers on the priority of the lines, the Study Team will prioritize Pugu Line in its plan and consider track improvement for the Ubungo Line separately.

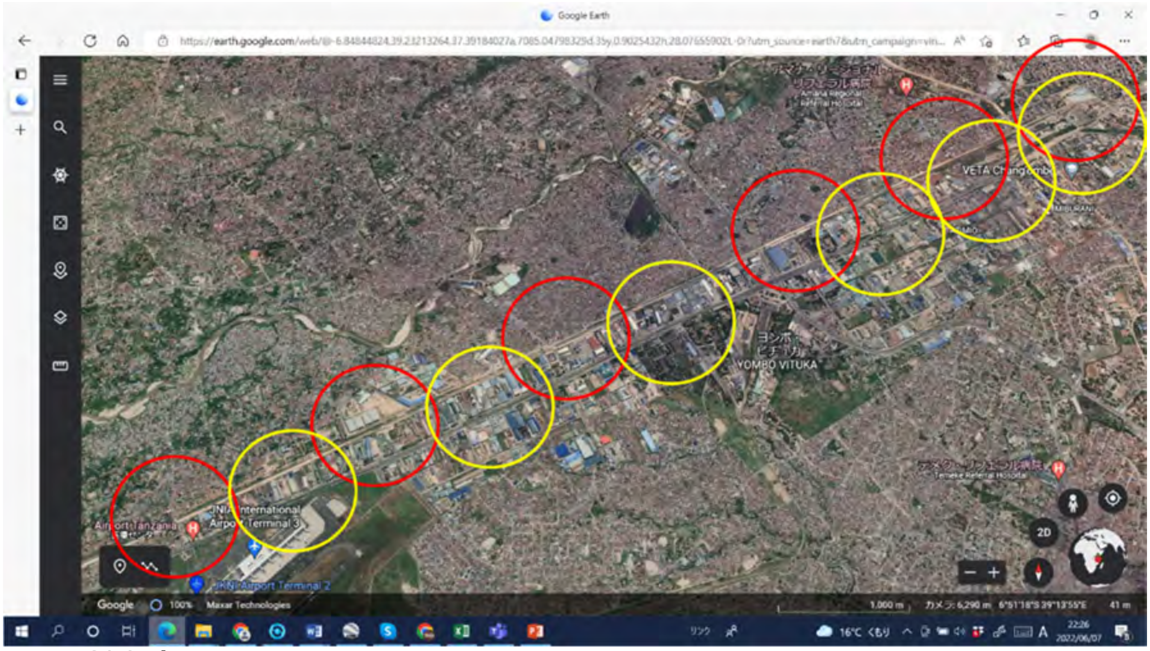
2.6.2 Need for Improvement

In addition to the issues discussed under each topic, the facilities and services of the lines shall be improved so they can cope with the increasing demand. Based on rough estimate, the current service level of the Pugu Line, which is already very congested today, will exceed its transportation capacity around 2028. Measures shall be taken to meet the demand.

Specifically, the ever-increasing population will further increase the traffic volume. With the current operation of three round trips in the morning and three round trips in the evening, the transport capacity per train at peak hours will be lower than the demand in the future. Therefore, it is necessary to increase transportation capacity by increasing the number of trains. Doubling the current three round trips in the morning and three round trips in the evening to six round trips each is proposed.

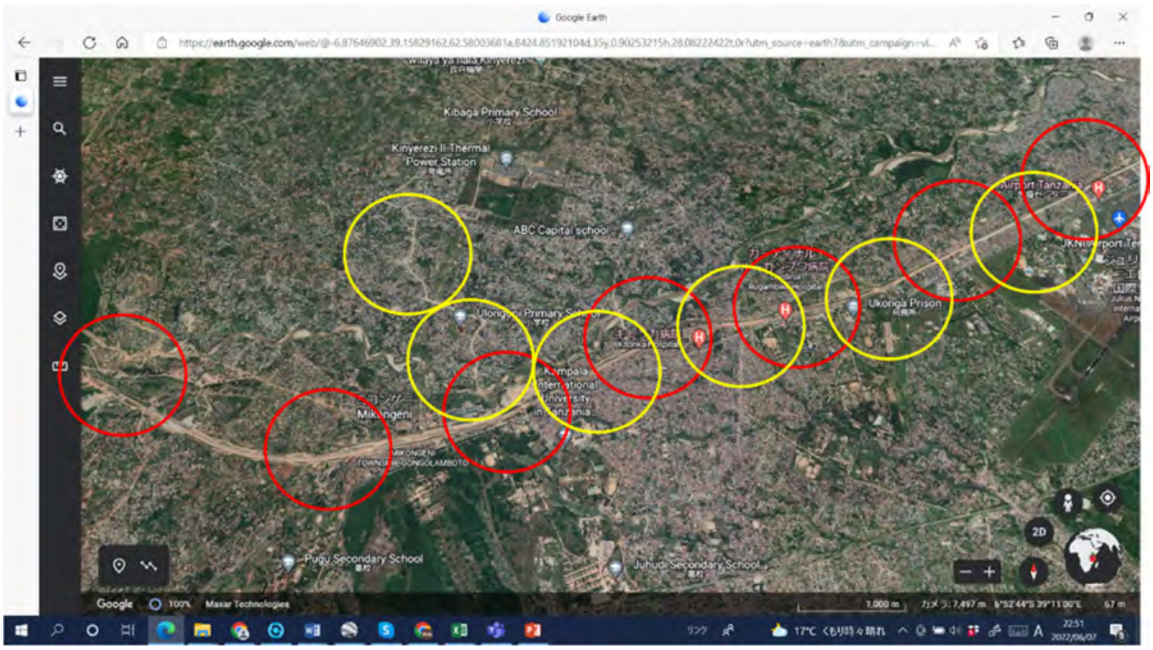
Figure 2-30 and Figure 2-31 show the service catchment areas (500-m radius) near the Ubungo Line stations and BRT stations. The BRT stations are scheduled to open in Phase 3. These two means of transportation are not in competition with each other but rather they complement each other and jointly handle the overall demand efficiently.

Although the 14th Joint Transport Sector Review (JTSR 2021) July, 2021 did not include improvement of the existing lines, it did advocate the importance of developing commuter lines in Dar es Salaam.



Source: JICA Study Team

Figure 2-30 Service Catchment Areas near Pugu Commuter Line Stations and BRT Stations (Kamata–Karakata Section)



Source: JICA Study Team

Figure 2-31 Service Catchment Areas near Pugu Commuter Line Stations and BRT Stations (Karakata–Pugu Section)

2.6.3 Improvement Plan for Pugu Line

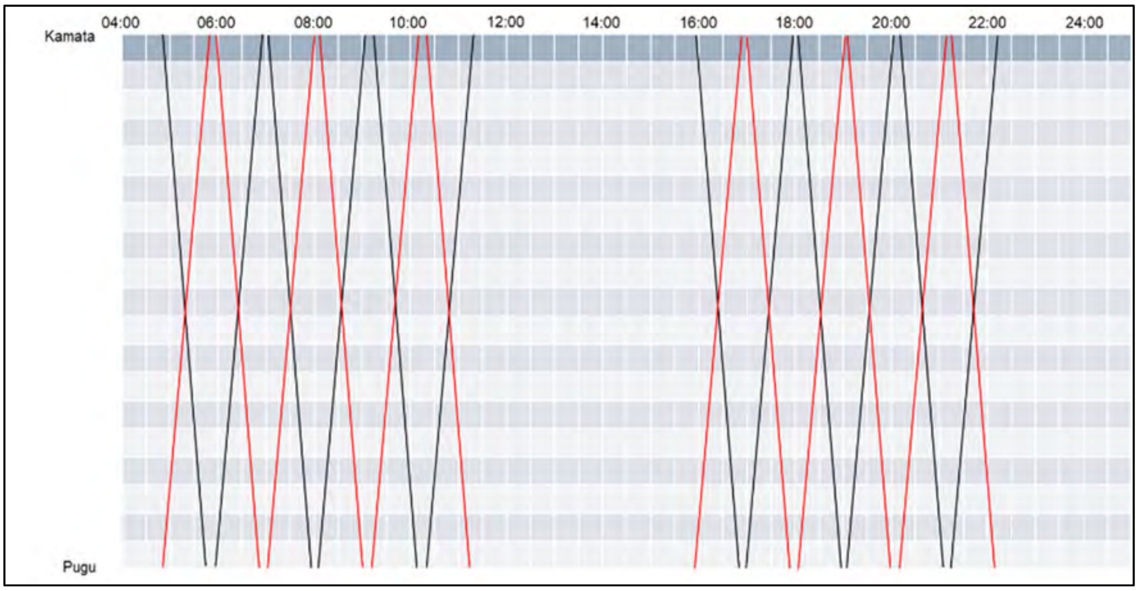
(1) Services Requiring Improvement and Scope of Improvement

"Enhancement of transport capacity" and "Improvement of safety and services" are proposed for the Pugu Line, based on the above discussions.

[Enhancement of Transport Capacity]

1) Increase the Number of Trains Operating on Pugu Line

In addition to the one train set currently in service, another train set shall be added, as indicated by the red line in the train operation schedule in Figure 2-32. In other words, the six round trips per day will be doubled to 12 round trips per day, as indicated by the black line. To do so, one diesel locomotive and several passenger cars will be needed. The diesel locomotive can be procured through a grant aid project, and the passenger cars currently owned by TRC can be used but they need to be repaired first.



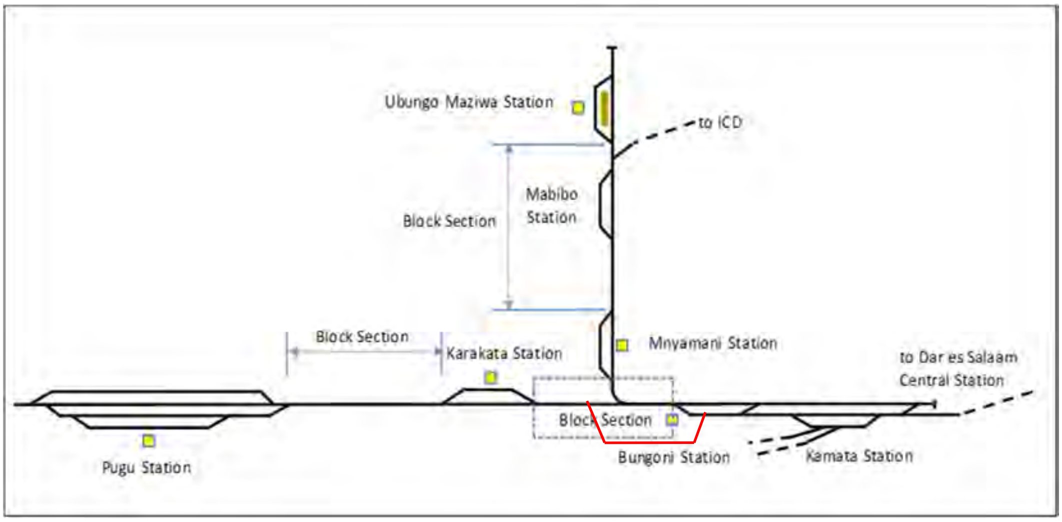
Source: JICA Study Team

Figure 2-32 Operation Schedule with Increased Number of Trains

[Improvement of Safety and Services]

2) Track Doubling and Track Improvement in Certain Sections

Currently, two single tracks, one from Ubungo Station and one from Pugu Station, merge on their way to Kamata Station. When the number of trains on the Pugu Line is increased, trains may have to wait longer in the block section where the tracks merge. To ensure safe train operation, a new single-track section of approximately 2.5 km shall be constructed between Bungoni Station and Vingunguti Station, as indicated by the red line in Figure 2-33.



Source: JICA Study Team

Figure 2-33 Track Doubling at Branch Line

As mentioned above, the section from the entrance of Ilala Yard to Kamata Station is not included in TIRP. Even if the tracks in the section do not need to be replaced, the ballast shall be replaced and compacted, and track irregularities corrected.

3) Installation of Signaling Equipment

The following signaling equipment shall be installed, taking into consideration the limited funding of a grant aid. An interlocking equipment that controls the routes of train arrivals and departures and the shunting of trains at certain stations shall be installed to ensure safety. It will help prevent accidents caused by operator errors and improve operation efficiency. Level crossing warning devices shall be installed to support increase in the number of trains in operation and enhance the safety of road traffic in the future. TRC is expected to bear the cost of construction for distributing power to the signaling equipment room.

① Interlocking equipment: It shall be installed at Karakata Station (station with a passing siding), which is located in the mid-section of the Pugu Line. The interlocking equipment controls the routes of trains on station premises, and ensures the safety of train operation by connecting the signals and the switches.

② Switch: It is a device for switching the turnouts on the tracks. The switch is operated manually using the current switch lever with counter-weight system. However, the turnout at Karakata Station will be switched automatically with the help of an electric switch machine and interlocking device.

③ Level crossing warning device: The installation plan is as follows:

Table 2-14 Installation Plan of Level Crossing Warning Devices

Item	Plan Summary
Target	Level crossings with heavy road traffic (installation of warning devices and crossing gates)
Level crossings identified	Near Kamata Station and Pugu Kwalla Station
Train approach information	Gatekeeper obtains train approach information from adjacent station using the current means of communication.
Function of gatekeeper	Operates warning devices and crossing gates manually
Incidental work	Construction of gatekeeper hut and civil engineering work to improve level crossings

Source: JICA Study Team

4) Construction of Stations and Station Plazas

Coordination with the "Proposal for Construction of Dar es Salaam Commuter Train Stations for Pugu Line and Ubungo Line" planned by TRC is necessary. The Study Team proposes that the improvement items "enhancement of transportation capacity" and "improvement of safety and service" mentioned above be implemented first before TRC develops the stations and station plazas. The TRC proposal does not contain any specific design for the station buildings, but parking spaces are expected to be constructed in front of the stations. As TRC has not presented any specific elements about the station plazas, the Study Team considered adding the traffic node function based on the examples in Japan.

Specifically, Kamata Station and Karakata Station, which are transit points with other modes of transportation and have certain levels of demand, shall be developed into medium-sized stations equipped with facilities (station buildings, platforms, toilets, etc.) that will enable passengers to use safely and comfortably. The other nine stations shall be constructed as simple stations equipped with platforms so that passengers can board and alight safely. Figures 2-34 to 37 are images of the stations.

For stations where station plazas are planned, the station plaza shall be paved, boarding and disembarking areas for buses and cars shall be constructed, and parking lots shall be set up to enable the station and station plaza to function as a transit node. Utilizing the station plaza’s function as a transit node to further enhance the convenience of the network, the Study Team also considered making the station plaza a rotary, designed based on its use by buses, automobiles, and others, as well as coordination with the BRT, which runs in parallel with the commuter trains.

Rolling stock, track, and signaling all have high priorities at present. Contents of the grant aid project are proposed as follows:

Table 2-15 Proposed Station Developments in Grant Aid Project

Station	Contents of improvement
Kamata Station	Construct a station plaza to enhance convenience for transfers to BRT, and other means of road transport
Kipawa Station	Construct a platform for this simple station to make it easier and safer for elementary and junior high school students to get on and off trains
Karakata Station	Develop a station plaza and other station facilities to strengthen its functions as a medium-sized station next to an international airport

Source: JICA Study Team

Kamata Station has no facilities other than a simple station building. However, this grant aid project can only cover the cost of constructing a plaza in front of the station. Construction of a platform will require a large-scale renovation, including changing the track layout, because the rail yard has a siding going to the train shed and there is not enough space to construct a platform between the railway tracks. Besides, the platform will be located on a curve.

Although Kipawa Station has many passengers boarding and alighting, most of them are students of elementary and junior high schools located near the station. Currently there is no demand for connections with other modes of transportation. Therefore, only station facilities shall be constructed.

Source: JICA Study Team

Figure 2-34 Image of Facilities at a Medium-sized Station (1)

Source: JICA Study Team

Figure 2-35 Image of Facilities at a Medium-sized Station (2)

Source: JICA Study Team

Figure 2-36 Image of Facilities at a Simple Station (1)

Source: JICA Study Team

Figure 2-37 Image of Facilities at a Simple Station (2)

2.6.4 Scenarios for Future Developments

(1) Positioning of Improvement Proposal (Grant Aid Project)

Almost the entire Pugu Line and Ubungo Line are single-track. The tracks used for the branching and merging of the Pugu Line and Ubungo Line are all single-track, which hinders the increase in transportation capacity. Therefore, this grant aid project proposes separating the branching and merging parts of the single-track Pugu Line and Ubungo Line into dedicated line sections, while utilizing the existing passing sidings, so that transportation capacity can be increased safely and efficiently. Due to the project cost limitation of a grant-financed project, the current proposal can only double the current number of train operations. Nevertheless, improvements made in this project will lay the foundation for future improvements to further increase transportation capacity and improve TRC operation.

(2) Development Scenarios after Grant Aid

As mentioned above, a track layout that separates the branching and merging parts of the single-track Pugu Line and Ubungo Line into separate dedicated line sections is proposed. However, doubling the tracks of the two commuter lines entirely in the future will further increase the transportation capacity.

Doubling the tracks of the existing lines is the short-term plan in the 2018 revised master plan, which also proposes extension of the existing lines as a mid- to long-term plan. Improvements made in this grant aid project are expected to increase the demand and interest of passengers for commuter rail services. Increase in TRC revenues will lead to further capital investment and greater transportation capacity.

2.7 Improvement-related Issues

Issues related to the improvements are as follows:

2.7.1 Coordinate the Procurement of Locomotive

It will take considerable time to research the required specifications, and then manufacture and deliver the locomotive. Once a consensus has been reached with TRC, details about the specifications should be discussed with the manufacturer as soon as possible.

2.7.2 Coordinate with TRC on Station Improvement (Menu Demarcation)

TRC is said to request the budget for the proposed station construction in the next fiscal year. Therefore, it is necessary to find out in detail the station improvements that TRC plans to carry out.

Since the quantity of construction work is considerably small and economies of scale are unlikely, Japanese companies might avoid this project due to lack of profitability.

2.7.3 TRC to Repair Passenger Cars

A shortage of spare parts may make some passenger cars not operable. TRC must repair these passenger cars to increase the transportation capacity of the Pugu Line. Accordingly, further investigation of the situation and technical assistance are needed.

2.7.4 Education and Training for TRC Staff

In tandem with the installation of signaling equipment, education and training for the operation and maintenance of the interlocking equipment, switching devices, and level crossing warning devices shall be provided through JICA technical support programs.

2.8 Evaluation Index and Effects

Effects from the Pugu Line improvements are shown under items (1) to (3) below.

Table 2-16 Effects of Pugu Line Improvement and Details

Item	Description
(1) Effects on service users	The effects on transport service users, i.e., railway users, after the Pugu Line has been improved are direct effects from the improvement of services, such as shortening travel time, alleviating congestion, and reducing transportation costs.
(2) Effects on service providers (railway operators)	The effects on railway operators, TRC in this case, are expected to have an increase in the number of users and increase in transportation revenues and expenses.
(3) Effects on society as a whole	Railway projects are expected to have effects not only on users and suppliers as described in (1) and (2) but also on the society as a whole. Specifically, the effects can be subdivided into five categories, as shown in Table 2-18 below.

Source: JICA Study Team

Table 2-17 Evaluation Items and Details of Social Effectiveness from Pugu Line Improvement

Evaluation items for effects on whole society	Details
People's lives	Reducing traffic congestion by reducing road traffic, improving accessibility to regional hubs and wide-area transportation networks (airports and long-distance bus terminals) by developing railways, eliminating areas that lack public transportation systems, and improving convenience in daily life, etc.

Local economy	Improving productivity in the region by enhancing transportation convenience, increasing the possibilities of location and scale of businesses, and increasing the number of visitors to regions along the railway lines
Local communities	Improving appeal as a residential area by increasing transportation convenience for business and commercial districts, resulting in an increase in residential population. Improving image of the region by making railways and stations symbols of the regions
Environment	Reducing CO_2 emissions thanks to reduction in automobile traffic, shift from the use of automobile to railway, and restriction of new automobile users. Changing NOx and SPM emissions on roads along the railway lines. Improving stations enhances the landscape of surrounding areas
Safety	Shifting from automobile to railway use reduces the volume of automobile traffic and reduces traffic accidents. Installing level crossing facilities and safety facilities, such as fences, prevent accidents

Source: Prepared by JICA Study Team based on MLIT's Railway Project Evaluation Methodology Manual (revised in 2012)

(1) Effects on Service Users

1) Increasing the Frequency of Operation

At present, the Pugu Line offers six round trips per day. After improvement, train services will double to twelve round trips per day.

2) Shortening Travel Time

As described above, increase in train frequency on the Pugu Line will reduce the waiting time for the next train and consequently reduce travel time.

(2) Effects on Service Providers (Railway Operators)

1) Increase in the Number of Users

Increasing train frequency on the Pugu Line from six to twelve round trips per day will double the transport capacity. Although the number of passengers will not double, demand is expected to be higher than the current level due to the easing of congestion and enhanced convenience.

2) Increase in Transportation Revenues and Expenses

Increase in the number of passengers on the Pugu Line will increase transportation revenues. However, additional train services will require more inspections and maintenance, thus generating expenses. Increase in the number of users will bring in new fare revenues, but measures shall be taken to minimize fare evasion.

(3) Effect on the Whole Society

1) People's Lives

The population of Dar es Salaam was 5,116,000 in 2015. It continues to grow and is expected to reach 15,970,000 by 2050. Improvements to the Pugu Line will alleviate road congestion in the short term as some automobile users will shift to the railway. Since a minibus has capacity to transport about 15 people, automobile traffic will be reduced by an estimated 960 vehicles per day. In the long term, the railway will shoulder some of the ever-increasing demand for transportation, thereby preventing further deterioration of road congestion in the future.

2) Local Economy

Improvement of the Pugu Line makes it more convenient to travel in areas along the railway line, thus contributing to the improvement of productivity by industries in the region. As a result, the region will have greater appeal to businesses, giving them incentive to expand and increase economic activities.

3) Local Communities

Increasing the capacity of the Pugu Line will greatly improve access to urban commercial areas and increase the attractiveness of areas along the railway line. More people are expected to move to the area, thus contributing to TOD (Public Transportation-Oriented Development) and creating an efficient urban structure and an affluent lifestyle. Unlike the construction of a new railway, which will entail relocation of the residents, this plan is a rehabilitation project for an existing railway line. In fact, residents and commercial groups along the railway line reacted favorably to the idea of improving the Pugu Line, suggesting that benefits for railway-related stakeholders could increase.

4) Environment

With increased transport capacity on the Pugu Line, some of the travel demand for cars in central and western Dar es Salaam will shift to the railway. As a result, emissions of CO_2, NOx, SPM, etc. from automobiles will be reduced.

5) Safety

In Dar es Salaam, where road accidents are frequent, the shift of transport demand to the railway will help reduce traffic accidents to a certain extent. Together with improvement of the Pugu Line, the installation of level crossing safety devices, fences, and other facilities will minimize railway-related accidents.

(4) Others (Contribution to Sustainable Development Goals)

This project will help alleviate serious traffic congestion in Dar es Salaam, reduce air pollution, and mitigate climate change. It will contribute to Goal 9 (Let's lay the foundations for industry and innovation), Goal 11 (Building a city where people can continue to live), and Goal 13 (Specific measures against climate change) out of the 17 goals of the UN General Assembly announced in 2015.

2.9 Conclusion

(1) Proposals in the Dar es Salaam Urban Transport Master Plan Revision Project

In 2018, JICA implemented the Dar es Salaam Urban Transport Master Plan Revision Project and proposed strengthening the existing commuter lines as a short-term plan. Improvement of the Pugu Line proposed in this Study matches the proposal perfectly.

(2) Improvement of the Pugu Line as a Relatively Low-cost, Short-term, Feasible Project

Interviews with the TRC and concerned parties of this Study did not yield any clear answers on the priority of the lines. However, it was found during the field survey that the congestion rate of the Pugu Line was very high. Upgrading the Pugu Line will be relatively low cost and effective in the short term, as TIRP has almost completed the track improvement. For this reason, improvement of the Pugu Line is considered a good candidate for the grant aid.

(3) Urgent Need to Alleviate Traffic Congestion in Dar es Salaam

Traffic on the Nyerere Road, which runs side by side to the Pugu Line, is heavy. Traffic congestion and crowded streets in Dar es Salaam are getting worse every year. Public transportation in Dar es Salaam is urgently needed to alleviate traffic congestion, as travel in the suburbs and downtown areas can take a long time depending on the time of the day.

(4) Future of Japan's Railway Assistance to the United Republic of Tanzania and Synergistic Effects

After completion of the Pugu Line improvements proposed in this Study, further increase in transport capacity and improvement of the Ubungo Line will likely follow. Improvements of these commuter lines will likely evolve into extension projects, which are the scenarios proposed in the 2018 Dar es Salaam Urban Transport Master Plan Revision Project. It is hoped that there will be further development of the urban railways, starting with the improvements proposed in this Study, and that the synergistic effects of the railway and road projects will bring further improvement to urban transportation in Dar es Salaam.

Chapter 3 Nairobi (Kenya)

3.1 Overview of Kenya and Nairobi

3.1.1 Kenya

(1) Topographical Overview

Kenya is located on the eastern side of Sub-Saharan Africa, bordering the Indian Ocean. The capital is Nairobi, which has an urban population of 4.34 million in 2019[5]. Although relatively close to the Equator, Nairobi has a cool climate, ranging from 15 to 20 degrees Celsius throughout the year, as it is about 1,700 meters above sea level. Nairobi is home to the United Nations Environment Programme (UNEP), the United Nations Human Settlements Programme (UN-HABITAT), and other UN organizations, making it the central city of East Africa.

Source: The World Fact Book

Figure 3-1 Location Map of Kenya and its Capital Nairobi

(2) Economic Overview

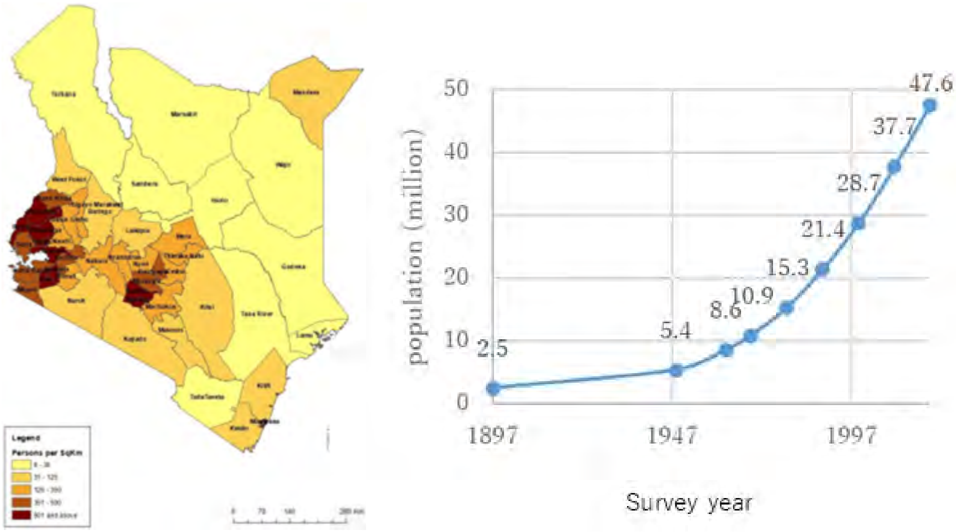
Kenya has a GDP of USD 226.9 billion (2020) or approximately USD 4,200 per capita, which is the highest among the countries in this Study. The population is growing exponentially, doubling between 2000 and 2020. It will reach 47 million people in 2019, making Kenya one of the fastest-growing countries in the Sub-Saharan region.

Table 3-1 GDP and Population of Each Country of the Five Cities Surveyed

	Country	GDP*	GDP per capita	Population**
1	Kenya	$226.9 billion	$4.200	47,564,296
2	Tanzania	$152.8 billion	$2.600	59,734,213
3	Zambia	$6.012 billion	$3.300	18,383,956
4	Mozambique	$38.42 billion	$1.200	31,255,435
5	Democratic Republic of the Congo (formerly Zaire)	$19.03 billion	$3.400	89,561,404

Sources: *THE WORLD FACTBOOK, **World Bank, and 2019 Kenya Population and Housing Census

[5] *2019 Kenya Population and Housing Census*: Volume I, p. 9 “Nairobi city”
https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county



Source: 2019 Kenya Population and Housing Census

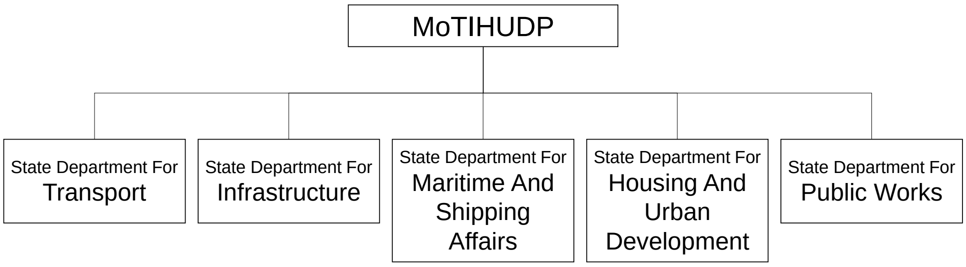
Figure 3-2 Population Trends in Kenya

(3) Political System and Administrative Structure

Kenya has 21 ministries. The Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works (MoTIHUDP) is in charge of the transportation sector. The Kenya Railway Corporation (KRC) operates the railways in Kenya and is the counterpart for this Study. The corporation is under the jurisdiction of MoTIHUDP.

1.	Ministry of Interior and Co-ordination of National Government	11.	Ministry of Sports, Culture and Heritage
2.	Ministry of Defense	12.	Ministry of Education
3.	The National Treasury and Planning	13.	Ministry of East African Community (EAC) and Regional Development
4.	Ministry of Foreign Affairs		
5.	Ministry of Industry, Trade & Co-operatives	14.	Ministry of Labor and Social Protection
6.	Ministry of Health	15.	Ministry of Tourism and Wildlife
7.	Ministry of Agriculture, Livestock, Fisheries and Irrigation	16.	Ministry of Environment and Forestry
8.	**Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works (MoTIHUDP)**	17.	Ministry of Water and Sanitation
		18.	Ministry of Lands and Physical Planning
		19.	Ministry of Energy
9.	Ministry of Devolution and the ASALS	20.	Ministry of Petroleum and Mining
		21.	Ministry of Public Service, Youth and Gender
10.	Ministry of Information, Communication and Technology (ICT)		

MoTIHUDP consists of the State Department For Transport, the State Department For Infrastructure, the State Department For Maritime And Shipping Affairs, the State Department For Housing And Urban Development, and the State Department For Public Works.



Source: Prepared by JICA Study Team based on http://www.kenyarep-jp.com/en_index.html

Figure 3-3 MoTIHUDP Organization Chart

(4) Japan's Aid Policy

Japan's development cooperation policy for Kenya states that "Depending on the issues and circumstances, Japan will consider assistance that utilizes Japan's knowledge and experience to not only introduce and disseminate advanced technology but also provide simple and low-cost technologies that employ local materials and equipment." [6] Of the aids provided to Kenya in the last 10 years, roads and container terminals were included under the transportation sector, but no aid was available for infrastructure development under the railway sector.

Table 3-2 Assistance in the Last Ten Years

Fiscal Year	Target cities/Regions	Contents of assistance
2021	City of Mombasa	Intelligent Highway Transportation System Implementation Plan
2020	Nakuru City, Mombasa City	Power Distribution Facility Improvement Plan
2019	Mombasa Special Economic Zone Donggokundu Area	Development of infrastructure in the Mombasa SEZ, including port, main roads, water supply, drainage system, and power supply facilities; construction of bridges and road improvements to connect Mombasa Island and Likoni District
2017	Mombasa Port	Construction of a road to connect the new container terminal at Mombasa Port and the Northern Corridor of East Africa, and a bypass road to the southern region of Mombasa
	Nairobi City	Widening of Ngong Road, which connects the western part of Nairobi City with the city center, and construction of ancillary facilities
2014	Mombasa Port	Construction of a container terminal at the Mombasa Port and installation of cargo-handling equipment, etc.
2013	Western Baringo Group, Kenya	Development of deep well water supply facilities and provision of related equipment
	Narok City, Western Kenya	Expansion of water supply facilities and provision of related equipment
2012	Mombasa Port	Construction of a road to connect the new container terminal and the Northern Corridor, and a road to the southern coast of Mombasa Bay
	Nairobi City	Widening and improvement of Ngong Road in Nairobi city center

Source: https://www.mofa.go.jp/mofaj/gaiko/oda/region/africa/kenya/exchange.html

The Kenyan government is restoring the commuter railway with its own funds, but the progress and level of maintenance are not satisfactory. The contents of assistance shall be reviewed in light

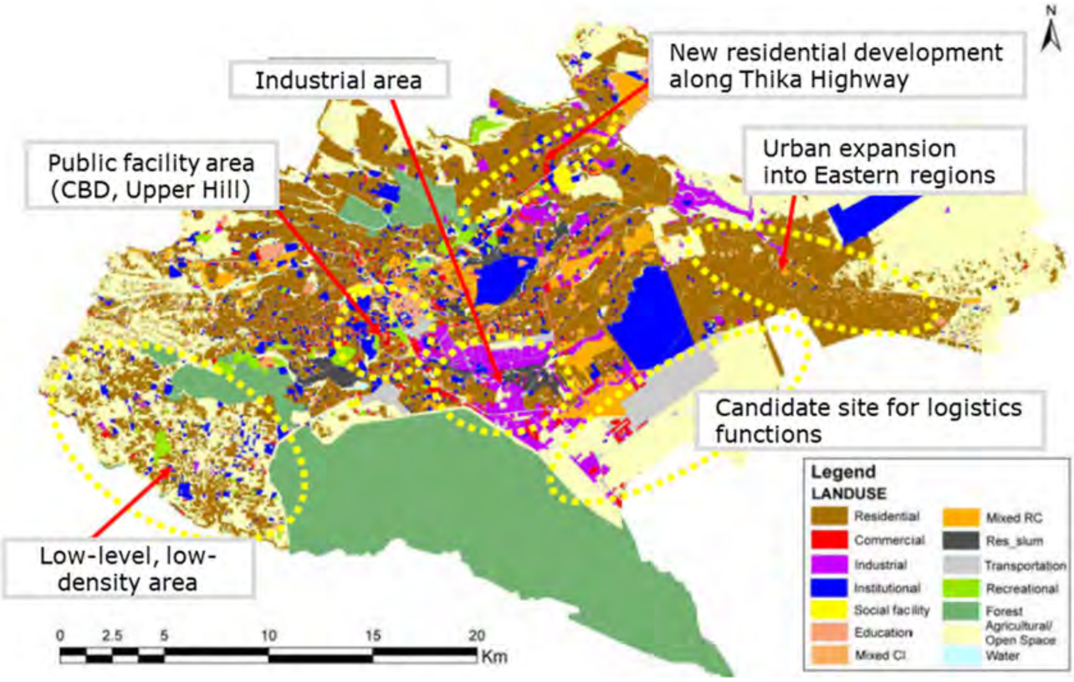
[6] https://www.mofa.go.jp/mofaj/gaiko/oda/files/000072382.pdf

of Japan's development cooperation policy so as to utilize the expertise of Japanese companies to upgrade Kenya's existing railway facilities at low cost.

3.1.2 Nairobi City

(1) Basic Data

Nairobi is located to the north of central Kenya, about 140 km north of the Equator. With a population of 4.34 million, the capital city has about 10% of Kenya's total population of 47.6 million. The urban areas extend from the city center eastward, with some low-rise, low-density areas in the southwest. South of Nairobi Central Station is a large industrial area, where a logistics base is planned.



Source: NIUPLAN

Figure 3-4 Land Use in Nairobi (2014)

(2) Administrative Departments

The City of Nairobi has 10 departments, as shown below. The commuter railway is under the jurisdiction of the Roads, Public Works and Transport Department as it belongs to the transportation sector. However, it is supervised by the Nairobi Metropolitan Area Transport Authority (NaMATA), which is directly under the Office of the President because the commuter railway serves not only Nairobi but also several other counties such as Kiambu, Machakos, and Kaziad. When these administrative districts are added to Nairobi City, the population reaches 20% of the national total.[7]

Governor- Nairobi City County
Departments
- Trade, Tourism and Cooperative development
- Education, Youth, Sports, Gender Affairs, Culture and Social Services
- **Roads, Public works and Transport**
- Devolution, Public service and Administration
- Environment, Energy, Water and Natural Resources

[7] The agency was established by presidential decree in 2017. Its main role is to determine strategies and policies for the planning of public transportation (including urban transportation) across multiple administrative districts, and to coordinate with related ministries, agencies, and administrative districts.

- Health Services
- Food, Agriculture, Livestock Development, Fisheries & Forestry
- ICT and E-Government
- Finance and Economic Planning
- Lands, Urban Planning, Urban Renewal, Housing and Project Management.

Table 3-3 Population in Neighboring Counties of Nairobi

County	Population	Percentage of total population
Nairobi	4,397,073	10%
Kiambu	2,417,735	5%
Machakos	1,421,932	3%
Kajiado	1,117,840	2%
Kenya (total)	47,564,296	100%

Source: 2019 Kenya Population and Housing Census

3.2 Current State of Urban Transportation Infrastructure

3.2.1 Railway

The railway network in Kenya extends in two directions from Nairobi, the capital, to Mombasa in the southeast and to Uganda in the northwest. All tracks are non-electrified and have meter gauge (1,000 mm gauge). The new Standard Gauge Railway (SGR) section, using a standard gauge (1,435 mm gauge), was constructed between Mombasa and Nairobi with Chinese assistance. The 578-km section from Mombasa to Nairobi has been in operation since 2017. All railway lines, including the Mombasa–Nairobi line, are operated by Kenya Railway Corporation (KRC), which was under the supervision of the Ministry of Transport, Infrastructure, Housing, Urban Development and Public Works (MoTIHUDP). There is information that KRC is now under the National Treasury.

Source: "Railways of the World", Japan Overseas Association for Railway Technical Cooperation (JARTS)

Figure 3-5 Overview of Rail Routes in Kenya

The commuter line provides medium-distance transport between Nairobi and the suburban areas (Thika, Limuru, Embakasi, and Lukenya) of the meter-gauge section. The demand for railway transportation, which is not affected by road congestion, is high with occupancy at nearly 100%. However, with a maximum of only 8.5 round trips, and only one round trip per day on Line 1 from Nairobi Central Station (NCR) to Limuru, the commuter services are not meeting transportation needs. This is because KRC has prioritized freight transport over commuter service and there is a shortage of locomotives for the passenger trains.Figure 3-5 and Table 3-4 show the route map, the number of trains per route), and a list of major stations (station ID).

Source: JICA Study Team

Figure 3-6 Railway route map in Nairobi

Table 3-4 List of Main Stations

ID	Station name	Km	ID	Station name	Km	ID	Station name	Km	ID	Station name	Km
Line 1 (1 round trip/day)											
L1-21	Limuru	46.81									
L1-17	Kikuyu	30.44									
L1-13	Dagoretti	18.63									
L1-8	Kibera	9.83	Line 2 (1-2 round trips/day)			Line 3 (7.5~8.5 round trips/day)			Line 5 (7.5 round trips/day)		
L1-1	NCS	0	L2-1	NCS	0	L3-1	NCS	0	L5-1	NCS	0
			L2-2	Makadara	5.28	L3-2	Makadara	5.28	L5-2	Makadara	5.28
			L2-5	Dandora	12.26	L3-4	Imara daima	11.05	L5-3	Donholm	7.45
			L2-8	Mwiki	17.57	L3-5	Syokimau	15.21	L5-6	Pipeline	10.19
			L2-10	Githurai	21.38	L3-7	Athi river	29.86	L5-8	Embakasi village	12.97
			L2-11	Kahawa	24.25	L3-8	Kitengela	37.49			
			L2-14	Ruiru	31.79	L3-9	Lukenya.	42.20			
			L2-19	Thika	57.00						

Note: Line 4 is not listed. It is an airport line to be developed in the future. NCS stands for Nairobi Central Station.
Source: KRC

3.2.2 Non-rail Public Transportation

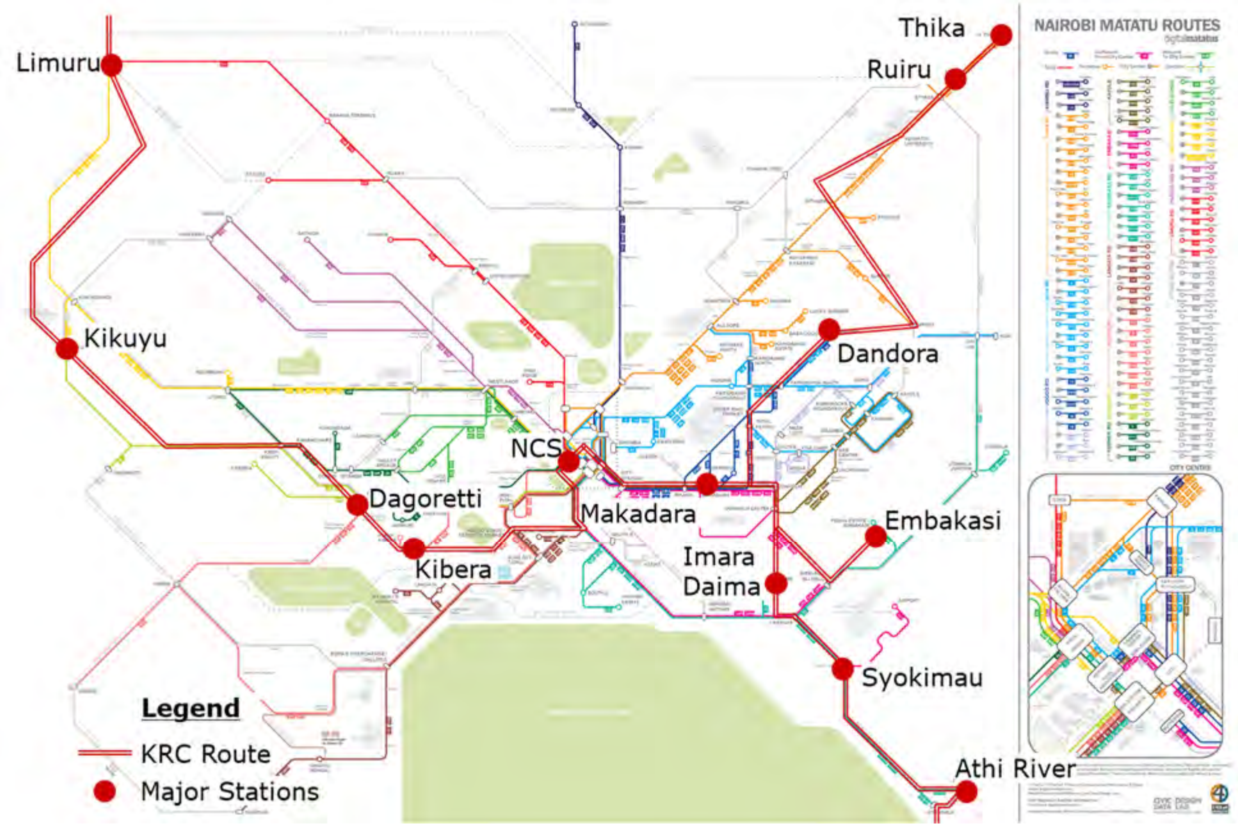
(1) Bus and Matatu

Bus and matatu are the public transportation means for the citizens of Nairobi. The buses are operated by private companies such as Kenya Bus Service (KBS). Matatu is a van-based transportation service, operated in a similar manner as buses by cooperatives (SACCOs), under the jurisdiction of MoTIHUDP. Each van has about 10 seats. There are many matatus in Nairobi, providing transportation for its citizens.

Source: JICA Study Team

Figure 3-7 Bus (left) and Matatu (right)

Matatu operates in the Nairobi metropolitan area, covering similar areas as the railway. Figure 3-8 shows the matatu routes and railway lines.



Source: Digital Matatus, additions by JICA Study Team

Figure 3-8 Matatu Routes

There are multiple bus and matatu terminals for different directions. The fact that these terminals are not consolidated is one of the causes of traffic congestion in the city (see photo below).

Source: JICA Study Team

Figure 3-9 Chaotic Matatu Terminal

3.3 Past JICA Aid Projects

Rail-based public transport for Nairobi has been proposed in various area-wide plans. Table 3.3-1 shows the main area-wide plans. Among them, three urban rail transportation plans, which are expected to directly improve the existing commuting lines, are summarized below.

- Nairobi Integrated Urban Development Master Plan (NIUPLAN) (JICA, 2014)
- The Project on Detailed Planning of Integrated Transport System and Loop Line in the Nairobi Urban Core (JICA, 2018)
- Development of Commuter Rail Master Plan for Nairobi Metropolitan Region (World Bank, 2019)

Table 3-5 Area-wide Plans of the Public Transportation Sector

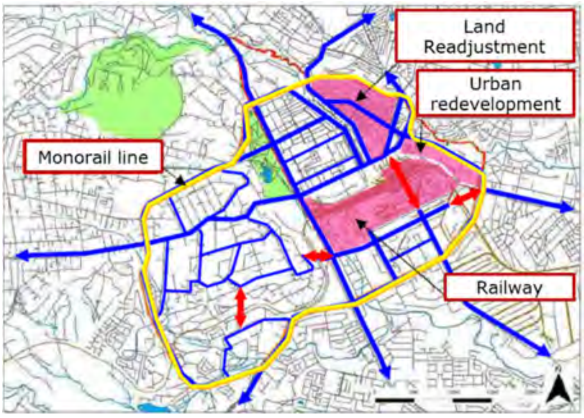
No.	Year	Title	Counterparts (donor, if appreciable)	Contents
1	2006	The Study on Master Plan for Urban Transport in the Nairobi Metropolitan Area in the Republic of Kenya (NIUTRANS)	Ministry of Roads and Public Works, ministry at the local government (JICA)	Proposed LRT
2	2008	Kenya Vision 2008	Office of the President	Top-level plan
3	2008	Nairobi Metro 2030	Ministry of Nairobi Metropolitan Development	Promoted MRT
4	2011	Feasibility Study & Technical Assistance for Mass Rapid Transit System for the Nairobi Metropolitan Region	Ministry of Transport	Proposed a radial metro line
5	2014	Nairobi City Urban Development Master Plan Project (NIUPLAN) in Kenya	Nairobi City County (JICA)	Proposed a loop line (monorail)
6	2014	Mass Rapid Transit System Harmonization Study Nairobi Metropolitan Region	Ministry of Transport and Infrastructure (African Development Bank)	Proposed BRT
7	2018	The Project on Detailed Planning of Integrated Transport System and Loop Line in the Nairobi Urban Core	Nairobi City County (JICA)	Proposed metro for Northeast and Southwest*
8	2019	Development of Commuter Rail Master Plan for Nairobi Metropolitan Region	KRC (World Bank)	Proposed improvements to existing commuter lines

NOTE: No. 7 has not been approved as a master plan.

Source: Additions by JICA Study Team based on the "Final Report of the Project for Formulation of Integrated Transportation System and Circular Route Project in Nairobi."

(1) Nairobi Integrated Urban Development Master Plan (NIUPLAN)

The Nairobi Integrated Urban Development Master Plan (NIUPLAN) formulated in 2014 proposed a monorail loop line around the Greater CBD (central business district and surrounding areas) as an urban railway.



Source: NIUPLAN

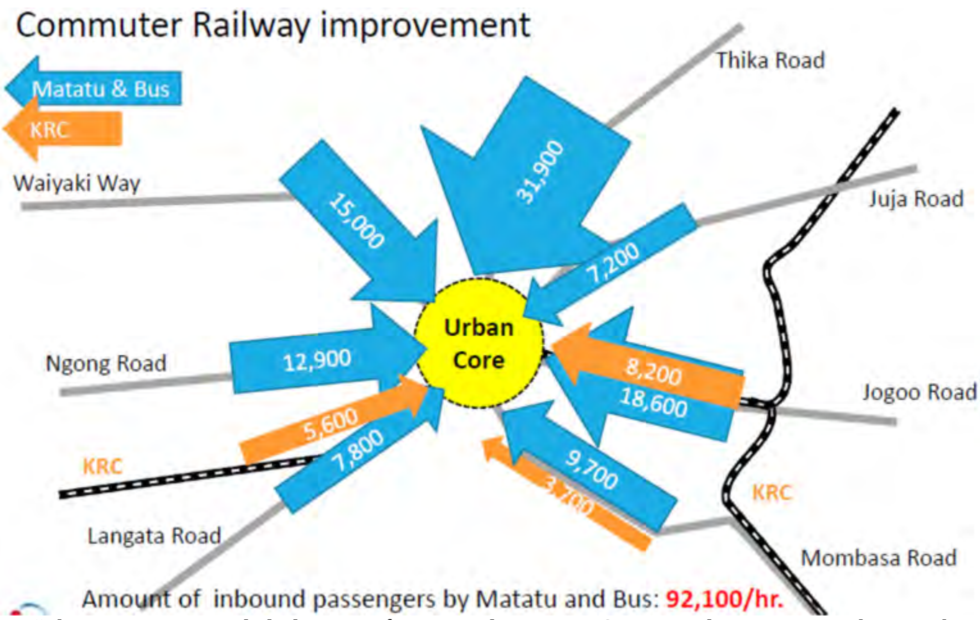
Figure 3-10 Loop Line Proposed by NIUPLAN

(2) The Project on Detailed Planning of Integrated Transport System and Loop Line in the Nairobi Urban Core

NIUPLAN proposed the Preparatory Study for Cooperation, the predecessor of this project, as a short-term plan, and JICA implemented the " The Project on Detailed Planning of Integrated Transport System and Loop Line in the Nairobi Urban Core " (hereinafter referred to as "JICA Prior Study") from 2017 to 2018. While continuing discussion on the loop line, the JICA Prior Study proposed plan for a new urban railway line in the Thika area where the demand is expected to be the highest (red line shown in Figure 3-11) and enhancing the capacity of commuter lines as medium-to long-term measures (2030).

Source: "The Project on Detailed Planning of Integrated Transport System and Loop Line in the Nairobi Urban Core"

Figure 3-11 Metro Plan



Source: "The Project on Detailed Planning of Integrated Transport System and Loop Line in the Nairobi Urban Core"

Figure 3-12 Peak Demand in 2030: Public Transportation (Matatu, Bus, KRC Commuter Line) Commuter Line Improvement Case

3.4 Initiatives by Other Donors

3.4.1 Development of Commuter Rail Master Plan for Nairobi Metropolitan Region (2019, World Bank)

With assistance from the World Bank, KRC prepared the "Development of Commuter Rail Master Plan for Nairobi Metropolitan Region" ("NCR MP"), with a view to modernizing the rail transportation infrastructure in the Nairobi metropolitan area. Figure 3-13 shows the route map of this plan.

Source: NCR MP

Figure 3-13 NCR MP Planned Route Map

Surveys were conducted for the NCR MP, including a traffic volume comparison, a passenger survey by train ride, interviews, a speed survey of major arterial roads, and a preference awareness survey.

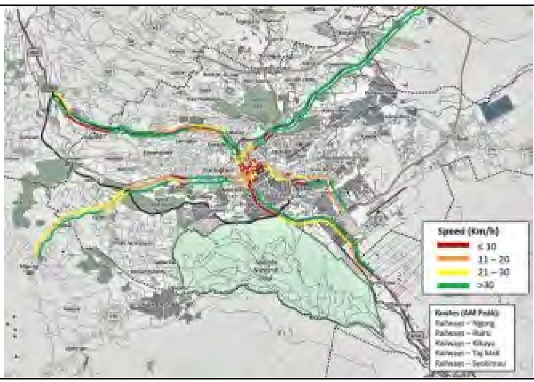


Figure 3-14 Travel Speed Survey Results (arterial roads: morning peak hours)

Figure 3-15 Travel Speed Survey Results (arterial roads: morning peak hours)

Source: NCR MP

(1) Demand Forecast Results and Proposed Routes

In addition to extending the existing commuter lines, the NCR MP proposed branch lines to the Ngong area in the southwest of the Greater CBD and to Kenyatta International Airport. Among the existing lines, demand for Line 2 (Ruiru–NCR) in the northeast direction is the highest, followed by Line 1 (Kikuyu–NCR) and Line 5 (Embakasi Village–NCR).

Figure 3-16 Proposed NCR MP Routes (2030)

Figure 3-17 Demand Forecast Results (2030)

Source: NCR MP

Table 3-6 Demand Forecast Results

Route	Maximum section PPHPD[8]			
	2030 Projection	Rank	2045 Projection	Rank
Line 1 (Kikuyu–NCS)	10,962	2	15,484	2
Line 2 (Ruiru–NCS)	12,052	1	22,187	1
Line 3 (Lukenya–NCS)	2,574	5	4,181	5
Line 4 (Airport Line: a new line for reference)	4,752	4	9,028	4
Line 5 (Embakasi Village–NCS)	8,689	3	10,668	3

Source: NCR MP

8 Passengers per hour per direction

As shown in Table 3-7, the NCR MP estimated that the total cost for upgrading all proposed lines, including the new lines, would be USD 3.6 billion. However, there is little prospect for raising such a huge amount of funds and there is no progress on any of the projects.

Table 3-7 Project Costs by Route

Category	Common	L1	L2	L3	L4*	L5	L8*	**Total**
01- Civil Works	0.00	78.66	55.83	75.12	4.24	10.71	8.48	**233**
02 - Track Works	0.00	96.80	125.41	92.11	10.27	30.58	20.08	**375**
03 - Stations (Buildings)	0.00	173.94	171.51	52.69	13.39	35.48	24.46	**471**
04 - Signaling	0.93	108.93	98.71	38.55	10.28	16.93	18.52	**293**
05 - Telecomm. & ICT Networks	5.02	28.63	33.12	12.13	3.02	7.79	3.98	**94**
06 - Operational Control Center	33.33	0.00	0.00	0.00	0.00	0.00	0.00	**33**
07 - New Makadara Workshop	95.67	0.00	0.00	0.00	0.00	0.00	0.00	**96**
08 - Rolling Stock	170.95	176.00	374.00	77.00	66.00	88.00	55.00	**1,007**
09- Power & Water Supply	0.00	19.91	18.74	7.31	5.17	8.91	2.96	**63**
10 - Urban Integration and Landscaping	0.00	27.77	30.73	22.58	3.29	9.01	7.64	**101**
11 - Contingencies	45.89	106.60	136.21	56.62	17.35	31.11	21.17	**415**
12 - Land Acquisition	0.00	89.23	38.55	13.15	9.75	0.00	52.58	**203**
13- Design, Monitoring and Commissioning	14.65	51.94	54.29	28.93	5.43	12.19	8.69	**176**
Total Masterplan Nairobi	**366.44**	**958.42**	**1,137.1**	**476.20**	**148.18**	**250.72**	**223.54**	**3,560**

Note: *Lines 4 and 8 are planned new lines. Unit: million USD
Source: NCR MP

(2) Quick Wins Projects

On the other hand, the NCR MP proposed a "Quick Wins" project for maintenance that shall be carried out within the next few years starting in 2019, when the report was published. The basic concepts are as follows:

- It is important to increase train frequency and improve convenience.
- Currently, freight transport has priority, making it difficult to secure rail cars for passenger transport. Passenger train service should be given a higher priority.
- Commuter trains are unreliable due to frequent delays and cancellations. As emergency measures, fencing and other improvements shall be made to ensure safe train operation.
- Connectivity with other transportation means shall be considered.

Table 3.4-3 lists the proposed Quick Wins projects. The total cost of the projects is USD 22 million. KRC is financing the projects on its own, without assistance from the World Bank.[9]

Table 3-8 Quick Wins Projects Proposed by NCR MP (2019)

No	Contents of NCR MP Proposal (Quick Wins)	Duration*	Remarks	Project scale USD mil.
1	Upgrade train stops (halt stations) to mini-stations	Half a year–1 year	20 mini-stations: maintenance of turnouts, platform, etc.	5
2	Procure Rolling stock parts	Half a year	-	6

[9]Based on interviews with KRC personnel (March 2022)

3	Improve tracks (ballast filling, butt consolidation, etc.)	Half a year	65 km (all routes)	2
4	Improve drainage facilities	Half a year	10 km (3 locations)	2
5	Install a loop line for train passing	Half a year	Imara Daima Station	1
6	Improve station facilities	Half a year–1 year	Nairobi Central Station: renovation of station building, including improvements to ticketing facilities, pavement, lighting, platform, etc.	6
Total				22

Note: *The starting point was 2019, when the NCR MP was formulated.
Source: NCR MP

Table 3-9 shows progress of the projects as of September 2021. About 80% of the track rehabilitation has been completed. Maintenance work is also being carried out at the Nairobi Central Station. Among the other 20 stations slated for upgrade, only one station has started the construction work. Upgrades for the other 19 stations are still in the design phase. No progress has been made on the other proposed items.

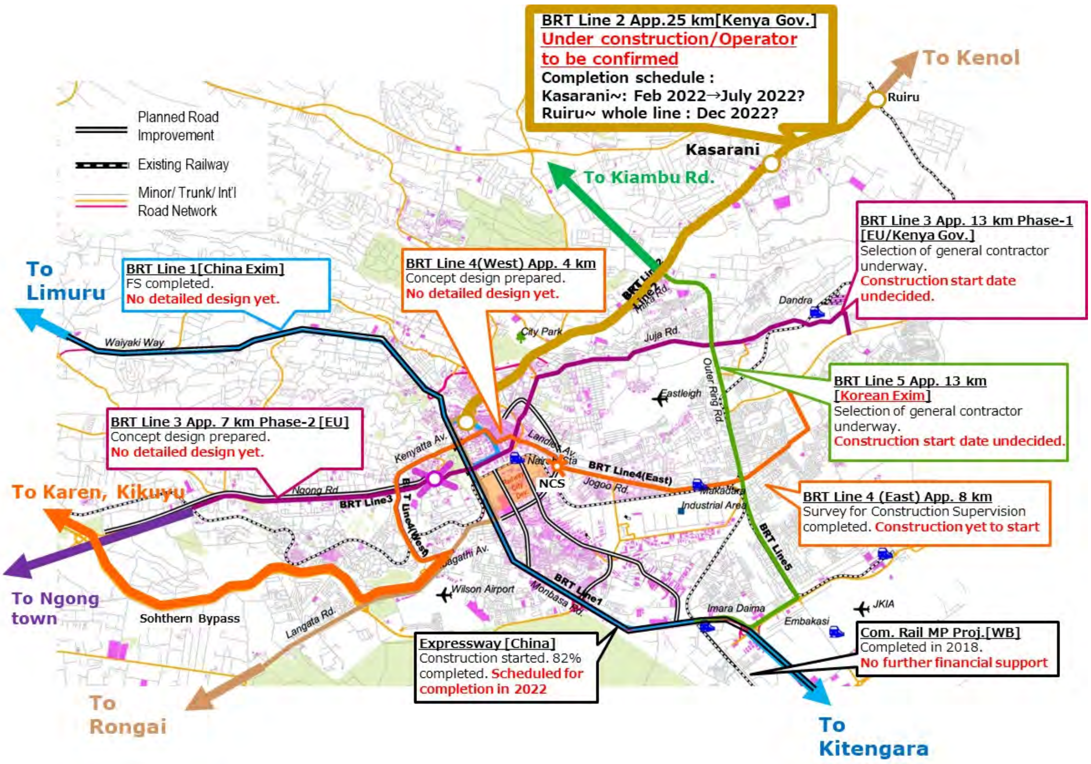
Table 3-9 Progress of NCR MP (as of September 2021)

No	Contents of NCR MP Proposal (Quick Wins)	Remarks	Progress as of September 2021
1	Upgrade train stops to mini-stations (construction of station buildings, toilets, platforms, perimeter walls, parking lots, and drainage systems)	20 stations	Only one station is under construction (Mukuru Station). The remaining 19 stations are in the design phase.
2	Procure Rolling stock parts	-	No progress
3	Improve tracks (ballast filling, butt consolidation, etc.)	65 km (all routes)	Progress: 81.5% Line 1 (Kikuyu): 69%, Line 2 (Thika): 91% Line 3 (Lukenya): 77%, Line 4 (Embakasi Village): 94%
4	Improve drainage facilities	10 km (3 locations)	
5	Install a loop line for train passing	Imara Daima Station	No progress
6	Improve station facilities	Nairobi Central Station	Completed renovation of station building and improvements to toilets, platform, perimeter walls, security guard room, parking lot, and drainage system

Source: KRC

3.4.2 BRT Plan and Transportation-related Plans

Following formulation of the NIUPLAN master plan, the Ministry of Transport (MOT) (formerly Ministry of Transportation) conducted the Harmonization Study (2016), which proposed a plan for five BRT lines. The survey, design, and construction of each line are in progress in accordance with the plan. The construction of an elevated highway parallel to Line 1 is also underway. An overview of the routes, donors, and progress as of February 2022 is shown in Figure 3-18 below.



Source: JICA Study Team

Figure 3-18 Progress of BRT Plan and Transportation-related Plans (as of February 2022)

(1) BRT Project

Compared to the BRT project in 2018 (JICA Prior Study), an extension plan for the routes has been added, as indicated by the arrows in Figure 3-18 above. Besides the start of construction for the Line 2 extension to the northwest, the plan has not been implemented yet. There have been changes to the donors of Line 1 (from World Bank to China Exim Bank) and Line 5 (from African Development Bank to Korea Exim Bank). Line 2 was scheduled to begin partial operation in February 2022. However, as of October 2021, the launch has been pushed back to July 2022 and the operator has not been determined yet[10].

As pointed out in the 2018 JICA Prior Study, coordination among the various lines (donors) is important. The full operation of all BRT lines will take some time.

(2) Nairobi Expressway Project

The expressway covers the urban areas of central Nairobi in a north–south direction (Figure 3-19). The project is implemented within the framework of a public-private partnership (PPP) by the China Road and Bridge Corporation (CRBC). CRBC will operate the highway under a 27-year concession agreement.

[10] The operation has not started as of July 2022.

Source: Openstreetmap contributor ©, prepared by JICA Study Team

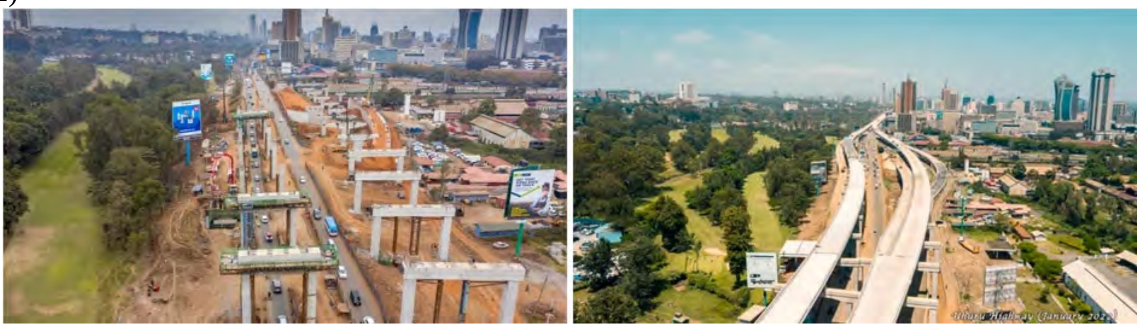
Figure 3-19 Location of the Nairobi Expressway Project

The construction work was started in July 2020. As of February 2022, 82% of the project had been completed. Trial operation began in May 2022, one month ahead of the initial June 2022 completion date. Table 3-10 summarized the project as of July 2022 and the photos below show the status of the construction.

Table 3-10 Summary of Nairobi Expressway Project (as of July 2022)

Item	Contents
Extension	27.1 km (including 8.5 km elevated section)
Start of construction	July 2020
Number of lanes	2–3 lanes one direction
Scheduled completion	May 2022 (currently in trial operation)
Donor	China Road and Bridge Corporation (CRBC)
EPC Contractor	Cale Infrastructure Construction Co., Ltd.
Contract amount	65 billion KSh (approximately 65 billion yen)

Source: KeNHA presentation materials
https://mobile.twitter.com/NrbXpressway_Ke/status/1474260221174468612/photo/1
https://kenhakenya.wixsite.com/nairobi-expressway/post/nairobi-expressway-updates-as-at-february-1-2022 (both viewed on March 11, 2022)
https://www.kbc.co.ke/review-of-the-nairobi-expressway-a-month-after-it-was-opened/ (viewed on July 6, 2022)



Source: https://kenhakenya.wixsite.com/nairobi-expressway

Figure 3-20 Construction of the Nairobi Expressway (Looking toward Nairobi City Center)

3.4.3 Donor Involvement in Transportation Sector

Table 3.4-6 below summarized the aid from each donor of the BRT, expressway, and rail projects. Although the BRT is being planned and developed with funds from various donor, there is no timetable for the start of operation. Construction of the expressway is underway with Chinese backing. Although the NCR MP was formulated by the World Bank, development of the existing railways is being carried out with KRC funds. As of February 2022, there is no specific donor involved.

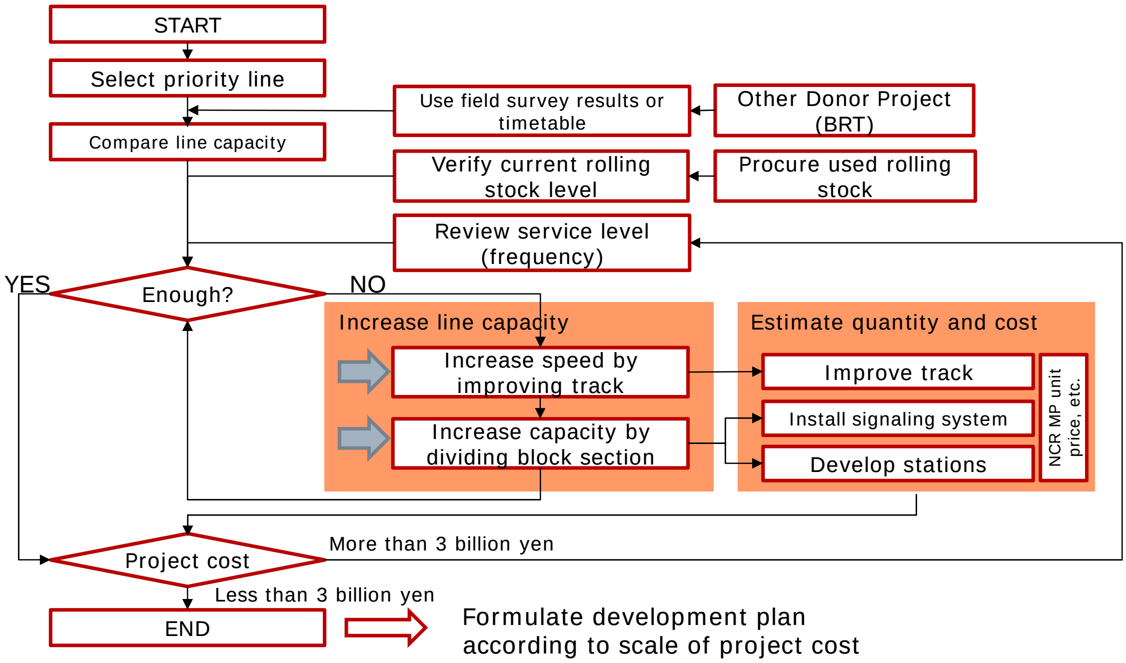
Table 3-11 Donors for the Transportation Sector in Nairobi

Transportation Sector	Donor	Remarks
BRT	EU, China, Korea, Government of Kenya, etc.*	Multiple plans. Start of operation not yet determined.
Expressway	China	Construction started, 82% completed as of January 2022, scheduled to open in 2022
Railway	World Bank (NCR MP) →No donor involvement after the master plan was completed.	Development underway with KRC funds based on NCR MP (Quick Wins projects only)

Note: * Involvement of the World Bank and African Development Bank as of 2018
Source: JICA Study Team

3.5 Target Route and Issues

The KRC commuter railway, subject of this Study, operates trains at a frequency of 1 to 8.5 round trips per day. Since the number of trips is low, the railway is not functioning as an urban railway system. In this Study, a development plan is prepared using the following decision-making flowchart with an objective to increase train frequency. Lines that have low frequency operations at present but are expected to have higher demand for the railway and other services after train frequency has been increased will be selected as the priority lines.



Source: JICA Study Team

Figure 3-21 Decision-making Flow

(1) Selection of the Priority Line

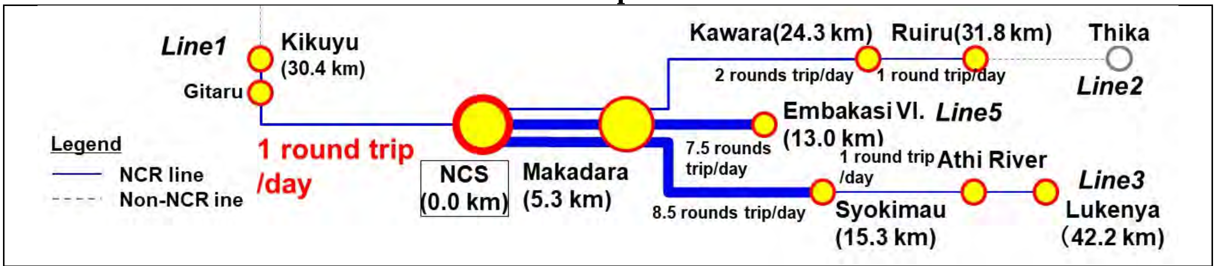
Due to budget constraints, it is difficult to secure funds for all the lines. Therefore, it is necessary to select a priority line that will have a high impact from the implementation of this project.

Table 3-12 below is a comparison of the lines. Line 2 has the highest demand. However, it is not under consideration because the BRT is being constructed from Ruiru to the CBD (as of

November 2021). The BRT is scheduled to start operation in December 2022. Line 5 is a shorter line, but it has three lines converging in the section between NCR and Makadara. Demand for Line 3 is expected to be low.

When two lines converge, the system of the priority line proposed in this Study and the system of the existing line will coexist, making it necessary to establish a system to facilitate coexistence and interface. Confusion in operation can also be a problem. In this regard, the proposed priority line should have as few convergences with other lines as possible. Of the four lines, Line 1 was selected as the priority line because it has low train frequency and no convergence with other lines.

Table 3-12 Comparison of Lines



Line	Outline	2019 Ridership survey	Frequency	Demand Forecast at Peak Hours[Note] (Rank)		Priority line	Reason
				Prior year survey ('30)	NCR MP ('45)		
Line 1	Kikuyu–NCS 30.4 km	Up 350 Down 150	1 round trip	5,600 (2nd place)	15,484 (2nd place)	✓	Train frequency is low. Have demand potential (2nd place). No line convergence. Easy to develop.
Line 2	Ruiru–NCS 31.8 km	Up 2,500 Down 1,000	2 round trips	8,200 (1st place)	19,252 (1st place)		Route with the highest demand, but competition with the BRT, which is under construction in the CBD–Ruiru section
Line 5	Embakasi –NCS 13.0 km	Up 2,000 Down 800	7.5 round trips		10,668 (3rd place)		Short line, making it possible to have lower construction cost, but Line 5 converges with other lines in the NCS–Makadara section
Line 3	Syokimau –NCS 15.3 km	Up 1,600 Down 800	8.5 round trips	3,700 (3rd place)	4,181 (7th place)		Low demand compared to other lines

Note: Up indicates the NCS direction.
Source: JICA Study Team

(2) Operational Status of Line 1

Table 3-13 shows the specifications of Line 1. The information was obtained based on KRC interview.

Table 3-13 Specifications of Nairobi Commuter Line 1

Item	Description
Year of construction	Around 1900 (British colonial period)*
Route length	46.8 km
Number of stations	16 stations: 5 intermediate stations and 11 stops (halt stations)
Number of tracks (electrified/non-electrified)	Single track (non-electrified)
Train set configuration	6-car train set (1 locomotive + 6 cars)
Number of passengers per day	1,360
Transport capacity per day	Capacity: 172 passengers/car (60 seated + 112 standing) x 6 cars = 1,032 passengers/train
Steepest gradient	4% *Technical Standard Interpretations in Japan specify 2.5% for freight trains and 3.5% for conventional railways, which are considered steep gradients.

Source: KRC, JICA Study Team, *"Republic of Kenya, Mombasa–Nairobi Railway Rehabilitation and Rehabilitation Project Formation Promotion Project Study Report" (1993, Japan Transport Cooperation Association).

To find out the current state of Line 1, the JICA Study Team mounted a video camera on the lead car to take photos and hired local personnel to use a GPS logger to verify the train's running speeds, alignment, station locations, and number of passengers.

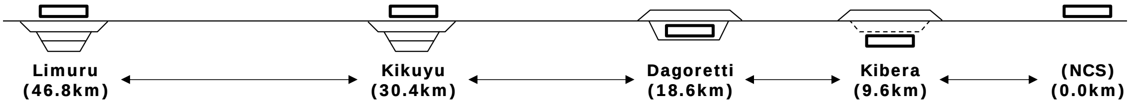
Table 3-14 Summary of Ride Survey

Date, time, and section	2021.11.24: Limuru–NCS (video recording, local personnel onboard) 2022.2.15: Limuru–NCS (JICA Study Team member onboard) 2022.2.24: NCS–Kikuyu (JICA Study Team member onboard)
Information collected	GPS logs, video images taken from the lead car, and photos
Trains surveyed	(NCS direction) Limuru 5:30 to NCS 7:52 (Limuru direction) NCS 17:20 to Kikuyu 18:55
Train configuration	Locomotive + 6 passenger cars + brake van

Source: JICA Study Team

Figure 3-22 shows the longitudinal gradient of the line (approximate), actual speed, and track layout of the main stations (Limuru, Kikuyu, Dagoretti, Kibera, and NCS), based on the train ride survey. The line is 46.8 km long. The average gradient between the terminal station at Limuru (2,249 m above sea level) and NCS (1,660 m above sea level) is 12.5 per mils, with a minimum curve radius of 200 m. The line is single-track and non-electrified. The main stations have loop lines to allow the trains to pass. There are four block sections, ranging from 9.6 km to 16.4 km. The interval between stations becomes longer as the line goes into the suburbs.[11]

[11]NCS has complicated track layout, only some of the tracks are used in the figure.



Note: The track layout of NCS is used as reference.
Source: JICA Study Team (based on GPS loggers)

Figure 3-22 Longitudinal Gradient, Operating Speed, and Track Layout of the Main Station

Besides the terminals and intermediate stations, the 11 train stops (known as halt stations) have neither platforms nor timetables. After the train arrives at a halt station, the driver will visually confirm that passengers have boarded the train before departing. There is no indication where the train should stop at a halt station, so the positions where a train stops vary. Trains arriving and departing earlier than the schedule on the timetable were observed on multiple occasions at even the terminals and intermediate stations, making it very inconvenient for users. There are also many people wandering into the tracks, which is the main reason why trains cannot increase speed.

Paper tickets are sold by the conductor on the train using a hand-held device. It is compatible with M-PESA, an electronic payment system. M-PESA is widely used as an alternative payment method to cash. The passenger receives the ticket after showing the payment completion screen to the conductor; however, the confirmation of remittance via text message (SMS) takes time (tens of seconds).

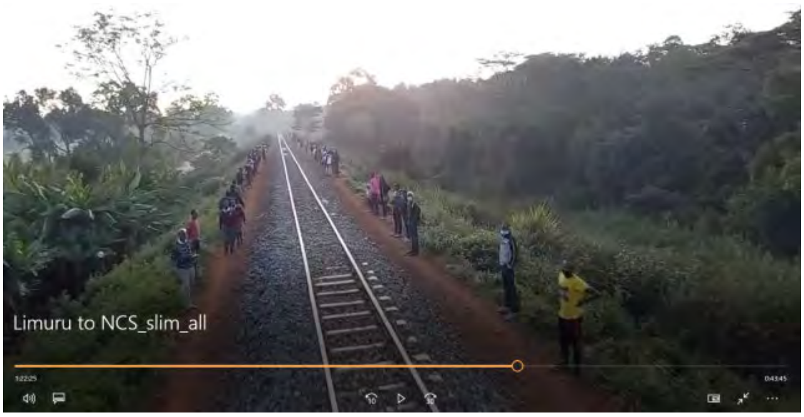
Source: JICA Study Team

Figure 3-23 Line 1 Route Information (Left: Boarding at a Halt Station, Middle: Waiting to Board at a Halt Station, Right: Tickets)

(3) Selection of Priority Line based on Demand

The Line 1 section currently in service between NCS and Limuru is approximately 47 km, which is a length comparable to intercity service. From the viewpoint of using the conventional railway as an urban transit, development shall focus on the high-demand section around NCS.

It is useful to find out roughly the number of boardings at each station in order to identify the high-demand sections on Line 1. To this end, video images (Figure 3-24) taken during the November 2021 ride survey, as described in the previous section, were analyzed and the number of passengers waiting for the train at the stations were counted to tabulate the results.



Source: JICA Study Team

Figure 3-24 Passengers Waiting to Board the Train at a Station (Video Image used in the Analysis)

Table 3-15 shows the tabulation results. It should be noted that since the video images analyzed were taken between stations, only the numbers of boardings at intermediate stations, excluding the NCS terminal station, were available.

Table 3-15 Estimated Number of Passengers (Survey Conducted on Dec. 24, 2021)

No.	Distance marker	Station name	Estimated number of passengers	Timetable	Stoppage time	Remarks
1	0.00 km	**NCS**	**n.a.**	7:52	7:35	**Terminal station**
2	6.51 km	Mashimoni	30		7:19	Halt station
3	7.38 km	Olympic	45		7:15	Halt station
4	9.83 km	**Kibera**	**10**	7:16–18	7:09	**Intermediate station**
5	11.79 km	Satellite	240		7:00	Halt station
6	14.45 km	Lenana/Riruta	100		6:54	Halt station
7	17.75 km	Mutuini	80		6:48	Halt station
8	18.63 km	**Dagoretti**	**130**	6:48–50	6:44	**Intermediate station**
9	20.43km	Dagoretti Market	65		6:39	Halt station
10	23.25 km	Thogoto	65		6:33	Halt station
11	27.98 km	Gitaru	30		6:24	Halt station
12	30.44 km	**Kikuyu**	**30**	6:15–17	6:15	**Intermediate station**
13	33.98 km	Nderi	0		6:06	Halt station
14	38.48 km	Muguga	5		5:59	Halt station
15	42.54km	Tilisi Estate	5		5:54	Halt station
16	46.81 km	**Limuru**	**n.a.**	5:30	5:30	**Terminal station**

Note: Because the video was recorded between stations, the number of passengers boarded at the terminal station Limuru was not known.
Source: JICA Study Team

The number of passengers from Limuru Station to Kikuyu Station was very small, but the number of passengers from east of Kikuyu was 30 to 60. Around 100 passengers could be seen after the Dagoretti Station, with the largest number of 240 passengers at the Satellite Station. Ridership east of Kibera Station was about one-third, compared to that of the peak section, as the train approached NCS, the terminal station. The train was packed at Satellite Station, which had the highest ridership. While this line operates only one round trip per day, it is serving many citizens, showing that the line has demand potential.

Source: JICA Study Team (Photo taken on Feb. 15, 2022)

Figure 3-25 Inside the Train between Satellite and Kibera Stations

Based on the above findings, the 18.63-km section between NCS and Dagoretti Station was selected as the priority section of Line 1. It has relatively high demand and can be developed into an urban railway, considering the route length.

3.5.2 Tracks

(1) Technical Standards and Specifications

The Study will focus its review on the development between Nairobi Central Station and Kikuyu Station (Line 1)

Table 3-16 Track Specifications of Target Route

Item	Specifications
Gauge	Meter gauge (1000 mm)
Track type	Ballast
Sleeper	Combination of PC sleepers and steel ties
Fastening device	Pandrol

Source: JICA Study Team

(2) Issues

Trains are currently in operation and KRC is performing its own track maintenance work. No immediate measures are deemed necessary.

Source: JICA Study Team

Figure 3-26 Track Conditions near Nairobi

On-site survey confirmed that the tracks are undergoing major improvement. Continuous efforts should be made to enhance capacity for the maintenance and management of tracks and to ensure compliance with maintenance standards in the future. Technical cooperation projects should consider supplying equipment that can be used for regular track maintenance and measurement, as well as providing technical guidance.

3.5.3 Signaling System

(1) Technical Standards and Specifications

1) Technical Specifications

Table 3-17 gives an outline of the technical specifications of signaling equipment for the section of Line 1 between NCS and Kikuyu Station.

Table 3-17 Technical Specifications of Signaling Equipment

Item	Technical Specifications
Block equipment	Token block equipment
Signal	Home/Starting Signal
Switch	Point lever (Counter-weight type) or trailable point
Interlocking device	Mechanical interlocking device (Class 1)
Traffic control system	*ATW/OBC (suitable for meter-gauge railway network) Transmits dispatcher's instructions and authority of operation to the train driver
Train detection equipment	None
Level crossing warning device	None

*ATW/OBC (All Track Warranty/Onboard Computer System)
Source: JICA Study Team

ATW/OBC is one of the traffic control systems that is operated manually. Although it is not compatible with international standards, it is a proprietary system of KRC. Its main functions are the prevention of train collisions through communication (voice and message) between the OCC and drivers, utilization of trailable point machines, detection of train set separation, and provision of operation support information to drivers, and so on.

2) Operation Condition

Except for a few, the signaling equipment is not operable, due to the general lack of proper maintenance, replacement, and upgrades for many years.

Table 3-18 summarized the current state of signaling equipment on Line 1.

Table 3-18 Current State of Signaling Equipment

Equipment	Condition
Block equipment	Token block equipment, not operable
Interlocking device	Mechanical interlocking equipment (Class 1), not operable
Signal	Most mechanical signals not operable (except a few)
Switch	Point lever with counter-weight and trailable point, not operable
Traffic control system	ATW/OBC in operation Detection of train set separation seemed not working.

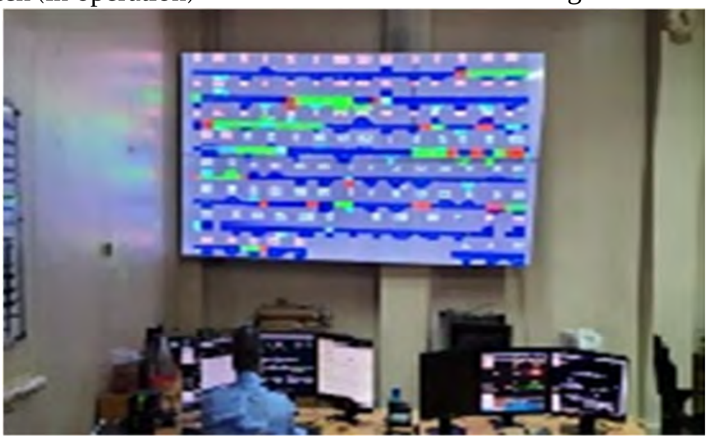
Source: JICA Study Team

Block Equipment (not in operation)

Mechanical Interlocking Device (not in operation)

Switch（in operation）

Level Crossing without Warning Device



Traffic Control System （in operation）

Source: JICA Study Team

Figure 3-27 Conditions of Signaling Equipment

Since no station masters are assigned to the stations to handle train operation, the train dispatcher at the OCC grants the authority of operation (audio and messages) to the train driver using the ATW/OBC. In other words, since there are only a few trains running, this system can still be used to ensure the safety of train operations without any block equipment.

Mechanical signals (lower quadrant signal: Starting/downward 45 degrees, Home/horizontal) are installed. Although the “Starting” signal at Kikuyu Station and the signal inside NCR Station indicate “Starting,” the other signals are not working, indicating only “Home.”

(2) Maintenance Management

For maintenance, field equipment such as trailable points and point levers with counter-weight are lubricated once a week.

(3) Issues

In the future, as the number of trains in operation increases, signaling equipment, such as block equipment and level crossing warning devices, shall be installed to ensure safety.

In tandem with the installation of signaling equipment, education and training shall be provided to the operators and maintenance staff.

3.5.4 Rolling stock

(1) Overview of Rolling Stock and Technical Standards

Table 3-19 gives an overview of the rolling stock owned by KRC.

Passenger transport is carried out by locomotive-hauled passenger cars or by diesel railcars. The train set for Line 1 is supposed to have seven cars, but there were only 6-car train sets (1 locomotive + 6 coaches) at the time of the field survey in February 2022. The number of cars per train set seems to vary depending on the situation. The subsequent analysis assumes a 6-car train set configuration, as was confirmed during the field survey.

There is a new plan to procure 16 locomotives from China, but they will be used for freight transport.

Table 3-19 KRC Rolling stock (excluding freight cars)

Type	Number	Remarks
Diesel locomotive	26	6 for passenger transport, 19 for freight transport, 1 spare
Diesel railcar	22	2 cars per unit, 5 units for passenger transport
Passenger car	80	64 seats, standing room for 180 passengers Line 1 Kikuyu: 7 cars Line 2 Ruiru: 21 cars Line 3 Syokimau: 7 cars, Lukenya: 5 cars Line 5 Embakasi: 16 cars

Source: JICA Study Team

Source: JICA Study Team

Figure 3-28 Current Rolling Stock

KRC uses mainly General Electric (U.S.A.) diesel locomotives. The Diesel Multiple Units (DMUs) manufactured by CAF (Spain) are secondhand rolling stock, they break down often. The supply of spare parts is insufficient, making it very inconvenient for KRC. In particular, air compressors and brakes are in short supply. Due to the gradients of the routes and specifications of the rolling stock, the DMUs can only operate on certain lines. They are not currently used on Line 1. A running test is planned to find out if DMUs can operate on Line 1 in the future. KRC has a fleet of 80 passenger cars, only 56 cars are in service. All of the remaining 24 cars are not in an operable condition. Many cars are being stored, waiting for repairs.

Although there is a shortage of parts, the car depot is equipped with facilities for maintenance. The local operator also performs overhauls.

Source: JICA Study Team

Figure 3-29 Depot Facilities

(2) Issues

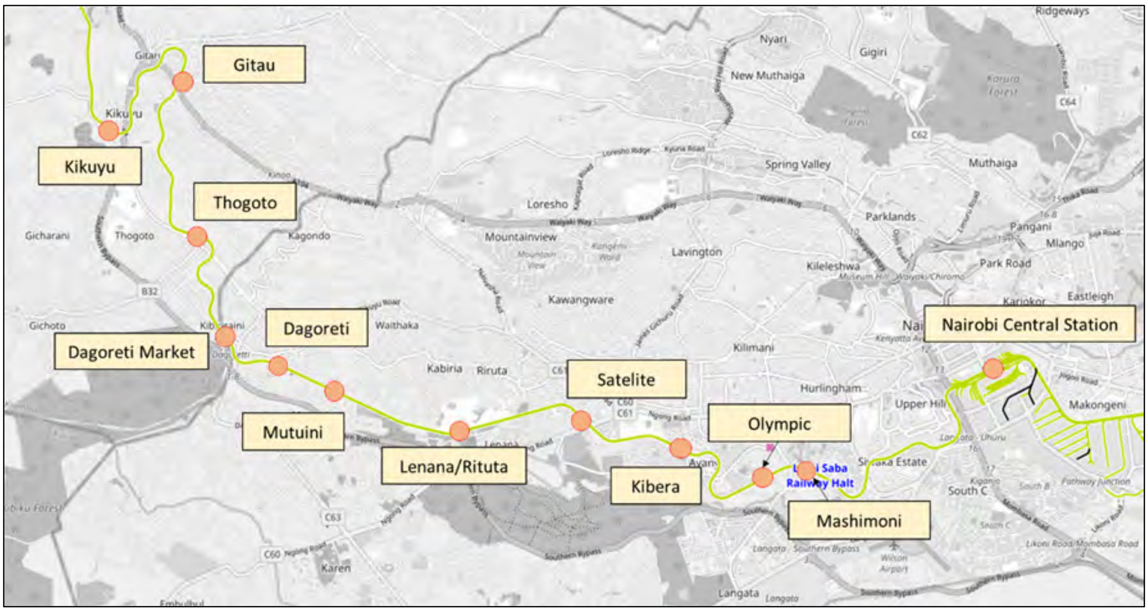
Imported locomotives must be compatible with the meter gauge. Malfunction is the primary cause of delays. Train service may be canceled due to the lack of spare parts (motors, brakes, etc.). Although KRC has facilities at the car depot, shortage of parts led to insufficient maintenance. There seems to be enough rolling stock, but only one locomotive is reserved as backup. This locomotive cannot afford to be used for new operation.

The DMU is said to be able to operate only on limited lines due to the gradient. More detailed information on route alignment and gradient is needed to determine if DMUs can be used for Line 1.

3.5.5 Station

(1) Conditions of Stations

Line 1 has 12 stations, including the terminal stations. Among the 12 stations, NCR designated the Kibera Station and Dagoretti Station as "intermediate stations." A timetable of one round trip per day is set with standard arrival and departure times. The other eight stations, excluding the two terminal stations and two intermediate stations, are train stops designated as “halt” stations, where passengers can get on and off freely.



Source: JICA Study Team

Figure 3-30 List of Existing Stations on Line 1

Nairobi Central Station (NCS) is the terminal station of four NCR lines. It is built to a high standard and is equipped with a station building, platforms, AFC system (European made), and certain facilities to enhance accessibility (access ramps, etc.). Kikuyu Station, the other terminal station, also has an AFC system (European made) and a parking lot in front of the station. Kibera and Dagoretti are intermediate stations. They have simple station buildings and platforms. The other stations do not have any station facilities.

The fare is 60 KSh between NCS and Kikuyu and 50 KSh between NCS and Dagoretti (*1 KSh = about 1 yen). Tickets can be purchased by cash or prepaid card. The payment system for AFC is made by Thales (France). Most of the users pay cash on the train (or present the M-Pesa payment screen to the conductor). It has been found during the field survey that the AFCs are mostly not in use.

NCS	Kikuyu	Dagoretti	Kibera
			

Source: JICA Study Team

Figure 3-31 Conditions of Stations on Line 1

(2) Station Issues

Converting the Line 1 into an urban railway has the following station-related issues:

1) Ensuring the Safety of Boarding at Halt Stations

Except Dagoretti Station, the other 11 stations do not have platforms. Passengers climb up the ladder (about 1.2 meters high) located under the doors at both ends of the rail car. Getting on and off the train is challenging especially for the elderly, children, and people with disabilities. The facilities shall be improved to enable smooth boarding and alighting of trains to enhance accessibility.

Source: JICA Study Team

Figure 3-32 Boarding the train without platform

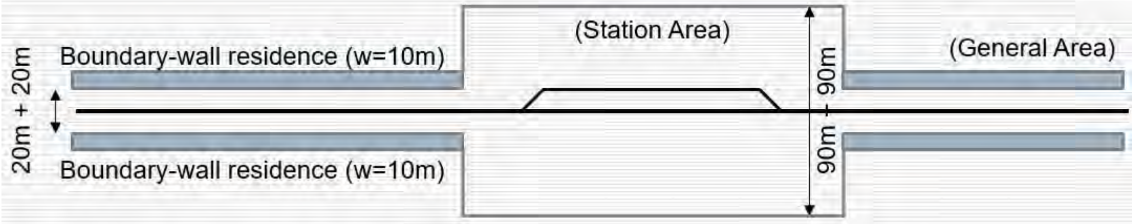
2) Improving Convenience of Intermediate Stations

Kibera and Dagoretti stations do not have facilities that can accommodate future increases in operation and demand. Stations at locations linked to the BRT development plan as junctions shall be equipped with appropriate facilities.

3.5.6 Station Plaza and Access Road

(1) Facilities and Condition of Use

There are only two stations in the section between NCS and Dagoretti Station on Line 1 that have station buildings. The other halt stations are merely train stops, which are in poor condition and have no station facilities. Although sufficient land has been secured in front of the stations, there are almost no facilities. The concept of using or utilizing a station plaza hardly exists.



Source: JICA Study Team

Figure 3-33 KRC Land around the Station

The access road from the main road to the halt station is not paved, making it inconvenient to connect to other means of transportation. Since there is no sign indicating the station position on the access road, there is also no facility that can be identified as the station entrance.

Source: JICA Study Team

Figure 3-34 Boarding and Alighting Passengers (Dagoretti Station)

Source: JICA Study Team

Figure 3-35 Boarding and Alighting Passengers (Train Stop)

Table 3-20 Facilities around Stations on Line 1 and Their Utilization

Station name	Condition of facility	Vicinity, condition of use, access (connection)
Degoretti Station	With station building (not in use)	･Poor Access to main road ･Has open space
Mutuini Station	Halt station (without facilities)	･Poor access (poor road development)
Lenana/Riruta Station	Halt station (without facilities)	･Poor access (near Lenana School)
Satellite Station	Halt station (without facilities) *Station building under construction	･Poor access to main road (Ngong Road) ･Planned terminal station of BRT Line 3
Kibera Station	With station building (not in use)	･Poor access (poor road development) ･Residential area around station
Olympic Station	Halt station (without facilities)	･Poor access (poor road development)
Mashimoni Station	Halt station (without facilities)	･Poor access (poor road development)

Source: JICA Study Team

(2) Planning

NIUPLAN recognized the importance of increasing rail transport capacity as a means to facilitate modal shift in transport. Strengthening and effectively utilizing the existing railways was proposed as the concept for a kickstart plan. A land use plan taking into consideration transit-oriented development (TOD) was also proposed to further promote the use of public transport.

(3) Issues

There is a plan to make the halt stations on Line 1 into mini-stations (a simple station with minimal station facilities such as a platform), but it lacks planning for facilities to connect the railway with other transportation means. Therefore, in order to develop a public transportation network with connections to stations and to improve the convenience of public transportation, a plan to construct station plazas to enhance connectivity between the railway and other transportation means is needed, in addition to upgrading the station facilities.

The characteristics of demand for other transportation modes, such as buses and matatus, the development of access roads, and space to accommodate future increase in demand shall also be considered when making plans to develop station plazas.

Connecting the railway with other public transportation systems such as buses, matatus, and BRT, and developing access roads to the stations are necessary. JICA is said to be providing technical assistance for buses currently. The approach to intermodal connectivity proposed in this Study can contribute to technical cooperation in improving and enhancing the convenience of public transportation as a whole. The size of the station plaza, to be developed with land owned by KRC, shall be planned in a scale that can accommodate future demand for the railway as well as future demand for transfers to other transportation means.

3.5.7 Passenger Services

Together with the railway facilities, the current state of passenger services provided by other public transportation means that are expected to be connected to Line 1 shall also be reviewed. This section reviews mainly the fare collection methods of public transportation systems that are connected to Line 1.

(1) Public Transportation Systems Connected to the Nairobi Conventional Railway and Fare Collection Methods

The following are the fare collection methods of the public transportation systems connected to the target route:

Table 3-21 Public Transportation Systems Connected to the Nairobi Conventional Railway and Fare Collection Methods

	Name of public transportation system	Fare Collection Method
1	Nairobi Commuter Rail (NCR)	Tickets purchased by cash, prepaid card, or mobile payment (M-Pesa)
2	Minibus (matatu)	Cash or mobile payment (M-Pesa)

Source: JICA Study Team

NCR also provides a bus service between Nairobi Central Station and central Nairobi as feeder transport for the trains. Fare collection for these buses uses a separate system from that of the railway.

Source: JICA Study Team

Figure 3-36 Timetable of Bus Service as Feeder Transport to Nairobi Central Station

(2) Need for a Comprehensive Public Transportation Promotion System

The Nairobi Metropolitan Area Transport Authority (NaMATA) has a plan to use a mobile app for all the different public transport services, such as rail and minibus, in Nairobi. Construction of the BRT, led by NaMATA, is underway and is expected to start service in the near future. Although several public transportation systems are in operation in Nairobi today, the fare collection systems make it difficult to combine different public transportation systems in a single trip. An integrated approach shall be adopted by digitalizing payment methods, such as development of a mobile app by NaMATA, and putting in place a comprehensive system to promote public transport. Since the main operators in Nairobi are public entities and there are few operators, implementation shall not have many hurdles.

(3) Difficulties in Introducing a Comprehensive Public Transportation Promotion Policy

The public transportation systems of railways and minibuses have many stakeholders, because state-owned enterprises, private companies, and private individuals are all involved. The participation of national, municipal and other administrative organizations is also essential for policy implementation. In order to introduce a comprehensive public transportation promotion policy in a way that coordinates with the various stakeholders, such as the introduction of a mobile app to facilitate the use of different public transportation means, NaMATA and its higher authorities shall take the lead in the implementation.

(4) Providing Connection Information to Users

KRC publishes the fares and timetables of Line 1 and the rest of the NCR rail network on the Internet, and basic information for using the system is publicly available. However, unlike in Japan, the stations in Nairobi do not have route maps that show the railway network at a glance or guide maps that show connections to buses and other public transportation systems. Therefore, it is important to find ways to inform rail users on how to transfer to other forms of public transportation. On the other hand, since the route network in Nairobi is relatively easy to understand, just increasing guidance to users may be sufficient.

3.6 Improvement Plan

3.6.1 Basic Policies of the Improvement Plan (Short-term)

As previously mentioned, the Nairobi commuter lines are operating at a frequency of only 1–8.5 round trips per day. Improving the frequency of their operations is the goal. Line 1 (NCS–Limuru Station), which is the target of this project, has one round trip per day. The train frequency is so low that its operation is hardly functioning as an urban transport service. On the other hand, a ride survey of the line did identify sections where the trains were full during the morning hours.

The NCR MP estimates that the demand will be 10,962 PPHPD in 2030, which is sevenfold of the current transportation capacity. Only one train set is assigned currently.[12]

The objective of this project is to improve train frequency (to 8 round trips/day) and convenience of the NCS–Dagoretti section (approx. 18 km) by providing grant aid focusing on the procurement and utilization of rolling stock, improvement of signals, and development of stations. It will be achieved by implementing the components shown in Table 3.6-1 below, in combination with technical cooperation projects for each field.

Table 3-22 shows the issues of each field, proposed components, and their impact.

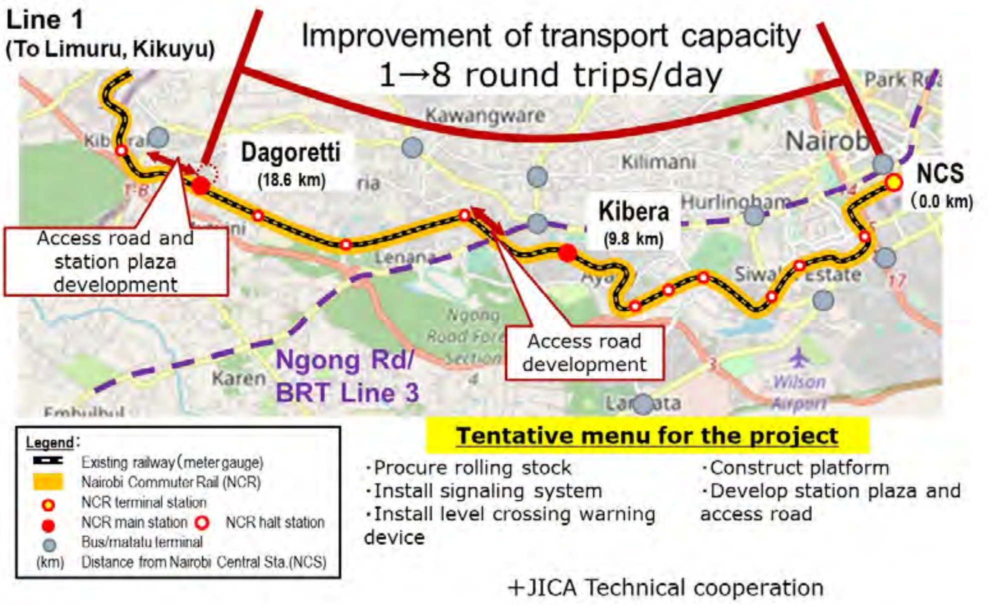
Table 3-22 Basic Policies of Improvement Plan

Current		Short-term outcome
Low frequency of train operation and lack of train set. Not functioning as urban transport	1 round trip/day (NCS-Kikuyu-Limuru:47 km) Transport Capacity: 1548 PPHPD*	Increase train frequency (NCS-Dagoretti) 8 round trips/day Double transport capacity during peak hours (1 train/hr → 2 trains/hr) Transport capacity: 3,096 PPHPD* (NCR MP 10,962PPHPD (30'))

Note: Assume 6-car train set, passenger car traction, and 150% peak occupancy
PPHPD: passengers per Hour per Direction

Field	Issue	Component	Impact
Rolling Stock	No locomotives available for Line 1	【Grant】Rolling stock procurement 【Technical cooperation】Capacity-building for rolling stock scheduling and maintenance of locomotives	Increase in number of trains, higher demand, modal shift
Track	Lack of track materials and safety awareness	【Technical cooperation】Capacity-building for track maintenance (including provision of maintenance tools and equipment)	Prevention of derailment, improvement in train ride comfort
Signal	Signaling system necessary to ensure safety when several trains are in operation	【Grant】Signaling system, level crossing warning equipment (excluding NCS) 【Technical cooperation】Guidance for operational structure, maintenance of signaling system	Prevention of collision
Station	Station development necessary to provide connectivity to other transport means and improve transport network	【Grant】Development of station facilities, access roads, and connections with other transport means	Prevention of accidents in boarding/alighting, modal shift

Source: JICA Study Team



Source: JICA Study Team

Figure 3-37 Basic Policies of Improvement Plan

[12]Current capacity: 172 passengers (60 seated + 112 standing) x 150% congestion rate x 6 cars = 1,548 PPHPD

(1) Proposals Based on Project Scale

Table 3-23 shows the contents of development proposed in this Study. The Study presents two proposals: the "Original Proposal" that covers all contents requiring development and the "Project Cost Reduction Proposal" that has reduced project costs.

Table 3-23 Proposed Contents of Development

No.	Field	Contents	Quantity, etc.	Remarks	Original proposal	Project cost reduction proposal
1	Rolling Stock	New diesel locomotive	1 unit	-	✓	✓
2	Signaling	Level crossing warning device	2 locations	Intersection with main road	✓	✓
3		Block equipment	1 set	-	✓	✓
4		Signaling equipment for operation control center, stations, etc.	4 locations	Signaling equipment for Operation Control Center (OCC) and stations (NCS, Kibera, Dagoretti)	✓	✓
5	Station Development	Development of station facilities (Medium scale)	1 station	Dagoretti Station (terminal)	✓	✓
6		(Medium scale)	1 station	Kibera Station (intermediate station)	✓	
7		(Small scale)	4 stations	Mutuini, Lenana/Riruta, Olympic, Mashimoni stations (halt stations)	✓	
8	Station Plaza Development	Pavement, etc. (Medium scale)	1 station	Dagoretti Station (terminal for improved section)	✓	✓
9		(Medium scale)	1 station	Kibera Station (intermediate station)	✓	
10		(Small scale)	4 stations	Mutuini, Lenana/Riruta, Olympic, Mashimoni stations (halt stations)	✓	
11	Access Roads	Connection with bus terminals/main roads	2.3 km	Dagoretti and Satellite stations	✓	

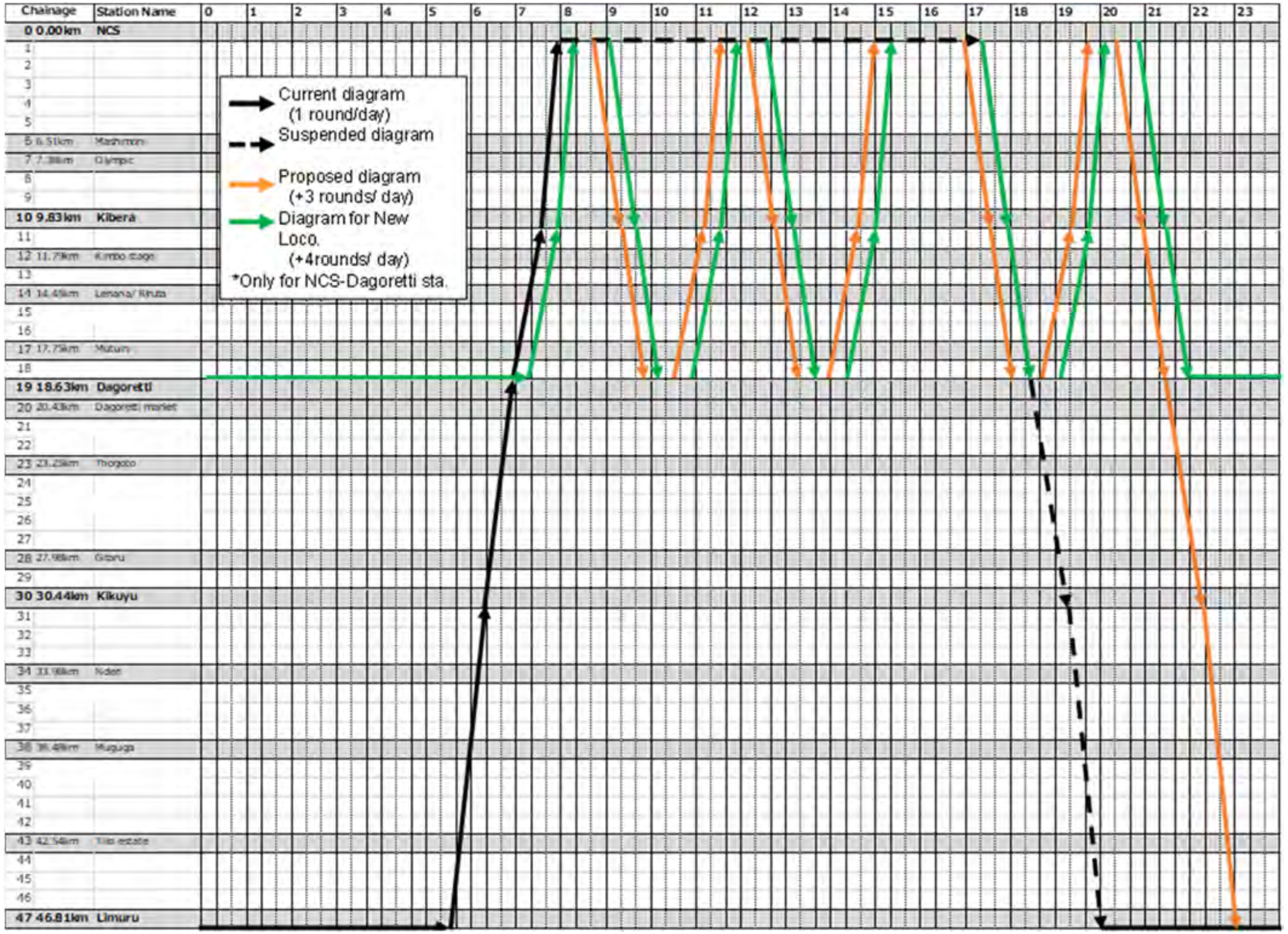
Note: Station Development (No. 6, 7), Station Plaza Development (No. 9, 10), and Access Roads (No. 11) are for reference only (not under the scope of the proposals).
Source: JICA Study Team

In the "Project Cost Reduction Proposal," the procurement of rolling stock and development of the signaling system are the same as in the “Original Proposal.” However, station development and station plaza development are limited to Dagoretti Station only and no access roads will be developed. The reasons are as follows:

- The objective of this project is to improve train frequency. KRC has a shortage of rolling stock for passenger transport, and rolling stock is necessary for increasing the frequency of train operation. Since Line 1 is a single-track line, it is necessary to install a signaling system to ensure safety, which is a prerequisite for increasing the frequency of train operation.
- Constructing access roads at the same time as railway development will enhance the connectivity with buses and matatus, but the access roads themselves do not contribute directly to increasing the frequency of train operation.
- In the same way, development of stations and station plazas do not directly increase the frequency of train operation. According to findings of the ride survey, Dagoretti Station, which will be the terminal station of the target section of this project, is the next busiest station after Satellite Station, which is already being developed by KRC. Dagoretti Station is expected to be a transit station to other transportation means, it should be a priority for development. For this reason, the development of Dagoretti Station is included in the "Project Cost Reduction Proposal."

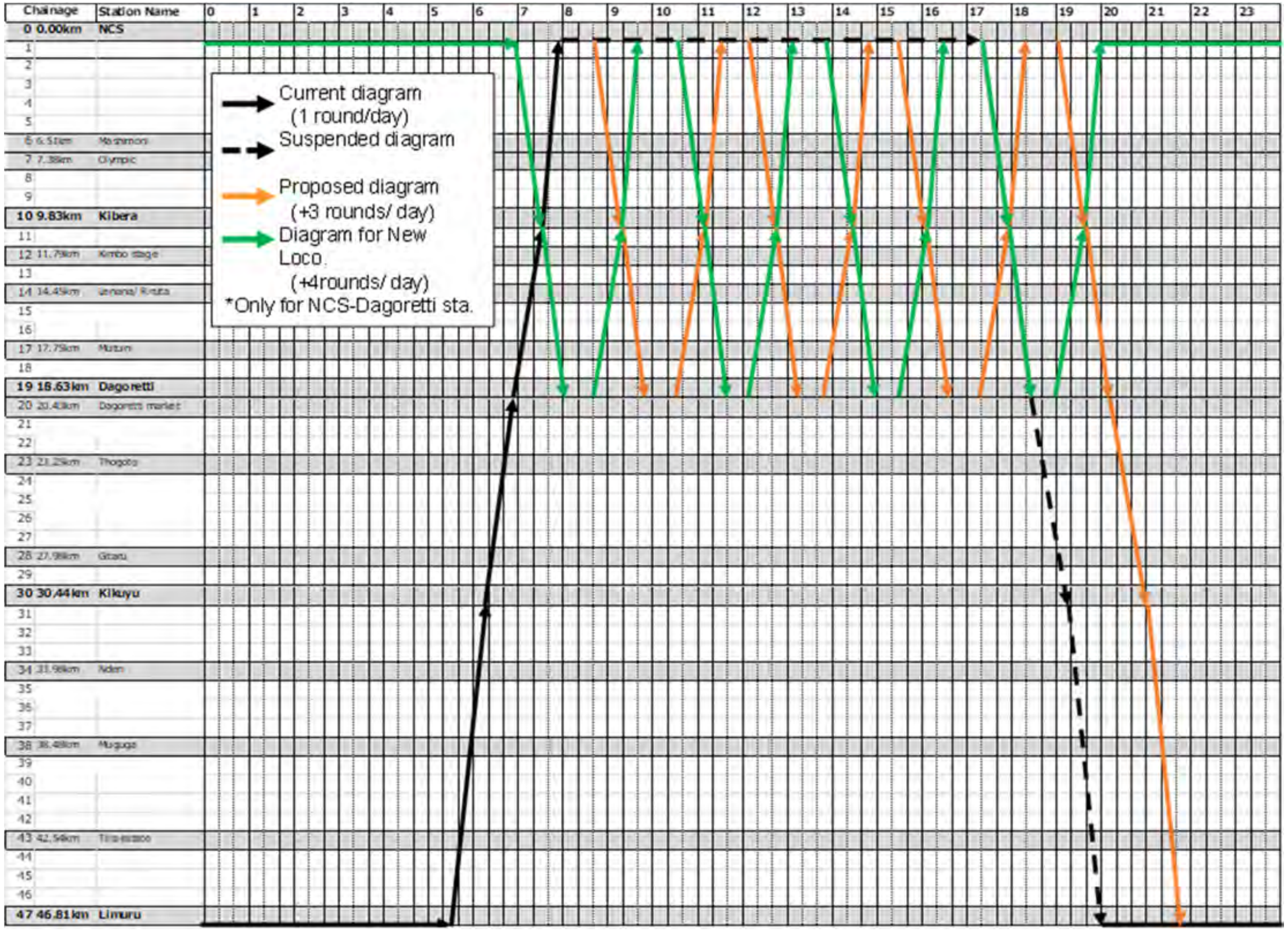
(2) Improvement of Operation Frequency

As of February 2022, Line 1 operates with only one locomotive. The locomotive arrives at NCS from Limuru in the morning and then goes to the Makadara yard for shunting. It returns to NCS in the evening for evening service to Limuru Station. The number of trips can increase if the train makes a round trip back to Lumuru after the morning service. The following shows two diagrams (A and B) of improvement, assuming the procurement of one new train set.



Source: JICA Study Team

Figure 3-38 Schedule Improvement Proposal A (Continuous Service)



Source: JICA Study Team

Figure 3-39 Schedule Improvement Proposal B

Table 3-24 below shows the characteristics of each schedule. The number of round trips can be increased from the current 1 round trip/day to +3 round trips/day by utilizing the existing train set efficiently, and to +4 round trips/day by using additional rail cars, for a total of 8 round trips/day.

Proposal A has the advantage of doubling the capacity during peak hours (increasing from 1 way/hour to 2 ways/hour), but the off-peak interval will be 3.5 hours. The night schedule west of Dagoretti will be delayed by 3 hours, as compared to the current schedule. This will be inconvenient for users at the Limuru Station. Under proposal B, the peak hour capacity will remain the same (1 way/hour), but the off-peak interval will be relatively short (2 hours) and the night schedule west of Dagoretti will be pushed back only to a limited extent (2-hour delay).

Table 3-24 Two Improvement Schedule Proposals and Their Characteristics

Proposal	A	B
Trips	8 round trips/day	8 round trips/day
Features	: Double peak hour transport capacity : Long off-peak transport intervals (every 3.5 hours) : Afternoon train schedule west of Dagoretti set back by 3 hours : Need to ensure safety for continuous operation (to avoid collision)	: Peak transport capacity remains the same. : Short off-peak transport intervals (every 2 hours) : Afternoon train schedules west of Dagoretti set back by 2 hours

Source: JICA Study Team

3.6.2 Basic Policies of Improvement Plan (Mid-term)

KRC puts priority on freight transport. It is faced with the need to improve the level of services for passengers. (The new locomotives procured from China this year will be used for freight transport). If this grant aid project increases the frequency of train services and generates fare revenues by stimulating passenger demand, it will motivate KRC to make more capital investment in passenger services.

For medium and long terms, it is desirable to increase rolling stock and safety facilities and to increase train frequency on other lines besides Line 1. An NCR MP Emergency Maintenance Project (Quick Wins) has proposed the addition of nine DEMUs (72 cars). (Table 3.6-4 shows the operating frequency and number of cars after improvement.) Currently, as the lines are single-track and non-electrified, it is necessary to add sidings for passing, as well as safety facilities as train frequency increases.

Table 3-25 Required Number of Train Sets and Planned Operating Frequency (NCR MP Quick Wins)

Line	Train sets	Number of trains/day
Line 1: Kikuyu–NCS	2 DEMU train sets	16 round trips
Line 2: Thika–Ruiru–Makadara–NCS	2 DEMU train sets	6 round trips (Thika–Kahawa–NCS) 12 round trips (Kahawa–NCS)
Line 3: Syokimau–NCS	2 DEMU train sets	26 round trips
Line 3: Kitengara–(Syokimau)–NCS	1 DEMU train set	8 round trips
Line 5: Embakasi Village–Makadara–NCS	1 DEMU train set	8 round trips
Total	8 DEMU train sets +1 reserve	81 round trips

NOTE: Operating hours are 5:00 a.m. to 11:00 p.m. *8-car train set
Source: NCR MP

3.6.3 Tracks

(1) Track Rehabilitation Plan

Based on photographs taken during the field survey, the Study Team reviewed track maintenance equipment that will likely be needed for the current track conditions.

1) Track Inspection Equipment

Track inspection, which serves as a guideline for track maintenance, is important. It is a standard procedure for regular maintenance work. The track inspection equipment shown below is widely used in Japan. It enables high-quality maintenance work and provides highly accurate measurements. Supplying this equipment through a technical cooperation project is being considered. Currently, not enough track maintenance and measurement are carried out on a regular basis. Use of this equipment will help increase operating speed, stabilize train service, and accumulate data for the future.

Source: JICA Study Team

Figure 3-40 Track Inspection Equipment

2) Compaction of Ballast

At present, the tracks are supplied with ballast. If realignment and tamping are carried out, train frequency can be increased.

Hand tie tamper

Rail jack

Source: Ishida Shoji Corporation

Figure 3-41 Proposed Equipment

The Study Team reviewed technical cooperation projects for providing the above equipment and technical training in order to strengthen the system for regular track maintenance and management.

3.6.4 Signaling System

Ensuring the safety of train operation is paramount as train frequency will increase with the improvements planned for Line 1. The following is the signaling equipment being considered in the plan for Line 1:

(1) Pre-conditions of Improvement Plan

- Be compatible with the current traffic control system (ATW/OBC transmits the authority to operate in the section from the dispatcher to the driver)
- Use the current switches because the turnouts will not be upgraded
- NCS excluded from the improvement plan (demarcated by signals for Line 1 inside NCS)

(2) Proposed Improvements for the Signaling System

1) Installation of Single-track Block Equipment

Single-track block equipment shall be installed and block signal cables shall be used to connect the main stations. The use of single-track block equipment between the main stations (Dagoretti–Kibera–NCS) can ensure safety and prevent the head-on or rear-end collision of trains.

The block condition ensures the interlocking of signals, axle counters, and switches.

Source: JICA Study Team

Figure 3-42 Image of Block Equipment (Station Equipment)

2) Installation of Color Light Signals and Axle Counters

Color light signals that can display 2 or 3 aspects for “Starting” indication and “Home” indication, and if necessary, a Distant signal, shall be installed.

Axle counter shall be installed at main stations to enable detection of the entry and exit of trains.

3) Installation of Level Crossing Warning Device

Level crossing warning devices and crossing gates manually operated by a gatekeeper shall be installed to ensure the safety of road transport. The gatekeeper receives notification of the approaching train from the adjacent main station via a telecommunication device.

Source: JICA Study Team

Figure 3-43 Image of Level Crossing Warning Device

4) Supply of Power to Signaling Equipment

Electric power shall be secured, including back-up power supply for emergency use, for the signaling equipment at stations and level crossings.

(3) Issues related to Improvement Work

The laying of signal cables between stations may require the relocation of residents in the suburban areas around Kibera Station. Generally, the cables shall be laid underground to prevent theft. Because the section in the suburb near Kibera Station has been excavated, it is necessary to find out if the signal cables can be laid directly underground. Methods to ensure the safe storage of equipment and materials during construction shall be explored.

On the other hand, it may be challenging to find constractors who will be interested in the installation of signaling equipment from Japanese suppliers and who also have the technical capability to do so. It is already difficult for other overseas projects currently underway to find constractors, resulting in competition. If there is a contract conflict, the number of constractors who can participate will be limited further.

(4) Review of One Proposed Solution for Solving Issues related to Improvement Work

Instead of the conventional method of laying signal cables between stations to deliver the block function, the signaling improvement plan may have the option of using a mobile data communication line (public wireless line). Results of the review are described below.

No actual example of a single-track block system utilizing mobile data communication lines, which is the proposed solution being considered for the signaling improvement plan of this project, is currently used by a Japanese railway operator with the assumption that the system has completed the safety evaluation process and gained approval. As it is also not clear which route will be selected for development in the near future, the feasibility of a signaling improvement plan utilizing mobile data communication lines is not clear.

When Japanese railway operators can successfully demonstrate the use of single-track block equipment via mobile data communication lines, Japanese suppliers can then take advantage of the opportunity to launch the product overseas. To this end, it is necessary to first apply for safety certification with a third-party organization such as the National Traffic Safety and Environment Laboratory.

It takes several years for the certification process to complete, using other cases as reference. The cost will be determined based on the cost of personnel responsible for the certification process, the contents and level of detail requested by the certification organization, whether the certification is for a new system, whether there are precedents of a similar system, and so on. Although the cost may vary, it is estimated to be at least several hundred million yen.

Even if this system can ensure the quality and reliability of communication under the communication environment in which Japanese telecommunications carriers operate, and even if it is employed in railway operation, it is still necessary to coordinate with local communication carriers in the country where the system will be deployed to confirm whether or not communication quality and reliability of equal or higher level can be achieved through a series of detailed surveys in different communication environments.

Based on the above, a signaling improvement plan using mobile data communication lines for this grant aid project is deemed not feasible because there are no proven examples at present of the actual operation of the system that has completed a safety evaluation, and the target route to be developed has not yet been determined. In the future, when the system has actually been used by a Japanese railway operator and demonstrated results, this improvement plan shall be revisited and the system shall be introduced to overseas markets.

As described above, considerations should be given first to acquiring safety certification from a third-party organization to pave the way for marketing the system overseas, and then reviewing the communication quality and reliability through a detailed technical survey in the different communication environments of local communication carriers in the target country, while giving due consideration to scheduling and funding.

(5) Through Operation with Other Existing Sections and Handling of Train Operation in the Proposed Improvement Section

① Questions and Answers

(Question 1)

Is the improved signaling system being proposed compatible with those of the other KRC sections? For example, what are the precautions to take for trains entering from sections outside of the section covered by the grant aid?

(Answer)

The current traffic control system does not have facilities that guarantee the safety of train operation between stations. On the other hand, the signaling system to be installed in the improvement section guarantees safety.

For trains that have through operation, they follow the conventional operation protocol when they are in the other sections and a protocol compatible with the signaling system to be used for the improved section. In other words, the train changes to a different operation protocol at the boundary station between the two sections.

(Question 2)

The improved section and the other sections will have different operation protocols. Does this happen to railway projects in other countries also?

(Answer)

In general, this issue is inevitable, no matter whether it is in Japan or overseas, when changing from the current system to a new one or when there is through operation between two sections that have different systems. Naturally, this issue can be resolved by providing education and training to the personnel involved, as well as providing manuals at the time of introduction.

(Question 3)

Why don't you propose a compatible system to the existing one? Will there be any problem with introducing a different system?

(Answer)

The current system (ATW/OBC) is a unique system that is not compatible with international standards. It is not practical to try to modify the current system into a mechanism that can guarantee the safety of train operation. In other words, it is impossible to provide a system that is compatible with the current system.

Besides, it is feasible to have through operation between the improved section and the other sections using the respective train operation protocols of the two different sections.

② Reference Information

- The current ATW/OBC traffic control system only enables the dispatcher to give instructions and grant authority of operation in the section to the driver. It does not have the function to ensure safety by indicating whether there is a train in the section. Adoption of the improved system in the proposal will ensure safety even with higher train frequency. On the other hand, the improved system will require a new operation protocol.
- Train operations to sections where the improved system has not been installed will follow the operation protocol of the current system starting from the boundary station. Namely, the

dispatcher and the station master at the boundary station will be responsible for the operation of both the current and improved systems.

- When the proposed improved system is expanded to the other sections of Line 1 and to other lines in the future, it is possible to coordinate the operation between the current system and the improved system through the dispatcher and other personnel.In the future, when there is a request for further increase of transportation capacity by the doubling of track, automatic signaling, or train protection systems, it is important to take the lead, ahead of other countries, in promoting Japanese products, which are in compliance with international standards, and to offer yen loans.

  As can be seen in Southeast Asia and other countries, if Japan joins the project after a European country or another country, and if Japan is responsible for the line section that already has facilities installed by another country or for a line section that has through operation, Japan will have to deal with interface issues (compatibility) in rolling stock and ground facilities. It is possible that even Japanese products that are in compliance with international standards may have a problem with compatibility. As a solution, there will be two onboard systems, one developed by the first country and one by the second country. The two systems will be linked functionally using a mechanism to switch between the two. Similarly, since the traffic control systems at the OCC for the line section built by the first country and the line section built by the second country have different equipment, each line section will have its own mechanism to interface with the traffic control system. The dispatcher will also use different terminals for the operation of the two different line sections.

3.6.5 Rolling Stock

(1) Transfer of Used Rolling stock

KRC had the following initial responses to the proposed transfer of used rolling stock from Japan:

- Due to the gauge difference, the used rolling stock has to be modified to be compatible with the meter gauge. KRC has no experience in modifying the gauge of rolling stock.
- Modifying the gauge of rolling stock is difficult without technical guidance.

For these reasons, it was decided not to consider the transfer of used rolling stock. However, it is still possible to increase transport capacity by procuring new rolling stock and increasing the number of rail cars within the framework of the grant aid, even if large-scale renovation of the tracks and signals is not implemented on the target line. The following is a review on procuring new rolling stock:

(2) Proposal

The proposal is based on the following premises:

- Supply of a new locomotive
  - Production and supply of a diesel hydraulic locomotive compatible with the meter gauge shall be considered. A similar example is the 1,067-mm gauge diesel hydraulic locomotive produced for the Democratic Republic of the Congo in 2020.
  - At KRC, the locomotive currently used on Line 1 is a US-made locomotive, which has large power output. It is difficult to manufacture comparable rolling stock in small quantity in Japan. An interview was conducted with KRC to find out the specifications of the locomotive, on the assumption that it will be used for passenger transport on Line 1. It may be possible to have a small-scale production in Japan, using past examples as reference. However, it is necessary to verify the required performance in detail, including alignment of the route, passenger cars to be hauled, and so on.
- Equipment, spare parts, and consumables for replacement equivalent to the quantities used for two general inspections in Japan shall be supplied in tandem with the delivery of the locomotive.

- Support for the KRC maintenance system through Japan's technical cooperation projects was proposed, considering the local rolling stock maintenance system. Although the car depot seems to be equipped to a certain extent, the work environment shall be improved and basic technical training for maintenance shall be provided in accordance with the delivery schedule of the locomotive in order to ensure that maintenance will be performed on a regular basis.

3.6.6 Stations

The stations are reviewed using the following steps:

1. Positioning of stations → 2. Guideline for improving station facilities → 3. Proposed measures for station improvement

Source: JICA Study Team

Figure 3-44 Steps of Review

(1) Positioning of Stations

The stations on Line 1 were classified based on the location, condition of use, and transportation role. It has been proposed in a KRC Quick Wins Project to add stations in sections that have a long interval between stations. This project will use the same approach.

The scope of this Study and grant aid will be limited to stations in the NCS and Dagoretti section that have large number of users.

Stations are classified as follows:

- Terminal Station: The central station in the CBD and the station with important connection with road transport
- Intermediate Station: Stations expected to have a certain level of demand due to connection with road transport and their location
- Mini Station: Existing stations other than the above (stations with minimal station facilities, such as platforms, etc.)

Table 3-26 Analysis of Station Attributes

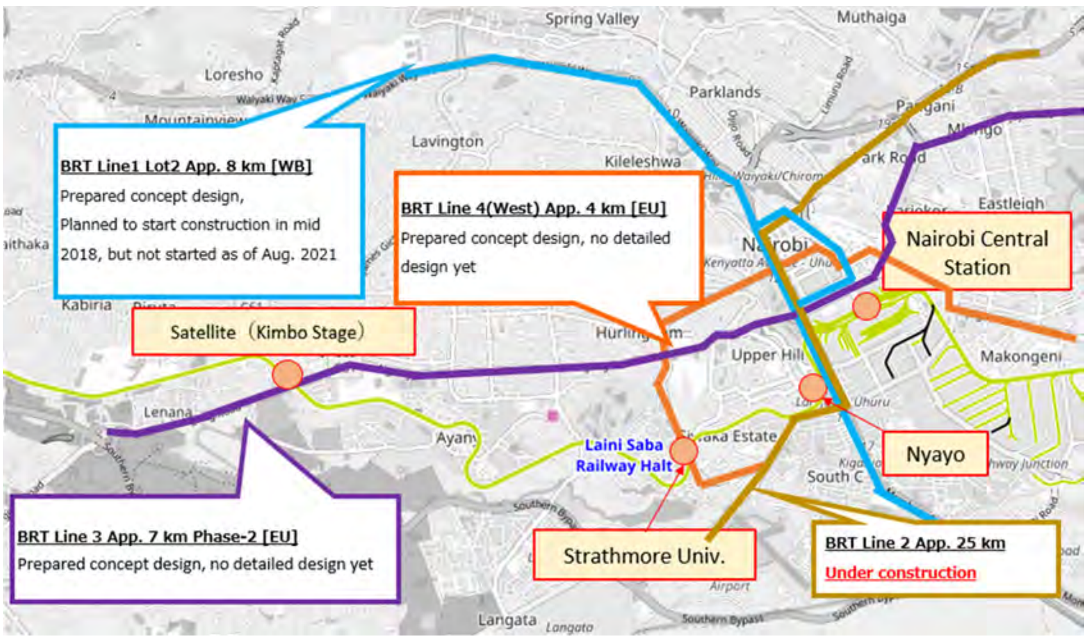
Station name	Positioning	Geographical conditions
Dagoretti	Intermediate	It is an existing halt station and has certain facilities such as a station building and a platform.
Mutuini	Mini	Residential area
Lenana/Riruta	Mini	The current Riruta Station is adjacent to Lenana Station. It will be merged with Lenana Station.
Satellite (Kimbo Stage)	Intermediate	It is at the intersection with Ngong Road, which is the main road and the last stop for BRT Line 3. The current ridership at this station is also high.
Kibera	Intermediate	It is currently a halt station. Although it is far from the main road, it is surrounded by some of the largest slums in Africa.
Olympic	Mini	Residential area
Mashimoni	Mini	Residential area
Ngummo	Mini	Currently trains do not stop here.
Strathmore University	Intermediate	Currently trains do not stop here. It can be a station connected to BRT Line 4 in the future.
Nyayo	Intermediate	Currently trains do not stop here.

		It can be a station connected to BRT Line 2 in the future.
Nairobi Central	Terminal	It is the largest station in Nairobi City. Its standard gauge tracks extend to Mombasa.

Source: JICA Study Team

Source: KRC MP

Figure 3-45 Future Plan for Line 1



Source: JICA Study Team

Figure 3-46 Future BRT Route Map

(2) Guidelines for the Improvement of Station Facilities

The following is the status of station improvement according to the KRC progress report as of September 30, 2021:

- Improvements at Nairobi Central Station and Kikuyu Station completed
- Upgrading halt stations into mini stations is planned but construction not yet started
- 20% overall progress in station improvement

Based on the above, the guidelines for station improvement for both the "Original Proposal" and the "Project Cost Reduction Proposal" are as follows:

Table 3-27 Guidelines for Station Improvement

Station name	Original Proposal	Project Cost Reduction Proposal	Guidelines for improvement
Nairobi Central Station, Kikuyu Station	−	−	Both stations are not under consideration in this project, as they already have sufficient facilities developed through the injection of funds from multiple countries.
Dagoretti Station, Kibera Station	✓ ✓	✓ -	Improvements should be made to enhance the convenience of the existing station buildings and platforms so that they can meet a certain level of demand as intermediate stations. Since both stations have double tracks, a separate platform should be built on the other side of the tracks. In the project cost reduction proposal, only <u>Dagoretti Station, which currently has higher demand than Kibera Station, is selected for improvement due to constraints of the project scale.</u>
Mutuini Station, Lenana/Riruta Station, Olympic Station, Mashimoni Station	✓	-	Station facilities should be developed so users can get on and off trains safely. Development of these simple stations are excluded under the project cost reduction proposal.
Ngummo Station, Strathmore University Station, Nyayo Station	-	-	Since trains do not currently stop at these three stations, demand in the near future is not expected to be high. Nyayo Station and Strathmore University Station can become transit stations to BRT Line 2 and BRT Line 4, respectively, but the openings of both BRT lines are expected to be in a distant future. Based on the above, the three stations shall be considered for future development but not be developed in this project.
Satellite Station	-	-	It was confirmed in the field survey that construction of the station has already started; therefore, it is excluded from the scope of this Study.

Legend: ✓Target for development, – Not target for development

Source: JICA Study Team

Source: JICA Study Team

Figure 3-47 Image of an Intermediate Station

Source: JICA Study Team

Figure 3-48 Image of a Simple Station

3.6.7 Station Plaza and Access Road

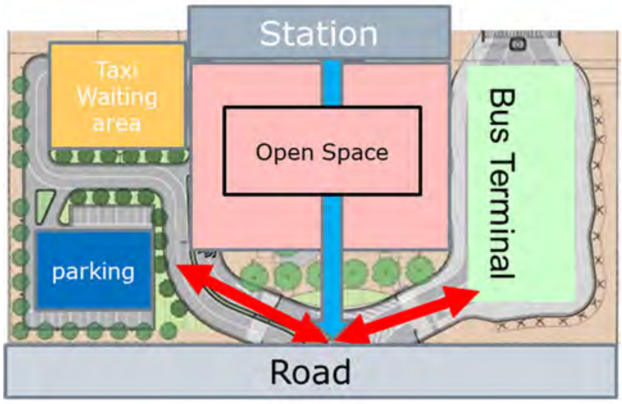
(1) Contents of Improvement

Formulation of the improvement plan for station plazas and access roads shall be coordinated with station facilities and the transportation network.

Table 3-28 Contents of Development and Effects

○ Construct pavements ○ Improve connectivity ○ Construct access roads	● Can enhance functionality as a station plaza ● Can classify land use and demarcate site boundaries (bus terminals, parking lots, platforms, etc.)
○ Demand level	● Can support station function (number of passengers in the future)

Source: JICA Study Team



Source: JICA Study Team

Figure 3-49 Image of Station Plaza

(2) Improvement plan

The plan for station plazas is shown together with the future plan, which takes into consideration the scale of station facilities and status of the transportation network. Beginning with paving the area to set the boundaries of the site for station plaza, development should be carried out according to land use, such as for buses, matatus, automobiles, and so on. In addition, parking spaces and P&R (Park and Ride) shall be developed to promote public transportation. The original proposal of the improvement plan includes the development of station plazas for “Dagoretti Station” and “Kibera Station,” improvements for halt stations such as pavement to demarcate the boundaries of the station sites; as well as construction of access roads to “Dagoretti

Station" and "Satellite Station" to form a transportation network. The project cost reduction proposal only covers "Dagoretti Station," which will be the terminal station.

Source: JICA Study Team

Figure 3-50 Before Station Plaza Improvement (Dagoretti Station)

Source: JICA Study Team

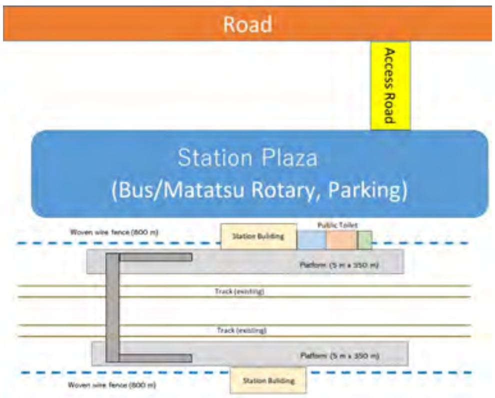
Figure 3-51 Before Station Plaza Improvement (Kibera Station)

It is important to develop access roads to improve convenience for the transportation network. It is desirable if the station and station plaza can serve as a landmark in the area as a transportation hub. Currently, access roads from the main roads to the stations are not paved. The absence of signs or markers indicating the station locations makes it difficult to connect to other transportation means.

The proposed improvements will enhance the ease of access from Dagoretti Market and the convenience of transferring to the BRT that goes through Ngong Road. An access road will have two lanes with a minimum width of 7 m to allow vehicles with a width of 2.5 m to pass on each lane.

Source: JICA Study Team

Figure 3-52 Access Road (Dagoretti Station)



Source: JICA Study Team

Figure 3-53 Dagoretti Station Plaza Improvement Plan

Source: JICA Study Team

Figure 3-54 Image of Station Plaza (Dagoretti Station and Kibera Station)

Source: JICA Study Team

Figure 3-55 Image of Station Plaza for Halt Stations

3.7 Improvement-related Issues

3.7.1 Signaling System

Method for cable construction, anti-theft measures, security of equipment rooms, safety management, and recruitment of level crossing guards are some of issues.

3.7.2 Rolling Stock

For the manufacture of a new locomotive, more in-depth study is needed to find out the track condition of the line, route alignment such as curves and gradients, conditions of the rail cars to be hauled by the locomotive, and capability of the Japanese manufacturers in delivering the required specifications. Many passenger cars under rehabilitation were seen being stored, and 56 of the 80 passenger cars are being used for operation. There was concern regarding the scheduling of rolling stock in the discussion about increasing train frequency and increasing the passenger transport volume. During discussion of the improvement plan, KRC indicated that there were not enough passenger cars.

When adding a new locomotive, it is necessary to confirm whether KRC will have enough rail cars to support the increase in passenger transport volume.

It is necessary to improve the maintenance work environment and provide basic technical training on maintenance in accordance with the schedule for the delivery of rolling stock so maintenance can be carried out on a regular basis.

3.7.3 Station

There are locations close to the slums where station construction and station improvement are planned. Security measures shall be taken to prevent theft and safeguard construction equipment and materials during construction. In the project cost reduction proposal, the quantity of construction work is considerably small. Since there will not be cost advantage from the economy of scale, there is a risk that Japanese companies may avoid the project from the standpoint of profitability.

3.7.4 Station Plaza

(1) Development of Access Roads and Connections to Other Transportation Means

Efforts shall be made to foster common understanding with KRC, NaMATA, operators such as Kenya Bus Service, and the county authority with jurisdiction over the acquisition and use of land for the access roads in the development of station plazas. It is also necessary to identify locations that will facilitate the development and establish a system for managing the station plazas after their development.

3.8 Technical Cooperation Project

Table 3-29 gives an overview of the technical cooperation project aimed at improving the operating capacity of the commuter railway. In the implementation of grant aid projects, it is essential to motivate the recipient government (KRC, etc.) to voluntarily improve transport quality (e.g. increase transport frequency). The outputs are classified by field (rolling stock, signaling and communication, track, awareness enhancement), with the assumption that activities will be carried out to confirm the existing conditions, provide training for KRC managers in Japan, prepare manuals (operating guidelines) based on the results of manager training, and offer follow-up training to KRC supervisors in Japan.

Table 3-29 Technical Cooperation Project（Draft）

Item	Description	
Project Period	3 years	
Overall Goal	Improvement in the safety and efficiency of commuter rail service will enhance the convenience of transport services for users and strengthen logistics for the Northern Economic Corridor.	
Project Purpose	Improve commuter train operation and maintenance capacity	
Stakeholders	Potential stakeholders	Description
	・ Ministry of Transport, Infrastructure, Housing and Urban Development (MoTIHUD)	State department of transport: governing body
	・ Kenya Railway Corporation	Railway operator
	・ Nairobi Metropolitan Area Transport Authority (NaMATA)	Governing body of public transport, particularly bus and BRT
Outputs	Activities	
Output 1: Operation and maintenance of rolling stock		
	Activity 1-1: Conduct survey on rolling stock O&M and review current condition and existing manual Activity 1-2: Conduct training in Japan, prepare O&M manual for rolling stock maintenance Activity 1-3: Conduct trial O&M based on the manual	
Output 2: Improve the operation and maintenance of signaling and communication system		
	Activity 2-1: Conduct survey on signaling and telecommunication conditions and review existing manual Activity 2-2: Conduct training in Japan, prepare signaling and communication system O&M plan Activity 2-3: Prepare manual for the signaling and communication system Activity 2-4: Conduct trial O&M based on the manual	
Output 3: Improve the operation and maintenance of tracks		
	Activity 3-1: Conduct survey on track conditions and review existing manual Activity 3-2: Conduct training in Japan, Prepare O&M plan Activity 3-3: Prepare manual for track O&M Activity 3-4: Conduct trail O&M on track	
Output 4: Enhance the safety awareness of communities along the commuter line, in cooperation with JOCV		
	Activity 4-1: Conduct railway safety awareness survey Activity 4-2: Prepare education materials on safety Activity 4-3: Conduct community workshop to enhance safety awareness	

Source: JICA Study Team
The following are guidances for the output activities:

(1) Guidance on Locomotive Maintenance and Operation (Output 1)

Guidance on maintenance technology shall be provided so that the delivered rolling stock can be maintained and managed by local companies on a regular basis. It is necessary to start improving the maintenance work environment and provide instructions of basic technology before the rolling stock is deployed in operation. It is important to start technical training specific to the rolling stock (inspection system, inspection contents, local training using the actual rolling stock, etc.) at the same time as the deployment. In addition, it is desirable to advice the operator on the maintenance system and other topics in accordance with the guidance given before deployment of the rolling stock.

(2) Guidance on Operational Structure and Maintenance of Signaling System during Upgrade (Output 2)

Actual equipment for training (complete set of equipment to be installed) and educational materials (equipment manuals and maintenance manuals) shall be prepared in order to provide training for operators and maintenance personnel from an operational standpoint. (Actual equipment for training include block equipment, level crossing warning device, axle counter, etc.).

(3) Track Maintenance Guidance (including Supply of Maintenance Equipment) (Output 3)

It has been confirmed that KRC is undertaking intensive track improvement. It is also necessary to perform track maintenance regularly to ensure stable train operation. For this purpose, the equipment identified in the issues discussed will be supplied and experts will be dispatched through a one-year technical cooperation project to oversee routine management and ensure stable train operation.

(4) Awareness-enhancing Activities to Improve Safety (Output 4)

KRC is already providing a greater level of passenger services and undertaking public relations activities compared to its neighboring countries. However, there is a concern that increased train frequency may lead to more accidents in the future. As part of the efforts to improve passenger service and public relations, KRC has partnered with Japan Overseas Cooperation Volunteers (JOCV) to conduct activities to enhance awareness for safety.

3.9 Evaluation Index and Effects

The following are the evaluation index and anticipated effects:

3.9.1 Quantitative Indicators

This Study examines the impacts from the perspectives of the number of users, improvement of train efficiency, and intermodal connectivity. Table 3-30 shows the indicators, standard values, and target values.

Table 3-30 Impact Indicators (Quantitative Indicators)

No.	Indicator Name	Classification	Standard value (Actual value in 2021)	Target value (2029) [3 years after completion of project]
1	Number of passengers transported on Line 1 (persons/year)	Number of users	340,000	1,720,000
2	Number of passengers boarding and alighting (persons/year) at Kibera Station and Dagoretti Station	Number of users	300,000	1,680,000
3	Train kilometers (km/year)	Rolling stock efficiency	23,000 train km/year	89,000 train km/year
4	Greenhouse gas reduction effect	Modal shift	-	-1,241 ton-CO_2/year
5	Economic benefits	Modal shift	-	
6	Bus/matatu transfer time (on foot)	Intermodal connectivity	20 minutes	Within 5 minutes

NOTE: Grey area indicates no impact in the “Project Cost Reduction Proposal.”
Source: JICA Study Team

(1) Number of Passengers

The numbers of passengers are calculated based on the results of the ride survey conducted in February 2022 and the results of traffic surveys conducted in previous years. The peak rate is 9%. Assuming that the ridership rate during the off-peak hours is 59% when the current one round trip/day is increased to eight round trips/day, the ratio to the current transportation volume is calculated to be 5.6 times.

Table 3-31 Ridership in Peak and Off-Peak Hours

Classification	Peak hours		Off-peak hours	
	Number of one-way operation	Occupancy rate	Number of one-way operation	Occupancy rate
Current state (2022)	2	100%	0	59%
After Improvement	4	100%	12	59%

Note: The current occupancy rate during peak hours is an assumption based on the February 2022 ride survey results. The occupancy rate during off-peak hours is calculated by taking into account the peak rate of 9% (NIUPLAN (2013, JICA), divided into peak hours after improvement).
Source: JICA Study Team

The number of passengers in the improvement section (between NCS and Dagoretti) under this project is 30,000 passengers/year (2021). Target for the future is 1,680,000 passengers/per year, an increase of 1,380,000 passengers. If this increase is added to the 340,000 passengers transported on Line 1 (2021), the number of passengers will be 1,720,000.

(2) Rolling Stock Efficiency

For rolling stock efficiency, the impact was interpreted using train-kilometer as a measure to indicate the workload of railway transport. Train-kilometer is the cumulative distance traveled by all trains. The project will revise the current timetable (one round trip per day) to provide round-trip services from NCS to Dagoretti Station. One additional train set will be added to increase the number of trains in operation to eight round trips, thereby improving rolling stock efficiency (train-kilometers). As shown in Table 3-32, the train-kilometer, excluding the distance to the rail yard, will improve from the current 23,405 km/year to 88,500 km/year (3.8 times).

Table 3-32 Improvement in Rolling Stock Efficiency (Train-kilometers)

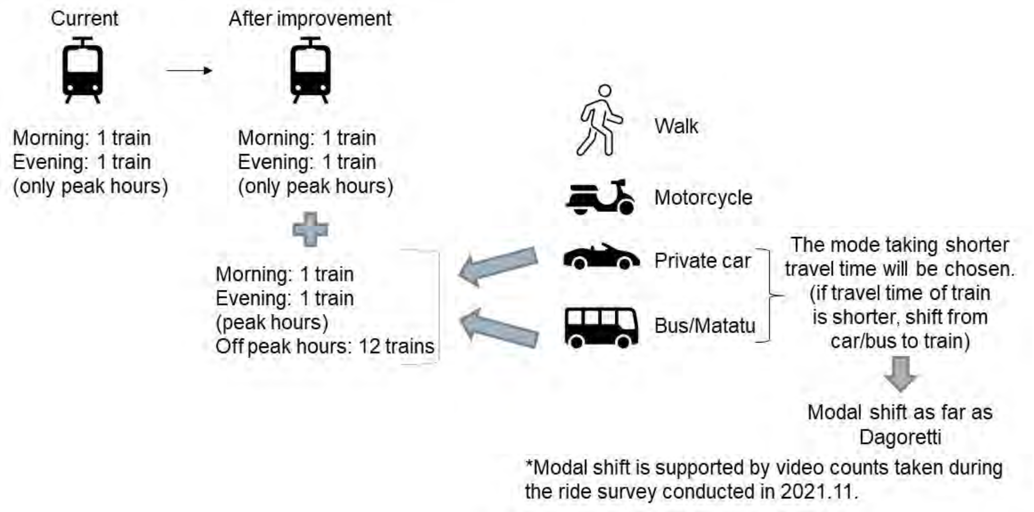
Section	Current		After improvement	
	Number of trains	Train-kilometer	Number of trains	Train-kilometer
NCS–Dagoretti (18.6 km)	1 round trip	38.2 km/day	8 round trips	297.6 km/day
Dagoretti–Limuru (28.2 km)	1 round trip	56.4 km/day	1 round trip	56.4 km/day
Total train-kilometers	-	94.6 km/day	-	354 km/day
(Annual)	250 days	23,405 km/year	250 days	88,500 km/year

Note: This train does not operate on Saturdays, Sundays, and holidays. It operated 250 days in 2021.
Source: JICA Study Team

(3) Modal Shift (Reduction in Environmental Impact and Time-saving Effect)

Implementation of this project will cause some car users along Line 1 to switch to the railway. Accordingly, CO_2, NOx, SPM, and other emissions from automobiles will be reduced.

Assuming that the increased number of railway operations (7 round trips) on the route (Dagoretti–NCS) covered by this project will shift users of private cars or buses to railway, the annual emission reduction is estimated to be 1,241 t-CO_2. Figure 3.9-1 shows an image of the modal shift and Table 3.9-4 shows the estimated results.



Source: JICA Study Team

Figure 3-56 Image of Modal Shift from Cars, Buses, and Matatus to Rail (Nairobi)

Table 3-33 Calculation of Reduction in CO_2 Emissions from Modal Shift

Classification	Unit	Pax-km	Emission volume	Remarks
A. Automobile	0.130	3873.305	504	kg-CO_2
B. Bus	0.057	7719.788	440	kg-CO_2
		Subtotal before modal shift	944	kg-CO_2
C. Railway	0.017	11,593	197	kg-CO_2
		Subtotal after modal shift	197	kg-CO_2
A+B-C Reduction (one-way during peak hours)			867	kg-CO_2/train (peak hours)
All trains			3,401	kg-CO_2/day (considering off-peak occupancy rate)
Annually	365	days	**1,241**	**t-CO2/year**

Note: Estimate based on the number of passengers counted by video recording in the ride survey.
Source: Ministry of Land, Infrastructure, Transport, and Tourism (2019), JICA Study Team.

The time-saving effect takes into consideration modal shift associated with the improvement in train operation. Results of the NIUPLAN survey and other data (modal share, time value, peak ratio) were used as reference. Adding up the number of passengers from the ride survey, the time-saving effect from the availability of transfer information, and other factors will render an economic benefit of about 18 million yen per year.

Table 3-34 Time-saving Effect (Nairobi)

	Car	Bus	Unit/ Remarks
a. Modal Share	12%	88%	NIUPLAN
b. Value of travel time	107.5	46.5	KSh/hr, NCR MP
c. Peak rate	**9%**		NIUPLAN, morning and evening trains currently in operation (2 trains each)
d. Number of trains in operation (including the number of trains currently in operation)	**16**		Train set, one way, 8 round trips
e. Off-peak occupancy per train	**59%**		Described in (1)
Time-saving Effect			

f. Reduction in time per train per one-way trip		113	195	hr/train, time saved from getting transfer information, etc.
g. Reduction in time per train per one-way trip (considering modal share)		14	171	hr/train/one way, f x a
h. Value of time saved per train (one-way)		1,504	8,494	KSh/one way train, g x b
i. Each round trip		**19,997**		KSh/train-both ways, car + bus
1	per day	**91,097**		
250	days/year - Annually	**4,999,226**		KSh/year
Time-saving Effect		**17,775,026**		KSh/year

Source: JICA Study Team

(4) Intermodal Connectivity

It is important to improve not only the railway but also the connectivity with buses and matatus, which provide feeder transport. This Study used the transfer time from the station to the matatu/bus terminal as an indicator to evaluate connectivity. The project will improve the station front of Dagoretti Station, which is the terminal station for the improved timetable, and the access road to the matatu/bus terminal. By facilitating direct transfer to the matatu/bus, the convenience of transfer will be enhanced. Currently, it takes about 20 minutes to walk the 1.5-km distance to the matatu/bus terminal but the travel time will be reduced to less than 5 minutes if the transfer takes place within the station premises.

Source: JICA Study Team

Figure 3-57 Location for Access Road Development

It should be noted that the “project cost reduction proposal” excluded the development of access roads; therefore, intermodal connectivity will not have any impact in the case of the “project cost reduction proposal.”

3.9.2 Qualitative Indicator

The following are results of the review on qualitative indicators, among the impacts from the implementation of this project. Table 3-35 shows the qualitative impacts of the three items.

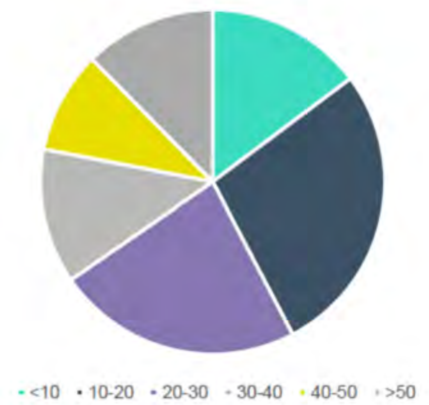
Table 3-35 Qualitative Indicators

No.	Qualitative impact	Summary
1	Provide transportation to the poor	Promote use by low-income groups
2	Provide a safe transportation means	Gender-responsive: establishment of women-only cars and priority seating
3	Provide accessibility	Construct platform at halt stations

Note: The grey area is the indicator that will not have impact in the "Project Cost Reduction Proposal."
Source: JICA Study Team

(1) Provide Transportation to the Poor

Figure 3-58 shows the income distribution of rail users in the NCR MP survey. More than half of those users have an annual income of less than 30,000 KSh. Currently, they can only make one round trip per day, which is extremely inconvenient. Instead of the current one round trip per day, providing two one-way trips in the morning and two one-way trips in the evening during commuting hours and six round trips during the off-peak hours will facilitate not only the morning and evening commute but also promote other uses such as shopping and hospital visits, thereby improving accessibility to social activities.



Note: Unit: 1,000 KSh
Source: NCR MP

Figure 3-58 Distribution of the Monthly Income of Railway Users

(2) Provide a Safe Transportation Means

According to reports, 23% female users of matatu/bus reported being victimized (touching incidents) by family members, relatives, teachers, classmates, or matatu-related personnel, putting matatu/bus users in a very difficult situation. KRC is providing student-only cars to ensure safe transportation, and is working to accommodate passengers who are concerned about using its services. In response to users' requests, this project plans to designate women-only cars to address the gender issue and provide priority seating, thereby providing a safer means of transportation.

(3) Provide Accessibility

Passengers can be seen climbing onto rail cars at the halt stations, showing that the station facilities are inaccessible to vulnerable users. This project will improve the convenience for vulnerable users by adding a platform to make the station more accessible. The project cost reduction proposal does not include station improvement for halt stations; therefore, the proposal will not show any impact of improved accessibility.

Discussion of the following items are premised on the project cost reduction proposal:

3.10 Utilization of Japanese Technology

(1) Rolling stock: Diesel Locomotive with Hydraulic Transmission

As in the case of Democratic Republic of the Congo in 2020, it adopted a diesel locomotive with a hydraulic transmission, which led to less competition from other foreign companies. The locomotive also has the advantage of lower manufacturing costs compared to the electric units.

Examples of locomotives adopted overseas include the locomotive delivered to the Democratic Republic of the Congo, which is being used for passenger transport as of 2022, and locomotives delivered to Egypt, Taiwan, and other countries.

(2) Signaling System: Integration of Single-track Block Equipment and Interlocking Device

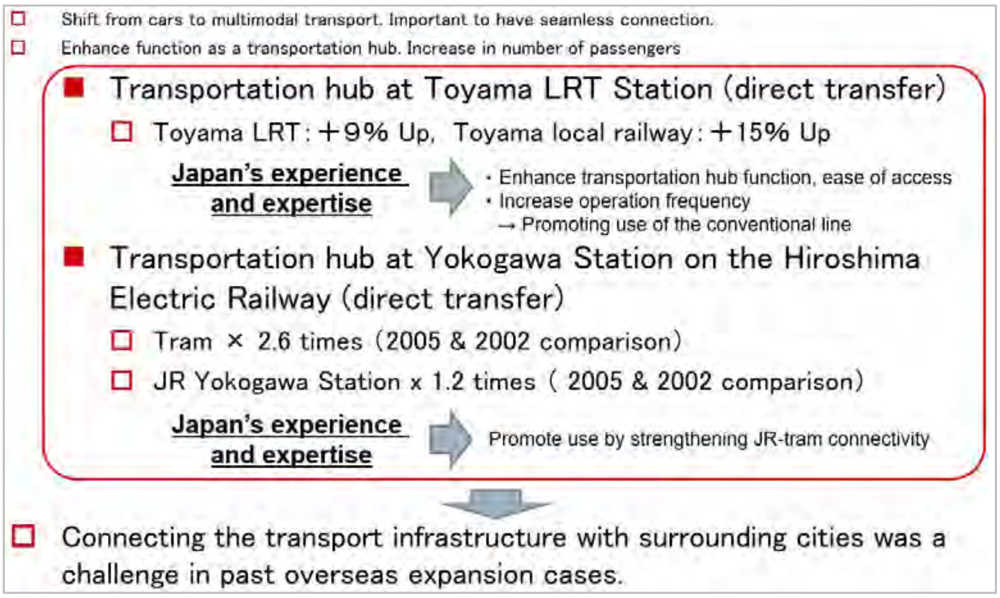
The yen-loan project for phase I of the Yangon Mandalay railway development in Myanmar by a Japanese company is currently being implemented with an integrated system that has single-track block function and interlocking function. Its relay configuration has the merits of low cost, high reliability, long useful life, and strong resistance against damage from lightning and environmental factors. Adding a block section to the railway line in the future is easy, just by installing the integrated system at the new station where there is a siding for train passing.

The system shall be installed at the ends of both block sections of new station. The station masters at both stations shall secure the block between the two stations based on the operating protocol. During the time after the train leaves the station and before its arrival is detected at the arrival station, the "Starting" signal at the departure station indicates Stop. As a result, rear-end collisions and collisions of trains between stations can be avoided. This system can ensure safety and reliability as the number of train operations increases.

(3) Station Plaza Development: Seamless Transport Connection

In terms of station plaza development in Japan, the railway station is positioned as an important facility in urban transport policy, serving as the focal point of a transportation hub. Station plaza plays the important roles of facilitating traffic at the transportation hub and enhancing the appeals of areas around the transportation hub.

Figure 3-59 shows the success of Japanese municipalities in promoting the use of public transportation by strengthening the transportation hub function of stations.



Source: JICA Study Team

※ "Important Points for Improving the Convenience of Public Transportation, Strengthening Transportation Hubs" (Japan Development Bank)

※ Compiled by JICA Study Team based on the "Overseas Development Strategy (Urban Development and Real Estate Development)," June 2018 (MLIT)

Figure 3-59 Success of Japanese Municipalities in Promoting the Use of Public Transportation

Source: Nippon Koei Co., Ltd.

Figure 3-60 Iwasehama Station (Toyama City)

Chapter 4 Kinshasa (Democratic Republic of the Congo)

4.1 Overview of Democratic Republic of the Congo and Kinshasa

4.1.1 Democratic Republic of the Congo

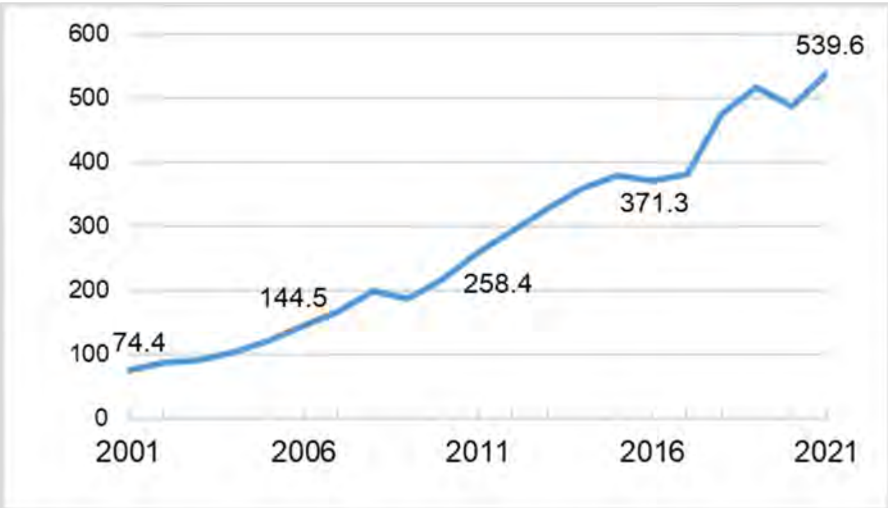
(1) Topographical Overview

The Democratic Republic of the Congo is situated in central Africa and has a land area of 2,345,410 km^2 (6.2 times that of Japan). The vast Congo Basin extends to the basin of the Greater Congo River (Zaire River), one of the world's foremost rivers. The country has various climate conditions: tropical rainforest climate with high annual temperatures in the central areas, tropical monsoon climate with distinct rainy and dry seasons or savannah climate in the surrounding areas, and subtropical climate in the southern and eastern mountains. Significant snowfall can be seen in the high-altitude mountainous areas in the east.

The capital city is Kinshasa, which faces the lower reaches of the Congo River. The population of the Democratic Republic of the Congo is 92.38 million (2021: World Bank). It consists mostly of the Bantu ethnic group, and also over 200 other tribes. Around 80% of the population is Christians. Islam and some prehistoric religions are also practiced. The country’s official language is French.

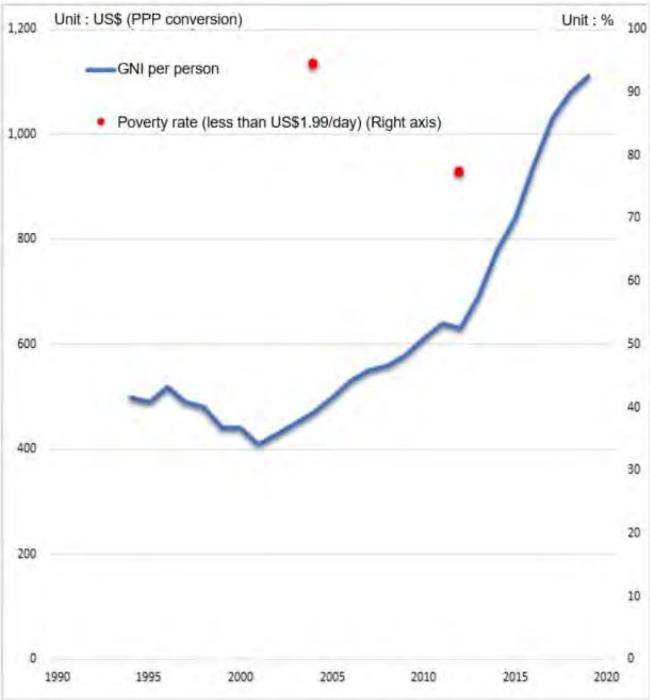
(2) Economic Overview

The Democratic Republic of the Congo has a nominal GDP of approximately US$53.96 billion (2021: World Bank) and its economic growth rate is 5.7% (2021: World Bank). The nominal GDP has grown rapidly over the last two decades, at approximately seven times the nominal GDP in 2001 (Figure 4-1). Accordingly, the per capita GNI has risen from $500 (1990) to $1100 (2021), bringing down the poverty rate, as shown in Figure 4-2 (2003–2014). This trend is expected to continue into the future as further economic expansion is expected.



Source: Prepared by JICA Study Team based on data from the World Bank

Figure 4-1 Evolution of the Nominal GDP of the Democratic Republic of the Congo



Source: World Development Indicators

Figure 4-2 GNI per Capita and Poverty Rate

(3) Political and Administrative Structure

The Democratic Republic of the Congo is a presidential democratic republic, with the president as the head of state. The government is divided into the executive, legislative, and judicial branches. Table 4-1 gives an overview of the government branches. President Félix Tshisekedi now heads the executive branch.

Table 4-1 Overview of the Democratic Republic of the Congo Government

Branch	Main functions	Method of election	Term of Office
Executive	The president is in charge of the executive branch of the government. The president appoints the Prime Minister and the nine judges of the Constitutional Court, and serves as the Commander-in-Chief of the military. The cabinet is headed by the Prime Minister, who advises and assists the president.	Elected by a majority vote of the people.	Five years
Legislative	The parliament is the legislative body that makes laws and has oversight of the prime minister's duties.	Senate: 108 members are elected on a proportional representation basis. The National Assembly: 61 members are elected for the single-seat constituency system and 439 members for the proportional	Five years

		representation system.	
Judicial	The Supreme Court deals with general civil and criminal matters and the Constitutional Court adjudicates on Constitution-related issues.	Judges of the Supreme Court are appointed by the Judicial Enforcement Council.	Indefinite period

Source: JICA Study Team

(4) Japan's Assistance Policy for the Democratic Republic of the Congo

Japan supports the Government of the Democratic Republic of the Congo in its efforts in the consolidation of peace, human resources development, economic diversification, expansion of value chains, improvement of agricultural productivity, infrastructure development, and environmental conservation, which are listed as priority areas in the Plan National Stratégique de Développement (PNSD) formulated in 2019.

1) Consolidation of Peace

To promote the consolidation of peace and stability through bilateral development cooperation and collaboration with international organizations, Japan will support Democratic Republic of the Congo in implementing structural reforms of the police and improving the quality and capacity of police officers—measures that will directly improve the safety of citizens.

2) Strengthening of Health Care Systems

Due to political instability since the 1990s, the health care system of the Democratic Republic of the Congo is lacking in all areas, including the development of health care personnel, reconstruction of the health care infrastructure, and supply of medicines and medical equipment. Japan’s assistance will focus on effective long-term development, capacity-building of health care personnel, countermeasures against infectious diseases, and strengthening of the health care system.

3) Economic Development

Japan will support Democratic Republic of the Congo's efforts to pursue economic development through infrastructure investment using Japan's high-quality products. The assistance will range from the development of economic infrastructure to the education and training of industrial personnel, with a special focus on the development of transport infrastructure to accommodate the increasing traffic volume from urbanization.

4) Environmental Conservation

The Democratic Republic the Congo has the second largest rainforest in the world. The annual rate of deforestation averages 400,000 hectares (2005–2010), which is the highest among the Congo Basin countries, making forest conservation an urgent task. Through "Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+)," Japan will assist Democratic Republic of the Congo in promoting a green growth policy and measures to mitigate global warming.

4.1.2 Kinshasa City

(1) Basic Data

Kinshasa is the capital city of the Democratic Republic of the Congo, and a river port city located downstream of the Congo River. Its urban areas, including the suburbs, had a population of 14 million as of 2019 (Institute National de la Statistique: INS), which ranked third in the African continent after Cairo and Lagos.

In the "Project for the Master Plan for Urban Transport in Kinshasa City" formulated by JICA in 2018, net migration of Kinshasa city at that time was estimated to be about 1% annually, which is equivalent to the difference between the rate of population increase in the entire the Democratic

Republic of the Congo and the rate of population increase in Kinshasa city, based on analysis by the United Nations (United Nations) Population Bureau.

The project also forecasts a gradual population decline from 1 percent per year to 0 percent per year between 2017 and 2040, leading to an estimated population of 19–20 million in 2030 and 24–27 million in 2040.

Kinshasa city has experienced rapid urbanization, as a result of its population growth. This trend is expected to continue. Traffic congestion is already occurring in various parts of the city due to insufficient urban transportation infrastructure, raising concerns that traffic problems will continue to deteriorate.

(2) Institutional Framework

Kinshasa is divided into 24 municipalities (communes) under four districts. The governor (Gouverneur) of Kinshasa and the head of each commune (Bourgmestre) are entrusted with the administration of Kinshasa and its communes. The current Gouverneur, Gentiny Ngobila, has been in office since 2019.

Civil services are provided by the commune offices, but the very end of the administrative functions are performed by the Communal Development Committee (Comité Communal de Développement: CCD), which acts as a bridge between the commune offices and the citizens. The Local Development Committees (Comités Locaux de Développement: CLD) are subdivisions of the CCD.

4.2 Current State of Urban Transport Infrastructure

4.2.1 Railways

(1) Railways in the Democratic Republic of the Congo

The railways in the Democratic Republic of the Congo are divided largely into two regions.

One is the railway linking Kinshasa, the capital, with Matadi, a river port serving as the gateway to the Atlantic. The railway line has 1,067 mm gauge and is 366 km in length. It is operated by the Commercial Transport and Ports Company (Société Commerciale des Transports: SCTP).

The other is a railway for transporting mineral resources in the southeastern province of Katanda, with activities centering mainly on Lubumbashi, the provincial capital. This railway network has 1,067-mm gauge and a route length of 3,516 km. It is operated by the National Railway of the Democratic Republic of the Congo (Société nationale des chemins de fer du Congo: SNCC). SNCC also operates a 125-km long railway that has a 1,000-mm gauge.

All the lines in the SCTP railway network are non-electrified, while 858 km of the SNCC 1,067-mm gauge railway network is electrified at 25,000 V AC (50 Hz).

In the north, there is also a 600-mm gauge railway network operated by Chemins de fer des Uele. This railway network was originally over 1,200 km long, but only 160 km in the west are currently in service.

Source: "Railways of the World", Japan Overseas Association for Railway Technical Cooperation (JARTS)

Figure 4-3 Railway Routes in the Democratic Republic of the Congo

(2) Suburban Railways in Kinshasa

The Kinshasa suburban railways (1,067mm in gauge) include three lines, which are operated by SCTP. Only the section between Kinshasa Est Station and Kasangulu Station (45 km in length) is in service; the other two lines are not in operation currently. Table 4-2 shows the current state of each line.

Source: JICA Study Team

Figure 4-4 Railway Lines in Kinshasa and Its Suburbs

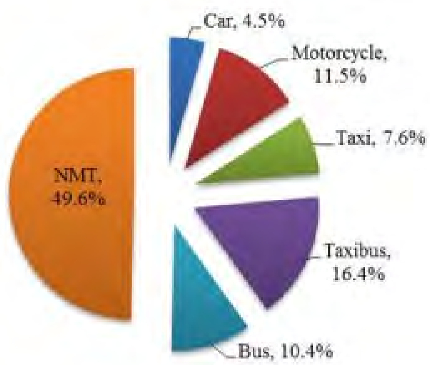
Table 4-2 Current State of Kinshasa Suburban Railways

Route	Length	Remarks
Matadi Line	45 km	・One round trip per day between Kinshasa Est and Kasangulu stations ・Diesel locomotive + eight passenger cars
Airport Line	20 km	Operation stopped in 2015
Kintambo Line	9 km	Operation stopped in 2007

Source: JICA Study Team

4.2.2 Non-rail Public Transportation

Public transportation in Kinshasa include buses and taxis, in addition to the railway. The buses and taxis can be further categorized into large buses, minibuses, taxi buses, share-ride taxis, and motorcycle taxis. Some large buses and minibuses are operated by Transport au Congo (Transco). Some minibuses and taxi buses are operated by sole proprietors. Since certain income groups cannot afford to pay the public transportation fares, walking and bicycles account for the non-motorized transport (NMT).



Source: "Project for Urban Transport Master Plan in Kinshasa City," JICA, 2018

Figure 4-5 Modal Share in Kinshasa

Source: JICA Study Team

Figure 4-6 Minibus

Source: JICA Study Team

Figure 4-7 Mototaxi

4.3 Past JICA Aid Projects

4.3.1 Project for Urban Transport Master Plan in Kinshasa City

JICA implemented the "Project for Urban Transport Master Plan in Kinshasa" from 2017 to 2018. Kinshasa city advocated the need for developing a master plan for urban transport in its Strategic Plan for Development of Kinshasa (Schéma d'Orientation Stratégique de l'Aggromérations de Kinshasa: SOSAK), which was formulated in 2015 due to concern over the low level of infrastructure development. In view of the above, this Study Team put together a master plan for urban transport, presenting a long-term development vision for 2040 and a medium-term development program for 2030 based on traffic demand projections.

4.3.2 Infrastructure Development by Upgrading Existing Railways

Urban areas in Kinshasa are in need of mass transit systems. Due to the lack of funds for infrastructure development, the Urban Transport Master Plan proposes improvement of the existing railway infrastructure as a viable solution at a relatively low cost. The Urban Transport Master Plan proposes track renovation, modernization of rolling stock, and installation of a signaling system, etc., with a view to increasing the frequency and speed of trains between Kinshasa Est and Kasangulu stations. The Airport Line is currently out of service but demand is expected to be high; therefore, track renovation and installment of a signaling system are proposed for this line.

It is said that a mass transit system will be considered after financing has been finalized in 2030 and beyond.

4.4 Urban Railway Rehabilitation and Modernization Project by Métro-Kin

In addition to the JICA Urban Transport Master Plan Project, a railway improvement project in Kinshasa city and its suburbs is planned by Métro-Kin, a new company involving several companies and government agencies. Due to the fact that the company is newly established, the feasibility of the proposed project and any concrete actions are still unclear at this time, nevertheless, an outline of the plan is given below.

4.4.1 Background of Urban Railway Project by Métro-Kin

On October 19, 2021, Mayor Gentiny Ngobila of Kinshasa announced a technical feasibility study on urban railways in Kinshasa city to tackle the serious traffic congestion. The announcement was made in conjunction with experts from SCTP, TCC (Trans Connexion Congo SARL) and Sinohydro Corporation. On January 20, 2022, Kinshasa city announced that it had formed a new company, Métro-Kin, together with the consortium of TCC to implement the project.

ITALFER, an Italian railway engineering company, and other railway engineering companies with proven track records overseas, also participate as partners.

4.4.2 Project Description

(1) Project Overview

Métro-Kin plans to build a 300-km urban railway network in Kinshasa. Of this, 75 km will be the rehabilitated (restored and modernized) existing SCTP lines. The project plan is divided into four phases. The construction period is expected to be 24 months.

1) Kinshasa Est Station–N'djili International Airport (25 km: renovation)

2) Routes along arterial roads (75 km: new construction)

3) Loop Line (Kinshasa Est Station–Kintambo–Mimosa–Kinsuka–Université Pédagogique Nationale (UPN)–Cité Verte–Kimwenza–Matete–Kinshasa Est Station) (90 km: new construction, partial renovation)

4) N'djili International Airport–Maluku (80 km: new construction)

(2) Overview of Phase 1

For Phase 1, the construction of a standard-gauge double-track line, installation of signaling equipment, construction of eight stations, rehabilitation of bridges across the N'djili and Tshenke rivers, construction of two railway bridges across Poids-Lords Street, and development of a transport hub at Pakadjuma Plaza are planned. In addition, eight 4-car trains will be put into service and a rolling stock inspection/repair depot will be constructed at Tshenke Station. Employee training is also planned.

4.4.3 Demand Forecast

During the first phase, the company expects more than 300,000 passengers a day. Three million trips per day are expected when the third phase is completed.[13]

4.4.4 Funds

The initial budget for the 300-km upgrade is estimated at $1.7 billion (approx. ¥192 billion). On May 26, 2022, Métro-Kin agreed to a $20 million (approx. ¥ 2.3 billion) grant from Bureau Central de Coordination Agency (Bceco) under the Ministry of Finance of the Democratic Republic of the Congo. The first phase is expected to cost $250 million (approx. ¥28.3 billion).

The construction costs are provided by Chinese, Italian and French companies, including China Water Resources and Hydropower Construction Co., Ltd.

4.5 Target Routes and Issues

4.5.1 Necessity of Improving Existing Railways

(1) Current Situation in Kinshasa

Kinshasa's population is growing rapidly and Kinshasa is expected to grow into one of the world's largest cities. The rapid urbanization accompanying this population growth is hindering urban functions and worsening traffic congestion due to insufficient urban transport infrastructure.

The main forms of public transportation in Kinshasa are buses, minibuses, taxi buses, and taxis. They are operated by public and private entities in an unregulated manner. Kinshasa has three railway lines but offer only one round trip per day (between Kinshasa Est Station and Kasangulu Station on the Matadi Line) due to deteriorated tracks and facilities. The Airport Line has been shut down since 2015 because the roadbed has been cut off, making safe operation impossible.

(2) Related Plans

Japan conducted the study "Project for Urban Transport Master Plan in Kinshasa City (JICA: 2018)" aimed at improving public transport in Kinshasa city. The Urban Transport Master Plan proposed modernization of the Matadi Line and the closed Airport Line.

The increasing traffic volume is putting strain on the road transport between Kinshasa and Matadi and causing many accidents. A new diesel locomotive and track maintenance equipment were procured to improve the inter-city railway between the two cities under the "Procurement of Diesel Locomotives and Track Maintenance Equipment under the Economic and Social

[13] The unit in which a person moves from one point to another for a purpose is called a trip. A trip is counted as one trip even if several modes of transportation are used.

Development Plan (Ministry of Foreign Affairs: 2020)." The addition of one diesel locomotive, in particular, has stabilized operation at SCTP by increasing the number of operable locomotives, as SCTP is facing a chronic lack of diesel locomotives due to shortage of replacement parts and accidents.

Source: JICA Study Team

Figure 4-8 Japanese Diesel Locomotive Hauling a Suburban Train on Matadi Line

(3) Necessity for Improving Existing Railways

As mentioned above, road transport accounts for most of the public transportation in Kinshasa. At present, Kinshasa has serious traffic congestion, which makes public transportation unreliable and forces Kinshasa citizens to walk long distances.

Because of this situation, there is an urgent need for new MRTs, such as subways and elevated railways, which are not affected by road traffic. Construction of an entirely new mass transit system, such as MRT, will require a large sum of money and long period of time from planning to the launch of service. On the other hand, rehabilitation of an existing railway in the urban areas can be finished in a short time from planning to the completion of rehabilitation work, and at a lower cost than the construction of a new railway. For example, the acquisition of land required for the construction of a new railway will not be necessary in the rehabilitation of an existing railway.

The conventional railways in and around Kinshasa connect several important districts in Kinshasa, including a north–south route that runs through the central part of Kinshasa and to Matadi, and a route that branches off from the north–south route and connects to N'djili International Airport in the eastern part of Kinshasa where the population is rapidly growing. Of these routes, the ones that are out of service are in ruins. However, some of these routes can be restored with a relatively small-scale investment. They can be restored as well as modernized. Since these lines have the same 1,067-mm gauge as the conventional railway lines in Japan, they can use secondhand rolling stock from Japan to increase the number of operational trains and equipment, thereby increasing transport capacity.

This Study will focus on the "Recovery of existing railways currently closed."

4.5.2 Selection of Target Route

In this Study, three suburban railway lines in operational or closed status were reviewed based on SCTP priorities and from the perspectives of beneficial effects, obtainability of land, and utilization of Japanese technologies. Ultimately, the Airport Line was selected. Table 4-3 shows the results of the review and the status of each line.

Table 4-3 Selection of Route for Rehabilitation

Route	Operating condition	Priority of SCTP	Beneficial effect	Land acquisition	Utilization of Japanese technologies	Study Team Proposal
Matadi Line	In service	2	△	◎	◎	
Airport Line	Closed	1	◎	○	◎	✓
Kintambo Line	Closed	3	○	△	◎	

Source: JICA Study Team

(1) SCTP Rehabilitation Priority

In the interview with SCTP, the Airport Line was identified as the highest priority for rehabilitation. As population growth is worsening traffic congestion in Kinshasa and its suburbs, SCTP hopes to restore the closed Airport Line to bring relief. After the Airport Line, the Matadi Line (between Kinshasa Est Station and Kasangulu Station), which is currently in operation, is expected to also be upgraded, followed by the Kintambo Line.

(2) Beneficial Effect

Since the Matadi Line is currently running one round trip a day, the minimum requirements for train operation are in place. On the other hand, the restoration and resumption of operations of the closed Airport Line and Kintambo Line will be more beneficial to the areas along the two railway lines. After the Airport Line has been restored, it will provide one of the few means for crossing the N'djili River, which runs along the line. The Airport Line also has a larger population along the line than the other districts and the population is expected to grow in the future. Therefore, the Airport Line is expected to bring more benefits than the Kintambo Line.

1) Elimination of Bottlenecks at N'djili River

The Airport Line’s bridge and Lumumba Street’s bridge are the only bridges over the N'djili River, which flows north to south along the eastern side of Kinshasa. The limited number of bridges created bottlenecks of mobility between the eastern district and the city center. Construction of a new bridge is difficult because it requires land acquisition. If the Airport Line resumes operation, the bottlenecks at the N'djili River can be eliminated, leading to alleviation of traffic congestion on Lumumba Street.

2) Large Population in Areas along the Railway Lines and Anticipated Population Growth

According to the Final Report on the Project for Urban Transport Master Plan in Kinshasa City implemented by JICA in 2018, the estimated population of the five communes (N'djili, Masina, Kimbanseke, N'select, and Maluku) located to the east of Kinshasa city in 2017 accounted for more than 40% of the city's population. In particular, Masina, a commune where the Airport Line goes through, has a population of 1,070,858. It is the third most populous commune out of the 24 communes in Kinshasa and is expected to generate large demand along the Airport Line.

In the report, the population of the three communes (N'djili, Masina, and Kimbanseke) in the eastern part of Kinshasa city is projected to increase by more than 1.5 times by 2030, compared to the 2017 level. Demand for the Airport Line is expected to rise continuously.

(3) Land Acquisition

Some houses are found occupying the railway right-of-way illegally on the Matadi Line, which is in operation. They do not interfere with train operation and their relocation should not be a problem when the land is repossessed. The roads parallel to the railway line also have enough space to accommodate the materials and heavy equipment for construction work.

A few houses and stalls have been constructed illegally near or on the idle tracks of the Airport Line in some urban and densely populated areas. SCTP confirmed in the interview that relocation of these structures is possible in the rehabilitation process in order to resume operations. Many of the roads along the Airport Line are narrow. Securing road space to accommodate the materials and heavy equipment for construction will be an issue.

The Kintambo Line passes through the center of the city. Houses and stalls constructed illegally near or on the idle railway tracks are found in almost all sections of the line. In urban areas, it is easier to secure roads to accommodate the materials and heavy equipment for construction. However, heavy traffic can become a problem when doing construction in urban areas, making safety a top priority.

(4) Utilization of Japanese Technologies

In 2020, Japan delivered a diesel hydraulic locomotive to SCTP under the “Economic and Social Development Plan” of the Ministry of Foreign Affairs of Japan. This locomotive is currently used to haul suburban trains between Kinshasa Est and Kasangulu stations on the Matadi Line. When the Airport Line rehabilitation project is completed, it will be one of the locomotives hauling trains on the newly renovated line.

As described above, the currently closed Airport Line will bring the most benefits among the three candidate routes. Securing land is an issue relatively easy to resolve. For these reasons, the Airport Line has been selected as the target for rehabilitation.

The Airport Line shares a common section with the Matadi Line between Kinshasa Est Station and Limite Station and branches off from the Matadi Line between Limite Station and Aéroport Station. In other words, the section between Kinshasa Est Station, N'dolo Station, Funa Station, and Limite Station are shared with the Matadi Line. The branched off section of the Airport Line ends at Tshenke and Aéroport stations.

Source: JICA Study Team

Figure 4-9 Airport Line Route Map

4.5.3 Railway Track

(1) Technical Standards, Specifications, and Current State

1) Technical Standards and Specifications

Table 4-4 shows the technical standards and specifications for the tracks between Kinshasa Est and Aéroport stations on the Airport Line.

Table 4-4 Track Specifications of the Airport Line

<table>
<tr><th>Type</th><th colspan="3">Specifications</th></tr>
<tr><td rowspan="4">Rail</td><td>Between Kinshasa Est Station and Limete Station</td><td>50 kg rail</td><td>Standard 18 m</td></tr>
<tr><td>Between Limete Station and PK7</td><td>33 kg rail</td><td>Standard 12 m</td></tr>
<tr><td>Between PK7 and PK9</td><td>40 kg rail</td><td>Standard 12 m</td></tr>
<tr><td>Between PK9 and Aéroport Station</td><td>33 kg rail</td><td>Standard 12 m</td></tr>
<tr><td rowspan="2">Ground beam</td><td>Between Kinshasa Est Station and Limete Station</td><td colspan="2">Concrete railway sleepers</td></tr>
<tr><td>Between Limete Station and Aéroport Station</td><td colspan="2">Steel railway sleepers</td></tr>
<tr><td>Sleeper pitch</td><td colspan="3">1500 pcs/km, 67 cm apart</td></tr>
<tr><td>Track</td><td colspan="3">Ballast track</td></tr>
<tr><td>Ballast thickness</td><td colspan="3">35 cm under railway sleepers and 40 cm above railway sleepers</td></tr>
<tr><td>Fastening device</td><td colspan="3">Bolt fixing type (inelastic fastening)</td></tr>
<tr><td>Railway switch</td><td colspan="3">Electrically operated, disabled due to power failure</td></tr>
<tr><td>Railway right-of-way width</td><td colspan="3">15 m to 50 m from the end of the track</td></tr>
</table>

Source: JICA Study Team

2) Current State

The Study Team conducted a route survey on Saturday, April 23, 2022 for approximately 12 km, from Limete Station where the Airport Line branches off from the Matadi Line, to a location 1 km from the Aéroport Station. The trains were running until 2015. However, in the seven years since operation has been suspended, some embankments have collapsed and some tracks are submerged due to poor drainage.

Figure 4-10 shows a full-length map of the route, surveyed on foot using GPS data on Google Earth.

Source: JICA Study Team

Figure 4-10 GPS Data of Airport Line

The light blue line on the map shows the survey route taken, with yellow line indicating the national highway from central Kinshasa city to N'djili International Airport. Far-left of the light blue line is Limete Station, and far-right is where the line meets the national highway in front of N'djili International Airport. The horizontal axis of the graph is the distance by kilometer from Limete Station, the vertical axis on the left and the red line on the graph show the elevations, and the vertical axis on the right and the blue lines indicate walking speeds during the survey.

It can be seen from the graph that the route gradually rises in altitude toward the N'djili International Airport. The height difference was about 30 m for the entire line, and there was no significant unevenness. (The large drop in the graph indicates the location where the Study Team members went down to a lower area to investigate a bridge.)

Below is a report on the current situation, divided into four sections.

3) Survey of Current Condition of Each Section

1. Between Limete Station and Former Petro Congo Station

Source: JICA Study Team

Figure 4-11 Intersection with Poids-Lords Street

Source: JICA Study Team

Figure 4-12 Shaved Roadbed/Embankment (Approx. 0.5 km from Limete Station)

Source: JICA Study Team

Figure 4-13 Occupied Track (Approx. 0.8 km from Limete Station)

Source: JICA Study Team

Figure 4-14 Submerged Track (Approx. 1.0 km from Limete Station)

Source: JICA Study Team

Figure 4-15 Bridge Section (Approx. 750 km from Limete Station)

Source: JICA Study Team

Figure 4-16 Near Former Petro Congo Station (Approx. 3.8 km from Limete Station)

As shown in Figure 4-11, the Airport Line branches off to the left from the Matadi Line as soon as it leaves Limete Station and crosses the four-lane road (Poids-Lords Street) diagonally. After this level crossing, the houses on both sides of the railway line are located close to each other. Relocation of these houses is necessary to secure road space for construction. The relocation will be carried out by the Kinshasa city authority. Materials used for the roadbed and embankment in this section have been stolen, causing the roadbed and embankment to collapse (see Figure 4-12). The roadbed and embankment materials used for the Airport Line contain a lot of sand. It is preferable that the roadbed and filling materials are mixed with high-density materials in different grain sizes. Single grain size may result in insufficient compaction, which may have led to the collapse.

In areas where the level of the railway tracks is the same as those of the surrounding areas, many mobile vendors have occupied the track. Their relocations are necessary (see Figure 4-13).

2. Between Former Petro Congo Station and Tshenke Station

Source: JICA Study Team

Figure 4-17 Collapsed Embankment (Approx. 5 k 800 m from Limete Station)

Source: JICA Study Team

Figure 4-18 Collapsed Steel Retaining Wall (Approx. 6 k100 m from Limete Station)

Source: JICA Study Team

Figure 4-19 Collapsed Track (Approx. 6 k 400 m from Limete Station)

Source: JICA Study Team

Figure 4-20 Submerged Track (Approx. 7 k 200 m from Limete Station)

The civil engineering structures in some areas of this section require considerable repair because the embankment has largely collapsed (see Figure 4-17), the steel earth retaining structure has collapsed (see Figure 4-18), and the track has collapsed (see Figure 4-19) due to the loss of roadbed. In the section where the track level seems low, the railway track has submerged (see Figure 4-20). In these sections, domestic wastewater from neighboring areas flows onto the railway track. If the water flow problem is not resolved, the water will stagnate and cause damage to the railway tracks, roadbeds, and filling materials.

3. Between Tshenke Station and Graveyard Entrance

Source: JICA Study Team

Figure 4-21 Tshenke Station Premises

Source: JICA Study Team

Figure 4-22 Poor Drainage (Approx. 9 k 000 m from Limete Station)

Source: JICA Study Team

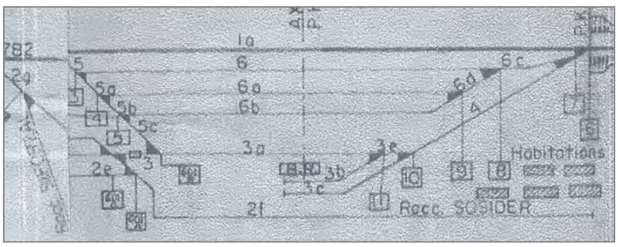
Figure 4-23 Garbage Dump (Approx. 9 k 300 m from Limete Station)

Source: JICA Study Team

Figure 4-24 Embankment Collapsed behind Garbage Dump (Approx. 9 k 400 m from Limete Station)

According to past data obtained from SCTP (see Figure 4-25), Tshenke Station was a large-scale passing station with storage tracks, as well as main and sub main lines. At present, almost all the rails have been removed but the wide open space is not used for any other purposes (see Figure 4-21).

There are many areas with poor drainage (see Figure 4-20) around Tshenke Station. Wastewater treatment measures shall be taken in these areas, as well as station premises. A large garbage dump is found in the vicinity of the Tshenke Station, near the entrance to the graveyard. The garbage is disposed of on the railway track (see Figure 4-23) and the embankment behind the garbage dump has collapsed (see Figure 4-24). It is not possible to ascertain the condition of the buried embankment without removing the garbage. Since the Tshenke River runs close by, part of the embankment may have been washed away by the river. Detailed investigation shall be conducted after the site clean-up.



Source: Provided by SCTP

Figure 4-25 Track Layout of the Former Tshenke Station

4. Between the Graveyard Entrance and the Airport

Source: JICA Study Team

Figure 4-26 General Section (Track Hidden by Grass)

Source: JICA Study Team

Figure 4-27 Grave Next to the Track

This section of the track is almost entirely hidden by grass (see Figure 4-26). There are no structures or flooded areas nearby, except some graves located next to the track (see Figure 4-27). Generally speaking, no structures or other obstacles may hinder construction, but detailed investigation is needed after the grass has been mowed.

5. Aéroport Station

Source: JICA Study Team

Figure 4-28 Aéroport Station Platform (Frame only)

Source: JICA Study Team

Figure 4-29 Front End of Aéroport Station Platform

At present, an area of the Aéroport Station near the N'djili International Airport and part of the platform are taken up by the shops. The rest of the station is in a poor condition (see Figure 4-28). A switch was inserted at the platform end in the past for the locomotives (see Figure 4-29).

(2) Issues

Issues based on the current condition of the Airport Line can be broadly classified into the following categories:

1) Section in a relatively good condition (area near N'djili International Airport)

This section has no major problem, provided that the trees and plants are removed and the track is maintained.

2) Section with poor drainage (excluding the vicinity of N'djili International Airport)

The track shall be raised to a level higher than the surrounding area to prevent water inflow. Drainage shall be installed to drain wastewater from the track.

3) Areas where the embankments have collapsed

The cause of the collapse shall be investigated, countermeasures shall be taken to prevent collapse, and the embankments shall be restored.

4) Areas where the embankments have been cut (mostly near private homes)

Measures shall be taken to prevent the soil from being removed and drainage shall be installed at the embankment.

5) Section with insufficient ballast (almost all sections)

Ballast shall be replenished to the specified ballast thickness and the ballast shall be tamped sufficiently.

4.5.4 Signaling system

(1) Technical Specifications and Operation Status

1) Specifications

Table 4-5 Technical Specifications of Signaling Devices

<table>
<tr><th>Type</th><th colspan="2">Technical Specification</th></tr>
<tr><td>Applicable standards</td><td colspan="2">European Standard (trace of past Belgium rule)</td></tr>
<tr><td rowspan="4">Signal

(Fitted on the right side)</td><td>Model (multi-lamp type)</td><td>Position fitted (right hand side)</td></tr>
<tr><td colspan="2">Home signal (4 presentation method)</td></tr>
<tr><td colspan="2">Departure signal (2 presentation and 3 presentation methods)</td></tr>
<tr><td colspan="2">Distance signal (4 presentation method)</td></tr>
<tr><td rowspan="3">Point switch movement</td><td colspan="2">Electric switching machine (relay interlocked station)</td></tr>
<tr><td colspan="2">Switching machine (with electric lock)</td></tr>
<tr><td colspan="2">Switching machines (spring type, weight type)</td></tr>
<tr><td rowspan="2">Blocking system</td><td colspan="2">Tablet blocking system</td></tr>
<tr><td colspan="2">One Engine shut-off system (only a single train can operate in a single-track section)</td></tr>
<tr><td rowspan="2">Train detector</td><td colspan="2">Track circuit (relay-linked station only)</td></tr>
<tr><td colspan="2">Magnetic check-in/out (only between relay interlocking stations)</td></tr>
<tr><td rowspan="2">Level crossing protection</td><td colspan="2">Level crossing alarm</td></tr>
<tr><td colspan="2">Manual crossing gate</td></tr>
</table>

Source: Prepared by JICA Study Team based on JICA's "Interim Report on Feasibility Study on the Construction Project of the Kisenso-Kimbanseke Railway Line" (1987)

2) Operation Status

Table 4-6 summarizes the operation status of signaling devices on the target route, based on findings from field survey.

Table 4-6 Operation Status of Signaling Devices

Device	Operation status
Signal	Out of order and out of service
Switching machine	Switchgear out of service
Blocking system	Shut down

Train detector	Not available or out of service
Level crossing protection	No alarms and no gates

Source: Prepared by JICA Study Team based on the JICA "Interim Report on Feasibility Study on the Construction Project of the Kisenso–Kimbanseke Railway Line" (1987)

The signaling system is summarized below based on the JICA "Interim Report on Feasibility Study on the Construction Project of the Kisenso–Kimbanseke Railway Line" (1987). At the time of the JICA Interim Report, there were Home, Departure, and Distance signals. However, the signals broke down and they stopped being used in operation. The tablet blocking method and the one-engine blocking method were in use. Subsequently, due to failure of the equipment, permission for the entry/exit of trains were communicated between station masters using dedicated radio (VHF: Very High Frequency, frequency of radio equipment (30-300 MHz)) until the suspension of service. There are four railway crossings between Limete Station and Aéroport Station.

(2) Issues

As the number of trains in service increases, the signaling system shall be upgraded step by step, starting with a level crossing warning system to improve safety at level crossings where the railway and road traffic intersect.

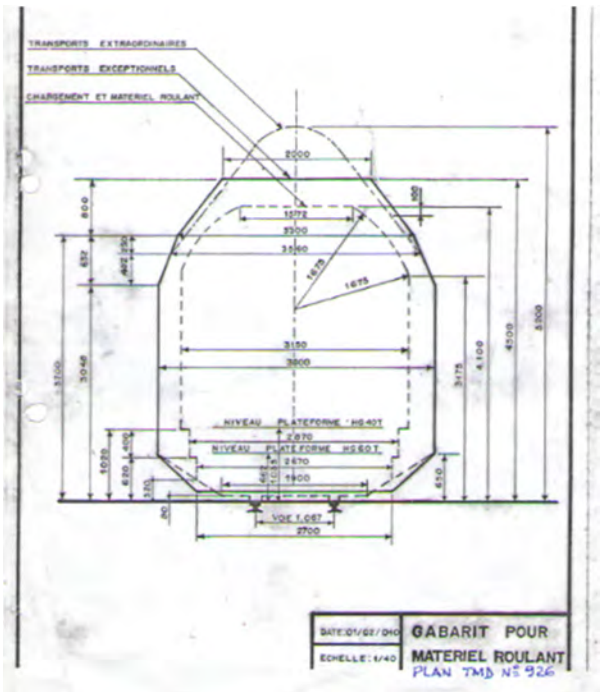
When the level crossing warning system is installed, the level crossing personnel shall be trained on the operation of the system, and maintenance personnel shall be trained on the maintenance and failure recovery.

4.5.5 Rolling Stock

(1) Technical Specifications

1) Rolling Stock Gauge

Figure 4-30 shows the SCTP rolling stock gauge.



Source: SCTP

Figure 4-30 SCTP Rolling Stock Gauge

The rolling stock gauge is not the same as in Japan. The dimensions at the lower part of the vehicle are smaller than those in Japan. For this reason, the use of secondhand Japanese rolling stock requires careful review of the actual dimensions of the vehicle, the conditions and various dimensions of existing facilities, and clearance in order to ensure safety.

2) Current Rolling Stock

The Matadi Line is providing commuter train services between Kinshasa Est Station and Kasangulu Station on weekdays. The train arrives at Kinshasa Est Station in the morning and departs in the evening. Long-distance train service was available on holidays between Kinshasa Est Station and Matadi Station in the past, but it has been discontinued due to the Coronavirus pandemic.

A train consisted of a locomotive and eight passenger cars, including a baggage car, provides passenger transport between Kinshasa Est Station and Kasangulu Station. Table 4-7 shows the number of locomotives and passenger cars owned by SCTP at the time of the field survey.

Table 4-7 Locomotives and Passenger Cars Owned by SCTP

Type	Number	Remarks
Locomotives for freight and passenger trains	15	Four locomotives are in operation and 11 are out of order. Some are being repaired.
Shunting locomotive	6	Two locomotives are in operation and four are out of order.
Passenger cars for commuter service	22	Seven cars are in operation between Kinshasa Est and Kasangulu stations. There are originally 13 cars but the other six are out of order or unusable.
Baggage car	1	It is being used between Kinshasa Est and Kasangulu stations.
Passenger cars for long-distance service	19	Nine cars are used between Kinshasa Est Station and Matadi Station (operation suspended currently). Ten cars have been purchased in recent years. They are not in use currently.

Source: JICA Study Team

The current diesel locomotives are manufactured by KRUPP (Germany) and General Electric (U.S.), as well as the HDCF-72LP locomotive manufactured by Hokuriku Heavy Industries, which was supplied by Japan in 2020. (Figure 4-31)

The number of rolling stock in operation is small compared to the number of rolling stock owned by SCTP. Some vehicles cannot be used for operation due to a shortage of parts and some are under repair（Figure 4-32). There are also vehicles under repair after derailment or overturning, which seems to be one of the reasons for the low operating rate of rolling stock.

Source: JICA Study Team

Figure 4-31 Diesel Locomotive from Japan

Source: JICA Study Team

Figure 4-32 Diesel Locomotive under Repair

Although SCTP has passenger cars for commuter service (Figures 4-33 and 4-34) and for long-distance service (Figures 4-35, 4-36 and 4-37), the number of cars in operation is limited. Some cars are stored at the stations or depot.

The passenger cars for commuter service are aging. Many of the seats and handrails inside the cars are damaged (Figure 4-38). A baggage car is being used as a passenger car (Figure 4-39 and Figure 4-40) between Kinshasa Est Station and Kasangulu Station. Six of the out-of-order passenger cars were allocated for the operation between Kinshasa Est and Kasangulu stations, and the other nine passenger cars are of multiple types. Some of the vehicles could not be used due to car body damage or lack of bogie parts that needed to be replaced, and some of them were put into the workshop for repairs, but the repairs were not made due to the lack of budget. Ten of the 19 long-distance vehicles purchased in recent years are not currently in use due to the high fuel consumption of generators, equipment malfunctions, and improper layout of underfloor equipment.

Source: JICA Study Team

Figure 4-33 Passenger Car for Commuter Service

Source: JICA Study Team

Figure 4-34 Interior of Passenger Car for Commuter Service

Source: JICA Study Team

Figure 4-35 Passenger Car for Long-distance Service

Source: JICA Study Team

Figure 4-36 Interior of Passenger Car for Long-distance Service

Source: JICA Study Team

Figure 4-37 Passenger Car for Long-distance Service (Out of Service)

Source: JICA Study Team

Figure 4-38 Damaged Seats in Passenger Car for Commuter Service

Source: JICA Study Team

Figure 4-39 Baggage Car

Source: JICA Study Team

Figure 4-40 Baggage Car Interior

1) System for Inspections and Repairs

Rolling stock inspection standards have been established, and inspections are carried out in accordance with the manual and maintenance schedule based on the mileage. Spare parts are procured through a bidding system. The budget is decided every year by the headquarters, but it is not sufficient.

Locomotives are inspected and repaired at Limete, Matadi and Mbanza-Ngungu (about 150 km from Kinshasa). There is also a workshop in Limete that maintains passenger cars and wheel axles. The Study Team visited the Limete depot, the Limete workshop for passenger cars and wheel axles, and the Mbanza-Ngungu workshop.

- Limete Depot (Figure 4-41)

This depot is used for the inspection of small locomotives and small-scale repairs. It is equipped with jacks, cranes, and lathes for metal processing, but the machines did not operate due to insufficient electricity. The inspection line was filled with water because of drainage problem. There is no storage for materials; most purchased parts are used immediately.

- Limete Workshop for Passenger Cars and Wheel Axles

While the wheel lathes, wheel shaft assemblies, cranes, jacks, and equipment for metal and wood machining are in working order, other equipment is out of order (Figure 4-42). Part of the siding is disabled as it has been occupied illegally. Some passenger cars have been left for five years without being repaired, and some others have large cracks in the deck. The lack of progress is due to insufficient budget.

- Mbanza-Ngungu Workshop (Figure 4-43)

The workshop is used for the overhaul of parts and large-scale repairs. Although some of the equipment is out of order, maintenance work can still be done. While some areas are organized, many parts are placed or stacked on the floor but the usable parts seem to be managed. There is a storage for supplies, but all materials are managed using paper. Some staff members pointed out problems such as the shortage of personnel, shortage of parts, and aging facilities.

Source: JICA Study Team

Figure 4-41 Limete Depot Inspection Line

Source: JICA Study Team

Figure 4-42 Wheel Lathe Machining at Limete Wheel Axel Workshop

Source: JICA Study Team

Figure 4-43 Motor Repair Shop at Mbanza-Ngungu Workshop

(2) Issues

The number of rolling stock in operation is few. There will not be enough rolling stock to provide sufficient transportation capacity after the facilities of the Airport Line targeted in this Study have been restored. New rolling stock for passenger transport shall be procured and the unusable ones shall be repaired.

The number of rolling stock in operation is small compared to the rolling stock owned. Given the state of the depot, the maintenance work environment is not good. Besides the problems of aging facilities, breakdowns, and shortages of parts, it is important to develop a maintenance system and a work environment to facilitate the maintenance of rolling stock. The tight budget for rolling stock maintenance is another major issue.

4.5.6 Station

The Airport Line has six stations. The Kinshasa Est, N'dolo, Funa, and Limete stations are shared with the Matadi Line. The Tshenke and Aéroport stations are at the end of the line after it branches off from the Matadi Line. According to the JICA "Interim Report on Feasibility Study on the Construction Project of the Kisenso-Kimbanseke Railway Line" (1987), the Airport Line had six other stations in the past, but signs of those stations are gone due to theft and other reasons.

(1) Current State of Station Facilities

Table 4-8 gives a summary of the current station facilities.

Table 4-8 Summary of Station Facilities on the Airport Line

Station name	Station building	Platform	Platform roof	Transit node function	Remarks
Kinshasa Est	○	○	○	○	Platform roof built with EU support
N'dolo	○	×	×	×	
Funa	○	×	×	×	
Limete	○	×	×	×	
Tshenke	○	×	×	○	
Aéroport	○	○	Frame only	○	

Source: JICA Study Team

1) Station Building

All the stations have station buildings. The station buildings of four intermediate stations, except the Kinshasa Est Station and Aéroport Station, are used as the station master's train operation room and housing for SCTP staff, including the station master's family.

Only the Kinshasa Est Station has a booth for ticket sales. As of the end of April 2022, this ticket sales booth was not in use. The first floor of the Kinshasa Est Station is used as a restaurant, and the railway operation room is on the second floor. The station building at the Aéroport Station does not have any operation facilities and is managed by Tshenke Station. A restaurant is operating on the N'djili International Airport side of the station building.

Source: JICA Study Team

Figure 4-44 Kinshasa Est Station

Source: JICA Study Team

Figure 4-45 N'dolo Station

Source: JICA Study Team

Figure 4-46 Funa Station

Source: JICA Study Team

Figure 4-47 Limete Station


Source: JICA Study Team
Figure 4-48 Tshenke Station


Source: JICA Study Team
Figure 4-49 Aéroport Station

1) Platform and Platform Roof

Only the Kinshasa Est Station and Aéroport Station have a platform.

Kinshasa Est Station has two platforms, one for the long-distance service to Matadi and one for commuter service. The long-distance train platform is in front of the station building, and the commuter train platform is located on the Congo River side. Due to aging, both platforms have holes in the ground that are filled with water and garbage.

A platform roof was built at the commuter train platform with EU support. Commuter trains have a dedicated track for each destination: the Congo River side is for the N'djili International Airport direction and the city center side is for the Kasanguru direction. Because the platform is low, it should be raised to facilitate the boarding and alighting of trains.


Source: JICA Study Team
Figure 4-50 Platform of Kinshasa Est Station


Source: JICA Study Team
Figure 4-51 Platform for Commuter Service at Kinshasa Est Station

The Aéroport Station has a single side platform, and the remaining frame of a platform roof. The platform is 600 mm high, which is higher than the platform at Kinshasa Est Station.

(2) Operation between Stations

At SCTP, each time a train proceeds from one station to the next, the station master will ascertain safety by using a radio or other device to confirm that the train is proceeding from the adjacent station. The current traffic management method can be done on a schedule with a small number of trains. However, if the number of trains increases in the future, a different traffic management method, such as setting up a train command room, is necessary.

Source: JICA Study Team

Figure 4-52 Operation Record Book at the N'dolo Station Master's Office

Source: JICA Study Team

Figure 4-53 Radio Equipment at the Funa Station Master's Office

(1) Issues

The station facilities are mainly used for train operation and staff lodging. Little is provided for the passengers. A minimum level of passenger facilities should be furnished.

The Kinshasa Est Station has a platform, but the significant difference in level makes it difficult for passengers to get on and off trains. The N'dolo, Funa, Limete, and Tshenke stations do not have platforms, so passengers cannot get on and off the trains without hanging onto the handrails. Minimum facilities are necessary to facilitate accessibility since some of the passengers on the commuter trains between Kinshasa and Kasangulu stations have disabilities.

4.5.7 Station Plaza and Transport Hub

(1) Status of Facilities and Use

Among the Airport Line stations currently open, only Kinshasa Est station has a station plaza at the front. Tshenke Station has a minibus terminal nearby.

1) Station Plaza of Kinshasa Est Station

Kinshasa Est Station has a station plaza at the front. It is decorated with monuments and fountains, providing a relaxation venue for Kinshasa citizens. A rotary circles around the station plaza, which has two Transco bus stops and a taxi stand, making it a transport hub. Figure 4-54 shows the positional relationship between the station, bus stops and taxi stand.

Source: Prepared by JICA Study Team based on Open Street Map

Figure 4-54 Location Relationship between Kinshasa Est Station, Bus Stop, and Taxi Stand

The Kinshasa Est Station has four bus lines, three of which terminate at Kinshasa Est station. The bus stops are located at two different locations, one for the three lines starting at Kinshasa Est Station and the other for the line passing through the station. The former is a bus terminal where multiple buses can stop. The latter is located at the same location as the taxi stand.

Source: JICA Study Team

Figure 4-55 Bus Terminals (In front of Kinshasa Est Station)

Source: JICA Study Team

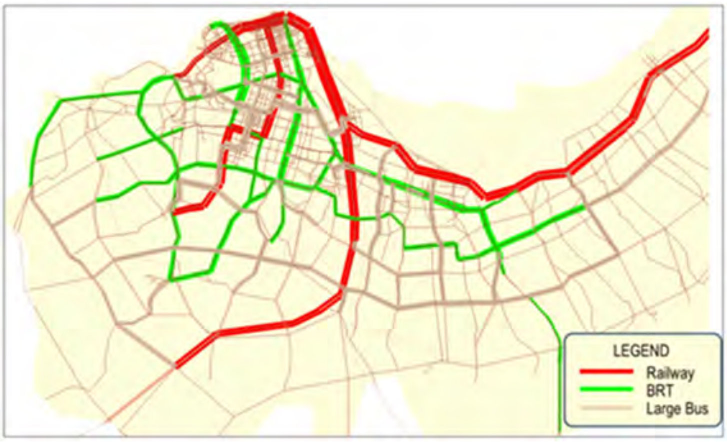
Figure 4-56 Bus Stop and Taxi Stand (In front of Kinshasa Est Station)

1) Minibus Terminal at Tshenke Station

The east side of the Tshenke Station has space that allows multiple minibuses to stop. The minibuses depart frequently for Lumumba Street.

(2) Planning

The Urban Transport Master Plan pointed out that improvements of existing railways can be made on an urgent and short-term basis with a relatively small-scale investment. Connecting the poor road network with the rail network can increase capacity to meet the rapidly growing demand for transport and improve the convenience of the transport networks.



Source: JICA Project for Urban Transport Master Plan in Kinshasa, Democratic Republic of the Congo (2018)

Figure 4-57 Results of Public Transportation Allocation in the Priority Development of Public Transportation (Emphasis on Railway Development) Scenario for 2040

(1) Issues

SCTP recognizes that the current public transportation network is weak and inconvenient, but it does not have future plans to develop public transportation networks, including the development of station plazas. One reason for this is the scarcity of funds.

At present, the N'djili River can only be crossed at Lumumba Street. Due to the closure of the Airport Line and increase in automobile use, Lumumba Street has become a bottleneck.

An improvement plan shall take into consideration connection between the railway and other public transportation modes, improvement of the station plaza so it can function as a transport hub for the transportation network, and increase in convenience. At the same time, a station plaza shall have enough capacity to receive feeder traffic from the railway.

4.5.8 Fare Collection

In order to check the current state of passenger services of the target route and other public transportation means that are expected to be connected to the railway facilities, the Study Team conducted a survey of the fare collection systems of these public transportation means.

(1) Fare Collection of the Conventional Railway and Connecting Public Transportation Means

1) Types of Public Transportation

In Kinshasa, there are minibuses, taxi buses, share-ride taxis, and mototaxis, as well as railways and ride-sharing buses. Only some minibuses are publicly operated, the other road transport means are operated by private companies or sole proprietors. These operators do not post information about their routes, schedules, or fares.

2) Fares of Conventional Railway (SCTP)

Fares of commuter trains vary from section to section, as shown in Table 4-9. The fares are determined by the City of Kinshasa. The long-distance train fares between Kinshasa and Matadi are determined by SCTP.

Table 4-9 Fare Table for Commuter Trains

Station name	Kinshasa Est	Kimwenza	Kasangulu
Kinshasa Est		500	1000
Kimwenza	500		1000
Kasangulu	1000	500	

Currency unit: Congo Franc (fc)
Source: JICA Study Team

In addition to the tickets mentioned above, monthly and weekly commuter passes are also available. Civil servants, military personnel, etc. can ride for free with an ID. According to SCTP, these users account for 40% of the total number of users.

3) Fares of Transco Bus

Transco's bus fare is based on 500 Fc per ride. A route with a traveling distance of 20 km or more is 1,000 Fc per ride.

(2) Fare Collection Method of the Conventional Railway and Connecting Public Transportation Means

1) Rail (SCTP) Fare Collection Method

An SCTP station building is used mainly for train operation and staff housing. Since the station building does not have any booth for ticket sales, the tickets are sold in front of the station and on the train.

At the Kinshasa Est Station, tickets are sold in front of the gate next to the station building, not inside the station building. The tickets are sold from 14:00 to 16:45 before the train for Kasangulu Station departs. When passengers purchase tickets from the salesperson, they receive the tickets and enter the station through the gate. After entering the station, the ticket inspector checks the tickets.

Source: JICA Study Team

Figure 4-58 Kinshasa Est Station Ticket Sales Area

Source: JICA Study Team

Figure 4-59 Kinshasa Est Station Ticket Salesperson

On a commuter train, the ticket salesperson's seat is next to the doorway. Passengers can also purchase tickets onboard. There are two salespersons onboard each car, one at each door, and also two ticket inspectors.

Nevertheless, there is still fare evasion. SCTP estimates fare evasion to be around 10% of the total riders.

Source: JICA Study Team

Figure 4-60 Ticket Salesperson's Seat in a Passenger Car for Commuter Service

1) Fare Collection on Buses (Transco)

The Transco bus utilizes a front-enter/rear-exit system. A passenger boards the bus using the door at the front and gets off using the door at the back. The bus has a ticket salesperson's seat and a rotating gate at the entrance to prevent passengers from boarding the bus without paying.

Source: JICA Study Team

Figure 4-61 Transco Bus

Source: JICA Study Team

Figure 4-62 Ticket Salesperson's Seat on the Bus

(1) Issues

1) Lack of a Comprehensive System to Promote the Use of Public Transportation

In Kinshasa, several public transportation systems are in operation, but their fare systems are completely different. For this reason, it is difficult to combine different public transportation modes in a single trip. This is due to the lack of a framework to coordinate the development and implementation of public transport plans in Kinshasa.

2) Difficulty of Introducing Comprehensive Policies for Promoting Public Transportation

Public transportation systems, such as the railway and public buses, have different operators. Private businesses and sole proprietors are engaged in road transportation. As a result, there are many stakeholders in the operation of public transportation. Participation of the national and state administrative organizations is also essential in the implementation of policies. Therefore, it will take time to coordinate the various stakeholders when introducing a comprehensive policy to promote the use of public transportation.

3) Passenger Services That Are Difficult to Reach Users

Although the railways and buses in and around Kinshasa have designated routes, schedules, fare tables, etc., there is no publicly available information on the operators' websites or on SNS, making it difficult for users to find out about the service situation.

4.6 Improvement Plan

4.6.1 Basic Policy of the Improvement Plan

(1) Restoration of the Suspended Airport Line and Strengthening of Transport Capacity through Grant Aid

The basic policy of this project is to use Japanese grant aid to restore the Airport Line, the operation of which was suspended due to dilapidated railway facilities. Before the suspension of services, the Airport Line was offering 2 round trips per day. The project aims to increase train services to 5 round trips per day when the operation is resumed.

(2) Overview of the Airport Line Restoration Plan

Partial collapse of the roadbed and poor rail maintenance are the main reasons for the suspension of the Airport Line operation. Therefore, the restoration will focus on reestablishing the roadbed structure and rail maintenance. Restoration of the railway tracks is a top priority. The restoration plan aims to improve the safety of train operation and convenience for passengers by installing warning devices at large level crossings along the railway line, upgrading the newly established stations, and improving connectivity with other transportation modes at major stations.

(3) Technical Cooperation Projects to Ensure the Effectiveness of Grant Aid

Given the existing capacity of SCTP in operating and maintaining railways, continuous support will be necessary in the operation and maintenance of the Airport Line after resumption of operation with the grant aid. In Myanmar, JICA cooperated with a Japanese railway operator in a technical cooperation project to maintain the tracks and vehicles ruined under the military regime. Based on such experience, similar technical cooperation projects shall be established with SCTP to put in place a system to support railway operations after the Airport Line is restored, in order to optimize the benefits from the grant aid project.

Source: JICA Study Team

Figure 4-63 On-site Guidance for the Improvement of Rolling Stock Maintenance skill

(1) Enhancement of Passenger Services and Adoption of Universal Design

The grant aid and technical cooperation projects will help SCTP develop railway facilities, as well as operate and maintain them. In addition to technical support, assistance in enhancing services for SCTP users can be provided so that SCTP can attract more passengers and increase fare revenues. The aforementioned technical cooperation project in Myanmar is designed to support station employees and crewmembers in improving passenger services; similar technical cooperation projects can be arranged for SCTP.

Universal design, such as signage and multi-purpose toilets, shall be installed at stations with many users so that the facilities can be used easily regardless of the age, gender, or physical ability of the users (see Figure 4-64).

Source: JICA Study Team

Figure 4-64 Example of Signage at an East Japan Railway Station

Table 4-10 Kinshasa: Summary of Policy for the Improvement of an Existing Railway

Improvement policy	(1) Restoration of the Airport Line (2) Increase in transport capacity (number of trains in service: from 0 to 5 round trips)	
Type of assistance	Field	Description
Grant Aid	Civil engineering	Improve civil engineering and track maintenance (Limete Station–Aéroport Station)
	Signaling	Install three level crossing warning devices (see Table 4-11)
	Rolling stock	Repair passenger cars
	Station	Renovate existing station buildings or construct new ones (5 intermediate stations) Upgrade station buildings (2 terminal stations) (See Table 4-12)
	Station plaza	Upgrade station plazas (2 terminal stations) (See Table 4-12)
Technical Cooperation Projects	Track	Support maintenance and management
	Rolling stock	Support maintenance and management
	Passenger service	Improve the quality of passenger services

Source: JICA Study Team

4.6.2 Track

(1) Project for the Rehabilitation of Track

1) Roadbed

Roadbeds must have the function to ensure safe train operation. To achieve this, high quality soil must be used as compact material so that the roadbeds will have sufficient bearing capacity.

There are various types of roadbeds, including concrete, asphalt, and crushed stone roadbeds. For this project, the crushed stone roadbed is preferred, considering the availability of materials, workability, etc. The construction should be scheduled to avoid the rainy season in order to prevent changes in water content during spraying of the crushed stones.

There is no record on the construction of the roadbed when the Airport Line was built; therefore, it is not possible to find out the condition of the roadbed at that time. However, based on the condition of the collapsed embankment, probably not much attention was paid to the selection and compaction of roadbed materials. For this reason, the roadbed must be re-compacted using a road roller after the current tracks and fills have been removed.

The design standards for railway structures, etc. (earth structures), which are the design standards used in Japan, require K30 ≥70 MN/m3 at a minimum, since K values are used as the standards for managing the construction of roadbeds. Figure 4-65 shows the maintenance of roadbed and Figure 4-66 shows the density test by sand replacement after the roadbed is compacted.

Source: JICA Study Team

Figure 4-65 Example of Roadbed Maintenance

Source: JICA Study Team

Figure 4-66 Example of Roadbed Test

1) Embankment (Low Embankment)

The embankment material used currently for the Airport Line has a large amount of sand and a uniform grain size. A dense embankment can only be formed with materials that have an appropriate distribution of particle sizes. For this reason, the current embankment materials at the low embankment sections shall be removed as much as possible and the embankments shall be reconstructed.

Soil shall be used as the material for rebuilding the embankment because it is easy to spread and compact, has high strength after compaction, and has little compressibility. It is preferable to use soil that is resistant to erosion by rainwater, and has a low swelling property after absorbing water. Gravel soil is preferred as it has a good distribution of grain sizes (soil particles have a wide range of grain sizes).

The basic criterion for design calculation is a structure that does not have any stability or subsidence problem.

The construction plan shall take into account the condition of the bearing ground, embankment material, weather conditions, and construction machinery. In general, the embankment material is rolled out every 30 cm, and rolling compaction is repeated to build an embankment.

2) Embankment (Regular Embankment)

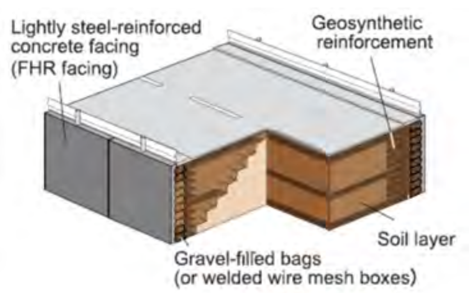
It was found during the survey that many of the decayed fills collapsed due to drainage problem and rainwater. Measures shall be taken to prevent water infiltration and to install proper drainage before the high embankment is rebuilt.

The embankment can either be reconstructed or be rebuilt using girders. With the girder method, abutments must be constructed first. Such construction is difficult at this time because considerable road width is required to bring heavy machinery to the site to construct the abutments and arrange the heavy machinery for the construction of girders. The reconstruction method is more feasible since an embankment had originally been constructed there.

When reconstructing the embankment, measures shall be taken to prevent the fills from collapsing and to drain the water. Use of anchors, use of better filling materials, and use of reinforced soil with planar reinforcement (e.g. geotextile) are methods to prevent the collapse of fills. Among them, the method that uses planar reinforcement to fortify earth construction is preferred because the surrounding environment does not allow the use of heavy machinery. The reinforced earth construction method is preferred in areas where the soil has collapsed due to rainfall, etc., even in areas with low filling.

Figure 4-67 is a summary of the reinforced earth construction method. It is an example of the Reinforced Railroad with Rigid Facing-Method (RRR-B) method, which combines planar reinforcement with cast-in-place concrete walls (integral wall with high flexural stiffness). The RRR method is a reinforced soil retaining wall method developed as an alternative to the conventional retaining wall method. The reinforced soil retaining wall construction of the embankment is called the RRR-B method. This method is also widely used as a disaster recovery method. All the RRR-B retaining walls that had been built in the damaged areas were intact even after the Great Hanshin-Awaji Earthquake in 1995 and the Great East Japan Earthquake in 2011. The overall strength is achieved by combining the planar reinforcement with a lattice frame, according to the site condition.

Figure 4-68 gives an example of the planar reinforcement.



Source: Materials from the 3R Method Association

Figure 4-67 Reinforced Earth Method (RRR-B Method)

Source: Maeda's Website

Figure 4-68 Geotechnics for Earth Filling and Ground Reinforcement

1) Track

Rails, railway sleepers, and other railway materials shall be removed temporarily and reused if possible. Parts that are partially damaged shall be replaced with new track materials from SCTP supplies. Some damaged rails and railway sleepers can also be reused as earth retaining materials. The construction plan shall schedule the delivery of ballast from SCTP supplies in accordance with the progress of railway construction.

After the roadbed and embankment have been constructed, ballast is added. After the ballast has been filled to the required thickness, sleepers and rails are installed. Then, the ballast is compacted and the track is restored (see Figure 4-70). Since the hopper cars can only enter from the Limete Station side, construction between Limete Station and Tshenke Station shall be prioritized.

Railway cranes, crane trucks, and other equipment are needed for the removal, loading, and unloading of rails and railway sleepers. The other track work is mainly done manually. The hand tie tamper and rail jack are the main components of ballast compaction. Such basic equipment for railway construction shall be prepared in advance.

Source: JICA Study Team

Figure 4-69 Hopper Cars with Ballast

Source: JICA Study Team

Figure 4-70 Compaction of Ballast

1) Wastewater Treatment

The current Airport Line has many areas where the water is stagnant or not drained. The surface of the construction base throughout the entire line shall be higher than the surrounding areas to prevent water from entering the track. It is important to construct drainage channels, taking into account the drainage gradient, and follow through with final treatment.

The slope surface shall be protected to prevent rainwater from penetrating into the embankment area as much as possible. Structure to discharge the water in the embankment shall be considered.

In areas where there are residential houses next to the railway line, no measures have been taken to prevent domestic wastewater from flowing onto the track. Drainage systems shall be installed at residential and commercial districts not only for the sake of the railway but also from the viewpoint of urban planning.

Regarding final treatment, it is common to drain wastewater into the river that intersects with the railway or into a large sewerage system. A drainage plan shall be formulated by studying the crossing rivers and sewerage facilities in conjunction with the longitudinal plan of the entire railway line. Figure 4-71 shows the construction of a drainage channel and Figure 4-72 shows the drainage channel after the construction.

Source: JICA Study Team

Figure 4-71 Construction of Drainage Channel

Source: JICA Study Team

Figure 4-72 After Construction of a Drainage Channel between Tracks (Double Track)

1) Slope Protection

Slope protection is carried out to protect the slope of the embankment fills and cut soil from being eroded by rainwater. Various types of slope protectors are used. Broadly speaking, vegetation protector that uses vegetation, structural protector that uses concrete or other materials, and combinations of these protectors are used. In the case of vegetation, weeding is necessary to keep the grass from becoming overgrown.

The Airport Line under consideration has low embankment sections that are next to residential areas and regular embankment sections that have collapsed. There is evidence that the embankment materials in some low embankment sections have been stolen. Since it is not possible to know the current state of the collapsed embankment section where the garbage has accumulated until after the garbage has been removed, the reinforced soil retaining wall method explained in 3) above is being considered, rather than slope protection. The optimal slope protection method for the low embankment sections of the Airport Line is explained below.

In general, slope protection work is not carried out for areas with low embankments but instead vegetation is allowed to grow. However, because the embankment material has been stolen from the Airport Line, protective construction is necessary to prevent theft. In this case, spraying or concrete block construction is considered appropriate because such method is inexpensive and can be done quickly and easily. Figure 4-73 is an example of the spraying work, and Figure 4-74 is an example of the concrete block work.

Spraying is performed by spraying mortar concrete onto the slope surface with compressed air using a spraying machine. As a general construction procedure, a diamond-shaped wire mesh, called a lath, is fixed to the slotted surface after cleaning to prevent cracking or peeling of the concrete and then the mortar concrete is sprayed. The mortar concrete is blended with the plant yard on site and pumped through the delivery hose onto the slope surface.

When constructing with concrete blocks, concrete blocks made in the concrete mill are laid on the slope using stretcher for protection.

Both construction methods will require the installation of drainage pipes.

Source: JICA Study Team

Figure 4-73 Example of Spraying Work

Source: JICA Study Team

Figure 4-74 Example of a Concrete Blocker

1) Platform

It is conceivable to use a girder-type platform in which concrete panels are arranged using H-shaped piles, given the availability of materials and workability.

The embankment slide platform is generally easier and cheaper to construct than the girder-type platform. Therefore, the embankment slide platform is selected.

After sufficiently compacting the roadbed, which is the foundation of the platform, base bricks are stacked into a four-sided frame. The platform is constructed by placing concrete panels that serve as the platform floor surface or placing concrete directly onto the soil after it is compacted into the bricks.

The maximum length of the platform shall be +10 m to accommodate the longest train, and the height of the platform shall be adjusted so that it will be 1100 mm from the rail level to the top of the platform. Figure 4-75 shows the construction of the embankment platform, and Figure 4-76 is an example of the embankment slide platform after it is completed.

Source: JICA Study Team

Figure 4-75 Platform Brick Stacking

Source: JICA Study Team

Figure 4-76 Completed Embankment Slide Platform

4.6.3 Signaling system

Adoption of railway crossing warning devices is proposed in consideration of future increase in the number of trains in operation and improvement in safety for road transport. Table 4-11 shows the plan for introducing the railway crossing warning system.

Table 4-11 Plan for the Introduction of Level Crossing Warning Devices

Item	Plan overview
Basis of selection	Selection of level crossings with high road traffic volume upon consultation with SCTP
Specification	Installation of level crossing warning devices and barriers
Level crossings being considered (draft)	(1) PK360+600 from Matadi Station (24 m wide) (2) 200 m from the above-mentioned point (8 m wide) (3) PK0+100 from Limete Station (16 m wide)
Train approach information	Level crossing guard obtains train approach information from neighboring stations using the current dedicated radio communications system.
Function of level crossing guard	Manually operate the alarm devices and level crossing barriers
Incidental work	Construction of level crossing huts and civil engineering work to improve level crossings
Securing power supply	Installation of a dedicated small generator due to unstable power supply from the electricity authority

Source: JICA Study Team

Source: JICA Study Team

Figure 4-77 Locations of Level Crossing Improvement

Source: JICA Study Team

Figure 4-78 Example of Level Crossing Alarm Device

4.6.4 Rolling Stock

(1) Procurement of Rolling Stock

1) Increase Transportation Capacity using Existing Passenger Cars

Manufacturing new vehicles in Japan or in a third country will increase the cost significantly. For this reason, use of passenger cars currently owned by SCTP is being considered. For example, it is possible to convert the passenger cars for long-distance service into passenger cars for commuter service; however, SCTP indicated that it is not possible to redirect vehicles designated for current services.

If it is not possible to obtain passenger cars by changing the scheduling of rolling stock, it is possible to repair the out-of-order passenger cars locally and use them for the Airport Line. There is information that nine passenger cars will be available after repairs. The passenger cars are of multiple types. The old ones were manufactured in the 1950s. Main repair items include cracks on the floor, damage to the car body, bogies needing maintenance, and so on. The repairs will require bogie parts, car body repair materials, and tools for processing, welding, and painting, etc. Assistance in the forms of repair equipment and advice on repairs is needed.

2) Increase Transportation Capacity using Secondhand Rolling Stock from Japan

Donation of secondhand diesel locomotives from Japanese railway operators is being considered. SCTP welcomes the idea of accepting secondhand rolling stock from Japanese railway operators. The transfer of secondhand rolling stock shall be implemented under a separate project different from the grant aid project for improving railway facilities and repairing passenger cars.

3) Procure New Rolling Stock

If it is difficult to find suitable secondhand rolling stock or spare parts, or repair existing passenger cars locally, it is necessary to consider the procurement of new rolling stock, taking into account the resumption of passenger transportation on the Airport Line and long-term operation in the future. While this option is more expensive, it is also more advantageous. It will be easier to procure spare parts and new rolling stock has longer service life than the secondhand ones. Even if secondhand rolling stock can be obtained, procurement of new rolling stock shall be considered in parallel in the future to ensure continuous improvement of passenger transport.

(2) Support for the Maintenance and Management of Rolling Stock

Given the rolling stock maintenance condition at SCTP, a technical cooperation project is proposed to facilitate the maintenance of secondhand rolling stock. Using the Myanmar case as reference, support shall be provided so that SCTP can maintain and manage the rolling stock on its own after the transfer. The first step is to improve the maintenance work environment at the car depot and provide basic technical training so that daily maintenance can be carried out. The technical cooperation project for the maintenance and management of secondhand rolling stock premised on its transfer is summarized below.

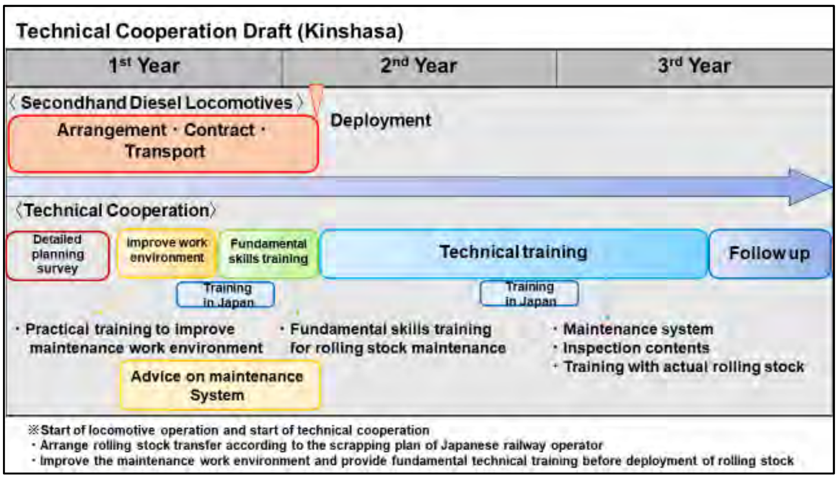
1) Transfer of Secondhand Rolling Stock

- The transfer of at least two diesel locomotives owned by Japanese railway operators is assumed. According to the timing of the scrapping plan, the rolling stock will be arranged, contracted, transported, and put into service once delivered.
- Spare parts shall be supplied at the same time as the transfer of locomotives. If spare parts are difficult to procure, it is desirable to have a spare for each locomotive to secure the spare parts. For example, if 3 locomotives are to be transferred, 6 locomotives shall be delivered.
- A detailed survey shall be conducted to find out about the towing and operation of SCTP passenger cars.

2) Implementing Technical Cooperation Project for Maintenance

The technical cooperation project for the maintenance and management of rolling stock shall start before the secondhand rolling stock is deployed. The maintenance personnel shall have acquired a certain level of basic technical capability when the service starts. It is also important that technical training specific to the type of rolling stock be provided at the same time when the rolling stock goes into service. In conjunction with the above guidance, it is desirable to advice SCTP on its maintenance system, etc.

- Figure 4-79 shows the schedule of 3 year project for transferring the rolling stock.
- Improvement of the maintenance work environment and basic technical guidance shall be completed before the rolling stock is deployed.
- After the locomotives are put into service, guidance on the inspection system and details of inspection shall be provided, on-the-job training shall be carried out using the actual locomotives, and a system shall be put in place to ensure that maintenance is carried out on a continuous basis.
- Experts shall not be dispatched on a long-term basis. After training is provided for several weeks, a certain voluntary improvement period shall be set up.



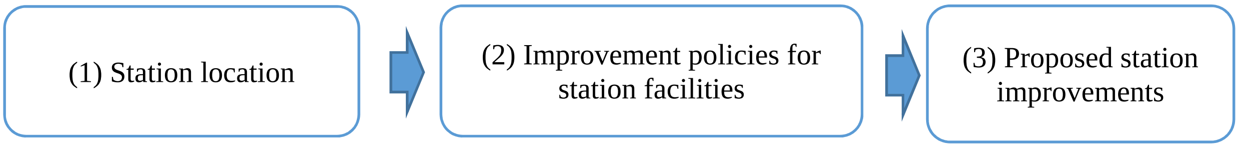
Source: JICA Study Team

Figure 4-79 Schedule of Technical Cooperation Project

- This Study was conducted in six countries. If similar technical cooperation projects were to be implemented in multiple countries, the expert team would not be dispersed, but rather, the same team would take part in the technical cooperation projects. Under such circumstances, it is important to coordinate the schedules to avoid the deployment of rolling stock at the same time.

4.6.5 Station

Based on the project plan submitted, the improvement plan was reviewed according to the following process flow.



Source: JICA Study Team

Figure 4-80 Steps in Reviewing Station Improvements

(1) Improvement of Stations

Since the Airport Line is currently out of service, the priority will be to resume operation. Station improvement will focus on the development of "minimum facilities that can be used safely by users." Specifically, the construction of station buildings and platforms shall be considered.

(2) SCTP New Station Installation Plan and Improvement Policy

As shown in Figure 4-81 below, SCTP is considering the construction of three stations (Petro Congo Station, PKTL Station, and Bandara Station). As mentioned earlier, there are signs and remnants of some station facilities of the former stations at the Petro Congo Station and Bandara Station sites. However, the stations are gone due to theft and other reasons. During the field survey, it was determined that the Petro Congo Station will be included in the improvement plan because shops and houses are nearby and demand is expected to be high. It is also easy to secure a site for the construction of a station building.

Source: JICA Study Team

Figure 4-81 Station map of Airport Line (Including the SCTP New Station Plan)

(1) Improvement Policies for Stations

Improvement policies were reviewed for the stations on the Airport Line, taking into consideration the location of each station. Table 4-14 shows the improvement policies for each station.

1) Development of Terminal Stations

The current facilities of the two terminal stations (Kinshasa Est Station and Aéroport Station) shall be repaired because the station buildings, platforms, and platform roofs have been constructed to some extent.

2) Rebuilding of Existing Intermediate Stations

The four intermediate stations (N'dolo, Funa, Limete, and Tshenke stations) already have station buildings, but they do not have facilities for passengers such as ticket sales counters. The existing station buildings shall be reconstructed to install passenger facilities. Since the existing station buildings also function as SCTP staff housing, SCTP shall be consulted when developing detailed specifications for the station buildings.

3) Construction of New Petro Congo Station

Among the new stations planned by SCTP, the Petro Congo Station will be constructed. The PKTL Station has limited areas around the railway line, it will not be possible to secure sufficient land for constructing a new station. Bandara Station and its vicinity are located inside the N'djili International Airport, making it impossible to secure land for a new station.

Table 4-12 Station Improvement Policies

Station name	Station building	Platform	Platform roof	Transit facilities	Remarks
Kinshasa Est	Repair	Reconstruction	No construction required	Reconstruction	
N'dolo	Reconstruction	New construction	-	-	
Funa	Reconstruction	New construction	-	-	
Limete	Reconstruction	New construction	-	-	
Petro Congo	New construction	New construction	-	-	New station
Tshenke	Reconstruction	New construction	-	Install signage	Passing siding available
Aéroport	Repair	Reconstruction	New construction	New station plaza	

Source: JICA Study Team

1) Station Development to Enhance Accessibility

The stations shall be developed to meet the needs of various users, including the elderly and people with disabilities. Ramps and other facilities shall be installed on station premises. Figure 4-82 is an example of the minimal facilities required to ensure accessibility to the station.

Source: JICA Study Team

Figure 4-82 Development of an Accessible Station

4.6.6 Station Plaza and Transit Facilities

(1) Details of Improvements

The improvement plan will be formulated with focus on the three areas explained below, taking into consideration the station facilities and transport networks. The content, schedule, and effects will be determined as improvement measures of the grant aid project.

1) Pavement

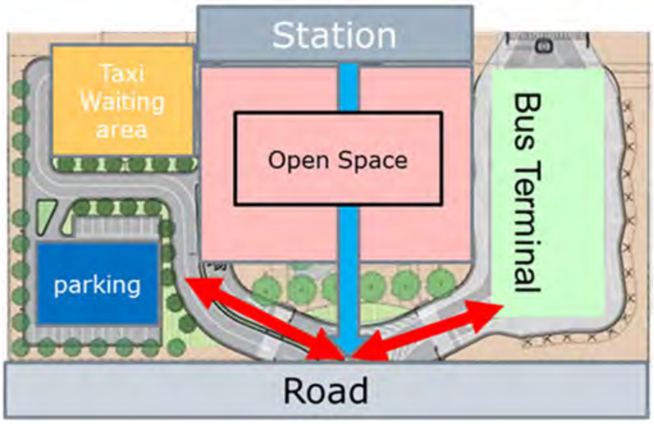
- Functionality as a station plaza
- Land use distinction and site boundaries (bus terminals, parking lots, boarding areas, etc.)

2) Transit Function (Kinshasa Est Station, Aéroport Station)

- Enhance the convenience to transfer from railway to other transportation modes
- To facilitate movement within transit facilities

3) Level of Demand

- Balance with station usage (number of future passengers)



Source: JICA Study Team

Figure 4-83 Basic Image of a Station Plaza

(1) Improvement Plan

It was found during the field survey that the Kinshasa Est Station is already functioning as a transit station. In addition to strengthening its transit node function, the Tshenke Station and Aéroport Station should also develop transit facilities, in anticipation of their future function as transit nodes. When constructing the station plaza, the site should be paved to demarcate the boundaries.

1) Kinshasa Est Station

The two existing bus stops and taxi stand will be reconstructed. Detailed discussions with Transco and others are necessary.

2) Tshenke Station

A minibus terminal is located near the station. When the construction of the station building starts, signs should be put up to make it easier to transfer between the railway and the minibus.

3) Aéroport Station

A region on the eastern side of N'djili International Airport, such as the Maluku district, has rapidly growing population. When the Aéroport Station has developed transit facilities and when these areas are connected to the station via bus lines, ridership of the Airport Line will increase. As shown in Figure 4-84, the Aéroport Station has sufficient land for the construction of a station plaza. Therefore, a station plaza shall be developed to enhance the convenience of transfer between trains and buses. N'djili International Airport has four Transco bus lines.

Source: Prepared by JICA Study Team based on Open Street Map

Figure 4-84 Planned Aéroport Station Plaza

(1) Coordination with Related Parties

Development of a station plaza and its transit node functions requires coordination not only with the railway operator but also with various stakeholders, including the land owners and operators of the connecting public transportation means. During the interview, Transco was open to reviewing and changing its routes. As the development project progresses, the connecting bus routes should be worked out in detail with Transco and other related parties.

(2) Improving Guidance for Users

It is desirable that the railway operator provide users with information on connection with other means of transportation. For example, the station can put up signs indicating the locations of bus stops near the station or a route map in the train showing the bus route connections at each station.

(3) Improving the Quality of Passenger Services

JICA has helped improve the quality of passenger services in urban transport through technical cooperation projects in many countries. In this context, assistance will be provided for the displaying of information about railway stations and creating bus route maps. For example, the technical cooperation projects in Myanmar included the "Railway Safety and Service Improvement Project" (2013–2015) and the "Railway Vehicle Maintenance and Management Improvement Project" (2017–Present), which provided training for local railway station employees and crewmembers, and supported the improvement of passenger services. Implementing similar technical cooperation projects at SCTP will help further disseminate Japan’s high-quality railway passenger services overseas.

4.7 Improvement-related Issues

4.7.1 Track

Interviews were conducted with SCTP and other relevant organizations regarding improvements. The following are issues related to tracks.

(1) Procuring Materials

According to interviews with SCTP, ballast can be produced at a quarry in Kiasikolo, which is about 150 km from Kinshasa city. The heavy machinery and equipment for producing crushed stones are all available; however, electricity is supplied for only four hours a day. Procurement of explosives remains an issue.

On the other hand, SCTP has nine ballast transporting vehicles (see Fig. 4-69 Hopper cars), including an open wagon, and can secure locomotives for transportation. Use of ballast transporting vehicles may become a critical part of the construction process. In some cases, a side track may need to be installed to give priority to passenger trains on the route from the crushed stone factory to the construction sites and multiple locomotives may be used to split the transportation of ballast.

(2) Securing Storage Site and Construction Space

It will probably be difficult for Japanese companies to prepare a material stockyard, but SCTP indicated that it could secure the material stockyard.

When excluding the area from the graveyard entrance to close to the N'djili International Airport, it is difficult to secure space for construction on the Airport Line because it has a long section with houses nearby. For construction purpose, at least 5 m on both sides of the track should be secured. After completion of the construction, the space can be developed into sidewalks along the railway track.

(3) Cooperation with Kinshasa City and SCTP

The cooperation of Kinshasa city and SCTP in removing the obstacles and garbage is indispensable. The removal of obstacles often cannot be achieved easily due to circumstances specific to the countries and vested interests. Failure to obtain the understanding of local residents will not only have a major impact on the construction schedule but may also lead to the failure of the entire project. It is necessary to keep close communication with Kinshasa city and SCTP and exchange information when implementing the project.

4.7.2 Signaling system

(1) Confirming Sites for the Installation of Level Crossing Warning Devices

The locations of level crossings are identified through interviews. It is necessary to find out if there is sufficient space for the installation of level crossing warning devices, land use classification, and land ownership in detail.

(2) Division of Civil Engineering, Construction, and Signaling Work

The installation of level crossing warning devices requires a variety of construction work, including the construction of level crossing buildings and equipment rooms, level crossings, and signals. The division of construction work between the Japanese contractors and local contractors shall be determined. The construction of level crossing buildings, equipment rooms, and level crossings will be outsourced to local contractors.

(3) Confirming the Maintenance and Management System

After reviewing the current maintenance and management system, a new maintenance and management system shall be set up after the level crossing warning devices have been installed.

4.7.3 Rolling Stock

(1) Securing Passenger Cars

According to SCTP, there are currently no passenger cars that can be used for passenger transport on the Airport Line after it has been restored, and it is also not possible to make operational changes to spare any passenger cars. It is difficult for SCTP to get the budget to repair the existing passenger cars. However, there is information that parts can be produced locally or purchased from suppliers, and repair work can be done at the passenger car factory in Limete if the necessary parts are available. Although the Study Team has a general idea about the rolling stock, including the necessary materials, and costs, a detailed survey shall be conducted to formulate a repair policy.

(2) Secondhand Rolling Stock

The availability and timing of the rolling stock transfer is dependent on the rolling stock scheduling plans of the Japanese railway operators. For this reason, development of a tailored support plan is necessary. The medium- and long-term rolling stock operation plan of the Japanese railway operators, the medium- and long-term plan of SCTP, and Japan’s support plan shall be considered in a comprehensive manner.

The supply of parts shall be considered in conjunction with the rolling stock transfer. Parts for old rolling stock shall be investigated because some parts may have been discontinued. The question is whether the necessary parts can be secured at the same time as the rolling stock transfer. It is advisable to transfer more than one unit, not only for operation but also for the purpose of securing spare parts. However, the cost of shipping has risen significantly due to high fuel cost and other factors. The rolling stock currently operate in Japan was manufactured many years ago and it will be used in an environment different from the one in Japan. Under such circumstances, it is important to determine the number of vehicles, spare parts, and costs required.

(3) Improvement of the Maintenance and Management System

A detailed survey of the site conditions, including the maintenance system and facilities, and the management system, shall be conducted. A support plan shall be formulated in conjunction with the rolling stock transfer schedule.

The Limete depot, which conducts daily inspection of locomotives, has power shortage and drainage problem currently. However, SCTP has worked out plans with local companies to secure power and improve drainage facilities.

4.7.4 Station

(1) Fare Collection System

According to SCTP, fare evasion was rampant. This could have been one of the causes that led to the suspension of operation. Therefore, when train operation resumes, the fare collection system shall be upgraded, such as selling tickets at a station counter.

(2) Station Staffing System

Passenger facilities at stations, such as ticket sales at a station counter, requires staff to manage the facilities. Setting up a station staffing system is necessary.

4.7.5 Station Plaza and Transit Node

(1) Contents of Development and Maintenance/Management System

Working out a common understanding with SCTP and other concerned parties regarding land acquisition and usages in the development of station plaza is important. For the development of station plazas in front of Kinshasa Est and Aéroport stations, it is necessary to verify the available sites for station plaza development and review the contents of development to ensure that they will bring significant benefits as transit nodes. In addition, a maintenance and management system will be necessary when the station plazas are developed in the future.

(2) Guidance for Users

The low levels of SCTP fare collection and passenger guidance have contributed to losses in demand and revenues. Since it is currently difficult to implement any fundamental changes involving secondary transportation such as buses, SCTP can take initiatives such as by improving passenger guidance at the stations. SCTP shall develop a vision for its passenger services, using Japanese passenger services for reference.

4.8 Condition of Sections Currently in Service

4.8.1 Test Ride on Matadi Line in Kinshasa and Suburban Section

Currently, SCTP operates only between Kinshasa Est and Kasangulu stations. Although the target route of this Study is the Airport Line, the Study Team surveyed the tracks from Kinshasa Est Station to Kasangulu Station on the Matadi Line and the current state of station facilities at each of the Matadi Line stations. The Study Team requested to ride a regular SCTP commuter train but it was not allowed for safety reason. SCTP arranged a special train from Kinshasa Est Station to Kasangulu Station on Sunday, April 24, 2022 since the regular SCTP trains do not run on weekends.

Table 4-13 shows the departure and arrival times of the special train at each station. There was an inflow of earth and sand between Lemba Station and Kimwenza Station. The train had to stop at several stations for more than an hour to wait for the cleanup.

The train was composed of a Japanese diesel locomotive and four suburban passenger cars currently in service.

Table 4-13 Test-ride between Kinshasa Est Station and Kasangulu Station

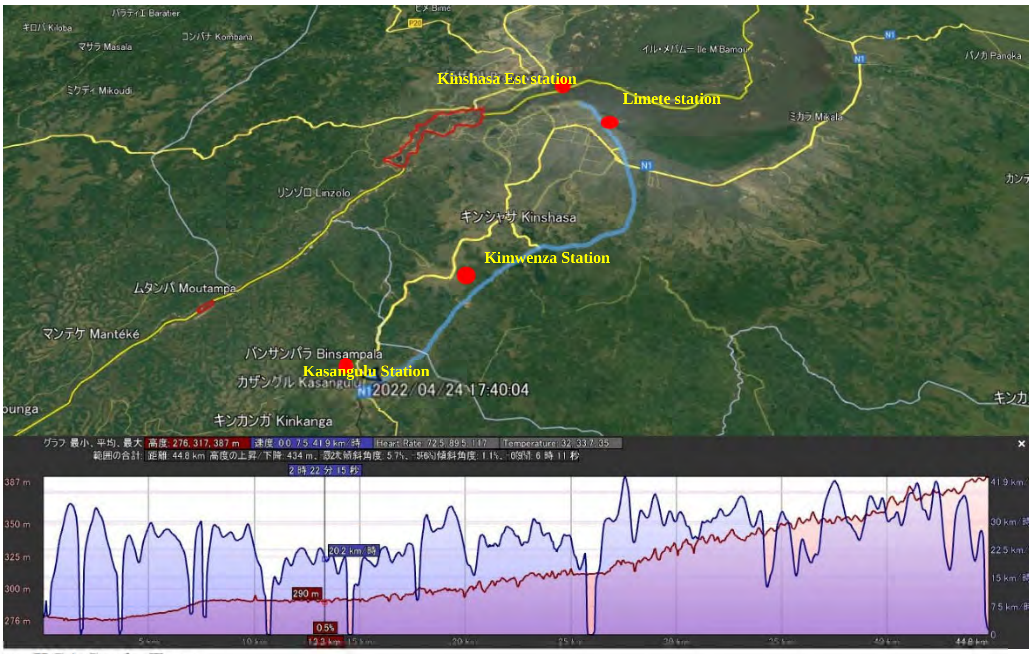
Station name	Kinshasa Est	N'dolo	Funa	Limete	Matete	Lemba	Kimwenza	Kasangulu
Arrival	-	9:47	9:58	10:14	10:25	12:05	14:18	15:35
Departure	9:40	9:52	10:04	10:15	11:52	13:48	14:55	-

Source: JICA Study Team

4.8.2 Current Track Condition between Kinshasa Est Station and Kasangulu Station on Matadi Line

(1) Measured Data and Results

Position data was collected using GPS during the train ride from Kinshasa Est Station to Kasangulu Station. Figure 4-85 is a picture of the train's trajectory and measured GPS data shown on the Google Earth image.

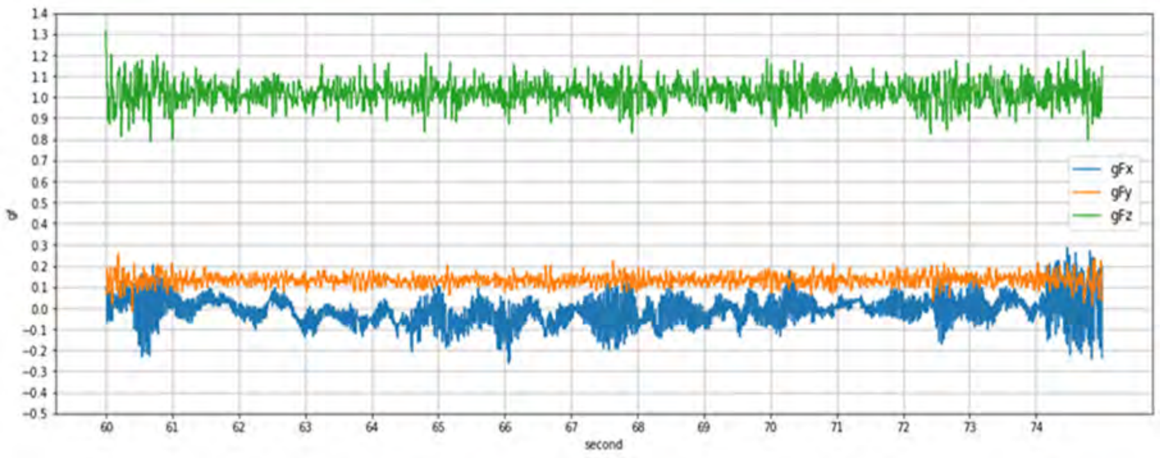


Source: JICA Study Team

Figure 4-85 GPS Data from Kinshasa Est Station to Kasangulu Station

The light blue line in the map in Figure 4-86 is the trajectory of the train taken by the Study Team. The two graphs at the bottom show the distance on the horizontal axis (left end at Kinshasa Est Station and right end at Kasangulu Station). The blue line on the vertical axis indicates the train speed, and the red line indicates the altitude. The blue line shows speeds up to 41.5 km/h. When the train stops at the stations, the speed drops to 0 km. The red line is inclined upward from Kinshasa Est to Kasangulu. After the Kinshasa Est Station, the train runs in a section with little gradient until after 20 km where the slope grows larger and steeper as it approaches Kasangulu Station. At Kasangulu Station, the error from this measurement was about 15 m because the indication at the station was 402 m above sea level.

A portable oscillation acceleration device was installed in the rearmost car of the train to measure acceleration during the train operation as a way to show the ride comfort of the train. This data provides an estimate of not only the ride comfort of the train but also the track condition. The oscillation acceleration is expressed in units of gravitational acceleration g (m/s2), indicating that the larger the value, the larger the shaking becomes, and the less comfortable the ride is. The direction of gravitational acceleration is X (right and left), Y (back and forth), and Z (up and down). Figure 4-86 is a graph of the oscillation acceleration with the exception of abnormal values.



Source: JICA Study Team

Figure 4-86 Oscillation Acceleration Data from Kinshasa Est Station to Kasangulu Station,

Figure 4-86 shows the measurement time on the horizontal axis and the acceleration on the vertical axis. The measurement time on the horizontal axis is a simple representation after the data on the time when the train stopped are deleted. The blue line on the graph indicates the horizontal direction (X), the orange line indicates the longitudinal direction (Y), and the green line indicates the vertical direction (Z). For X and Y, 0.0 g is used as a reference, and 0.15 g is shifted to make the orange line easier to see.

The greater the amplitude, the greater the oscillation. Generally, pitch (Z) and roll (X) are used as indicators for ride comfort. When the deflection width is 0.3 g or more, there is a possibility that the track is displaced, or it is often a change point in the track or structure such as a turnout, level crossing, bridge, etc. The overall range is 0.3 g, so if the vehicle runs at the maximum speed of 41.5 km/h or less, the ride comfort will not be greatly affected. However, if the speed is to be increased, the shaking width will be larger and track improvement will be necessary. Since some parts in certain sections have almost no ballast, it is important to focus track improvement especially on these areas, using the data of oscillation acceleration as guidance.

(2) Track Condition

The distance between Kinshasa Est and Kasanguku is approximately 45 km, and the track condition varies depending on the conditions of the surrounding areas. The Airport Line and the Limete Station, which is the service section, are close to private homes. Since there are many residential facilities around Limite Station, some domestic wastewater flowed into the station premises, and many areas of the station have poor drainage. The track sections with no dwellings nearby are overgrown with vegetation. It was confirmed that the roadbeds are not sufficiently compacted. Besides adding ballast to restore the tracks in the future, the roadbeds shall be compacted sufficiently underneath the ballast to prevent water from flowing into the station premises and a drainage system shall be installed. Figure 4-87 shows water flowing into the turnout and Figure 4-88 shows grass growing on the track.

Source: JICA Study Team

Figure 4-87 Turnout Submerged in Water

Source: JICA Study Team

Figure 4-88 Grass Growing on Track

Similar to the Airport Line, the Matadi Line was also found to have trash disposed of on the track. Because the trains are in operation, the volume of trash is small. Mobile vendors could be seen nearby, posing a danger to train operation. Measures shall be taken to prevent people from entering the track. Figure 4-89 shows trash being disposed of on station premises, and Figure 4-90 shows the sales of goods next to the railway track.

Source: JICA Study Team

Figure 4-89 Trash on Railway Track

Source: JICA Study Team

Figure 4-90 Vendors Near Railway Track

There were fewer houses once the train left the busy streets. The edges of some sleepers have broken off in some sections of the Matadi Line where trains operate and no countermeasures have been taken to remediate the slopes. During our train ride, the train had to stop for more than an hour due to the inflow of earth and sand. Some other areas also seemed to have inflow of soil and sand. Not enough maintenance seems to have been carried out to prevent disasters. Figure 4-91 shows the condition in which the edges of the sleepers have collapsed, Figure 4-92 shows the slope close to the railway line, and Figure 4-93 and Figure 4-94 show the condition in which a large amount of soil and water flowed in.

Source: JICA Study Team

Figure 4-91 Sleepers with Collapsed

Source: JICA Study Team

Figure 4-92 Slopes Next to Track

Edges **Overgrown with Vegetation**

Source: JICA Study Team

Figure 4-93 Track Submerged by Earth and Sand

Source: JICA Study Team

Figure 4-94 Track Submerged by Water is No Longer Visible

There were many so-called level crossings set up by residents. These level crossings were not set up by the railway operator or road administrator, but by local residents for the convenience of crossing the track. Because they pose danger to safe train operation, these level crossings must be either constructed into regular level crossings, integrated with other level crossings, or removed in the future. Figure 4-95 shows the condition of a level crossing in the suburb. There are also level crossings in the suburbs without level crossing plates. Such level crossings are dangerous because they may cause train derailment. Level crossings intersect with roads should have level crossing plates. Figure 4-96 shows a level crossing without level crossing plates.

Source: JICA Study Team

Figure 4-95 So-called "Level Crossing" Set Up by Residents

Source: JICA Study Team

Figure 4-96 Level Crossing Without Level Crossing Plates

Ballast has been added to the track in some sections, restoring the track to a shape closest to its original structure. If the restoration and maintenance are carried out properly, SCTP has shown to be capable of maintaining the tracks on its own. A maintenance vehicle was seen on the premises of Kasangulu Station. Although there were no large railway maintenance machines, periodic inspections seem to have been carried out. Track maintenance is probably being carried out on a regular basis, as no significant track deformation was detected visually overall. Therefore, if effluent treatment and disaster prevention measures are implemented, the tracks can be strengthened and the train speed can be increased in the future. Figure 4-97 and Figure 4-98 show the track on which ballast has been added and the maintenance vehicles, respectively.

Source: JICA Study Team

Figure 4-97 Track after Laying of Ballast

Source: JICA Study Team

Figure 4-98 Maintenance Vehicle

4.8.3 Current State of Stations between Matete Station and Kasangulu Station on Matadi Line

There are four stations on the Matadi Line from Matete Station to Kasangulu Station. From Kinshasa Est Station, there are the Matete Station, Lemba Station, Kimwenza Station and Kasangulu Station.

(1) Current State of Station Facilities

Table 4-14 summarizes the current station facilities.

Table 4-14 Summary of Station Facilities in the Section between Matete and Kasangulu Stations on Matadi Line

Station name	Station building	Platform	Platform roof	Remarks
Matete	○	×	○	Fence around the station building
Lemba	○	○	×	
Kimwenza	○	○	×	
Kasangulu	○	○	×	

Source: JICA Study Team

1) Station Facilities

Every station has station building. Similar to the intermediate stations of the Airport Line, these stations do not have passenger service facilities, such as a ticket sales counter, in the station building. Unlike the intermediate stations in central Kinshasa, the Lemba, Kimwenza, and Kasangulu stations have platforms. The platforms are low in height, and steps are needed for passengers to get in and out of the trains. The platform had holes and puddles, similar to the condition at Kinshasa Est Station. On the other hand, Matete Station does not have any platform, but a roof covering the railway track where the trains stop.

Source: JICA Study Team
Figure 4-99 Premises of Matete Station

Source: JICA Study Team
Figure 4-100 Matete Station Building

Source: JICA Study Team
Figure 4-101 Premises of Lemba Station

Source: JICA Study Team
Figure 4-102 Lemba Station Building

1) Suburban Stations with Standardized Structures

The structures of the station buildings, platforms, and storage tracks at Kimwenza and Kasangulu stations are similar. The station building is located higher than the platform and track, and the station building and platform are connected by stairs. A storage track is on the opposite side of the station building. It is used to store passenger cars and maintenance vehicles.

Source: JICA Study Team
Figure 4-103 Premises of Kimwenza Station

Source: JICA Study Team
Figure 4-104 Premises of Kasangulu Station

1) Station Plaza and Connection with Other Transportation Means

Matete Station has a station plaza at the front, where a number of discarded cars are parked. The area in front of Lemba Station is a large market, bustling with people. Kimwenza Station and Kasangulu Station have a T-intersection in front and several small shops.

As mentioned above, the Study Team rode the special train on a Sunday when there were no trains, buses, or other forms of public transportation in service. It was confirmed that there were spaces in front of the stations for station plaza development.

Source: JICA Study Team

Figure 4-105 Area in Front of Matete Station

Source: JICA Study Team

Figure 4-106 Market in Front of Lemba Station

4.9 Evaluation Indexes and Effects

Table 4-11 shows the effects from the restoration of the Airport Line and the resumption of services.

Table 4-15 Effects from the Restoration of Airport Line

Item	Effects	Description
1	Effects on service users	The effects on service users, i.e. railway users after restoration of the Airport Line, include direct effects of service improvement for transport service users, such as shortening travel time, alleviating congestion, and reducing transportation costs.
2	Effects on service providers (railway operator)	The effects on the railway operator, SCTP in this case, are increase in the number of users and increase in transportation revenues and expenses.
3	Effect on society as a whole	Railway projects are expected to have effects not only on users and providers, as shown in 1 and 2, but also on the society as a whole. Specifically, it can be subdivided into five categories, as shown in Table 4-18 below.

Source: JICA Study Team

Table 4-16 Evaluation Items and Effects on the Society from Restoration of the Airport Line

Evaluation items for effects on the society as a whole	Details
People' lives	Reducing traffic congestion by reducing road traffic, improving accessibility to regional hubs and wide-area transportation networks (airports and long-distance bus terminals) by developing railways, eliminating areas that lack public transportation systems, and improving convenience in daily life, etc.
Regional economy	Improving regional productivity by enhancing transportation convenience, increasing the potential locations and scale of businesses, and increasing the number of visitors to regions along the railway line
Local communities	Improving appeal as a residential area by increasing transportation convenience for businesses and commercial districts, resulting in an

	increase in residential population. Improving image of the region by making railways and stations symbols of the region
Environment	Reducing CO_2 emissions thanks to reduction in automobile traffic, shift from the use of automobile to railway, and restriction of new automobile users. Reducing NOx and SPM emissions on roads along the railway lines. Improving stations enhances the landscape of surrounding areas
Safety	Shift from automobile to railway use reduces the volume of automobile traffic and reduces traffic accidents. Installing level crossing facilities and safety facilities, such as fences, prevents accidents

Source: Prepared by JICA Study Team based on MLIT's Railway Project Evaluation Methodology Manual (revised in 2012)

(1) Effects on Service Users

1) Shorten Travel Time

The highway Rumumba Street, which connects Kinshasa to the suburbs, runs parallel to the Airport Line. It has serious traffic congestion throughout the day. Depending on the traffic congestion situation, it may take about three hours each way from the city center to the airport. On the other hand, when the Airport Line is restored, the travel time between the city center and the airport areas will be shortened to less than an hour.

2) Increase Operation Frequency

Although the Airport Line is not currently in service, the number of trains after restoration is expected to be five one-way trips per day per direction, resulting in a net increase of five round trips per day. Furthermore, the number of trips will be more than three times that of the 1.5 round-trips/day before the shutdown in 2015.

3) Reduce Transportation Costs

In Kinshasa, the railway fares are lower than the bus fares. Therefore, resumption of the Airport Line operation will reduce the transportation costs for many public transport users, thus contributing to the improvement in living standard.

(2) Effects on Service Provider (Railway Operator)

1) Growth in the Number of Users

When the Airport Line is restored, assuming that the same diesel locomotive as the one before the shutdown will haul eight passenger cars, the volume of transportation will be 1,200 passengers/train x 10 trains/day = 12,000 passengers/day, which will add up to about 4.4 million passengers annually. The current plan is premised on five round trips per day. However, if traffic signals and passing sidings are added, the number of trains can be increased and the number of users will increase in the future.

2) Increase in Transportation Revenues and Expenses

Increase in the number of Airport Line users will bring in higher revenues. On the other hand, train operation, and the inspection and maintenance of facilities and equipment, will incur expenses. Fare revenues will be generated as passenger numbers increase, but measures shall be taken to minimize fare evasion. Utilizing the surplus personnel who remain employed even after the Airport Line has suspended operations can help reduce cost to some extent.

(3) Effect on the Society as a Whole

1) People's Lives

As of 2021, the population of Kinshasa was about 14 million (Institute National de la Statistique: INS), and it is still on the rise. According to the Kinshasa Municipal Urban Transport Master Plan Project implemented by JICA, the population is projected to reach 24–27 million by 2040. Restoration of the Airport Line is expected to alleviate traffic congestion in the short term with the transfer of some road users to the railway. Specifically, since a minibus has capacity for about 15 people, an estimated 800 automobile traffic will be reduced per day. In the long term, however, the railway will shoulder some of the ever-increasing demand for transportation, thus preventing further deterioration of road congestion in the future.

The Airport Line connects the N'djili International Airport, one of the leading airports in the Democratic Republic of the Congo, with Kinshasa city. The Airport Line is expected to play an important role not only in transporting residents along the railway line but also in transporting people inside and outside of the Democratic Republic of the Congo. Smooth access between the city center and the airport improves user convenience over a wide area. Therefore, the Airport Line is expected to have a significant impact from the viewpoint of accessibility to wide-area and high-speed transportation facilities.

2) Regional Economy

Restoration of the Airport Line will facilitate movement in areas along the line and increase industrial productivity in the entire region. As a result, there will be more incentives for companies to relocate to the region and expand their businesses, leading to the expansion of economic activities. In particular, since this route is directly connected to the airport, it will strengthen the city's competitiveness in attracting foreign companies.

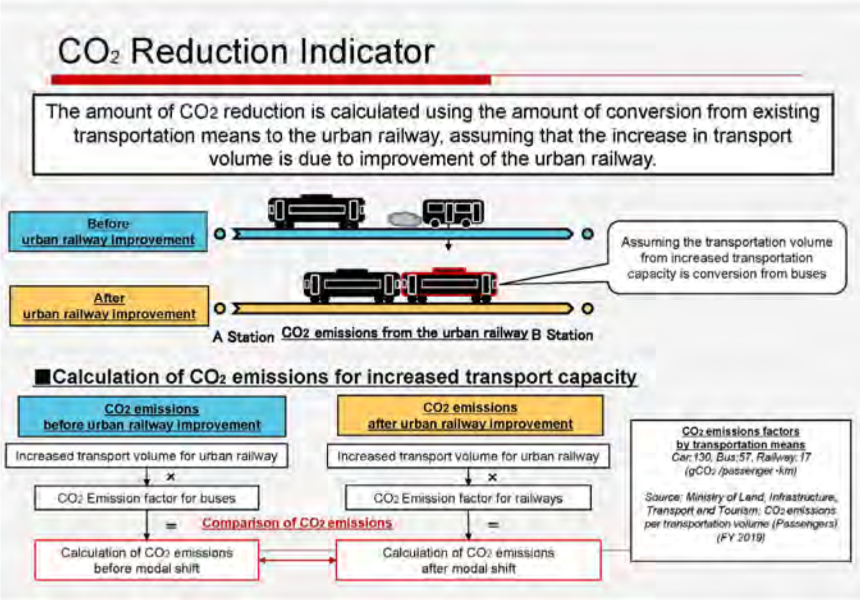
3) Local Communities

Restoration of the railway line will greatly improve access to urban commercial areas, increase the attractiveness of areas along the railway line, and attract more people to live in those areas. This will contribute to TOD (Transportation-Oriented Development) and help create an efficient urban structure and an affluent lifestyle. Unlike the construction of a new railway, which will entail relocation of the residents, this plan is a rehabilitation project for an existing railway line. In fact, residents and commercial groups along the railway line reacted favorably to the idea of restoring the Airport Line, suggesting that benefits for railway-related stakeholders could increase.

4) Environment

With restoration of the Airport Line, some of the travel demand from cars in central and eastern Kinshasa will shift to the railway. As a result, emissions of CO_2, NOx, SPM, etc. from automobiles will be reduced.

The difference in CO_2 emissions between the railway and automobiles is used to calculate the amount of CO_2 reduction due to the shift from automobiles to railway. The midpoint value (93.5 g CO_2/person-kilometer) between automobiles and buses is used, as shown in Figure 4-107. Comparing with the railway, the annual CO_2 reduction is 12,000 persons/day x 365 days x 20 km (extension of the Airport Line) x (93.5-17) g CO_2/person-kilometer) = 6701 tons/year.



Source: JICA Study Team

Figure 4-107 Method of Calculating CO_2 Reduction Effect

1) Safety

In Kinshasa, where traffic accidents occur frequently, transferring transport demand to the railway will help reduce traffic accidents to a certain extent. Together with restoration of the Airport Line, installation of level crossing safety devices, fences, and other facilities will minimize railway-related accidents.

(4) Others (Contribution to Sustainable Development Goals)

This project will help alleviate serious traffic congestion in Kinshasa, reduce air pollution, and mitigate climate change. It will contribute to Goal 9 (Let's lay the foundations for industry and innovation), Goal 11 (Building a city where people can continue to live), and Goal 13 (Specific measures against climate change) out of the 17 goals of the UN General Assembly announced in 2015.

4.10 Conclusion

(1) Proposal in Kinshasa City Urban Transport Master Plan

JICA implemented the Kinshasa City Urban Transport Master Plan Project from FY 2017 to FY 2018. Of the three existing railway lines owned and operated by SCTP (one in-service and two out-of-service), the Urban Transport Master Plan proposed improvement of the Matadi Line between Kinshasa Est Station and Kasangulu Station, and the restoration and resumption of operation of the Airport Line, which is out-of-service, as a relatively low-cost, short-term feasible project. Ideally, new urban railways, such as subways and elevated railways, should be constructed. However, funding, land acquisition, and other issues make it difficult to pursue these developments in the near-term. Existing railways, on the other hand, can be improved in a relatively short period of time and at low cost because there is little new construction, and no land acquisition problem.

(2) Airport Line Rehabilitation a Relatively Low-cost, Short-term Feasible Project

In interviews conducted during this Study, the government officials of the Democratic Republic of the Congo and SCTP expressed strong desire to resume operation of the Airport Line, which is currently out-of-service, among the three railway lines.

As proposed by JICA in the "Project for the Master Plan for Urban Transport in Kinshasa City, Democratic Republic of Congo" (2018), results of the field survey confirmed that it is feasible to restore the Airport Line at relatively low cost and in a short time. Therefore, the Airport Line is selected for rehabilitation using grant aid.

(3) Urgent Need to Mitigate Severe Traffic Congestion in Kinshasa

Heavy traffic and road congestion in Kinshasa are worsening every year, especially the main roads (Lumumba and Poids-Lords) that are parallel to the Airport Line and connect the city center with N'djili International Airport. Traveling between the airport and the city center may take more than three hours, depending on the time of the day. Public transportation is urgently needed in Kinshasa to alleviate traffic congestion.

(4) Need to Cope with Population Growth in Eastern Kinshasa

Population in the eastern part of Kinshasa City, where the Airport Line passes, and in the eastern part of N'djili International Airport, where the Airport Line ends, is on the rise. People going into the city center intensify traffic congestion. A public mass transportation system shall be constructed to meet the transportation need of the growing population in these areas.

(5) History of Japan’s Assistance to the Railway Sector in the Democratic Republic of the Congo and Need for Continued Support

Japan's assistance to the railway sector in the Democratic Republic of the Congo has continued for many years, beginning with the construction of Matadi Bridge, which opened in 1983. With funding from the Ministry of Foreign Affairs of Japan, a diesel locomotive and track maintenance equipment were delivered to the Democratic Republic of the Congo in 2020. The locomotive is used to haul passenger trains in the section between Kinshasa Est and Kasangulu. JICA is currently collaborating with a Japanese railway operator to train SCTP personnel in the maintenance of locomotives. In this way, the two countries share a history of cooperation in the railway sector. Continued support will help modernize the aging railways in the Democratic Republic of the Congo and develop human resources.

(6) Future Assistance and Synergy Effect

After rehabilitation of the Airport Line proposed in this Study has completed, further assistance for improvement in the section between Kinshasa Est and Kasangulu stations where passenger trains are currently in operation and the section between Kasangulu and Matadi stations is conceivable.

Matadi, where about 40 percent of the imported cargoes are unloaded, has the largest river port in the Democratic Republic of the Congo. Currently, the section between Kinshasa and Matadi is the main artery for the transportation of cargoes to Kinshasa. The distribution relies mainly on trucks. National Highway No.1 connects the two cities. It is steep and has only one lane in each direction. Traffic accidents occur frequently. If the railway in the same section is improved in the future, modal shift from trucks to freight trains will reduce traffic accidents. JICA is working with SCTP through grant aid on the Container Terminal Development Project in Matadi Port, which is aging. Upgrading the railway that connects Kinshasa and Matadi will enable the railway to meet the logistical needs between the terminal and Kinshasa, creating a synergistic effect.

Future population growth in Kinshasa will necessitate the development of new urban railways such as subways and elevated railways. The positive experience of developing urban transportation through the restoration of an existing railway line, as proposed in this Study, will give impetus to the construction, operation, maintenance, and management of new urban railways in the future.

Chapter 5 Maputo (Mozambique)

5.1 Overview of Mozambique and Maputo

5.1.1 Mozambique

(1) Topographical Overview

The Republic of Mozambique (hereafter "Mozambique") is located in the southeastern part of the African continent, bordering South Africa in the south, Eswatini in the southwest, Zimbabwe in the west, Zambia and Malawi in the northwest, and Tanzania in the north. Mozambique faces the Indian Ocean in the east and Madagascar across the Mozambique Strait.

The national land area is about 800,000 km^2 (more than twice that of Japan). The population is about 29 million people in 2018, showing a rising trend. The climate is divided into tropical rain forest climate and Savannah climate. The southern part, where the capital Maputo is situated, has an average temperature below 20°C in the winter, and a relatively mild weather between May and September.

(2) Economic Overview

The economy of Mozambique was devastated by a civil war, drought, and failure of domestic affairs in the 1980s after the country's independence in 1975. After the end of the civil war, along with the progress of peace, economic growth was around 6% annually in the latter half of the 1990s. Investment from South Africa and other countries increased. Large-scale projects such as aluminum smelting, the Maputo Corridor Plan, and the Beira Corridor Plan were launched. Unfortunately, the economy was hit again by successive floods in 2000 and 2001, but it recovered in the latter half of 2001, against the backdrop of infrastructure restoration projects for reconstruction and robust foreign direct investment. The economy had been growing at an annual rate of 7–8%[14] until recent years.

Agriculture, such as cotton, cashew nuts, tea, and sugar, and fisheries were once major industries. In 2000, however, the country began refining aluminum using its abundant electricity. As a core industry, aluminum has supported the economic growth of Mozambique. Large-scale coal fields have been excavated in Tete Province in the west. The coal is transported to Beira and Nacala by rail and exported to other countries.

At present, although the economy is temporarily in a downturn due to decline in the prices of resources and the existence of government debts that have not been disclosed externally. The private sector is highly motivated to invest due to the abundant natural resources (natural gas and coal). Mozambique is one of the countries expected to see stable growth in the future.

(3) Political System and Administrative Structure

Mozambique is a republic with the president as the head of state. Since January 1994, its presidents have been elected in direct elections for a five-year term. In addition to the president, there is also a prime minister, who is the head of the government.

Mozambique is divided into ten provinces and one capital city (Maputo) with provincial status.

(4) Japan's Assistance Policy

The Gross National Income (GNI) per capita of Mozambique is as low as $480 (2021, World Bank[15]) and Mozambique remains one of the poorest countries in the world. Its ever-growing

[14] GDP growth (annual %) – Mozambique, World Bank (https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=MZ)
[15] GNI per capita, Atlas method (US$) – Mozambique, World Bank (https://data.worldbank.org/indicator/NY.GNP.PCAP.CD?locations=MZ)

economy is resource-dependent. It needs assistance to help achieve Sustainable Development Goals (SDGs) and "Quality Growth."

Japan has set "Promotion of Social Development and Sustainable Economic Growth" as its basic policy for assistance (a major goal) to Mozambique. It is providing assistance in four priority areas: (1) Human development and social development; (2) Economic growth, productivity improvement, and creation of jobs; (3) Sustainable use of natural resources and natural environment; and (4) Peace-building and security measures, in accordance with Mozambique's five-year national development plan.

(2) Economic growth, productivity improvement, and creation of jobs, in particular, will support infrastructure development such as electricity, ports, transportation, and logistics. The railway improvement project in the Maputo metropolitan area is considered conducive to this priority.

5.1.2 Maputo Metropolitan Area

(1) Basic Data

The Maputo metropolitan area is situated at the southern end of Mozambique. It is composed of Maputo City—the capital, Matola City, and the Marracuene area in Maputo Province. It has an area of approximately 1,147 km^2 and a population of approximately 3 million in 2017[16].

Maputo City is the starting point of the Maputo Corridor (Maputo–Johannesburg), which has the highest traffic volume in the Southern African Development Community (SADC). It is also the political and industrial center where approximately 1.1 million people resided in 2017.

Matola City, which is adjacent to Maputo City, and the neighboring areas of Maputo are moving forward with housing development and industrial development. The population of the Maputo metropolitan area is expected to increase from 2.2 million in 2012 to 3.7 million in 2035. The increasing demand for passenger transport and logistical needs accompanying urban and economic growth created the rush to commute from Matola City and Marracuene District to Maputo City. Congestion at transportation nodes are becoming a serious problem.

5.2 Current State of Urban Transportation Infrastructure

5.2.1 Railway

The railways in Mozambique are operated by the Porto e Caminhos de Ferro de Moçambique (hereafter CFM), under the Ministry of Transport and Communications. CFM was established in 1990 and reorganized in 1995. It is now divided into four regional railways: CFM Sul (Southern Railway), CFM Centro (Central Railway), CFM Norte (Northern Railway), and CFM Zambezia Railway. Figure 5-1 shows the CFM railway map.

[16] National Institute of Statistics of Mozambique (http://www.ine.gov.mz/)

Source: “Railways of the World”, Japan Overseas Association for Railway Technical Cooperation (JARTS)

Figure 5-1 Railway Map of Mozambique

The railways in the Maputo metropolitan area are under the jurisdiction of CFM Sul, which operates three lines from Maputo Station to Eswatini via Boane Station, to South Africa via Matola Gare Station, and to Zimbabwe via Marracuene Station. CFM's main business is freight transportation. It also operates the suburban and long-distance passenger trains, but railway only has a small transportation share in the Maputo metropolitan area.

Table 5-1 below shows the current sections, route lengths, and train frequencies in the Maputo metropolitan area.

Table 5-1 Passenger Train Services in the Maputo Metropolitan Area

Section		Route length	Service frequency
1	Maputo–Marracuene–Manhiça	79 km	2 round trips per day
2	Maputo–Machava–Matola Gare–Ressano Garcia	88 km	2 round trips per day
3	Maputo–Machava–Boane–Goba	69 km	2 round trips per day
4	Maputo–Machava–Matola Gare	20 km	4 round trips per day

Source: JICA Study Team

Source: JICA Study Team

Figure 5-2 Railway Map of Maputo Metropolitan Area

The number of CFM Sul passengers increased significantly from 4.17 million in 2015 to 5.36 million in 2019. However, the service level was low, due to the limited number of trains in operation, congestion inside trains as a result of insufficient rail services, deterioration of trains, unreliable train schedules, travel time required for using railway service, etc. Fortunately, there were signs of improvement. A private operator (Metrobus) started offering passenger services in 2018 using secondhand diesel multiple units (DMUs) from New Zealand, and CFM also procured new DMUs from India.

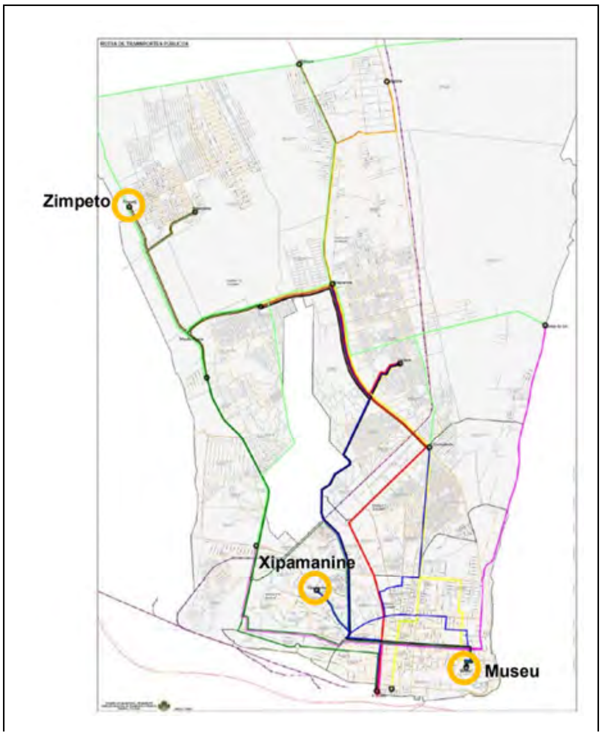
5.2.2 Maputo City

According to the "Comprehensive Urban Transport Master Plan for the Greater Maputo" (JICA, 2014), public transportation in the Maputo metropolitan area is mostly provided by chapas, which are small to medium-sized minibuses with 15 to 25 seats. They account for approximately 60% of all non-walking trips. There are also large buses with capacity for 50 or more passengers. They account for about 17% of all non-walking trips.

In tandem with the launch of train services in recent years using secondhand DMUs, Metrobus also started bus services as feeder transport for its trains at Maputo Station and nearby stations. The figures below show the Metrobus route map around Maputo Station and the Chapa route map of Maputo City.

Source: Metrobus

Figure 5-3 Metrobus Route Map (to/from Maputo Station)



Source: "Comprehensive Urban Transport Master Plan for the Greater Maputo," JICA

Figure 5-4 Chapa Route Map

5.3 Past JICA Aid Projects

5.3.1 Urban Transportation Master Plan

In 2014, JICA implemented the "Comprehensive Urban Transport Master Plan for the Greater Maputo"[17] (hereinafter "Transport Master Plan") to formulate a master plan for urban transport in the Maputo metropolitan area. The Transport Master Plan put together a master plan, selected priority projects, and implemented prefeasibility study (Pre-F/S) with a target year of 2035.

Previously, the Mozambique government formulated the "Maputo Municipal Development Program (ProMaputo) [18]" (2013, World Bank). However, the lack of a long-term vision for urban transport made it difficult to make investment decisions and secure funding. The planned development of a mass bus transport system (BRT) and the construction of a light rail linking Maputo and Matola have yet to become a reality.

Against this backdrop, the Transport Master Plan was formulated to compensate for the insufficiency in policies and planning, and to improve public transportation and road networks, while taking into consideration the expanding Maputo metropolitan area.

5.3.2 Rail-based Public transportation

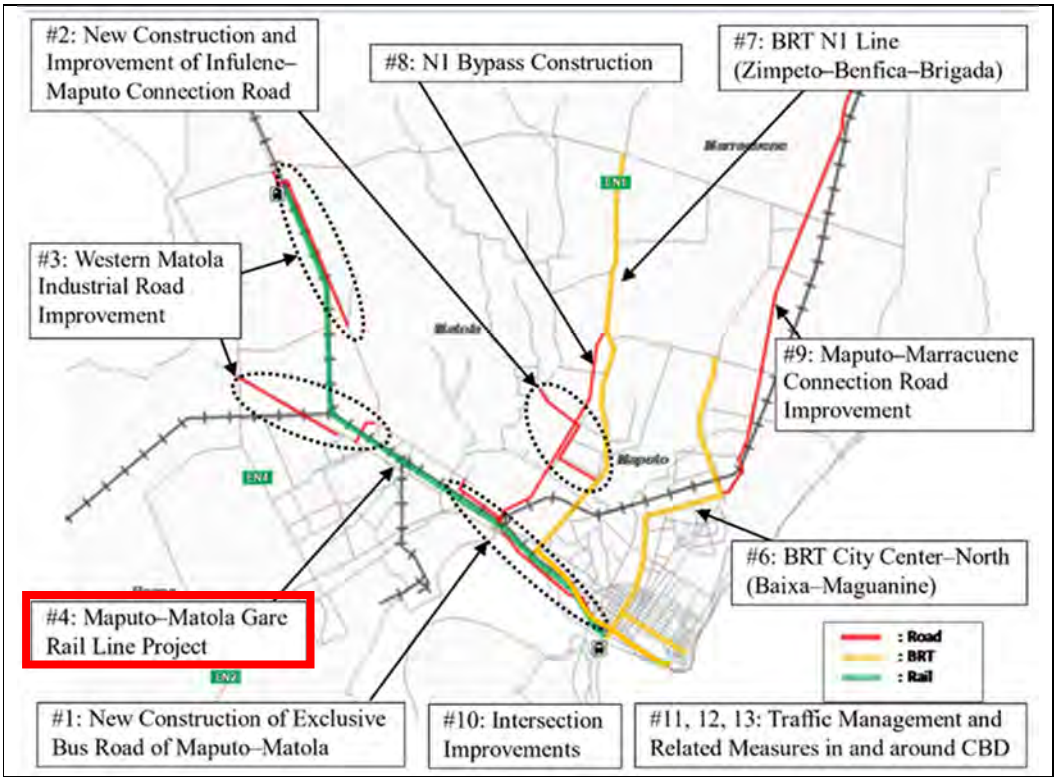
The Transport Master Plan proposed implementation of the following four development programs in the next 20 years:

- Maputo–Matola (East–West Axis) Transport Development Program

[17] https://openjicareport.jica.go.jp/710/710/710_521_12152591.html
[18] ProMaputo, Maputo Municipal Development Program - P096332 (https://projects.worldbank.org › proje...

- North–South Axis Transport Development Program
- Program for the Implementation of Traffic Management and Related Measures in and around CBD
- Capacity/Institutional Development Program

Among them, preparation for the Maputo–Matola Gare Rail Line Project under the Maputo–Matola (East–West Axis) Transport Development Program was identified as one of the priority projects. Figure 5-5 below shows the locations of the priority projects.



Source: "Comprehensive Urban Transport Master Plan for the Greater Maputo," JICA

Figure 5-5 Map of Priority Projects

Table 5-2 shows the forecast demand of each route, based on the Transport Master Plan. The Maputo–Matola Gare Rail Line has greater demand than the other two lines.

Table 5-2 Demand Forecast of the Lines

	Daily passenger volume (both directions)	Maximum design one direction hourly volume*
Maputo–Matola Gare Line	332,000	33,200
Maputo–Marracuene Line	237,000	23,700
Machava–Boane Line	271,000	27,100

* Peak hour factor : 20%
Source: "Comprehensive Urban Transport Master Plan for the Greater Maputo," JICA

5.3.3 Priority Project for Railway Modernization

In the Transport Master Plan, the BRT project along the north–south axis (development of #7: BRT N1 Line in) was selected as the top-priority project for Pre-FS. Only a brief description of a railway improvement plan was given. The following is an outline of the plan:

(1) Train Operation Plan

All lines will have the following operation plan:

- Number of rolling stock: 500 cars (10- cars/train set x 50 train sets)
- Average speed: 50 km/h in urban areas and 60 km/h in suburban areas
- Interval: 4 minutes in urban areas and 10 minutes in suburban areas

(2) Doubling of Track

The following two options have been proposed as measures to increase line capacity:

- Doubling of track (2 tracks, one track in each direction) in single-track section: commuter trains, long-distance trains, and freight trains operate on the same tracks
- Quadrupling (4 tracks, 2 tracks in each direction) or sextupling (6 tracks, 3 tracks in each direction) of track to separate the operation of commuter trains and long-distance trains from freight trains

Since the existing Right-of-Way (ROW, basically 50 m on each side) can be used for the doubling of track, land expropriation is unlikely to be a problem.

The Transport Master Plan did not specify which sections to be improved.

(3) Car Depot

The car depot for the 500 cars in the above-mentioned operation plan will be set up on the siding that branches off from Machava and extends to Maputo Port. The site area is expected to be 15 to 20 ha.

(4) Estimated Project Cost

The cost for developing the Maputo–Matola Gare Rail Line is estimated to be USD 450–650 million (including electrification) and USD 1,605 million for all three lines.

(5) Target Year of Development

The Maputo–Matola Gare Rail Line is scheduled to be developed by 2025, while the Maputo–Marracuene and Maputo–Boane lines are scheduled to be developed by 2035.

5.3.4 Review of Transport Master Plan

The FY 2022 Technical Cooperation Request Survey mentioned review of the Transport Master Plan and improvement of bus transport.

5.4 Initiatives by Other Donors

5.4.1 Feasibility Study for the Improvement of Maputo–Matola Gare Rail Line

According to the Ministry of Transport and Communications (MTC), an Egyptian company entered into an MOU with MTC in September 2021 to conduct an F/S for improvement of the Maputo–Matola Gare Rail Line. It will be necessary to obtain detailed information about the F/S when conducting related research in the future in order to ensure consistency with the proposed improvement plans in this Study.

5.4.2 BRT Plan

In Maputo City, a BRT project is underway with the support of the World Bank and others. The connection between an urban railway and the BRT plays an important role in urban development. It will be necessary to obtain detailed information when conducting related research in the future.

5.4.3 Procurement of Rolling Stock from India

CFM is in the process of procuring 30 DMUs (6-car train set x 5 train sets), 5 locomotives, 300 freight cars, and 122 passenger cars from India.

The DMUs will be used on railway lines in the Maputo metropolitan area. The passenger cars will be used for medium- to long- distance transport. Half of them will be used in other areas (CFM Centro).

5.5 Target routes and Issues

5.5.1 Need for Improving the Conventional Railway

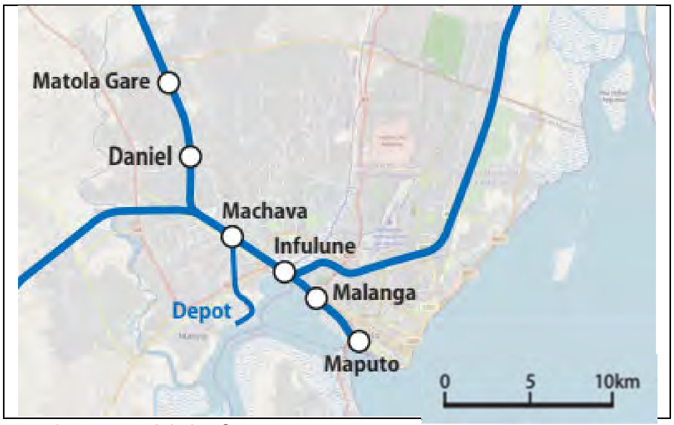
As of February 2022, the railways in the Maputo metropolitan area all operate about 1 to 2 round trips in the morning and evening. According to the "Comprehensive Urban Transport Master Plan for the Greater Maputo" (JICA), the railway's share in the total number of trips traveled in the Maputo metropolitan area is about 1%. As mentioned above, the total number of trips made by chapas and large buses is close to 80%. Road transport accounts for most of the travel in the Maputo metropolitan area, and the railways are not functioning adequately as an urban transportation means. Today the roads heading into the city center and in downtown areas are already having severe traffic congestion, especially in the morning and evening. It is certain that economic growth in Mozambique will further increase the traffic volume and worsen the situation.

In light of this situation, the conventional railway shall be improved to enable it to function as an urban transportation means, thereby raising the railway's share in the total number of trips traveled.

5.5.2 Selection of Line for Improvement

The Maputo–Matola Gare Rail Line is considered by the Mozambique counterpart as the most important route in the Maputo metropolitan area. It is also mentioned as a priority project in the abovementioned Transport Master Plan.

Accordingly, this line will be given priority for development in this Study. However, CFM also expressed interest in improving the Maputo–Marracuene and Maputo–Boane lines.



Source: JICA Study Team

Figure 5-6 Location Map of Maputo-Matola Gare Rail Line

The Maputo–Matola Gare Rail Line is 20 km in length. It is non-electrified and double-track. It branches off to Marracuene from Infulene and to Boane from Machava. Beyond Matola Gare, the line becomes single-track and extends to the border with South Africa.

Except for the section shared with the Maputo–Matola Gare Rail line, the Maputo–Marracuene Line and the Maputo–Boane Line are both single-track.

5.5.3 Status of Usage at Target Line

Although details on the usage of the Maputo–Matola Gare Rail Line are unknown because CFM has not provided data, the line is probably functioning well as a commuter railway line because all the trains were seen full of passengers in the morning and evening during our local survey.

5.5.4 Track

(1) Track Specifications

The Maputo–(Matola Gare)–Ressano Garcia section is an important route. The doubling of track to Matola Gare has been complete. The plan to double-track the 33-kilometer section to Moamba is underway.

This line is mainly used for freight transport but passenger trains to South Africa are scheduled to resume service.

Table 5-1 shows the track specifications of the target route.

Table 5-3 Track Specifications of Target Route

Item	Specification
Gauge	1,067mm
Track	Ballast track
Rail	54 kg/m
Sleeper	PC Sleeper
Rail fastener	Pandrol

Source: JICA Study Team

(2) Track Condition

The Maputo–Matola Gare Rail Line is being used for transporting heavy cargoes. Basic maintenance of the tracks are believed to be carried out. However, damage to the rail top and dents at the joints can be seen, showing that track maintenance has not been done with sufficient attention to detail.

Figure 5-7 shows the current track condition of the Maputo–Matola Gare Rail Line.

Coal Train on Matola Gare Rail Line

Track Condition


Damage on Rail Top	Rail Welding Point

Source: JICA Study Team

Figure 5-7 Track Condition of Maputo-Matola Gare Rail Line

As shown in Figure 5-8 below, the level crossing plates are made of blocks. There are many potholes, creating obstacles for road traffic. The tracks before and after the level crossings are buried in sand from surrounding areas. Such conditions become a weak link in transportation. The level crossing plates shall be repaired, along with the installation of safety devices.


Current Condition of Level Crossing	Damage of Level Crossing Plates

Source: JICA Study Team

Figure 5-8 Current Condition of Level Crossing on Maputo–Matola Gare Rail Line

(3) Track Maintenance Equipment

CFM purchased a multiple tie tamper machine (made in South Africa) and other equipment to improve the efficiency of track maintenance. At present, the necessary equipment and spare parts are sufficient. Figure 5-9 below shows some of the maintenance equipment owned by CFM.


Multiple Tie Tamper	Ballast Regulator

Motorcar with Crane

Tie Tamper

Source: JICA Study Team

Figure 5-9 Track Maintenance Equipment owned by CFM

5.5.5 Signaling System

The current state of the railway signaling system in the Maputo metropolitan area and possible challenges are as follows:

(1) Specifications of Signaling System

Table 5-1 shows specifications of the signaling system.

Table 5-4 Specifications of Signaling System

Type	Technical Specifications
Signal	Mechanical signals (Home/Start)
Point Machine	Point lever with counter-weight
Operation Monitoring Device	Transmits authority of operation and response from dispatcher to driver (radio message)
Train detector	Not installed
Level crossing warning device	Sign, Sign and warning light, no railway crossing barrier

Source: JICA Study Team

(2) Level Crossing

The level crossings have either a sign, or a sign and a warning light, but no railway crossing barriers. However, there are always gatekeepers stationed at major level crossings. When the gatekeeper receives notification that a train is approaching, he/she will activate the warning light and buzzer to alert the road users.

Figure 5-10 shows the conditions of level crossings on the Maputo–Matola Gare Rail Line.

Level Crossing near Machava Station

Level Crossing near Daniel Station

Level Crossing Warning Light

Gatekeeper Hut

Level Crossing Buzzer

Warning Light in Action

Source: JICA Study Team

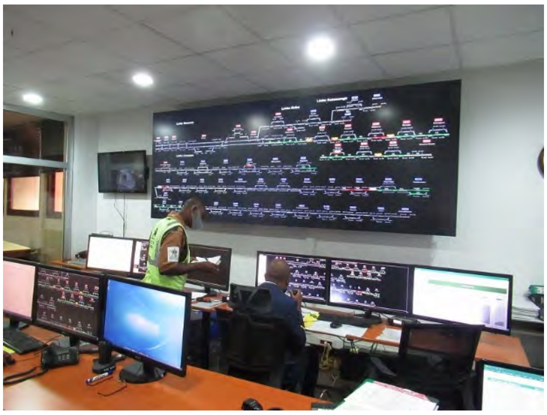
Figure 5-10 Conditions of Level Crossing Equipment on Maputo–Matola Gare Rail Line

(3) Traffic Control System

The traffic control system for all the CFM Sul lines is set up at the operation control center (OCC) near Malanga Station. A dispatcher at the OCC checks the current position of the train and grants authority of operation to the driver via text messages. The turnouts are not controlled centrally at the OCC but operated manually at each station.

Each station keeps the daily operation records of trains (e.g. the scheduled and actual arrival/departure times of each train).

Figure 5-11 shows the scene in the OCC and daily operation records.



Operation Control Center

Train Operation Records

Source: JICA Study Team

Figure 5-11 Operation Control Center and Train Operation Records

(4) Surveillance Cameras

CFM is installing surveillance cameras at the stations in order to monitor constantly the situation on the station premises. The images of each camera can be monitored at the OCC. As of April 2022, cameras at the Maputo Station have started the monitoring.

Figure 5-12 shows the images captured by cameras at the Maputo Station and a surveillance camera installed at the Matola Gare Station.

Surveillance Camera Monitor in OCC

Surveillance Camera at Matola Gare Station

Source: JICA Study Team

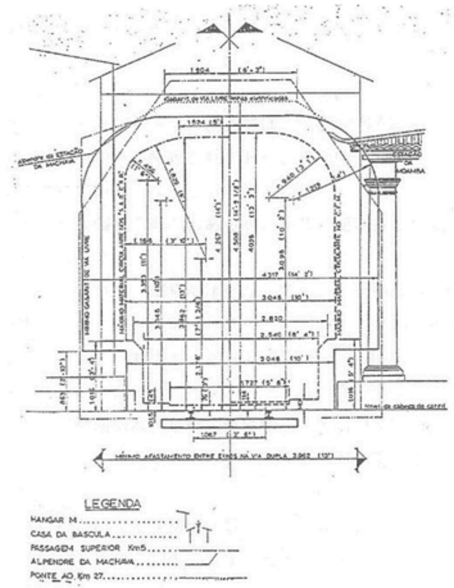
Figure 5-12 Surveillance Cameras

5.5.6 Rolling Stock

(1) Technical Specifications

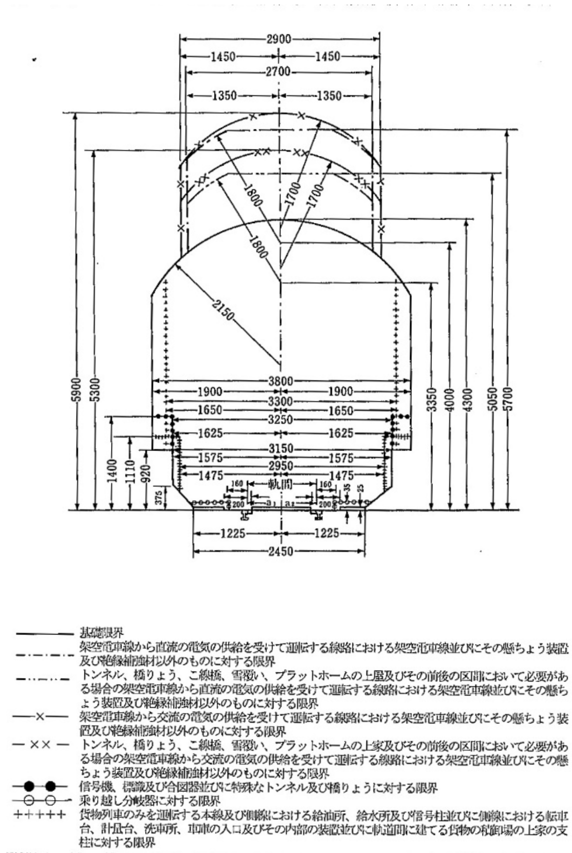
1) Construction Gauge

Figure 5-8 shows the construction gauges of CFM and Japan.



CFM

Source : CFM



Japan

Source: Ministerial Ordinance for Technical Standards for Railways, Ministry of Land, Infrastructure, Transport and Tourism

Figure 5-13 Construction Gauges of CFM and Japan

Since the CFM rolling stock gauge and construction gauge differ from those used in Japan[19], precautions shall be taken when considering the use of secondhand Japanese rolling stock, including the need to ensure that there is enough clearance from the platform or to raise the platform[20]. The new passenger cars and DMUs made in India are probably designed to meet the CFM standards. Details about the DMUs manufactured in New Zealand are unknown, such as the differences between CFM and New Zealand standards and modifications that have been made to enable operation on CFM tracks, and so on.

(2) Condition of Rolling Stock

Two types of commuter trains are in operation: passenger trains operated by CFM and DMUs by Metrobus.

1) CFM

The commuter trains operated by CFM are not suitable for commuter service because they were probably designed originally for medium- or long- distance service. The seats are facing each other and they are limited in number. It takes longer time to get off the train due to the small decks at both ends of the railcar.

[19] For example, the construction gauge for platform height is 864 mm at CFM and 920 mm or 1,100 mm in Japan.

[20] It is necessary to raise the platform and modify the existing vehicle, such as removing the steps, in order to eliminate the difference in level between the platform and the vehicle floor.

The cars are not well maintained and the seats are worn out. In contrast, the car interior seems to have been cleaned thoroughly.

A commuter train has 14 to 15 cars, with capacity for about 100 passengers per car. When comparing ticket sales and the boarding situation at Maputo Station visually, the trains arriving at Maputo Station in the morning appeared to be almost full.

Figure 5-14 below shows conditions of the CFM commuter trains.

Commuter Train

Boarding Deck

Interior of Commuter Train

Worn-out Chairs

Source: JICA Study Team

Figure 5-14 CFM Commuter Train

Since 2021, CFM has been using DMU trains and passenger cars made in India. The DMU train has a 6-car configuration. The lead car is a power-driven unit, the car on the other end is a control unit (no power, with driver's cab), and the middle cars are trailers (no power). This is a so-called push-pull system. The train set has capacity for 408 persons (50 to 80 persons per car). Ultimately, five DMU trains consist of 30 cars will be used for three lines in the Maputo metropolitan area.

As for the passenger cars, judging from the composition of the train set (with sleeping and dining cars), they will be used mainly for long-distance passenger transport.


New DMU Train (Made in India)


Motor Car of New DMU Train


Interior of New DMU Train


New Passenger Train

Source: JICA Study Team

Figure 5-15 New DMU Train and New Passenger Train from India

2) Metrobus

Metrobus purchased 16 used DMU trains from New Zealand in 2018, including one car for spare parts. They operate from Maputo Station to Matola Gare Station and from Maputo Station to Boane Station. The 16 DMUs were reassembled into two 6-car trains; the remaining 4 cars are reserved as backups.

Each DMU is made up of 2 cars (1 power car and 1 trailer car), but the cabs on the side of the trailer cars were removed during the New Zealand period. For this reason, the two ends of the train are always arranged to be power cars.

The power car has two double-sided automatic doors and the trailer car has one double-sided automatic door.


Exterior of DMU Train


Interior of DMU Train

	
Retractable Seat for Wheelchair Space	Automatic Passenger Door

Source: JICA Study Team

Figure 5-16 Metrobus DMU Train

The Metrobus DMU trains operate basically only on weekdays. They head toward Maputo Station in the morning and leave Maputo Station in the evening. Since the evening Maputo–Matola Gare train runs one and half round trips, there are actually three trains in the section between Maputo and Machava Station, including the one bound for Boane Station.

The trains are stored at the terminal stations (Matola Gare Station and Boane Station) at night and on weekends and holidays.

(3) Condition of Car Depot

1) CFM

The CFM car depot is located to the west of Maputo Station. The building is 100 meters long and 30 meters wide. It has three lines. This building is used mainly for routine inspections. It is equipped with decks, pits, and overhead cranes. The inspection cycle is based on the travel time. Inspection is performed when the total travel time reaches 12,000 hours. Overhaul is performed elsewhere.

Currently, a new DMU has just arrived from India for assembly. Because the building is not long enough for assembling a 6-car train set, the train set has to be assembled three cars at a time.

The roundhouse locomotive shed that houses a turntable, from the steam locomotive era, is still in use.

Figure 5-17 shows the interior of the locomotive shed.

	
Interior of Locomotive Shed (1)	Interior of Locomotive Shed (2)

Source: JICA Study Team

Figure 5-17 CFM Locomotive Shed

2) Metrobus

Metrobus rents one of CFM's inspection shed near Maputo Station as a car depot.

The inspection shed was built long time ago. It has no large machinery other than a jack to lift the vehicle. Since the shed has little lighting, inspection can only be done during daytime. The CFM criteria are used, such as inspection cycle, etc. Four years have passed since Metrobus started the DMU operation. Because its trains only operate in the mornings and evenings, the total running time is only about 5,000 hours, which is less than half of the 12,000 hours required for an overhaul. The spare parts are well stocked. There have been no problem that would hinder operation.

This inspection shed will be abolished when the new platform described later is constructed. The Metrobus depot will be relocated near Machava Station in the near future. Metrobus will do the procurement for its new car depot.

	
Exterior of Inspection Shed	Interior of Inspection Shed

Source: JICA Study Team

Figure 5-18 Metrobus Car Depot

5.5.7 Station

Figure 5-6 shows the six stations of the Maputo–Matola Gare Rail Line, the subject of this Study. The line starts at the terminal Maputo Station and continues to Malanga Station, Infulene Station, Machava Station, Daniel Station, and Matola Gare Station.

All the stations have station buildings. Some stations have platforms with low floors but the difference in level between the platform and the train floor is too large. Some stations do not have platforms. Passengers have to get on and off the CFM trains directly at the tracks. At the stations where the Metrobus DMU trains stop, temporary steps are set up in front of the vehicle doors, but the difference in level between the steps and the train floor is still large. With the exception of Maputo Station, the platforms at other stations do not have roofs or covers.

The following is the condition of each station:

1) Maputo Station

Maputo Station is known to have one of the most beautiful station buildings in Africa. It was constructed in 1916 in the Bozar style[21]. The station was selected by the U.S. magazine "Travel + Leisure" as one of the "Ten Beautiful Stations in the World[22]." The station building and other station facilities are well maintained. There is a railway museum, art gallery, and café on the platforms. The station is also a tourist attraction.

[21] An architectural style seen in public buildings in America and elsewhere in the late 19th century
[22] https://galeriemagazine.com/10-of-the-most-beautiful-train-stations-in-the-world/

The station has three low-floor platforms, all of them are bay platforms. Only one platform in the middle has roof. The platforms and the entrance/exit of the station are at the same level so no stairs are necessary.

On the other hand, the platform is too short for the train. Three of its rail cars in the back stop outside of the platform. Passengers on these cars can either get off directly onto the tracks or walk to the front of the train to get off onto the platform. As a solution, a new platform is being constructed on the north side of the existing platform.

Temporary steps are set up at the platform where the Metrobus DMU trains arrive and depart to reduce the difference in level between the vehicle floor and the platform. A ramp for wheelchair use, instead of steps, is set up at the platform area closest to the station building (as mentioned above, there are retractable seats for wheelchair spaces in the railcars).

Station Building

Bay Platform

Passengers during Morning Rush Hours

Some Railcars Stop Outside of the Platform

Temporary Steps and Ramp for DMU Trains

Constrution Site of New Platfrom
(Track Works in Progress as of April 2022)

Source: JICA Study Team

Figure 5-19 Condition of Maputo Station

2) Malanga Station

Construction of high-floor platforms is underway as of April 2021.

	
Station Building	High-floor Platform (Under Construction)

Source: JICA Study Team

Figure 5-20 Condition of Malanga Station

3) Infulene Station

It is a junction station for the line going to the Marracuene and Manhiça direction. The station does not have platforms for the Maputo–Matola Gare Rail Line or the Maputo–Marracuene Line.

	
Station Building	View of Infulene Station (Left Track Goes to Matola Gare and Right Track Goes to Marracuene)

Source: JICA Study Team

Figure 5-21 Condition of Infulene Station

4) Machava Station

The station has two low-floor platforms for three tracks. Similar to Maputo Station, temporary steps are set up on the platform for the DMU trains. Although there is an underground passageway between the platforms, most passengers prefer to cross the tracks instead. The passageway seems to be underutilized. There are no lights on the station premises and none on the platforms.

Transit facilities for Metrobus trains, buses, and private cars are available at the front of the station.


Station Building


Temporary Steps for DMU Trains


Underground Passageway Entrances


Passengers Crossing the Track

Source: JICA Study Team

Figure 5-22 Condition of Machava Station

5) Matola Gare Station

This station has no platforms, only temporary steps for the DMU trains. In the case of a passenger train, the passengers have to get on and off the train directly at the track.

There is a passageway that connects the two sides of the station to the north of the station, but the passageway does not have any warning device or crossing barrier.

Figure 6-23 shows the condition of Matola Gare Station.


Station Building


Temporary Steps and Ramp for DMU Trains

People Waiting for Freight Train to Pass

Source: JICA Study Team

Figure 5-23 Condition of Matola Gare Station

6) Boane Station and Marracuene Station

Boane Station is an intermediate station on the line that branches off from the Matola Gare Line at Machava Station and ends at Goba Station on the Eswatini (formerly Swaziland) border. At present, the Metrobus DMUs operate as far as Boane Station.

The minibuses from Maputo to Boane are cheaper and take shorter time. Therefore, the railway has few users. On the other hand, since the opposite direction (Goba Station direction) does not have any roads that are parallel to the railway, there are more railway users.

Similar to Matola Gare Station, Boane Station does not have any platforms, only temporary steps for the DMU trains.

The station building is aging, requiring urgent reconstruction or renovation.

This station has side lines going to the cement and concrete sleeper factories.

Figure 5-24 shows the condition of Boane Station.

Station Building

Temporary Steps for DMU Trains


Cracked Wall inside Station Building


Corroded Window Frame

Source: JICA Study Team

Figure 5-24 Condition of Boane Station

Marracuene Station is an intermediate station on the line that branches off from the Matola Gare Rail Line at Infulene Station and reaches Chicualacuala on the Zimbabwe border. The CFM passenger train runs one round trip a day to Maputo Station but the up-bound train for Maputo Station leaves Marracuene Station early in the morning (around 4:00 am) and the down-bound train from Maputo Station also runs during the daytime hours, making it impossible for the train to function as a commuter train. The station is located slightly out of the city center. It takes about an hour and a half from this station to Maputo Station, whereas the minibus takes only about an hour to the center of Maputo and its fare is cheaper than the railway.

There is no lighting on the premises of the station. Since the morning outbound train for Maputo Station departs before sunrise, it is difficult to ascertain the actual level of users. Safety is also a concern.

In addition to one passenger train per day, an international train also makes two round trips per week directly to Zimbabwe on this route. However, the train is currently out of service due to the effects of COVID-19.

The tracks are not sufficiently maintained due to the fact that the number of trains in operation is small and the line has lower priority.

Figure 5-27 shows the condition of Marracuene Station.


Station Building


Track Condition

Source: JICA Study Team

Figure 5-25 Condition of Marracuene Station

5.5.8 Station Plaza

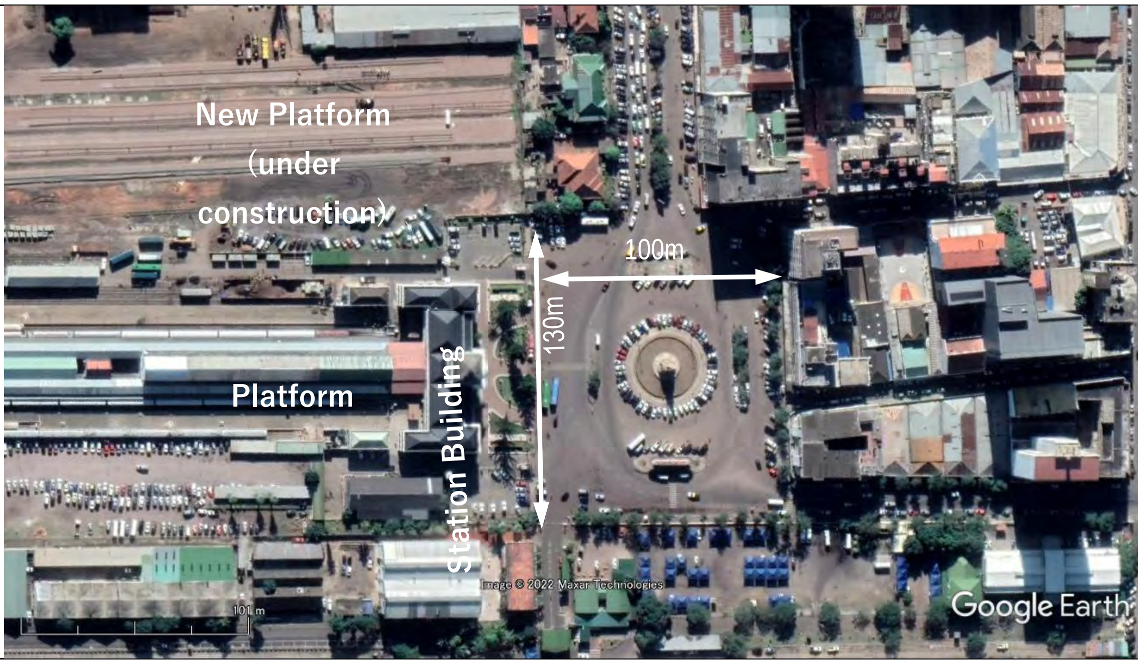
Most of the land in front of CFM stations is owned by CFM. With the exception of Maputo Station, these stations do not have pavement, bus stops, or other station plaza facilities. Metrobus has constructed some facilities at some stations to facilitate the departure and arrival of its own buses, as well as parking spaces for private cars (Park & Ride).

Fences are being installed at some stations to prevent unauthorized occupation of railway land.

The station front condition of each station is described below.

(1) Maputo Station

A station plaza (about 130 m x 100 m) has been constructed in front of the Maputo Station. Roofs and benches have been installed mainly in front of the station building where bus stops for the Zimpeto direction and others are located. The station plaza facilitates not only transfers to the railway but also serves as a hub for the central bus network. The station and its neighboring areas are far from the city center. The station plaza is quiet during daytime because there are no passenger trains arriving or departing.



Maputo Station Plaza

Buses at Maputo Staton Plaza

Sources: Google Earth image edited by JICA Study Team and photos taken by JICA Study Team

Figure 5-26 Maputo Station Plaza and Buses

(2) Machava Station

There are facilities in front of Machava Station for transfers to Metrobus trains or buses, and parking for cars. Figure 5-27 shows the situation during the evening rush hours. The buses are placed on standby according to the arrival time of the Metrobus train. After picking up the passengers from the train, the buses depart one after another. The bus ticket is integrated with the train ride card, and the card is read when a passenger boards the bus. It does not seem possible to only use the bus. A card reader is set up at the entrance and exit of the parking lot. The gate opens after the train card is read. Similarly, it does not seem possible to only use the parking lot.

The bus waiting area and parking lot are surrounded by fences. The parking lot is paved with blocks. The bus waiting area and the bus boarding area outside the fence are not paved, large puddles of water form especially at the boarding area when it rains.

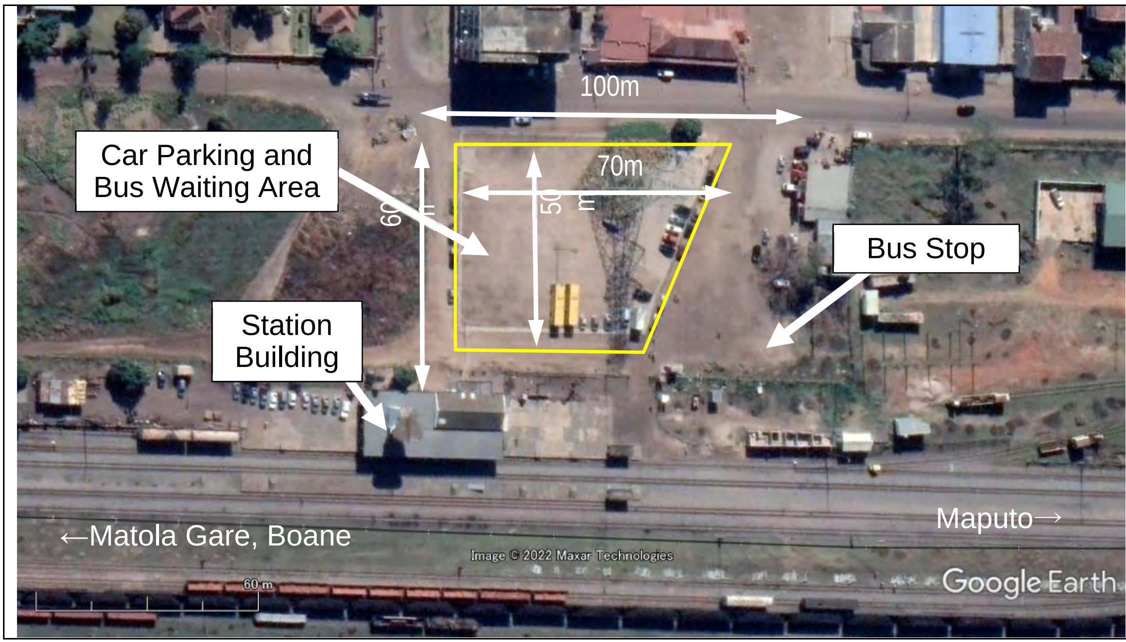
Chapa, which is a common form of public transportation in Mozambique, did not seem to enter the station plaza directly.

	
Buses Waiting for Train Arrival	Passengers Transferring from Metrobus Train to a Bus
	
Car Parking Entrance	Card Reader at Car Parking Entrance

Source: JICA Study Team

Figure 5-27 Machava Station Plaza (1)

The Metrobus buses arrive before the Metrobus train departs in the morning (four routes, of which 1 route has 2 runs and the others have 1 run). In the evening, the buses depart after each train arrives (7 routes, 2 of which have 2 runs, 1 route has 1 run, and the others have 3 runs).



Source: Google Earth image edited by JICA Study Team

Figure 5-28 Machava Station Plaza (2)

(3) Daniel Station

Daniel Station does not have any specific space like a station plaza. The Metrobus buses arrive and depart at the open space in front of the station. There are only two buses in the morning.

Figure 5-29 shows the condition of the area in front of Daniel Station.

Area in front of Daniel Station

	
Bus Stop	Bus to/from Daniel Station

Sources: Google Earth image edited by JICA Study Team and photos taken by JICA Study Team

Figure 5-29 Area in front of Daniel Station and Buses

(4) Matola Gare Station

Some route buses are operating near Matola Gare Station, but they do not enter the undeveloped area in front of the station. On the other hand, Metrobus offers one bus in the morning and one in the evening in line with its trains. They also come into the station front area.

A fence has been installed at the boundary of the CFM site to prevent any business installations or building construction within the CFM ROW without permission.

Figure 5-30 shows the condition in front of the Matola Gare Station.

Area in front of Matola Gare Station

Area in front of Matola Gare Station

Fence at Entrance of Matola Gare Station

Bus to/from Matola Gare Station

Sources: Google Earth image edited by JICA Study Team and photos taken by JICA Study Team

Figure 5-30 Area in front of Matola Gare Station

5.5.9 Fare Collection System

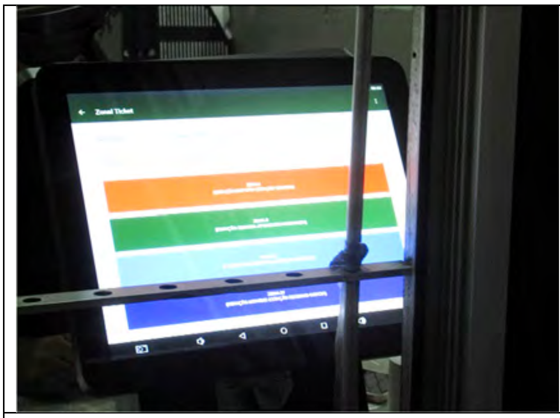
The fare collection systems of CFM, Metrobus, and the connecting buses that operate on the Maputo–Matola Gare Rail Line are described below.

1) CFM

Passengers purchase tickets at the station ticket office or from a crewmember with a portable ticket vending machine. The portable ticket vending machine can issue not only tickets but also prepaid cards (registration of ID, etc.). Ticket sales are managed in real time, making it easier for employees to verify on their smartphones.

A new system for issuing electronic tickets is under review, but it has not been put into practical use yet.

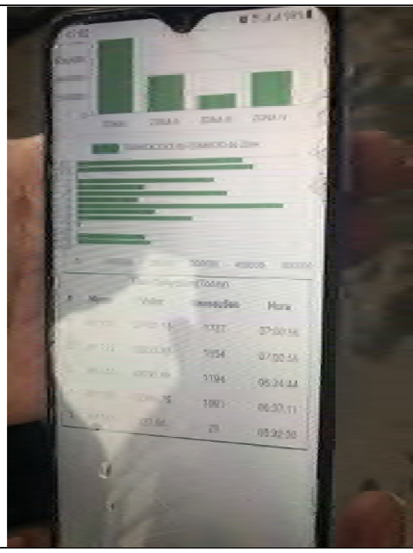
Figure 5-30 below shows the stationary and portable ticket vending machines.



Stationary Ticket Vending Machine

Portable Ticket Vending Machine

Pre-paid Card



Screen Showing Status of Ticket Sales of Each Train

Source: JICA Study Team

Figure 5-31 CFM Ticket Vending Machines and Pre-paid Card, etc.

To promote railway use, CFM is conducting a campaign in which passengers who write their name and mobile phone number on the back of the used ticket and put it in a designated box have the chance to win a free ticket for up to three months.

	
Promotion Campaign Poster	Designated Box and Tickets Submitted

Source: JICA Study Team

Figure 5-32 Campaign for Promoting CFM Use

2) Metrobus

Passengers can purchase tickets at the station counter or on the train. Payments can also be made by card, which is integrated with a bank's cash card. Monthly commuter passes are available, and up to four family members in the same household can purchase the second and subsequent commuter passes at half price. Ticket owners can use the parking at Machava Station free of charge. An advertisement for the Metrobus commuter passes is shown below.

Source: Metrobus Facebook

Figure 5-33 Advertisement of Metrobus Commuter Pass

3) Route Buses

Passengers pay their fares in cash on the bus. In February 2021, the Maputo Metropolitan Transportation Authority introduced an electronic ticket called Famba, which combines an IC card with a mobile application, for some buses. The contract of this service was awarded to Maxcom Africa in Tanzania with the support of the Financial Sector Deepening Moçambique–Investing in Financial Inclusion (FSD). Four types of cards are available: for high-frequency users, students, businesses, and the elderly/war wounded. In the future, Famba will be introduced not only to buses but also to ferries, railways, and taxis. Figure 5-34 shows the advertisement for Famba cards.

Source: Famba Card Facebook

Figure 5-34 Advertisement for Different Types of Famba Cards

5.6 Recommendations for Improvement Plan and Challenges

5.6.1 Basic Policies for Improvement

CFM expressed interest in improving the Maputo–Marracuene Line and Maputo–Boane Line, which are less developed than the Maputo–Matola Gare Rail line. It was observed during the field survey that the trains operating on the Maputo–Marracuene and Maputo–Boane lines were crowded in the morning and evening, showing that the lines are being used effectively for commuting. However, road traffic now accounts for most of the travel in the Maputo metropolitan area, causing severe traffic congestion in the city center. It is certain that the economic growth of Mozambique will further increase traffic volume, thereby worsening urban traffic and causing severe traffic congestion.

Under these circumstances, the conventional railways shall be upgraded so they can function as an urban transportation means and shoulder a greater transportation share.

During the interview, CFM mentioned "Additional procurement of passenger cars and/or DMU trains," "Facility maintenance and management," "Improvement of station facilities," and "Installation of lighting and fences" as issues. The following are policies for improvement, taking into consideration the CFM request and the current situation of each specific topic mentioned above.

- Increase the number of trains in the morning and evening, and increase the transportation capacity for daytime train services in line with the demand for commuting to work and school
- Improve ride comfort, raise the reliability of train operations, and enhance safety for both the railway and road users at level crossings
- Improve transit facilities between railways and other modes (such as BRT) at stations where Metrobus connects railways and buses
- Improve passenger service

The issues below shall be addressed when implementing these policies.

5.6.2 Recommendations for Improvements and Their Challenges

(1) Increase Transportation Capacity

In terms of urban transportation today, traffic congestion on the main roads is severe, and the morning and evening commuting trains are congested. Since future population growth and increase in car ownership from economic development will put further strain on road traffic, there seems to be a latent demand for conventional railways. Both CFM and Metrobus are considering increase in their transportation capacity, and are interested in acquiring used rolling stocks from Japan. However, even though the railways in Japan and Mozambique have the same 1,067mm gauge, there may still be issues, as explained below. Careful study is needed for the transfer of used rolling stock.

- Rolling stock and construction gauge
  As mentioned above, the construction gauge and the vehicle gauge in Mozambique are slightly smaller than those in Japan. It is necessary to ensure that the car body, especially the bogies and steps, do not come into contact with the platform or other facilities.
- Coupling with existing rolling stock
  In the case of a locomotive, it will be coupled to an existing passenger car or a freight car. It is possible, however, that the couplers and brake systems will not be compatible and will need to be refurbished.
- Rolling stock maintenance using the existing inspection equipment and system
  A Japanese DMU has its engine, transmission, and other equipment installed under the floor. Since such rolling stock is not currently in use in Mozambique, it is unclear if the existing inspection facilities and systems in Mozambique can handle the maintenance.

(2) Improvement of Ride Comfort and Safety

1) Improvement of Level Crossing

As the number of trains in operation increases, ensuring safety at level crossings becomes more important. Level crossing panels shall be installed to enable both the trains and automobiles to cross safely and quickly. Figure 5-35 shows the current condition of a level crossing and the image of a level crossing after improvement.

This level crossing panel is called a “Tightly Connected Precast Concrete Track.” Because the track and level crossing panel are integrated and rigidly connected with PC steel bars, it has high strength, functions well under heavy vehicles, and has a long service life.

Current Condition After Improvement (Image)

Source: JICA Study Team

Figure 5-35 Tightly Connected Precast Concrete Track for Level Crossing

2) Installation of Level Crossing Barriers

Currently, there are gatekeepers stationed at major level crossings and operate the level crossing warning lights manually. In the future as the number of trains in operation increases, the time shutting off road traffic becomes longer, and the road traffic volume rises, the number of accidents at level crossings will also increase. Level crossing barriers shall be installed to prevent accidents. The objective is not to install fully automated level crossings (automatic detection of train approach and operation of warning lights and barriers). It is recommended to start by introducing a type of level crossing that has low installation cost and that its equipment, such as warning lights and barriers, can be operated manually by a gatekeeper. To this end, standards for the installation of level crossing barriers shall be formulated, taking into account local conditions. Assistance in this area is needed.

3) Signaling

Train operations are currently managed by the operation control center (OCC), but the traffic lights and point machines are not automated. They can become a bottleneck when train frequency increases. In particular, because three railway lines share the double-track section between Maputo and Infulene stations, the section is congested with many trains.

In order to realize the operation plan for the railway modernization priority project based on the "Comprehensive Urban Transport Master Plan for the Greater Maputo" (refer to 5.3.3), the train stations must be linked and automated signaling must be installed. This can not only contribute to an increase in the number of trains and an increase in train speeds but also contributes to the speedy and reliable route setting at stations, and the rationalization of personnel through improvement in operation efficiency.

For the future, the Centralized Train Control (CTC) system shall be adopted to centralize traffic control at the OCC. In doing so, the handling of train operations, which has been delegated to individual stations, will be centralized at the OCC, thereby enhancing operation efficiency.

(3) Improvement of Transit Facilities between Railways and Other Modes (BRT)

Metrobus is developing transit facilities, but they are not necessarily user friendly. Some bus stops are not paved and have no roofs or covers. Going forward, transit facilities shall be developed at each station in the Maputo metropolitan area. It is important to construct safe and convenient transit facilities and improve the public transportation network to further promote the use of commuter railways.

Table 5-5 shows the conditions of facilities and the proposed improvements at stations where Metrobus connects trains and buses on the Maputo–Matola Gare Rail Line. Figure 5-36 shows an image of the improvements.

Table 5-5 Conditions of Transit Facilities on Maputo–Matola Gare Rail Line and Proposed Station Improvements

	Station building	Platform	Station plaza (Site conditions)	Proposed station development plan
Maputo Station	Yes	3 platforms *Not long enough	Yes (paved)	Platform extension
Machava Station	Yes	2 platforms	Yes (unpaved)	Installation of overbridge Paving of station plaza
Daniel Station	None	None	None (*no space)	Installation of platform

Matola Gare Station	Yes	None	Yes (unpaved)	Installation of platform Installation of overbridge Paving of station plaza

Source: JICA Study Team

	
Image of Station Development (Installation of Overhead Bridges, Construction of Station Plaza)	Image of Station Development (Installation of Platform)

Source: JICA Study Team

Figure 5-36 Images of Station Development

(4) Improvement of Passenger Service

CFM and Metrobus each have their own electronic tickets, as well as the route buses. Their electronic tickets have not been standardized. Standardizing them requires measures beyond the scope of an individual transport operator. Coordination among the various stakeholders, including administrative organizations such as the national and city governments, is necessary. Therefore, it will probably take a long time before standardization can come to fruition.

Nevertheless, the common use of e-tickets is important for enhancing convenience for users.

5.7 Conclusion

The government of Mozambique formulated the "Maputo City Development Program" (ProMaputo) in 2013 and JICA also formulated the "Comprehensive Urban Transport Master Plan for the Greater Maputo" in 2014. The target year for the development of the Maputo–Marracuene Line and Maputo–Boane Line is 2035, but the prospect of completion is low at this point. On the other hand, there is a strong demand for increasing the transport capacity of railway to address the urban transportation problems, and to develop transportation nodes to facilitate seamless transfer between public transportation modes. The government of Mozambique has requested JICA to review the Transport Master Plan and improve bus transportation in the FY 2022 Technical Cooperation Request Survey. In that context, JICA shall identify the assistance needed from the Japanese side based on the latest information on public transportation, including railways.

With regard to passenger transport from Maputo City and nearby cities, there is a risk that traffic congestion on roads, especially on main roads, will worsen as the population grows and car ownership rises. It is necessary to pay close attention to the socio-economic situation going forward. From this perspective as well, the railway holds the key to meeting the strong demand for commuter transport. Since the accompanying improvement of railway facilities will be necessary, an in-depth study should be conducted.

The station plaza, which is the transit point between the railways and buses, will be an important facility in the context of future technical cooperation regarding buses. From the perspective of accessibility as well, measures shall be taken to enhance convenience for users.

Chapter 6 Lusaka (Zambia)

6.1 Overview of Zambia and Lusaka

6.1.1 Zambia

(1) Topographical Overview

Zambia is a republic in southern Africa with a land area of 752,610 km^2 (approximately twice as large as Japan). It was once the Northern Rhodesia of the United Kingdom and remains one of the Commonwealth member states of the United Kingdom after independence. The official language is English. It is landlocked and borders the Democratic Republic of the Congo, Tanzania, Malawi, Mozambique, Zimbabwe, Namibia, Angola, and Botswana. The population of Zambia was about 18.38 million in 2020. It has increased by about 35% in the last decade.[23][24][25]

Source: Eziron maps

Figure 6-1 Location of Zambia

(2) Economic Overview

Zambia has a monoculture economy dependent on copper production, with copper accounting for the majority of exports. Major copper mines in Zambia are concentrated in Copperbelt Province, which borders the Democratic Republic of the Congo in northern Zambia. In addition to copper, Zambia is blessed with mineral resources such as cobalt, iron, gold, uranium and manganese. As Zambia is a landlocked country, the exporting of goods depends on air transportation and the ports of other countries. A road network composed of international corridors, including the Nacala Corridor, the North–South Corridor, the Dar es Salaam Corridor, and the Baylor Corridor, serve as trade routes. Transportation costs tend to be high due to the fragile domestic infrastructure and political instability in neighboring countries.

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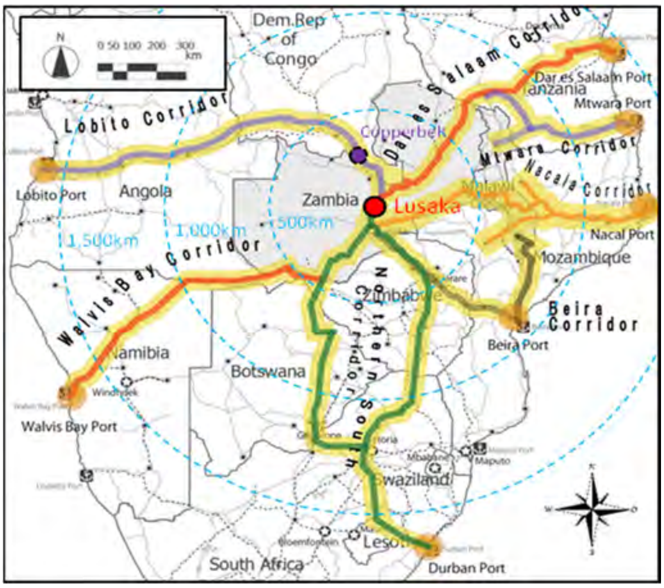
[23] Source: Basic Data of the Republic of Zambia (Ministry of Foreign Affairs)
[24] Source: World Bank Open Data (World Bank)
[25] Source: Compared with Zambian population of approximately 13.6 million people in 2010 in World Bank Open Data (World Bank)



Source: JICA, "Data Collection Survey on Urban Development and Urban Transportation in Lusaka City, Zambia," 2022

Figure 6-2 Major Corridors Traversing Zambia

(3) Political System and Administrative Structure

Zambia is a republic with a presidential form of government. After gaining independence from Britain in 1964, it established a one-party system in 1972 and pursued a socialist economy. In 1991, the country was forced to hold elections for a multi-party system, leading to a change in government and the active promotion of economic liberalization policies. In August 2021, general elections were held and the power was transferred to a new administration led by President Hichilema. The new administration reorganized the ministries into 27 ministries. The Ministry of Transport and Logistics (MTL) oversees the transport sector, including air, rail, water, road, and transport. The Ministry of Transport and Logistics has jurisdiction over Zambia Railway Limited, Zambia Airways Limited, and the Road Transport and Safety Agency.

Table 6-1 Reorganization of Ministries under the New Administration

Field	Ministries and Agencies	Remarks (Former Ministry and Agency)
Administration	Office of the President	Same as left
	Office of the Vice President	Same as left
	Ministry of Home Affairs and Internal Security	Ministry of Home Affairs
	Ministry of Foreign Affairs and International Cooperation	Ministry of Foreign Affairs
	Ministry of Finance and National Planning	Ministry of Finance
	Abolished	Ministry of National Development Planning
	Ministry of Defense	Same as left
	Ministry of Justice	Same as left
	Ministry of Local Government and Rural Development	Ministry of Local Government
Economy and Industry	Ministry of Agriculture	Same as left
	Ministry of Commerce, Trade and Industry	Same as left
	Ministry of Small Medium Enterprise Development	Newly established
	Ministry of Tourism	Ministry of Tourism and Arts
	Ministry of Mines and Minerals Development	Same as left
	Ministry of Fisheries and Livestock	Same as left
Education	Ministry of Education	Ministry of General Education
	Abolished	Ministry of Higher Education
Health Care	Ministry of Health	Same as left

Social Infrastructure	Ministry of Water Development, Sanitation	Ministry of Water Development, Sanitation and Environmental Protection
	Ministry of Energy	Same as left
	Ministry of Transport and Logistics	Ministry of Transport and Communications
	Ministry of Infrastructure, Housing and Urban Development	Ministry of Housing and Infrastructure Development
	Ministry of Information and Media	Ministry of Information and Broadcasting
	Ministry of Technology and Science	Newly established
	Abolished	Ministry of Works and Supply
Social Welfare and Culture	Ministry of Labor and Social Security	Same as left
	Ministry of Community Development and Social Services	Ministry of Community Development and Social Welfare
	Ministry of Youth, Sports and Arts	Ministry of Youth, Sport and Child Development
	Abolished	Ministry of Gender
	Abolished	Ministry of Chiefs and Traditional Affairs
Land and Conservation	Ministry of Lands and Natural Resources	Same as left
	Ministry of Green Economy and Environment	Newly established

Source: JICA, “Data Collection Survey on Urban Development and Urban Transportation in Lusaka City, Zambia,” 2022

(4) Japan's Assistance Policy

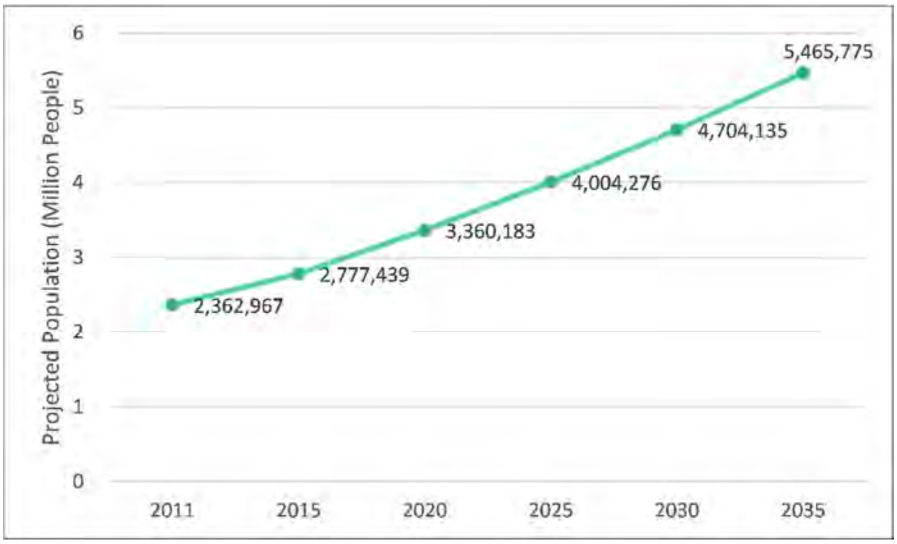
While Zambia is rich in mineral resources, it is a monoculture economy. A decrease in rainfall in 2015, due to the El Niño phenomenon, caused a decline in agricultural production and a drop in power generation because of water shortage at dams. Exacerbated by the fall in international copper prices and the subsequent slump in the mining sector, Zambia’s economy suffered a downturn. The downturn was also attributable to the underdevelopment of industries that would generate high employment and the over-reliance on rainfed agriculture and related industries. The government of Zambia, under the Lungu administration, formulated the Seventh National Development Plan in 2017. In line with the Plan, Japan is committed to supporting the revitalization of industries that facilitate economic diversification, as well as the improvement of infrastructure and social services that support economic activities, in accordance with its Country Assistance Policy for Development Cooperation with the Republic of Zambia.

6.1.2 City of Lusaka

(1) Basic Data

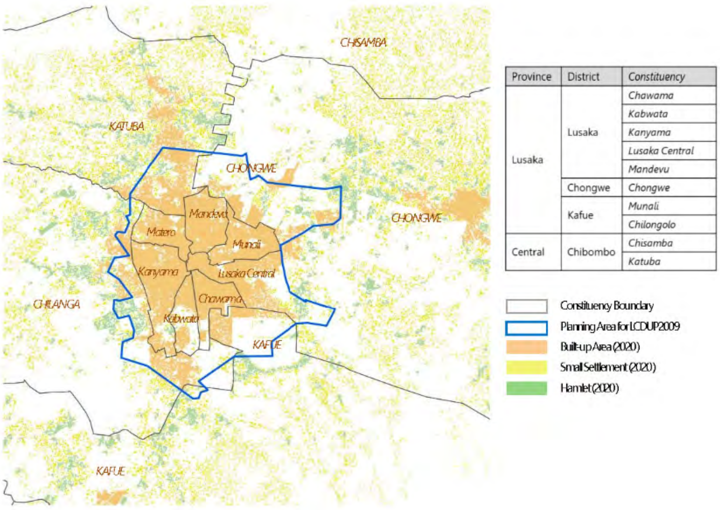
Lusaka is the capital city of Zambia and one of the early-developed cities in southern Africa. Lusaka is an important economic hub in Zambia, providing a market for agricultural products produced in the surrounding areas and transported from various locations. The future population of Lusaka was projected in 2013 to reach approximately 3.4 million by 2020 and 5.47 million by 2035, suggesting that urbanization would continue in the vicinity of Lusaka.[26]

[26] Source: “Zambia Population and Demographic Projects 2011–2035” (Central Statistical Office), 2013



Source: JICA Study Team based on the 2013 “Zambia Population and Demographic Projects 2011–2035”

Figure 6-3 Projected Population of Lusaka



Source: JICA, “Data Collection Survey on Urban Development and Urban Transportation in Lusaka City, Zambia,” 2022

Figure 6-4 Progress of Urbanization in Lusaka Suburbs

(2) Institutional Framework

The City of Lusaka is governed by a political division led by the Mayor, as well as an administrative division led by the Deputy Mayor (Town Clerk) and eight directors representing the eight departments of Human Resources and Administration, Legal, Engineering Services, Urban Planning, Public Health, Housing and Social Services, Finance, and Assessment and Property Management. In terms of transportation, the Engineering Services Department is in charge of road construction and maintenance.

6.2 Current State of Urban Transport Infrastructure

(1) Roads

The international corridors, such as the North-South Corridor, the Nacala Corridor, and the west corridor to Angola, are located in the center of Lusaka City. In addition to these roads, several radial roads are connected to form the road network of Lusaka City. JICA developed inner ring roads and access roads to the Lusaka South Multi Facility Economic Zone (LS-MFEZ). Other donors have also participated in road development, such as the Lusaka 400 Project financed by

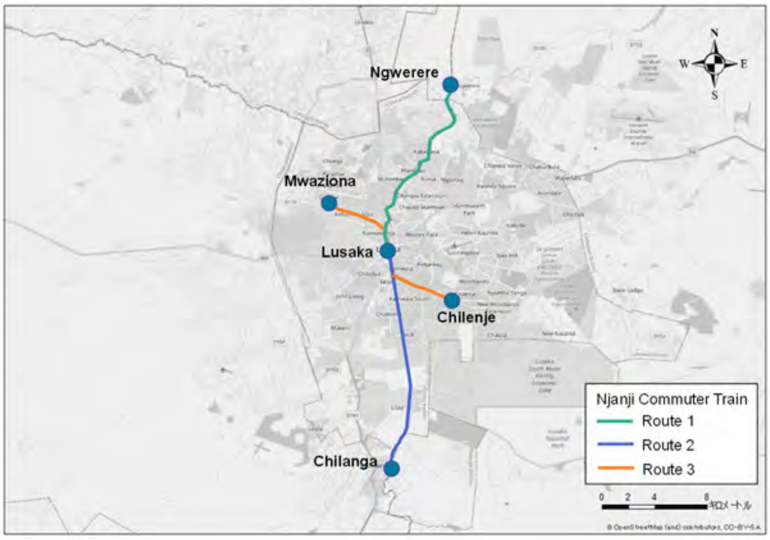
Chinese loans and the Lusaka Decongestion Project by Indian loans. However, the development of ring roads and other roads is still insufficient, causing many vehicles to enter the city center and exacerbating traffic congestion.

(2) Railways

Zambia Railway Limited (ZRL) commenced operations in 1905 as part of the Rhodesia Railway, the predecessor of the Zambia Railway, under the British rule. It currently operates 1,266 kilometers in Zambia, under the jurisdiction of the Ministry of Transport and Logistics. In addition to the Zambia Railway, there is also the Tanzania–Zambia Railway (Tazara Railway) in Zambia. It was constructed in 1967 with the assistance of China and started operation in 1976. The Tanzania–Zambia Railway operates between Kapiri Mposhi in Zambia and Dar Es Salaam in neighboring Tanzania. Zambia Railway operates mainly copper-based freight trains. An intercity passenger train operates twice a week between Kitwe and Livingstone (currently, one train per week due to the COVID-19 pandemic). Commuter service is currently not available in Lusaka and its suburbs. The Njanji Commuter Train was operating three lines in Lusaka since 1991 but the service was suspended in 1998 due to a shortage of diesel locomotives and other factors. In 2015, Zambia Railway offered commuter service for about 27 km between Ngwerere and Lilayi. However, the service was halted in March 2016 due to a lack of rolling stock and equipment suitable for commuter service. The resumption of commuter service shall be considered in the development of a public transportation network to promote transition from automobile to public transportation.

Source: "Railways of the World", Japan Overseas Association for Railway Technical Cooperation (JARTS)

Figure 6-5 Railway Network in Zambia



Source: JICA Study Team

Figure 6-6 Route Map of Njanji Commuter Train (1991–1998)

Source: JICA Study Team

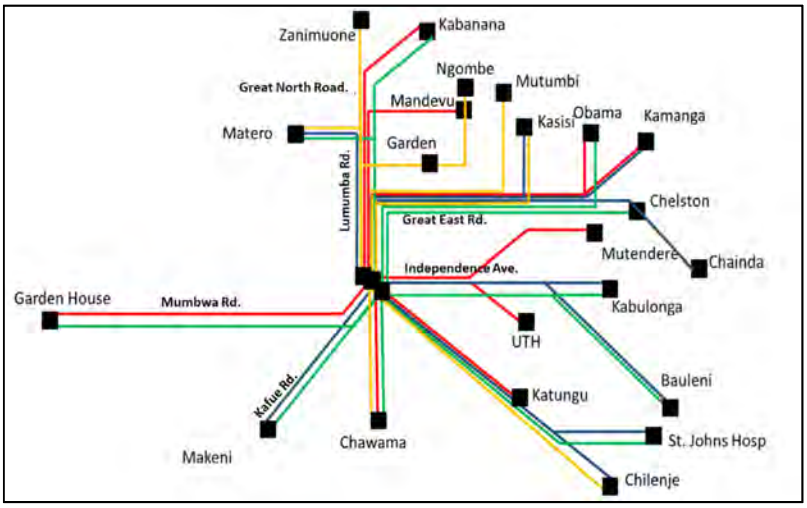
Figure 6-7 Route Map of ZRL Commuter Train (2015–2016)

(3) Non-rail Public Transportation

Minibus is currently the main public transportation means in Lusaka and its suburbs. Although the minibuses have designated routes, their schedules are not fixed. Punctuality is not guaranteed since a minibus typically will not depart until it has full occupancy.

Source: JICA Study Team

Figure 6-8 Minibuses



Source: JICA, "Data Collection Survey on Urban Development and Urban Transportation in Lusaka City, Zambia," 2022

Figure 6-9 Route Diagram of Minibuses

6.3 Past JICA Aid Projects

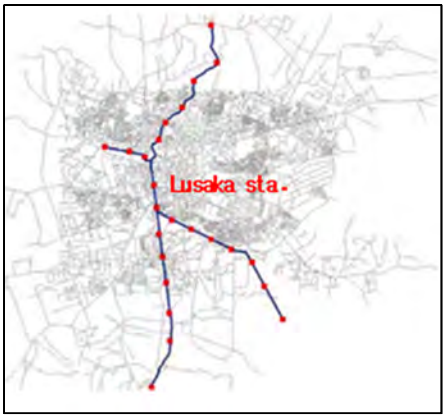
6.3.1 The Study on Comprehensive Urban Development Plan for the City of Lusaka in the Republic of Zambia (JICA)

1) Background

Zambia's economy was fast growing particularly in manufacturing, construction, and agriculture. Lusaka's urban population also grew rapidly. The 600,000 people added in the last 20 years (as of 2009) settled mainly in unplanned residential areas, intensifying urban sprawl. In response to the request for "Technical Assistance for Industrial Development and Urban Development" by the Zambian government and Lusaka City, the Japanese government formulated the Comprehensive Urban Development Plan in 2009.

2) Public Transportation Centering on Railways

According to "The Study on Comprehensive Urban Development Plan for the City of Lusaka," a significant modal shift from private cars to public transportation by 2030 is necessary. This study recommends regular bus service with priority lanes and dedicated lanes by 2030. The development of commuter train service is recommended after 2030, when Zambia becomes a middle-income country.



Source: JICA, "The Study on Comprehensive Urban Development Plan for the City of Lusaka in the Republic of Zambia," 2009

Figure 6-10 Railway Development Plan after 2030

3) Railway Modernization Priority Projects

A transportation network shall be developed. Road development projects, such as the construction of inner ring roads and access roads to the Lusaka South Multi Facility Economic Zone (LS-MFEZ), are identified as priority projects. On the other hand, the development of commuter train service is not among the railway modernization priority projects.

6.3.2 Data Collection Survey on Urban Development and Urban Transportation in Lusaka City, Zambia (JICA)

1) Background

In 2009, JICA assisted in the formulation of the Comprehensive Urban Development Plan for the City of Lusaka. Against the backdrop of the population growth projected in the Lusaka City Comprehensive Urban Development Plan, traffic congestion is spreading to the suburbs of Lusaka, along with increased demand for road transport and growing urban sprawl. The "Data Collection Survey on Urban Development and Urban Transportation in Lusaka City" conducted in 2022 aims to identify and analyze progress of the Lusaka City Comprehensive Urban Development Plan, traffic demand trends, and issues related to the future urban development plan of Lusaka City, as well as review the remaining sections of the inner ring roads.

2) Progress of Railway Policies and Future Challenges in Road and Urban Transport Planning

Among the urban transport sub-programs of the Comrehensive Urban Development Plan for the City of Lusaka formulated in 2009, the "Revival of Commuter Railways" was designated as a project program for railways (target year: 2015), but no projects have been undertaken as of 2021.

When the "Data Collection Survey on Urban Development and Urban Transportation in Lusaka City, Zambia" was carried out in 2022, "Addressing traffic congestion and traffic safety," "Ensuring consistency with urban structural planning and land use planning," and "Addressing global issues" were identified as issues of road and urban transport planning.

6.4 Initiatives by Zambia Government

6.4.1 Zambia National Transport Master Plan

Zambia has come to a turning point in its commitment to provide mobility for all, reduce dependence on automobiles, generate significant economic benefits, and improve the quality of life for the Zambian people. The Ministry of Transport and Communications formulated the

Transport Infrastructure Master Plan in 2017, with a target year of 2037, in order to meet the country's transport needs over the short, medium, and long term beyond 2030.

6.4.2 Measures for the Railway Sector

(1) Reference Projects

According to the National Transport Master Plan of Zambia, Reference Projects are projects of the transport sector that have been committed or are in progress. The table below shows a list of Reference Projects related to Zambia Railway.

Table 6-2 Reference Projects

Project	Year of completion
Annual Maintenance of Existing Railways	Annually
Comprehensive Railway Rehabilitation	2024
Mainline Signaling Phase I	2020
Construction on Inter-Mine railway	2019
Establishment of a Concrete Sleeper Factory	2018
Establishment of Quarry Plants	2018
Rehabilitation of the Mulobezi Line	2020
Rehabilitation and Acquisition of Rolling Stock Assets	2027
Serenje–Chipata Greenfield Railway	2021

Source: JICA Study Team

(2) Mandatory Projects

According to Zambia's National Transport Master Plan, Mandatory Projects are projects essential to the future of the transport sector. The table below lists the Mandatory Projects related to Zambia Railway.

Table 6-3 Manual Projects

Project	Year of completion
Mainline Signaling Phase II	2022
Greenfield Railways Annual Maintenance	Annually
Road Flyover Program	2017

Source: JICA Study Team

(3) Unique Projects

According to Zambia's National Transport Master Plan, Unique Projects are projects that require large-scale investment in the transport sector. The table below shows the list of Unique Projects related to Zambia Railway.

Table 6-4 Unique Projects

Project	Year of completion
Central Corridor Fast Passenger Train	2025
Greenfield Freight Railway	2028

Source: JICA Study Team

6.5 Initiatives by Other Donors

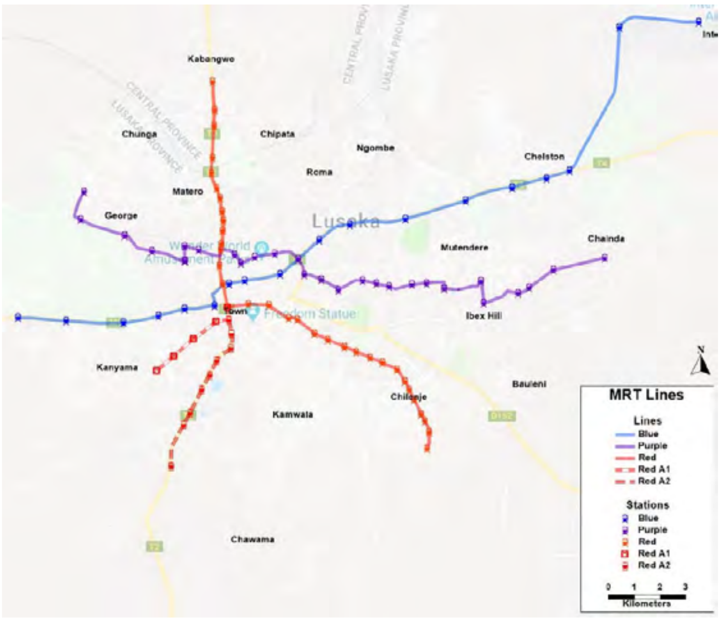
6.5.1 African Development Bank (AfDB)

As traffic congestion is worsening, Lusaka is faced with a number of transport issues such as a rapid increase in automobiles, lack of sustainable transport infrastructure and management, and insufficient transport services. The Ministry of Transport and Communications, with the support of the African Development Bank, carried out the "Feasibility Study and Proposed Solutions for Decongestions of Traffic, the City of Lusaka" in 2020. In order to alleviate traffic congestion in Lusaka, the Study investigates the feasibility of proposed solutions in solveing traffic congestion, presents concepts and preliminary designs for implementing the solutions, and proposes a project for 2040.

Upgrading the Chisamba–Kafue section of the Zambia Railway for commuter train service has also been proposed to strengthen public transportation. The introduction of MRT and the Formal Urban Bus Service System for reorganizing minibuses have been proposed. According to the interview with the AfDB, the Ministry of Transport and Logistics are taking the initiative to review the menu of proposals, and the Ministry of Transport and Communications are informed of the specific progress of the review. Although an interview was conducted with the Ministry of Transport and Logistics in this survey, specific information regarding the progress of these proposals could not be obtained.

Source: AfDB, “Feasibility Studies and Proposed Solutions for Decongestion of Traffic, the City of Lusaka,” 2020.

Figure 6-11 AfDB Proposal of Commuter Railway Development through Improvement of Zambia Railway



Source: AfDB, "Feasibility Studies and Proposed Solutions for Decongestion of Traffic, the City of Lusaka," 2020.

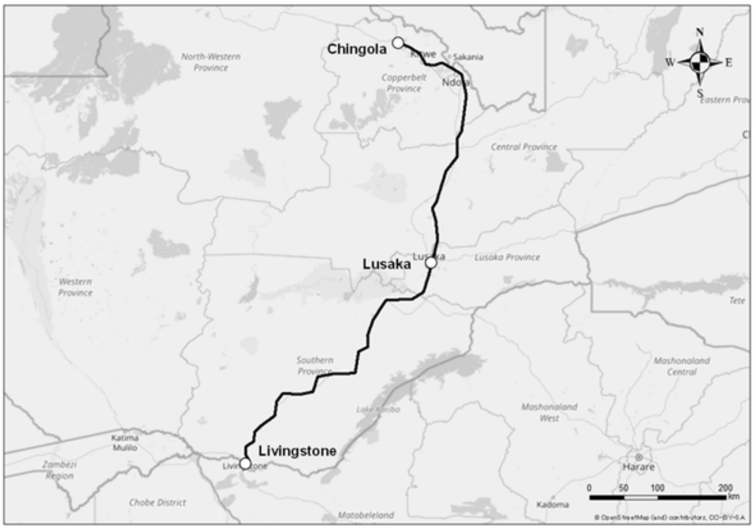
Figure 6-12 AfDB Proposal of MRT Development

Source: AfDB, "Feasibility Studies and Proposed Solutions for Decongestion of Traffic, the City of Lusaka," 2020.

Figure 6-13 AfDB Proposal of Formal Urban Bus Service System (Phase 1) Development

6.5.2 Team Sweden Consortium

The Team Sweden Consortium plans to upgrade the tracks, signals, and rolling stock of the Chingloa–Livingstone section of the Zambia Railway. These projects are assumed to be relevant to the "Comprehensive Railway Rehabilitation," "Mainline Signaling Phase I," and "Rehabilitation and Acquisition of Rolling Stock Assets" of the Reference Projects in the Zambia National Transportation Master Plan. According to the interview with Zambia Railway, the Consortium's projects are improvements to the existing facilities of the Zambia Railway. The Consortium has no plan for new construction, such as a commuter railway. As of April 2022, all projects are at the data collection stage.



Source: JICA Study Team

Figure 6-14 Section of Zambia Railway Slated for Upgrade

6.6 Target Routes and Issues

6.6.1 Need for Improving the Conventional Railway

Lusaka is projected to have its population reaching about 5.47 million in 2035. At present, traffic congestion occurs during peak hours on major roads near the central business district (CBD). Traffic congestion in central Lusaka is expected to deteriorate further due to population growth in the future. In response to a request for "Technical Assistance for Industrial Development and Urban Development" from the governments of Zambia and Lusaka, JICA formulated the Comprehensive Urban Development Plan in 2009. Many of the priority projects for the urban transport sector are projects for developing and improving the road infrastructure. Meanwhile, the Ministry of Transport and Communications formulated the Zambia National Traffic Master Plan in 2018 with a view to reducing dependence on automobiles and the Ministry is taking initiatives accordingly. In the Greater Lusaka area, there is a growing need for a mass transit system to facilitate modal shift from cars but the development of a new mode of transit requires huge investment. As commuter trains were running in Lusaka in the past, it is possible to develop a mass transport system by utilizing the existing railway infrastructure to reduce installation cost. Against this backdrop, this survey focuses on "Support for resumption of operation of commuter railways."[27]

6.6.2 Selection of Route

Routes shall be selected for improvement to support the resumption of commuter train service. According to interviews with the Ministry of Transport and Logistics and Zambia Railway, the ZRL Commuter Train (Ngwerere–Lilayi), Njanji Commuter Train, and Airport Link (Lusaka CBD–Kenneth Kaunda International Airport) were the three routes considered for development. The Njanji Commuter Train has not been in use for over 20 years. Most of the tracks have been removed and residents have constructed buildings along the tracks. Restoration of the Njanj Commuter Train will entail the relocation of residents and construction of new railway facilities. The airport link requires construction of an entirely new route. On the other hand, since Zambia Railway is already using the existing facilities (Ngwerere–Lilayi) for intercity passenger service and freight transport, the cost of route improvement is estimated to be lower compared to the other routes being considered. The Zambia Railway (Ngwerere–Lilayi) is selected for line

[27] Source: *Zambia Population and Demographic Projects 2011–2035* (Central Statistical Office), 2013

improvement because development of an urban rail system is expected to contribute to the easing of congestion on Cairo Road, Kafue Road, and other roads.

Source: JICA Study Team

Figure 6-15 Routes Being Considered for Improvement

Table 6-5 Details of Routes Being Considered for Improvement

Route	Remark	MTC/ZRL's Priority	Reason	Conclusion of the Study Team
ZRL (Ngwerere–Lilayi)	· Approx. 27 km · Commuter service suspended (Infrastructure is currently used for freight transport and intercity passenger service)	◎	· Possibility of grant aid as compared to the other routes · Rehabilitation of tracks necessary · Ease of congestion on Cairo Road and Kafue Road	◎
Njanji Commuter Train	· Approx. 16 km · Commuter service suspended	○	·Tracks removed ·Residents occupying railway site, relocation necessary	○
Airport Link (CBD–Airport)	· Extension unknown (approx. 22 km)	○	·New construction necessary	△

Source: JICA Study Team

Source: JICA Study Team

Figure 6-16 Track Condition on the Njanji Commuter Train (1)

Source: JICA Study Team

Figure 6-17 Track Condition on the Njanji Commuter Train (2)

6.6.3 Track

(1) Technical Specifications

Intercity passenger service and freight service are offered between Ngwerere Station and Lilayi Station on the ZRL; however, commuter service has been suspended. The track specifications of this route are shown below.

Table 6-6 Track Specifications of the Target Route

Type	Technical Specifications
Gauge	1,067 mm
Track Type	Ballast Track
Rail	40 kg, 45 kg
Sleeper	PC sleepers, partially mixed with steel ties
Fastening device	Pandrol

Source: JICA Study Team

(2) Track Condition

The track condition of the entire section is poor due to insufficient ballast and rail wear. Traces of derailment are visible in some areas. Freight trains and intercity passenger trains operate at a maximum speed of 15 km/h in this section to prevent derailment and other accidents. Due to vandalism, electric switches are operated by hand. Some parts of the pandrol clips are welded to the rails to prevent theft. The tracks are used by local residents as a community road. Many areas on the railway premises are occupied illegally. The Team Sweden Consortium is slated to upgrade the entire Zambia Railway line. However, the improvements are planned for the existing facilities only, not for the restoration of ZRL's commuter rail services.

Source: JICA Study Team

Figure 6-18 Vandalized Electrical Switch

Source: JICA Study Team

Figure 6-19 Rail Wear

Source: JICA Study Team

Figure 6-20 Welded Pandrol Clip

Source: JICA Study Team

Figure 6-21 Roadbed Condition

Source: JICA Study Team

Figure 6-22 Missing Rail Joint Plate Bolt

Source: JICA Study Team

Figure 6-23 Damaged Sleepers caused by Derailment

Source: JICA Study Team

Figure 6-24 Track Condition and Pedestrians

Source: JICA Study Team

Figure 6-25 Illegal Occupation of Track Site

(3) Maintenance Management System

A track maintenance team, consists of one track supervisor and one permanent inspector, is based at Lusaka Station to oversee the section between Lilayi and Karubwe near Lusaka. ZRL also commissions cooperatives organized by communities along the railway line to patrol the tracks. The patrol is performed every day. If any abnormality in the tracks is identified, the patrol team will contact the Track Supervisor, who will then schedule a track maintenance. ZRL provides in-house training for all members of the cooperatives performing the patrol.

(4) Track Maintenance Equipment

Zambia Railway bought two tamping machines for tracks in 2015. However, since most of the sections do not have enough ballast, maintenance work on those sections is done manually. Large track maintenance machines, such as the track tamping machines, are housed in Kabwe's rolling stock depot. Track tamping machine and other such equipment were not seen at the Lusaka Station maintenance equipment warehouse. There is probably a shortage of maintenance equipment.


Source: JICA Study Team
Figure 6-26 Tamping Machine for Tracks


Source: JICA Study Team
Figure 6-27 Ballast Transport Motor Car

Source: JICA Study Team
Figure 6-28 Rail Crane


Source: JICA Study Team
Figure 6-29 Motor Car


Source: JICA Study Team
Figure 6-30 Lusaka Station Maintenance Equipment Warehouse


Source: JICA Study Team
Figure 6-31 Inside Lusaka Station Maintenance Equipment Warehouse

6.6.4 Signaling System

(1) Technical Specifications

Technical specifications of signaling equipment for the target route are as follows:

Table 6-7 Signal Specifications of Target Route

Type	Technical Specification
Signal	Not installed
Switch	Point lever with counter-weight type or electric point machine
Block system	Staff and ticket block system
Traffic control system	Centralized dispatch system
Train detection equipment	Not installed
Level Crossing Warning equipment	Not installed, only road sign post

Source: JICA Study Team

(2) Condition of Level Crossings

Although level crossings used to have warning lights and bells, the Zambia Railway has removed all the alarm devices because of vandalism. Today level crossings only have road sign posts, some level crossings do not even have signs. Since the vehicles and pedestrians using the roads are not required to stop at level crossing, trains have to decelerate just before the level crossing and sound the horn while entering the level crossing. Some level crossings have cracks on the roads, creating bottlenecks for road traffic.

Source: JICA Study Team

Figure 6-32 Road Sign Post near Chisango Road

Source: JICA Study Team

Figure 6-33 Level crossing near Makishi Road

(3) Current State of the Operation Control Center (OCC)

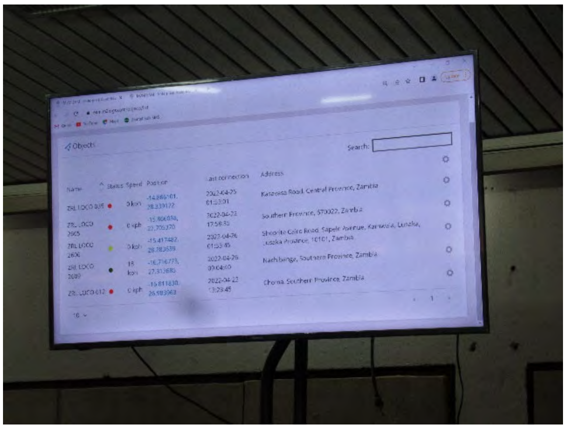
The Operation Control Center (OCC) of the Zambia Railway is located in Kabwe. It manages the operation of the entire Zambia Railway line. Until the 1990s, ZRI used the train operation control system produced by Siemens for traffic control, in conjunction with an electric signaling system. However, cable damage caused by vandalism put a stop to the train operation control system. Today, the OCC obtains train position information from the GPS mounted on locomotives. Operation instructions are communicated by telephone between the OCC and the driver. According to the commands from the OCC, the driver writes down the commands in the operation instruction form.

The Ngwerere–Lusaka and Lusaka–Lilayi sections are the block sections of the target route. Only one train is allowed to be in each of these two sections. Ngwerere Station, Lusaka Station, and Lilayi Station, which mark the boundaries of the block sections, are equipped with passing loops to allow two trains to pass each other. The train must stop before entering the passing loop to obtain entry permission from the OCC via telephone. The locomotive assistant then switches the point machine manually. A similar procedure is performed when the train departs the passing loop. The procedure for the block section at these passing stations leads to longer train operating hours.

The Team Sweden Consortium is slated to upgrade the signaling system of the entire Zambia Railway line.

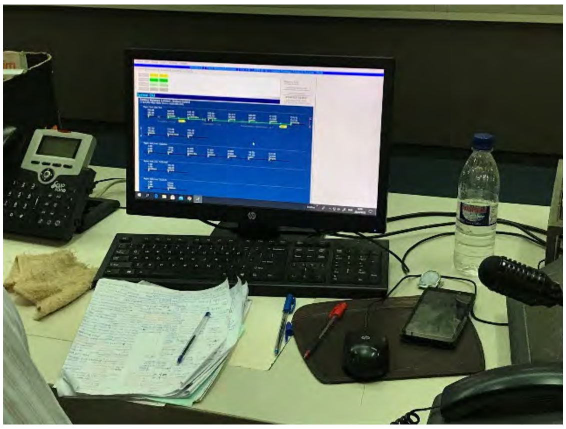
Source: JICA Study Team

Figure 6-34 Operation Control Center



Source: JICA Study Team

Figure 6-35 Train GPS information



Source: JICA Study Team

Figure 6-36 Traffic Control System

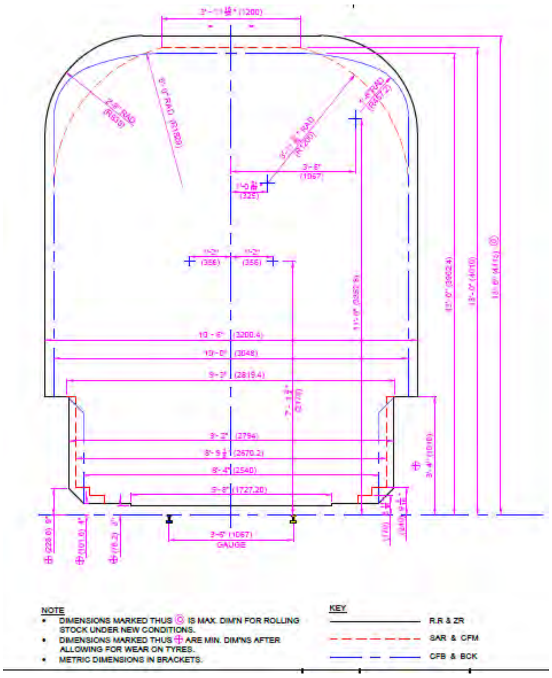
Source: JICA Study Team

Figure 6-37 Electric Signaling System Not in Use

6.6.5 Rolling Stock

(1) Technical Standards and Specifications

The rolling stock gauge information of Zambia Railway is as follows:



Source: Zambia Railway

Figure 6-38 Zambia Railway Rolling Stock Gauge

The rolling stock gauge in Zambia is not the same as in Japan. It is necessary to verify the dimensions when considering the use of secondhand rolling stock from Japan. There should be enough clearance from buildings and other structures.

(2) Condition of Rolling Stock

According to information obtained at the interview, Zambia Railway owns 54 passenger cars, about 25 of which are operable. The passenger cars formerly used for commuter service have capacity for 88 passengers per car and are currently used for the Economy Class of intercity service. ZRL has 25 diesel locomotives but a number of them have broken down and are not in use. Spare parts have been in short supply for several years. ZRL has a maintenance budget but ZRL is not generating enough revenue to finance the budget for necessary repairs.

Source: JICA Study Team

Figure 6-39 Passenger Car Formerly Used for Commuter Service

Source: JICA Study Team

Figure 6-40 Inside the Passenger Car

(3) Rolling Stock Depot and Rolling Stock Inspection Facilities

The depot is located at Kabwe (130 km north of Lusaka). The equipment for the simple maintenance of locomotives is located in Kitwe, Ndola, Kabwe, and Livingstone and the heavy maintenance equipment for overhauling diesel locomotives is located in Kabwe. The diesel locomotives are maintained in accordance with the manufacturer (General Electric Company) manuals. The diesel locomotive refueling facilities are located at Kitwe, Ndola, Kabwe, Kafue, and Livingstone. There is no refueling facility at Lusaka Station.

Source: JICA Study Team

Figure 6-41 Heavy Maintenance Equipment for Diesel Locomotives (1)

Source: JICA Study Team

Figure 6-42 Heavy Maintenance Equipment for Diesel Locomotives (2)

Source: JICA Study Team

Figure 6-43 Spare Parts

Source: JICA Study Team

Figure 6-44 Passenger Car Maintenance Facility

Source: JICA Study Team

Figure 6-45 Passenger Car Depot

Source: JICA Study Team

Figure 6-46 Light Maintenance Equipment for Diesel Locomotives (1)

Source: JICA Study Team

Figure 6-47 Light Maintenance Equipment for Diesel Locomotives (2)

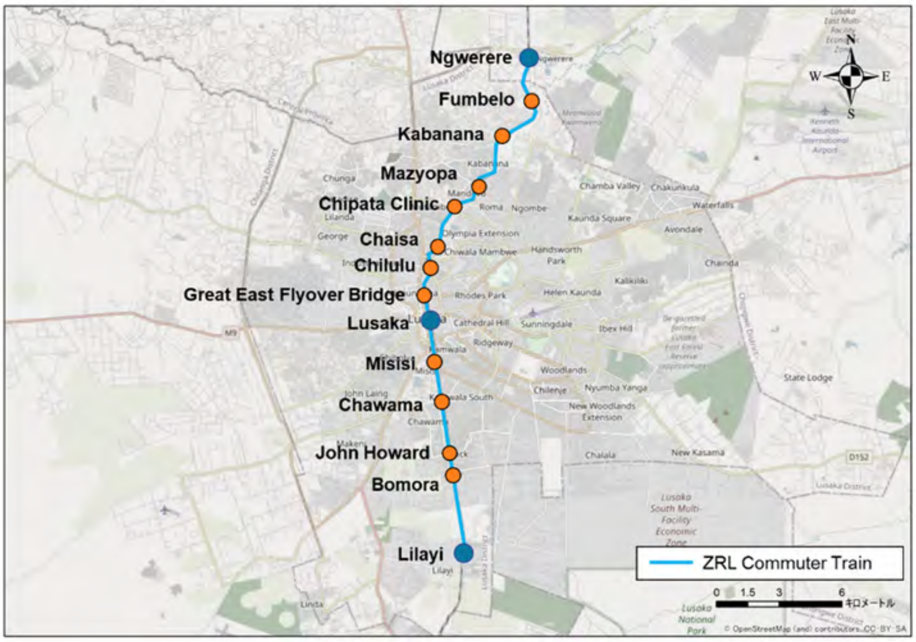
Source: JICA Study Team

Figure 6-48 Light Maintenance Equipment for Diesel Locomotives (3)

6.6.6 Stations

(1) Current State of Stations

The Ngwerere–Lilayi section of the Zambia Railway, which is the route being considered, used to have commuter train service. The three major stations of Ngwerere, Lusaka, and Lilayi still serve as stations for the intercity train service, which connects Kitwe and Livingstone. Lusaka Station has a platform and a station building but Ngwerere Station and Lilayi Station do not have station facilities. When the commuter service was in operation, there were intermediate stations at Bomora, John Howard, Chawama, Mississi, Great East Flyover Bridge, Chilulu, Chaisa, Chiata Clinic, Mazyopa, Kabanana, and Fumbelo.



Source: JICA Study Team

Figure 6-49 Stations for the Previous Commuter Service

1) Ngwerere Station

Ngwerere Station is a stop in the intercity train service. This station has a passing loop as it is a boundary station of the block section. Ngwerere does not have any station building or platform, only signs indicating the station name and a previously used roofed waiting area.

Source: JICA Study Team

Figure 6-50 Ngwerere Station

Source: JICA Study Team

Figure 6-51 Signs for Ngwerere Station

2) Lusaka Station

Lusaka Station is the gateway to the capital city of Lusaka. It is the terminal station for intercity trains. The platform currently in use is located on the east side of the station. The west side of the station has a passing loop and a storage track. There used to be a platform for commuter service on the west side of the station but it has now turned into a storage track. The station building for the commuter trains and exit/entrance to the CBD are also on the west side of the station.

Source: JICA Study Team

Figure 6-52 Platform for Intercity Service

Source: JICA Study Team

Figure 6-53 Intercity Train Entering Lusaka Station

Source: JICA Study Team

Figure 6-54 Platform Crowded with Passengers Alighted from the Train

*The Livingstone-bound train upon arrival at Lusaka Station

Source: JICA Study Team

Figure 6-55 Passing Loop and Storage Track

Source: JICA Study Team

Figure 6-56 Platform for Commuter Service

Source: JICA Study Team

Figure 6-57 Previously Used Station Building on West Side of Station

3) Lilayi Station

Lilayi Station is a station in intercity service. It has a passing loop as it is a boundary station of the block section. Lilayi does not have any station building or platform, only signs indicating the station name and a previously used roofed waiting area.

Source: JICA Study Team

Figure 6-58 Intercity Train Approaching Lilayi Station

Source: JICA Study Team

Figure 6-59 Crossing Trains

Source: JICA Study Team

Figure 6-60 Station Sign Post andPreviously Used Waiting Area

Source: JICA Study Team

Figure 6-61 Premises of Lilayi Station

4) Other Intermediate Stations

Bomora, John Howard, Chawama, Mississi, Great East Flyover Bridge, Chilulu, Chaisa, Chiata Clinic, Mazyopa, Kabanana, and Fumbelo were intermediate stations for the commuter train service; however, they are not in use currently. These intermediate stations have no platforms or station buildings, only signs showing station names. Some do not even have signs.

Source: JICA Study Team

Figure 6-62 Bomora Station

Source: JICA Study Team

Figure 6-63 John Howard Station

Source: JICA Study Team

Figure 6-64 Chawama Station

Source: JICA Study Team

Figure 6-65 Mississi Station

Source: JICA Study Team

Figure 6-66 Great East Flyover Bridge Station

Source: JICA Study Team

Figure 6-67 Chilulu Station

Source: JICA Study Team

Figure 6-68 Chaisa Station

Source: JICA Study Team

Figure 6-69 Chipata Clinic Station

Source: JICA Study Team

Figure 6-70 Mazyopa Station

Source: JICA Study Team

Figure 6-71 Kabanana Station

Source: JICA Study Team

Figure 6-72 Fumbelo Station

6.6.7 Station Plaza

(1) Current State of Facilities and Use

Lusaka Station has a paved station plaza and parking lot. On the other hand, Ngwerere Station and Lilayi Station are poorly equipped. They do not have station building, platform, station facilities, or station plaza. Zambia Railway designated 50 m to the left and right (100 m in total) of the track, a total of 100 m, as its premises. Some areas of the premises are leased to other companies, many areas are illegally occupied.

1) Ngwerere Station

Ngwerere Station does not have a station plaza, nor paved access roads from the main road. There is a small market near the station and minibuses run along the main road. According to interviews with local residents, when they could not catch a minibus near Ngwerere Station, they would walk about 6 kilometers west to Great North Road to take the minibus to the CBD.

Source: JICA Study Team

Figure 6-73 Access Road to Ngwerere Station (1)

Source: JICA Study Team

Figure 6-74 Access Road to Ngwerere Station (2)

Source: JICA Study Team

Figure 6-75 Market near Ngwerere Station

2) Lusaka Station

Lusaka Station has a paved station plaza and parking lot. Lusaka uses the railway mainly for freight transport, and rarely for passenger transport in the city. Lusaka has a bus network, with 5 bus terminals scattered around the city. However, there are no connections between the minibuses and the train stations. Zambia Railway owns a vast piece of open space in front of Lusaka Station.

Source: JICA Study Team

Figure 6-76 Lusaka Station Parking Lot

Source: JICA Study Team

Figure 6-77 Lusaka Station Plaza Station

Source: JICA Study Team

Figure 6-78 Access Road to Lusaka Station

Source: JICA Study Team

Figure 6-79 Open lot of Zambia Railway in front of Lusaka Station

Source: JICA Study Team

Figure 6-80 Intercity Bus Terminal

Source: JICA Study Team

Figure 6-81 Kulima Towere Bus Terminal

Source: JICA Study Team

Figure 6-82 City Market Bus Terminal

Source: JICA Study Team

Figure 6-83 Lummumba Bus Terminal

Source: JICA Study Team

Figure 6-84 Millennium Bus Terminal

3) Lilayi Station

Lilayi Station does not have a station plaza. Currently, access roads connecting the station and the main road are unpaved. Minibuses arrive and depart at the T-intersections with the main road around the station, where small shops cluster. The east side of Lilayi Station, within the premises of the Zambia Railway, is lined with illegally constructed houses.

Source: JICA Study Team

Figure 6-85 Central Area of Lilayi where Minibuses Arrive and Depart

Source: JICA Study Team

Figure 6-86 Access Road to Lilayi Station

Source: JICA Study Team

Figure 6-87 Houses Built on Zambia Railway Site near Lilayi Station

(2) Planning

According to the "Study on Comprehensive Urban Development Plan," a major modal shift from private cars to public transportation as of 2030 is necessary. The use of buses and resumption of commuter train service are being considered. Determination of the appropriate modal shares is essential in the development of urban transportation means for reducing congestion.

6.6.8 Passenger Service

(1) Fare Collection Methods of Public Transportation Means to be Connected to the Commuter Railway Being Considered

Passengers can make reservation for intercity service offered by Zambia Railway by telephone and purchase tickets at the station counter by cash or credit cards. Besides tickets, the ticket sale terminal can also process luggage transportation fees. Two conductors onboard the intercity train have portable terminals for ticket sale. Passengers who boarded at stations without station facilities can purchase their tickets through these terminals. Zambia Railway hopes to have a system that will allow people to book trains and purchase tickets on the Internet.

At present, minibus is the public transportation means in Lusaka. Bus fares can be paid by cash only and the fares vary depending on the distance traveled. The fare from Lusaka City to Lilayi is K20 (about 166 yen).[28]

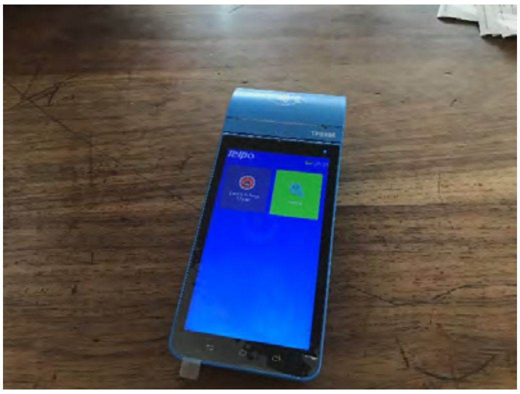
[28] 1 USD = 16.08 ZMW (Zambia Bank exchange rate in August 2022) converted using 1 USD = 134 yen (BOJ-NET FX rate

Source: JICA Study Team

Figure 6-88 Train Tickets

Source: JICA Study Team

Figure 6-89 Ticket Sale Terminal



Source: JICA Study Team

Figure 6-90 Portable Ticket Sale Terminal

Source: JICA Study Team

Figure 6-91 Ticket Counter

(2) Condition of Commuter Train Service

Zambia Railway provided commuter train service between Ngwerere and Lilayi from May 2015 to September 2016. According to the interview with Zambia Railway, it launched the commuter train service in response to requests from commuters who were unable to get to their workplaces on time due to the deterioration of traffic congestion in Lusaka City.

Each commuter train had one diesel locomotive and three passenger cars. The trains ran mainly in the morning and evening hours, making three round trips per day between Ngwerere and Lusaka and two round trips per day between Lusaka and Lilayi. The fares were approximately 79 yen from Ngwerere to Lusaka and about 63 yen from Lusaka to Lilayi.

Table 6-8 Timetable of the Commuter Service

Station From	Station To	Departure Time	Arrival Time
Lusaka	Ngwerere	5:30	6:10
Ngwerere	Lusaka	6:30	7:07
Lusaka	Lilayi	7:17	8:00
Lilayi	Lusaka	8:20	9:03
Lusaka	Ngwerere	9:13	9:50
Ngwerere	Lusaka	10:10	10:47
Lusaka	Lilayi	16:04	17:30
Lilayi	Lusaka	17:40	18:10
Lusaka	Ngwerere	18:20	19:20
Ngwerere	Lusaka	19:30	20:20

Source: Zambia Railway

in August 2022)

Table 6-9 Fares of Commuter Service from Lusaka Station to Other Stations

Station	Amount (ZMK)	Amount (yen)[29]
Lilayi/Bomora	4	63
Chawama/John Howard	3	47
Misisi	2	32
Chilulu/Chaisa	2	32
Chipata/Mazyopa	3	47
Kabanana/Fumbelo	4	63
Ngwerere	5	79

Source: Zambia Railway

The commuter train service had 55,263 passengers in the month with the highest ridership. June 2016, the month immediately before the suspension of service, had the lowest ridership of 16,725 passengers (excluding the first month as the service started on May 22, 2015). On average, there were about 278 passengers per trip, suggesting that demand exceeded the capacity of the passenger car (88 passengers/car) immediately before the commuter service was suspended. The number of trains varied from month to month. It was greatly reduced, in particular, between May 2016 and September 2016, the months immediately before the suspension of service.

In September 2016, Zambia Railway suspended the commuter service. In the interview, Zambia Railway gave the following reasons for the suspension:

- No diesel rail cars or other rolling stock suitable for commuter service
- No dedicated locomotives for commuter service(Commuter trains shared locomotives with the freight trains. Commuter trains could not operate while the locomotives were being used for freight transport. The locomotives also had technical problems frequently.)
- No locomotives or rail cars to increase the number of commuter trains during peak hours
- No station facilities (waiting rooms, toilets, etc.) for passengers

Table 6-10 Number of Trains Operated and Users of Commuter Service

Year	2015							
Month	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Trips (Trip)	44	143	121	108	129	122	115	108
Ridership (People)	8,691	55,263	33,656	29,478	34,646	33,361	26,662	28,082

Year	2016								
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Trips (Trip)	116	113	107	116	96	92	87	89	60
Ridership (People)	25,216	24,912	20,552	23,579	20,568	26,116	25,243	24,172	16,725

Source: Zambia Railway

[29] 1 USD = 7.67 ZMW (Zambian Central Bank's exchange rate in July 2015) converted using 1 USD = 121 yen (Bank of Japan's base exchange rate in July 2015)

6.7 Recommendations for Improvement Plans and Challenges

6.7.1 Basic Policy for Improvement

According to the interview (Ngwerere–Lilayi) with Zambia Railway, despite a temporary demand for commuter service between 2015 and 2016, ZRI has no plan to resume the commuter train service due to the lack of facilities (rolling stock, etc.).

It is not urgent for Zambia Railway to resume commuter train service, in view of the operation condition of Zambia Railway, its improvement plan, and the current situation of urban transportation in Lusaka City, as explained below. The resumption of commuter service shall be considered in a medium- to long-term perspective, taking into account progress of the ongoing projects at Zambia Railway and the present situation of urban transportation in Lusaka City.

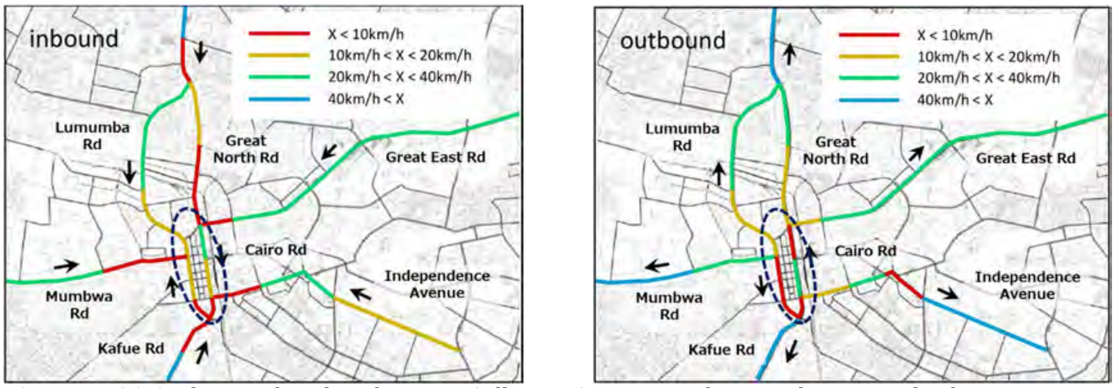
1) Operation Status and Improvement Plan for Zambia Railway

The infrastructure facilities of Zambia Railway, including tracks and signals, are not properly maintained and managed, thus threatening the safe operation of trains. As freight transportation account for approximately 90% (2020) of Zambia Railway's revenues, ensuring the safe operation of freight transportation—its main source of income—is a top priority.

Projects to upgrade the tracks, signals and rolling stock of the Zambia Railway are underway with the support of the Team Sweden Consortium. These projects are currently in the information gathering stage. Given that it may take some time for JICA to put together a grant aid project for Zambia, development of the infrastructure for commuter service shall be considered after the current projects for improving the Zambia railway system have been completed.

2) Current Traffic Situation in the City

Lusaka's CBD has traffic congestion during the morning and evening peak hours and lunch time on a daily basis. Car ownership in Zambia has been on the rise every year, reaching approximately 820,000 in 2019. Traffic congestion in the urban areas is expected to deteriorate further due to future economic development. However, the Travel Speed Survey conducted by JICA in the "Data Collection Survey on Urban Development and Urban Transportation in Lusaka City" shows that only a limited number of locations are experiencing lower travel speeds during the morning and evening peak hours. Therefore, the traffic congestion situation in Lusaka may not be so serious as to merit the construction of a rail transport system. However, as traffic congestion is already occurring near the CBD during peak hours, follow-up surveys and studies shall be conducted with a view to introducing a rail transport system in the future.



Source: JICA Study Team based on the "Data Collection Survey on Urban Development and Urban Transportation in Lusaka City, Zambia," 2022 conducted by JICA

Figure 6-92 Travel Speeds on Major Roads during Morning and Evening Peak Hours

3) Toward the Development of a Rail Transport System

Development of a rail transport system, such as for the resumption of commuter service on the Zambia Railway, has a high investment cost. However, because the major roads near the CBD already have traffic congestion during peak hours, it is advisable to identify routes for rail development and conduct surveys to forecast the demand of these routes. According to the "Survey on the Future of Development through Linking Railway Development with Urban and Regional Development" conducted by JICA in 2017, the problems shown below are problems commonly faced by large cities in developing countries that have populations over 5 million but do not have urban railways. Although Lusaka's population, which reached 2.73 million in 2020, is less than five million, a rail transport system shall be developed before the problems below become more serious.

- Competition for road space from the development of public transportation systems such as BRT, bus, and paratransit
- Decline in competitiveness of public transportation as motorcycles gain popularity
- Traffic congestion deteriorates as the number of private vehicles increases
- Overcrowding and deterioration of the living environment in urban centers accelerate the sprawling of suburban areas and increase trip distance
- Deterioration of traffic congestion and increase in trip distance drastically lengthen the travel time for commuters and students

6.7.2 Preconditions for Commuter Service

As mentioned above, the resumption of commuter service by Zambia Railway should be considered with a medium- to long-term perspective. The following are some of the issues related to the resumption of commuter service that should be considered:

(1) Tracks

As mentioned in the section on Track Condition, the resumption of commuter service will require the addition of a passing loop in the Ngwerere–Lilaii section and track improvement at the Ngwerere, Lusaka, and Lilayi stations.

Since the existing railway maintenance facilities and systems are not sufficient to maintain and manage the tracks, capacity-building measures, such as by sending local staff to train in a third country like Indonesia where Japanese technology and know-how have been used for railway operations, should be considered in order to enhance capacity.

(2) Signals

As shown in the section on Signaling System, a manual level crossing warning system should be installed to improve the safety of railways and road traffic. Installation of a level crossing warning system will necessitate the training of level-crossing gatemen for the operation, as well as maintenance and failure recovery training for maintenance staff.

The Team Sweden Consortium is scheduled to upgrade the existing signaling equipment of Zambia Railway. A detailed understanding of the contents of improvements to the signaling equipment by the Team Sweden Consortium is imperative to the resumption of commuter service. Addition of a block section between Ngwerere and Lilayi should be considered.

(3) Rolling Stock

As shown in the section on Condition of Rolling Stock, rolling stock suitable for commuter service is needed. Besides the shortage of parts, many rail cars are out of order. Therefore, in addition to procuring new rolling stock, a maintenance system should also be put in place in order to maintain and manage the rolling stock on a continuous basis. At present, since Lusaka Station does not have refueling facilities, the diesel locomotives have to be transferred to Kabwe or Kafue for refuels. Therefore, facilities for refueling and light maintenance should be set up near the stations of commuter service when operation is resumed.

(4) Station Facilities

Although Ngwerere and Lilayi stations are currently used for intercity service, they do not have station buildings or platforms, nor the conditions to ensure safe use by passengers. The platform and station building previously used for commuter service at Lusaka Station are aging. One of the reasons for the suspension of commuter service was because the station facilities were not maintained properly during rainy seasons. These station facilities must be restored for the commuter service to resume.

Bomora Station, John Howard Station, Chawama Station, Mississi Station, Great East Flyover Bridge Station, Chilulu Station, Chaisa Station, Chiata Clinic Station, Mazyopa Station, Kabanana Station, and Fumbelo Station were the intermediate stations during the commuter train service, but they are not currently in use. At present, the suburbs of Lusaka have few stations, making it difficult to provide commuter service to meet demand. The development of new stations and restoration of the existing ones for operation should be considered.

(5) Station Plaza

Since the railway in Lusaka is used mainly for freight service, Lusaka Station and its station plaza do not have adequate facilities. It also lacks connection with other transportation modes. To make it easier for passengers to use the commuter train service in the future, the station plaza shall be improved to facilitate connection with other transportation means.

Source: JICA Study Team

Figure 6-93 Image of Station Plaza

(6) Passenger Service

The public transportation system, including railways and minibuses, has different operators. Because private businesses and individuals are involved in road transportation, there are many stakeholders in the operation of the public transportation system. Since the participation of national and state governments is essential for the implementation of policies, it may take time to coordinate with the various stakeholders in order to introduce comprehensive policies to promote the use of public transportation. Nevertheless, it is imperative for Zambia Railway to work with the minibuses—the existing public transportation means—in formulating policies to promote the use of public transportation when it resumes commuter train service.

6.8 Conclusion

In 2009, JICA formulated the Comprehensive Urban Development Plan for the City of Lusaka. In view of the fact that more than 10 years have passed since the urban development plan was formulated and the urban situation is evolving constantly, JICA is focusing its efforts on conducting surveys to draw up a new comprehensive development plan and reviewing road development projects to alleviate traffic congestion in Lusaka. On the other hand, given that traffic congestion is occurring on the main roads around the CBD in Lusaka during peak hours, a new rail-based public transportation system should be introduced.

In light of the situation, it is necessary to select candidate routes for development and conduct surveys to forecast the demand of each route with a view to introducing a railway transportation system.

Chapter 7 Dakar (Senegal)

7.1 Overview of Senegal and Dakar

7.1.1 Senegal

(1) Geographic Overview

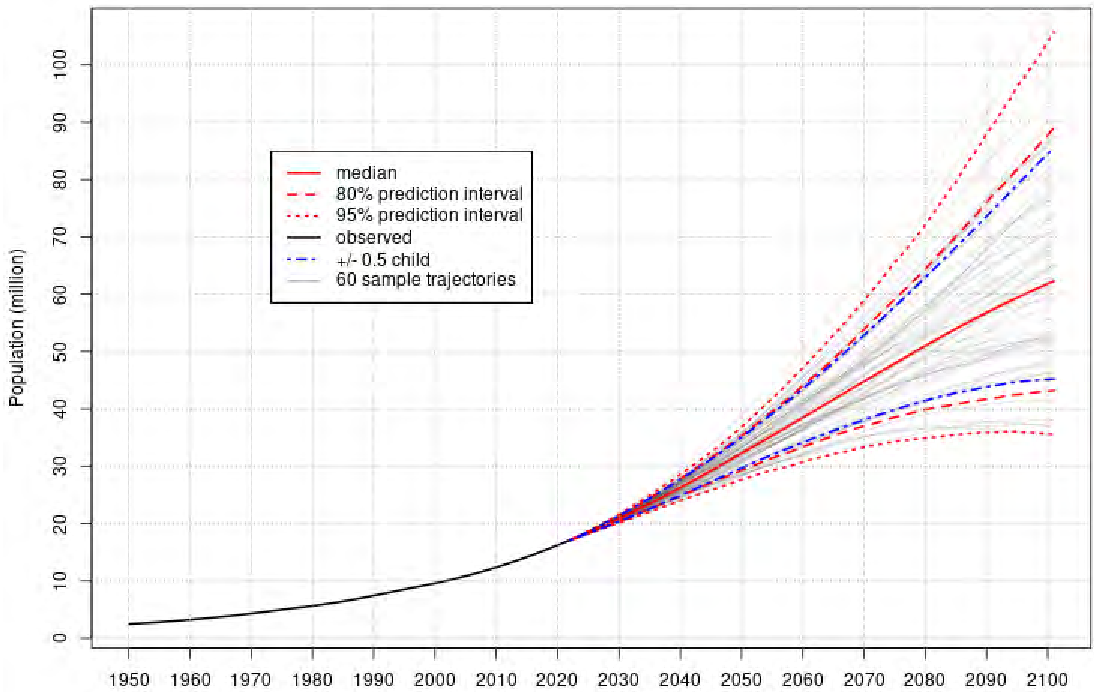
The Republic of Senegal is located at the western edge of the African continent, bordering the Republic of Mauritania in the north and northeast, the Republic of Mali in the east, and the Republic of The Gambia, the Republic of Guinea-Bissau, and the Republic of Guinea in the south (Figure 7-1). There are highlands in the eastern and southern parts of the Republic of Senegal; however, the vast majority of the land is plains less than 100 m above sea level, with desert spreading in the north. Senegal plays an important logistical role in trading with North America, Europe, the Middle East, South Africa, and the inland countries of West Africa.

The population of Senegal reached 17.2 million as of 2021[30]. It has doubled in the last 20 years. The population is expected to continue to grow in the future. It is projected to exceed 30 million in 2045 and over 40 million in 2065 (Figure 7-2).

Source: Prepared by JICA Study Team based on Open Street Map

Figure 7-1 Location of the Republic of Senegal and the Capital of Dakar

[30] World Bank https://data.worldbank.org/



Source: United Nations, Department of Economic and Social Affairs, Population Division[31]

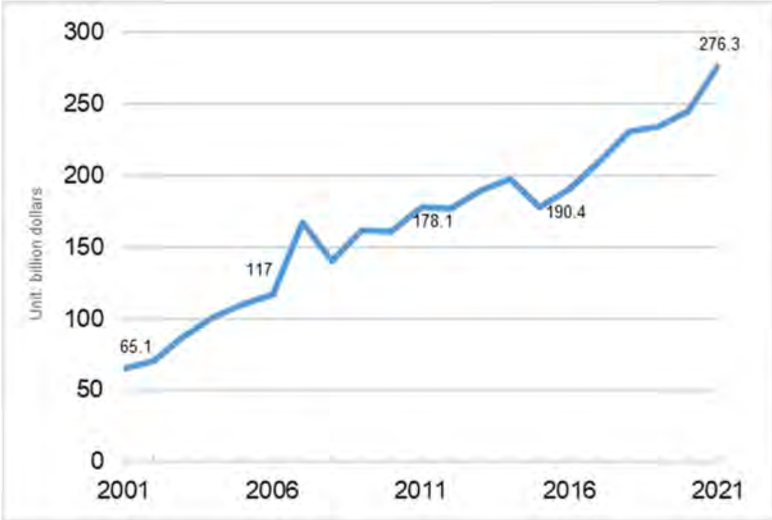
Figure 7-2 Trends and Projections of Senegal Population

(2) Economic Overview

The economy of Senegal had been stagnant since the end of the 1970s due to budget deficit, current account deficit, and external debt caused by a slump in the peanut industry, etc. In 1994, the government of Senegal carried out various structural reforms, including devaluation of the CFA franc, privatization of state-owned enterprises, revision of the labor law, and liberalization of import prices. Since 1995, the economy has been on a growth trend, maintaining an economic growth rate of around 5% or more. According to the World Bank, Senegal's economic growth rate in 2021 was 6.1%. The GDP per capita rose to $1607 (2021: World Bank), and the nominal GDP reached $27.6 billion (2021: World Bank). The economy has more than quadrupled in size over the last 20 years (Figure 7-3). Especially the tertiary sector, which accounts for two-thirds of GDP, has seen considerable development in commerce, logistics, and communications. This trend is expected to continue, and significant growth is expected in the future. The mining industry, such as gold, titanium, and phosphorus ore, is expected to expand. The oil and gas industries are expected to flourish. The oil and gas fields on the coastal areas of Senegal, Mauritania, and Gambia will start operations in 2023. On the other hand, Senegal is faced with many issues, such as the widening gap between the rich and the poor, and the unemployment among young people.

The current Macky Sall administration formulated the "Plan Sénégal Emergent (PSE)," a development strategy for Senegal to become an emerging country by 2035. It has been working to diversify the areas of economic growth and revitalize the private sector. The development strategy covers the 10 years from 2014 to 2023. It has three pillars: "economic structural reform and growth," "human capital, social security and sustainable development," and "governance, institutions, peace, and security."

[31] United Nations, Department of Economic and Social Affairs, Population Division https://population.un.org/wpp/



Source: Prepared by JICA Study Team based on World Bank data

Figure 7-3 Trends in Nominal GDP

(3) Political and Administrative Systems

President Senghor, also one of Africa's leading literary scholars, established the foundation of today's democratic Senegal. As a center-left politician, he introduced a multi-party system in 1976. In the 1970s, he promoted the Agency of cultural and technical cooperation (Agence de cooperation culturelle et technique, ACCT), which changed the name later to the International Organization of La Francophonie (Organisation Internationale de la Francophonie, OIF). President Diouf, who assumed the presidency in January 1981, continued to follow the basic policy of the previous administration, but promoted a series of democratization policies, including the removal of restrictions on the number of political parties and the liberalization of political associations. However, people's support for the ruling party gradually declined. In the March 2000 presidential election, President Wade of the Senegalese Democratic Party (Parti Démocratique Sénégalais, PDS) defeated President Duff, bringing an end to the long-term rule of the Socialist Party of Senegal (Parti Socialiste du Sénégal, PSS) (formerly Senegalese Progressive Union, Union progressiste sénégalaise, UPS), which lasted for about 40 years. The Wade administration, which continued for two consecutive terms, worked to launch the New Partnership for Africa's Development (NEPAD), while promoting the reorganization and privatization of state-owned enterprises, large-scale infrastructure development, and agricultural policies.

In the presidential elections in February and March 2012, President Sall of the Alliance for the Republic (Alliance Pour la République, APR), who served as prime minister during the Wade administration, was elected to the presidency. Following the previous elections, a peaceful and democratic change of government was achieved, which garnered praise from the international community. President Sall has set out policies for political transparency and decentralization with the aim of reducing social disparities and revitalizing the local economy. In the Casamance region, where separatist movements have been active since the 1980s and where the situation is still unstable, President Sall has been working to resolve the long-standing issues, such as by promoting peace negotiations with representatives of the Movement of Democratic Forces of Casamance (Mouvement des forces démocratiques de Casamance, MFDC) and revitalizing the economy of the region. President Sall was reelected in the 2019 presidential election, and the inauguration ceremony was held in April of the same year. (The term of office is five years due to the 2016 constitutional amendment.).

Senegal pursues a moderate and realistic foreign policy. It has established friendly relations with France, a former imperial country, and many other Western countries. Senegal is also a member of the Organization for Islamic Cooperation (OIC). It is working to strengthen its economic partnerships with the Islamic countries.

Senegal is a stabilizing force in the region because it has never experienced political instability or a coup d'état since independence. It has been actively involved in the African Union (AU) and the Economic Community of West African States (ECOWAS). President Sall served as chair of the New Partnership for Africa's Development from 2013 to February 2020, and currently chairs the AU. Senegal has been contributing to the stabilization of West Africa by dispatching personnel to the United Nations Peacekeeping missions in Mali and Central African Republic, as well as acting as an intermediary between neighboring countries such as Burkina Faso and Guinea-Bissau. The Minister of Justice of Senegal, Mr. Sidiki Kaba, was the first African elected to be the Chair of the International Criminal Court (ICC) in December 2014. Senegal also served as a non-permanent member of the United Nations Security Council from 2016 to 2017. It is contributing proactively to the peace and stability of the international community.

Senegal recognized Taiwan, instead of China, in 1996, but it restored diplomatic relations with China in October 2005. It broke off diplomatic relations with Iran in 2011, but announced the restoration of it in February 2013. In June 2022, the economic sanctions imposed by ECOWAS on neighboring Mali were lifted.

(4) Japan's Assistance Policy (Official Development Assistance)

Japan's development cooperation policy for Senegal is based on the Senegal Emerging Development Program (PSE), which aims to make Senegal an emerging country by 2035. To assist Senegal in pursuing sustainable development with an economic growth rate of over 6% per year, Japan will support Senegal in social development to reduce disparities and strengthen resilience in parallel with promoting economic development. Through these measures, Japan aims to promote development in Senegal that balances both the economic and social aspects, support high quality growth, and contribute to the SDGs.

7.1.2 The City of Dakar

(1) Basic Data

Dakar is the commercial center of West Africa, located at the westernmost tip of the African continent. It has offices of multilateral institutions, and headquarters of the Central Bank of West African States (Banque centrale des États de l'Afrique de l'Ouest, BCEAO).

The population of the Dakar metropolitan area is on the rise and is expected to reach 3.7 million in 2020[32] and 5 million in 2025.

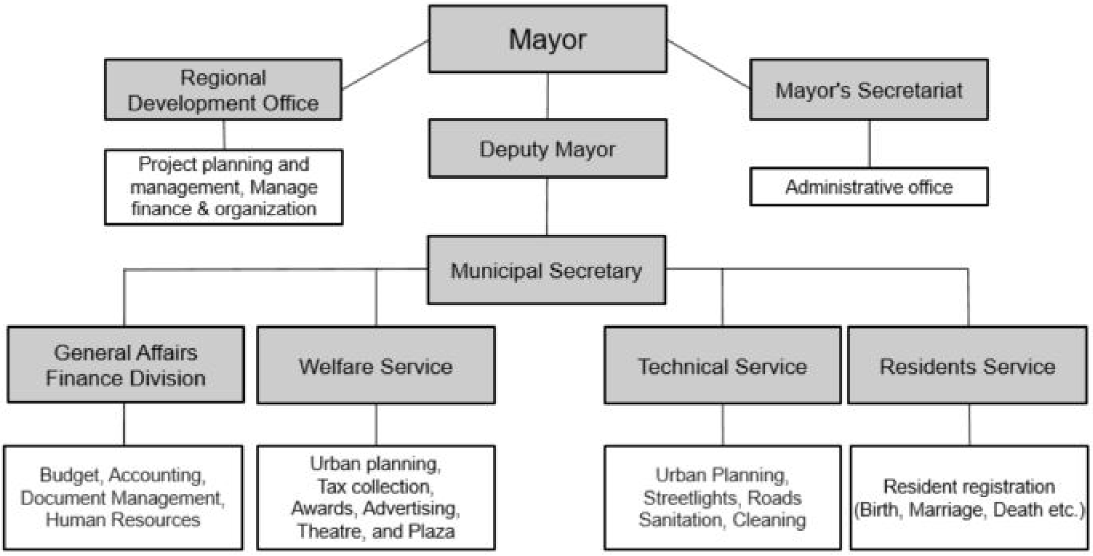
Pompidou Street is the city's main street, used by many trucks, cars, and minibuses. The city center has the Kermel market, Soumbédioune market, and Sandaka Merket, which is the biggest in Senegal. The urban areas have expanded without much planning, and infrastructure development is lagging behind. There are also problems such as flooding and unreliable power supply.

(2) Institutional Framework

Dakar City has 19 districts in four areas. The chief executive of the municipal government is the mayor, who is elected by citizen votes. The term of office is five years with no reelection. The municipal government is organized by function. Each department provides various civil services. The Regional Development Office, under the direct control of the mayor, coordinates projects

[32] Embassy of Japan in Senegal https://www.sn.emb-japan.go.jp/files/100101922.pdf

and serves as a contact point for project implementation. Figure 7-4 shows the organization chart of the municipal government.



Source: Prepared by JICA Study Team based on the official website of Dakar City

Figure 7-4 Dakar City Organization Chart

7.2 Current State of Urban Transport Infrastructure

7.2.1 Rail

(1) Overview of Railways around Dakar

The Senegal National Railways (Société Nationale des Chemins de fer du Sénégal, SNCS) started suburban passenger transport in 1987 between Dakar and Rufisque under the name Petit Train Blue. Then in 2003, a new company "Petit Train de Banlieue (PTB)" was established to operate suburban railways. The suburban railways and buses have been severely congested in recent years. Therefore, the Senegalese government decided to construct a new railway line to connect Dakar, Diamniadio, and Blaise Diagne International Airport (Aéroport international Blaise-Diagne: AIBD). The new railway line was incorporated into "The Plan for an Emerging Senegal (PSE)," the new policy framework of President Macky Sall's government. Diamniadio is a newly constructed city, serving as a subcenter of Dakar. The right of way of PTB (a meter-gauge line) was utilized to construct the new railway, named TER (Train Express Régional). It is developed by the Agency for the Promotion of Investments and Major Works (Agence nationale chargée de le Promotion des Investissements et des Grands Travaux: APIX), which undertakes national projects for the government of Senegal. The project is financed by the French Development Agency (Agence Francaise de Development, AFD) and the African Development Bank (AfDB). The Dakar–Diamniadio section was opened in December 2021 as the first phase, and at the same time, the PTB, which used to operate the meter-gauge lines, was abolished. The second phase is currently being constructed between Diamniadio and the AIBD.

(2) Current Senegal Railway Organizations

Figure 7-5 shows the relationships between the railway organizations in Senegal. In Senegal, as in Europe, the railway industry is shifting to a so-called vertical separation structure, consisting of two kinds of organizations: an asset management company and a train operation company (operator). The former owns and manages the railway infrastructure, and the latter manages train operations. Various regulatory bodies are also in place.

MITTD : Ministére des Infrastrutures, des Transports Terrestres et du Désenclavement
(Ministry of Infrastructure and Land Transport)

SERF : Secrétariat d'État au Réseau Ferroviaire
(National Secretariat for Railway Network)
Regulatory body responsible for legislation about railway,
and supervision of railway operators and asset management companies

Gauge / Organization	Metre-gauge Railway	Standard-gauge Railway (TER)
Operation companies	**GTS S.A. : Grands Trains du Sénégal (Senegal Mainline Railway Co., Ltd.)** ・Public company for meter-gauge network (Passenger and Freight) ・Successor organization of PTB(Petit Train Banlieue) **ICS : Industries Chimiques du Sénégal (Chemical Industry of Senegal)** ・Phosphorus mining company ・Singapore-based subsidiary of Indonesian company Indorama **GCO S.A. : Grande Côte Opérations (Grande Côte Co., Ltd.)** ・Zircon Ilmenite mining company	**SETER S.A.** ・Operation company for TER
Infrastructure management company	**CFS S.A.: Chemins de fer du Sénégal (Senegal railways Co., Ltd.)** ・Asset management company for meter-gauge network ・Successor organization of ANCF and DBF	**SEN-TER S.A.** ・Infrastructure management company for TER ・Established in June 2019

Source: JICA Study Team

Figure 7-5 Organization of Railways in Senegal

Currently, Senegal has two types of railways: the meter-gauge railway, which was developed nationwide during the French colonial era and is still in use, and the standard-gauge railway (TER), which was newly developed near Dakar at the end of 2021.

As mentioned earlier, Senegal has adopted vertical separation. The operators of the meter-gauge railways currently include two mining companies, which are still operating cargo trains for mineral transportation. On the other hand, GTS (Grands Trains du Sénégal S.A.) is planning to operate passenger and freight trains too. CFS (Chemins de Fer du Sénégal S.A.) has been established to take over the ownership and management of all the assets of past meter-gauge railways.

On the other hand, SETER (Société d'Exploitation et de maintenance de la ligne du TER S.A.) and SEN-TER (Société Nationale de Gestion du Patrimoine du Train Express Régional S.A.) have been established as the operator and the asset management company, respectively. SETER is currently operating as a subsidiary of Keolis S.A. of the French National Railways Group. On the other hand, SEN-TER does not have any activities currently. APIX, which was in charge of developing the TER, still holds and manages the assets. The transfer of assets to SEN-TER has not been completed.

In addition, the National Secretariat for Railway Network (Secrétariat d'État au Réseau Ferroviaire, SERF) was established under the Ministry of Infrastructure and Land Transport (Ministère des Infrastructures et des Transports Terrestres et du Désenclavement, MITTD) in 2019.

(3) Petit Train de Banlieue (Previous Meter-gauge Railways)

The PTB (Petit Train de Banlieue) was operated mainly between Dakar and Rufisque, and between Dakar and Thiès. During the annual pilgrimage of Mouride brotherhood to Touba and the pilgrimage of Tijaniyyah brotherhood to Tivaouane, the train operation was extended from Thiès to the nearest station of each mosque.

The train consisted of first-class cars and second-class cars. There were four train sets, each with 20 cars. Three of the four train sets were DMUs, and eight of the twenty cars were equipped with air conditioners.

Table 7-1 summarizes the PTB routes and services at the time of operation.

Table 7-1 Outline of Petit Train de Banlieue (PTB) Operation

Route	Dakar–Rufisque	Dakar–Thiès
Stop stations	15 stations	7 stations
Number of trains per day	14 round trips	1 round trip

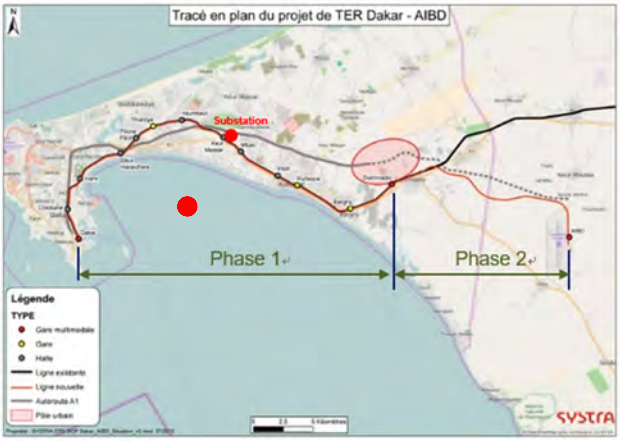
Source: Prepared by JICA Study Team from the Dakar Urban Traffic Executive Committee website, etc.

Source: Dakar Urban Transport Execution Committee website

Figure 7-6 Train of Petit Train de Banlieue (PTB)

(4) TER (Standard-gauge Railway with Support from France and Others)

APIX, which implements national projects for the government of Senegal, has constructed a standard-gauge railway line near Dakar, called the Train Express Régional, in recent years. The first phase, consisted of 13 stations (36 km) between Dakar and Diamniadio, was opened in December 2021. The second phase, consisted of 19 km between Diamniadio and the AIBD, is currently under construction. The launch of TER has created jobs for 950 new employees, and 20% of all drivers are women.



Source: JICA Study Team from MITTD website

Figure 7-7 TER Route

1) Track

The existing meter-gauge railway site between Dakar and Diamniadio was expanded and reconstructed, and the section was opened in December 2021. The track width of the past meter-gauge railway was 30 to 35 meters. Removing the buildings on both sides of the railway line secured a width of 55 meters, making it possible to have a site where both the TER standard-gauge railway and the meter-gauge railway could be double track. In the first phase, a double track of the TER standard-gauge railway and a single track of the meter gauge railway were constructed. The construction work for the track was ordered separately for the standard gauge and meter gauge. The construction of the standard gauge was carried out by a joint venture of the leading French construction company Eiffage S.A., the major Turkish construction company Yapi Merkezi, and the Senegalese construction company CSE (Compagnie Sahélienne d' Entreprises), a major Senegalese construction company. The meter-gauge track was handled by TSO (Travaux du Sud-Ouest), which is a subsidiary of Nouvelles Générations d'Enterpreneurs (NGE) and a major French construction company specialized in railway construction.

These railway tracks are surrounded by fences to ensure safety, and all of the intersecting roads and sidewalks are made into overpasses above the railway.

Source: JICA Study team

Figure 7-8 Double-track Standard Gauge and Single-track Meter Gauge

Source: JICA Study team

Figure 7-9 Track Surrounded by Fences

2) Signals, Communication Systems, and Power Supply

The ETCS (European Train Control System) Level 2 is used as the signaling system, and GSM-R (Global System for Mobile Communications-Railway) is used as the communication system.

The systems were delivered by Engie Ineo S.A. and Thales S.A. from France. The signaling system for the meter-gauge railway has also been changed and the turnouts have been made controllable by TER's Operation Control Center (OCC) but they have not been used yet.

The overhead line system is used for current collection, and the voltage of the overhead wire is 25000V AC. The substations are located at Mbao commune near the Keur Mbaye Fall Station.

3) Rolling Stock

The “Coradia Polyvalent” series EMUs, used by the French national railway company, has also been used by TER since 2016. The Coradia Polyvalent series has two types of propulsion systems: trains powered only by electricity and trains powered by both electricity and diesel (bi-mode type). TER uses the bi-mode type trains to avoid power outages. Each train set has four cars, with capacity for 565 passengers. Fifteen train sets were introduced in the first phase of the project. The cars are divided into 1st class and 2nd class.

Source: JICA Study Team

Figure 7-10 Exterior of a TER Train

Source: JICA Study Team

Figure 7-11 Interior of Second Class Car

4) Stations

The Dakar and Rufisque stations, built in 1914, have been renovated. The other stations were also upgraded to enhance accessibility. A new station has been built in Diamniadio, with buses going to and from the airport.

Elevators, escalators, and ramps have been installed at each station, providing access to people with disabilities. The level difference between the platform and the train is also reduced.

Source: JICA Study Team

Figure 7-12 Dakar Station

Source: JICA Study Team

Figure 7-13 Dakar Station Building

Source: JICA Study Team

Figure 7-14 Diamniadio Station

Source: JICA Study Team

Figure 7-15 Diamniadio Station Building

5) Operation

Trains operate on weekdays from 5:30 to 23:00, and on Sundays and holidays from 6:30 to 23:00. The trains run every ten minutes from 5:30 to 20:00 on weekdays, and every twenty minutes during the other hours on weekdays and on Sundays and holidays.

6) Fares

The fares are set based on the three zones of the route. The tickets are paper tickets with a QR code printed on them, which can be held up to an automatic ticket gate for entry and exit of the station. Commuter passes for 10 trips, one week, and one month are also available, with additional discounts for children (ages between 4 and 10) and young people (ages between 10 and 22). The commuter passes are issued on IC cards called Sama TER cards (Carte Sama TER). They come in two types: bearer and registered. The IC cards can be credited with as little as 1500 CFA.

Source: SETER website

Figure 7-16 TER Fare Zone

Table 7-2 TER Second Class Fares

Zone	Zone 1	Zone 2	Zone 3
Zone 1	500 CFA	1000 CFA	1500 CFA
Zone 2	1000 CFA	500 CFA	1000 CFA
Zone 3	1500 CFA	1000 CFA	-

The fare between two stations at the boundary of two zones is 500 CFA.
Source: SETER website

Source: SETER website

Figure 7-17 TER Ticket and IC card

7) Current State and Future Plans for the Coexistence of Meter-gauge Railway and TER

As mentioned earlier, TER was constructed using the past meter-gauge railway site. In the first phase of construction, a single track of the meter-gauge railway was also installed, and freight trains are in operation now. The TER trains need to cross the meter-gauge track from the main line when entering the depot. In the past, the meter-gauge railways frequently derailed, causing safety problems. Currently, the meter-gauge freight trains operate only from midnight to early morning, outside the TER operating hours in order to prioritize TER operations.

Platforms for the meter-gauge railway are being built at Dakar and Diamnadio stations, in preparation for the future operation of meter-gauge passenger trains. Although there is no specific timeline for the resumption of passenger train services, GTS is currently preparing for the resumption of passenger train services from Diamnadio to Saint-Louis, Touba, and Kaolack.

7.2.2 Non-rail Public Transportation

In addition to the railways, route buses, minibuses, and taxis provide public transportation around Dakar city. The operation of motorcycle taxis, however, is prohibited around Dakar.

(1) Route Buses Operated by Two Operators

Two bus operators operate route buses around Dakar: “Association de Financement des professionnels du Transport Urban (AFTU)” and “Dakar Dem Dikk (DDD).” Table 7-3 gives an outline of the two companies.

Dakar Dem Dikk operates mainly buses manufactured by Ashok Leyland in India. The buses were introduced in 2016. The company has also been operating feeder buses around three TER stations since February 2022: one line from Dakar Station, four lines from Colobane Station, and two lines from Diamniadio Station, totaling seven lines. The fares start at around 100 CFA.

Table 7-3 Outline of Route Bus Network around Dakar

Route Bus Operator	Association de Financement des professionnel du Transport Urban (AFTU)	Dakar Dem Dikk (DDD)
Typical vehicle		
Number of routes	64 routes	31 routes
Annual number of passengers	266 million people	54.75 million people

Source: Prepared by JICA Study Team based on information from the Dakar Urban Traffic Executive Committee website, etc.

(2) Minibuses Converted from Old Commercial Vehicles

In addition to route buses, minibuses are also operated around Dakar city. There are two types of minibuses: the “Cars rapides” minibuses, which are converted from old commercial French vehicles and painted in yellow and blue, and the “Ndiaga Ndiaye” minibuses, which are also converted from old commercial vehicles but painted in white, and the body is longer than that of the Cars rapides. The fares start at around 50 CFA.

Source: JICA Study Team

Figure 7-18 Cars Rapides

Source: JICA Study Team

Figure 7-19 Ndiaga Ndiaye

(3) Minibus Cars Rapides as a Symbol of Senegal

The vehicles used for the minibus Cars Rapides were imported from Europe to Senegal as commercial vans called “Super Goélette.” They were manufactured by Renault from 1965 to 1982. The vehicles have been modified. Windows and seats were installed and traditional motifs and prayer words were printed on the car body. Cars Rapides vehicles with such decoration are famous as a symbol of Senegal. Cars Rapides models and paintings are widely used as souvenirs from Senegal. At the “Musée de I’Homme” in Paris, France, the actual car of a Cars Rapides is displayed as “an industrial product of a developed country reconstructed for globalization."

(4) Taxis and Others

Similar to the minibuses, the taxis are old vehicles. These taxis can be called using a dispatch application. In addition to licensed taxis, there are also unlicensed taxis, known as Clandos, in Dakar.

Toyota Tsusho Corporation invested in YEEG S.A.S, the company that developed the taxi dispatch application “KAI” in Senegal, through an investment company Mobility 54, which Toyota Tsusho Corporation established with its subsidiary, CFAO S.A.S. Together with deployment of the application, KAI purchased new Toyota cars and has begun operating them as taxis. The service aims to become a major player in the taxi industry in Dakar by the end of 2022. It is also considering expansion into other countries in West Africa.

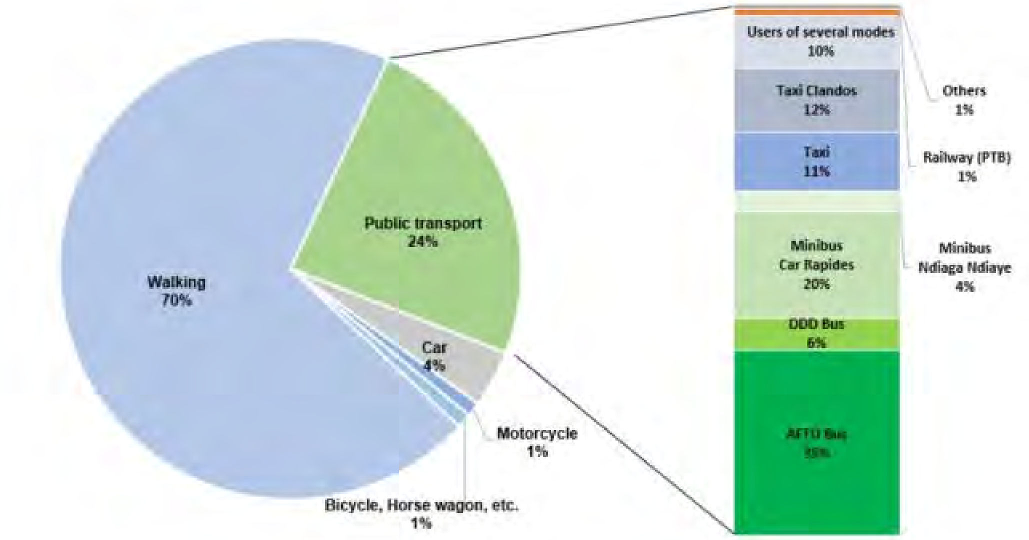
Source: JICA Study Team

Figure 7-20 Taxis in Dakar

7.2.3 Modal Share in Dakar

In 2015, the Dakar Urban Transport Executive Committee (Counseil Executif des Transports Urbains de Dakar: CETUD) conducted a household survey on mobility, transport, and access to urban services in the Dakar metropolitan area (Enquête- ménages sur la Mobilité, les Transports et l'Accès aux Services Urbains dans l'Agglomération de Dakar, EMTASUD), with support from the World Bank. The survey studied the mobility of residents aged 11 years old and over.

According to the survey, 70% of the transport share in Dakar was foot traffic, while public transport accounted for 24%. Buses, minibuses, and taxis accounted for the majority of public transport use, with railways (PTB) accounting for only 1% of public transport use. In addition to the railways, route buses, minibuses, and taxis provide public transportation around Dakar city. On the other hand, the operation of motorcycle taxis is prohibited around Dakar.



Source: Dakar Urban Traffic Executive Committee website

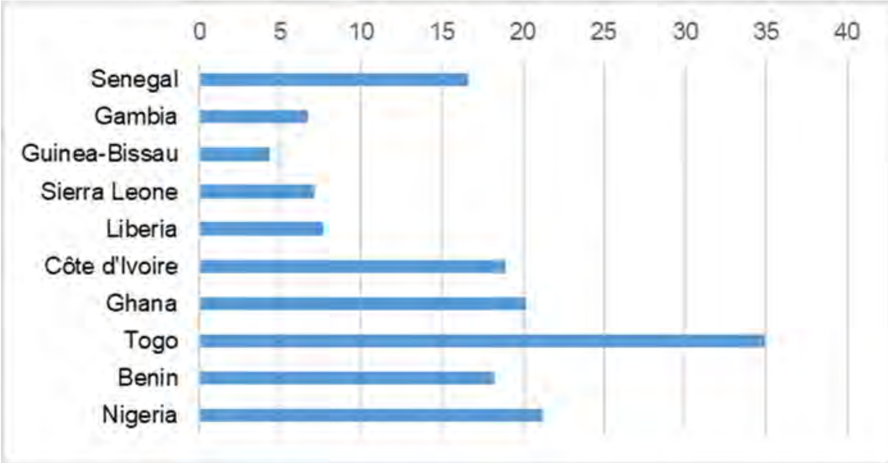
Figure 7-21 Modal Share in Dakar

7.3 Current Status Wide-Area Transport

7.3.1 Port and Harbor Infrastructure

(1) Overview of the Port of Dakar

The Port of Dakar is located at the westernmost tip of the African continent and is one of the leading international trading ports in the West African region. Figure 7-22 is a comparison of the values of the Liner Shipping Connectivity Index (LSCI) published by the United Nations. The comparison provides an overall assessment of the position of Senegal in the maritime logistics network. In the Gulf of Guinea, countries with a relatively high capacity to handle maritime logistics are lined up, led by Togo, which has the port of Lome. On the other hand, Senegal's handling capacity is particularly prominent among the countries on the Atlantic coast, making the port of Dakar an important logistics hub not only for the country but also for neighboring countries. The Port of Dakar is also an important location from a geographical point of view for maritime logistics. It is a strategic point for maritime connection between the European–South American and European–South African routes. The port of Dakar is the gateway for Senegal's import and export cargoes, which are increasing every year. The volume of cargoes handled has been increasing from about 10 million tons in 2008 to about 19 million tons in 2018, almost doubling the volume.



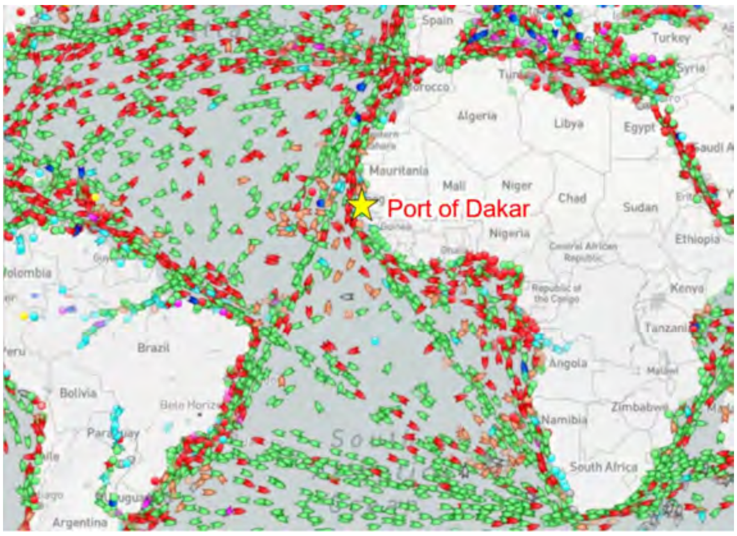
Source: UNCTAD STAT

Figure 7-22 Comparison of LSCI of West African countries

The Port of Dakar also serves as an important logistics hub for the countries inland. In particular, approximately 80% of Mali's import cargoes are transported through the Port of Dakar as of 2022 (source: ECDPM). As Mali is a landlocked country, its trade through maritime logistics must go through the ports of coastal countries. Trade by sea in Mali has traditionally been conducted via the ports of Conakry (Guinea) and Abidjan (Côte d'Ivoire), in addition to Port of Dakar. In 2000, 80% of Mali's imports by sea were via the Port of Abidjan. By 2003, they had fallen to 14%.

Between 2011 and 2015, the volumes of Malian imports and exports handled at the Port of Dakar averaged approximately 1.8 million tons. They continued to increase in tandem with GDP growth. The Port of Dakar handled 1.85 million tons of Malian imports and exports in 2013, of which 230,000 tons were exports from Mali and 1.62 million tons were imports, with imports accounting for the majority. Rice, fertilizers, sugar, hydrocarbons (fuel), and urea were the main import items, while exports were mainly ores and cotton. Mali's largest export is gold, but the ore is rarely exported via the Port of Dakar as it is processed domestically.

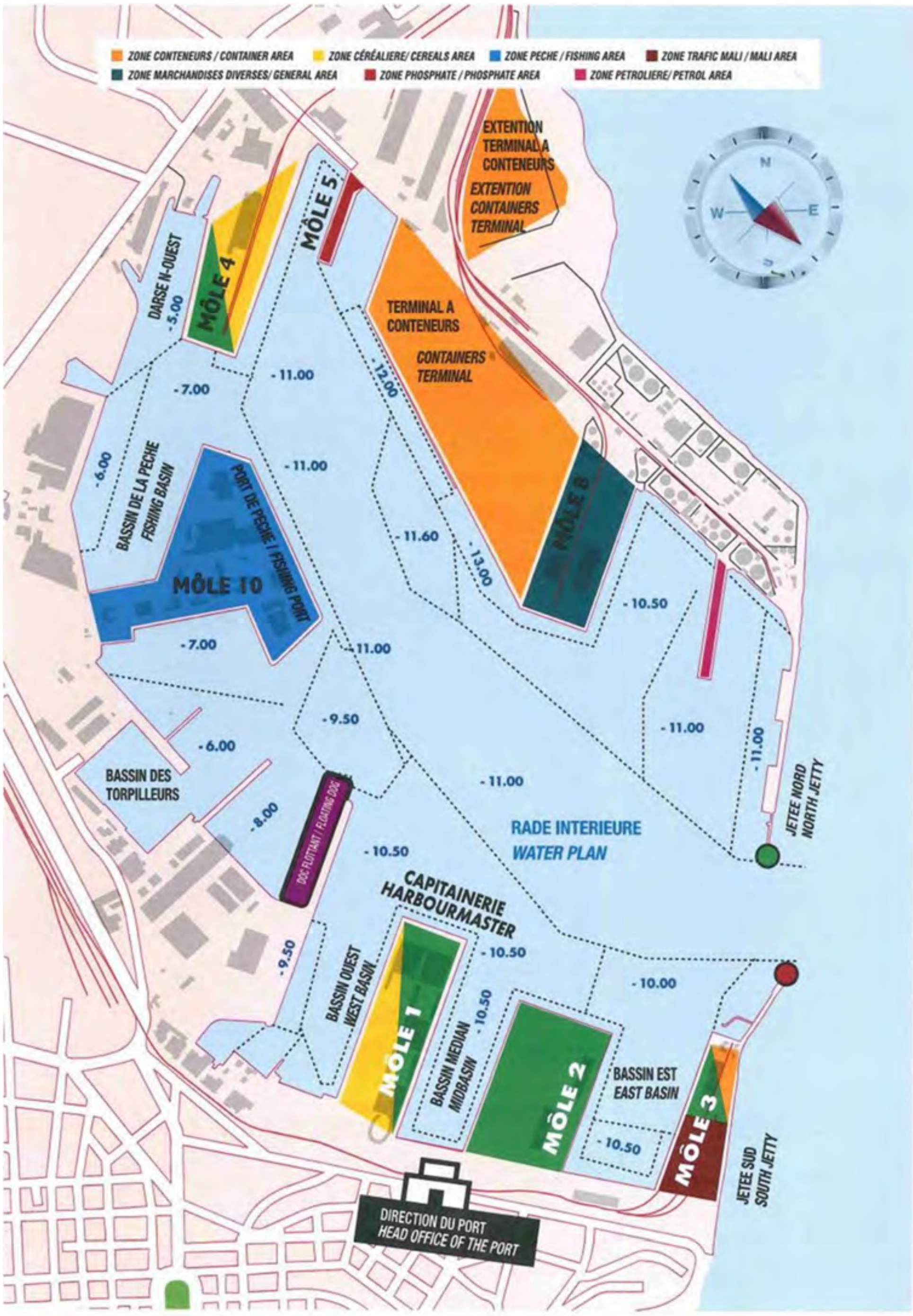
The Port Autonome de Dakar (PAD), which was established in 1987 as a state-owned enterprise, manages and operates the port. Figure 7-23 is an example of the navigation condition of vessels around the Dakar port.



Source: Prepared by JICA Study Team based on Marine Traffic

Figure 7-23 Example of Ship Navigation around Dakar Port

Broadly speaking, the Port of Dakar has freight handling areas in the north and in the south. The two areas include a military port, a fishing port, a marine product processing plant, and docks for ship repairs. The area where the cargoes are handled has 10 wharfs, from the first to the tenth. Previously, all the wharfs were connected to railway lines. Cargoes unloaded at each wharf were transported by rail to and from Senegal via Bel-Air Station located north of the Dakar port. The locations and characteristics of the wharfs are shown below.



Source: Cited from PAD website

Figure 7-24 Locations of Wharfs at Dakar Port

- South Wharfs

The south wharfs handle mainly general cargoes. About 40% of the container cargoes at the Dakar port are handled by the wharfs on the south side.

1) First Wharf

It handles general cargoes and container cargoes. In addition, cruise ships mainly berth at the First Wharf.

2) Second Wharf

This is a terminal for RORO vessels. Many imported cars for West African countries are handled here.

3) Third Wharf

This wharf gives priority to cargoes to Mali, under an agreement between Senegal and Mali. It has two quays. The main cargoes are dry bulk. Details are given in 7.3.1(2).

4) Ferry terminal

This terminal is for passenger ferries to and from Gore Island—a World Heritage site, and to Ziguinchor—the central city of the Casamance region in southern Senegal.

- North Wharfs

This area handles everything from container cargoes to minerals and petroleum products. It has six wharfs, from the fourth to the ninth (the tenth is a fishing port). Among them, the Sixth and the Seventh wharfs are container piers. The other wharfs handle mainly bulk cargoes. While hydrocarbons (fuels and others), oil, wine, and others are mainly handled as liquid bulk, phosphate, rare metals, clinkers, coal, wheat, rice, and others are handled as dry bulk.

5) Fourth Wharf

This wharf handles mainly dry bulk, specifically grains.

6) Fifth Wharf

A mineral mining company, GCO (detailed in Section 7.3.3), has a special stockpiling warehouse and freight handling equipment for ships at the Dakar port. The ores mined and transported by rail is placed in a warehouse in the port and then loaded onto a dry bulk ship berthed at the Fifth Wharf using a belt conveyor. The warehouse is capable of storing 100,000 tons of ores.

Source: Grande Côte Opérations website

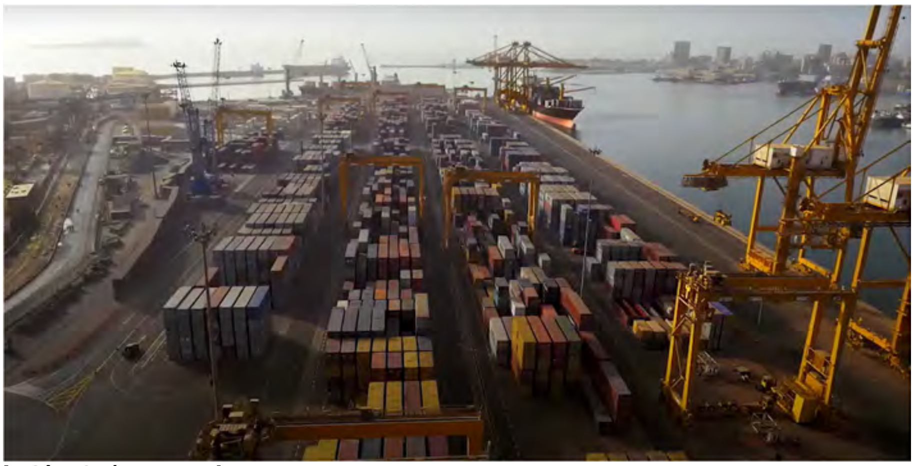
Figure 7-25 Mineral Warehouse Owned and Managed by GCO

Source: Grande Côte Opérations website

Figure 7-26 Loading Ores onto a Ship at the Fifth Wharf with a Freight Handling Equipment (Belt Conveyor)

7) Sixth and Seventh Wharfs

Until 2008, the Sixth and Seventh wharfs were managed by the French company Bollore, which previously had a dock-management concession contract. Since 2008, the wharfs have been managed by Dubai Ports World, which has been awarded a new 25-year concession contract. In addition to the operation and maintenance of the existing container terminals, the concession contract also includes the construction of new facilities. The wharfs handle approximately 300,000 TEU of cargoes annually.



Source: Grande Côte Opérations website

Figure 7-27 Wharf View (Viewed from Fifth Wharf)

8) Eighth Wharf

The Eighth Wharf is operated by a French logistics company, Necotrans, for a period of 25 years. It handles non-food dry bulk, specifically ores, fertilizers, and cement.

9) Ninth Wharf

The Ninth Wharf is operated by a Luxembourg-based company, SEA-Invest, which specializes in the operation of wharfs that handle bulk and general cargoes, especially oil. The wharf has an oil storage facility in the back.

(2) Details of the Third Wharf

Among the wharfs at the Dakar port, the Third Wharf mainly handles bulk cargoes and sundry goods for Senegal and hinterland countries. It is managed directly by the Dakar Port Authority (PAD). In particular, cargoes destined for Mali are prioritized at the Third Wharf in accordance with the agreement between Senegal and Mali, and thus the wharf becomes an important hub for transporting rice, fertilizers, sugar, and other agricultural and industrial goods to Mali.

The Third Wharf has two berths, the No. 31 and No. 32 berths. They were constructed adjacent to each other opposite to the open sea. The No.31 and No.32 berths were constructed in 1969 and 1939, respectively. They were severely damaged due to aging. Deterioration of the apron affected the efficiency of freight handling and inadequate drainage caused sanitation problem.

Under these circumstances, the Government of Senegal (Dakar Port Authority) requested the Japanese Government to renovate the Third Wharf in 2013, and the F/S and detailed design were carried out. The construction was started in 2019 but was delayed due to the impact of the coronavirus pandemic. Nevertheless, the wharf was scheduled to be completed and put into service in September 2022.

Table 7-4 Overview of Dakar Port No. 3 Wharf Rehabilitation Project

Project name	Dakar Port No. 3 Terminal Renovation Project
ODA Type	Grant Aid (3.971 billion Yen)
Construction site	Dakar, Senegal
Client	Port Autonome de Dakar: PAD
Design/construction management	JV of Mitsui Kyodo Construction Consultant Co., Ltd. and Construction Technology Center
Principal contractor	Toa Construction Co., Ltd.
Construction company	Giken Seko Co. Ltd.
Project period	January 11, 2019 to May 31, 2021 (initial schedule)
Press-in construction period	September to November 2019 (Phase 1) February to March 2021 (Phase 2)

Source: Prepared by JICA Study Team based on Press Release of Geiken Co., Ltd.[33]

(3) Development of New Dakar Port

The increasing volume of cargoes being handled at the existing Dakar port and the worsening road congestion around the port made it difficult to enhance the port’s functions. As a countermeasure, the Senegalese government plans to develop a new port in Ndayane, which is about 45 km from Dakar, in order to increase significantly the freight handling capacity, including the transfer of functions from the existing Dakar port. The development and operation of the New Dakar Port will be carried out by Dubai Ports World, which already operates the Sixth and the Seventh wharfs at the Dakar port. The total investment is approximately 1.1 billion USD, making it the largest investment in Africa for Dubai Ports World and the largest private sector investment in Senegal. The new port will also be the largest port in West Africa.

The project is divided into Phase 1 and Phase 2. The project cost of Phase 1 is 82.7 billion USD. In addition to the 840-m long and 18-m deep quays, and a 300-ha container terminal, a sea route that can be berthed by one of the world's largest container ships over a distance of about 5 km is planned. The project cost of Phase 2 is 290 million USD. In addition to 410 meters of quays,

[33] "Repair of wharfs in the ODA project in Port of Senegal Dakar by gilo press construction," https://www.giken.com/ja/news/release/gkn21nw007ja/

freight terminals, fishing-related facilities, and ship repair facilities will be constructed. Dubai Ports World plans to create a new industrial zone near the New Dakar Port with distribution and industrial hub functions.

JICA is implementing the "Project for Formulation of Multifunctional Port Development Master Plan in Ndayan, Senegal" between June 2022 and November 2024. Construction of the container terminal has already started as Phase 1. However, there is no comprehensive plan to provide a roadmap for the entire port, besides the container terminal, with regard to the functions of the facilities and their layouts, the division of functions between the existing Dakar port and the new port, and development of the surrounding areas. In response to a request from the Government of Senegal, this Study will formulate a master plan for the development area focusing on the new port.

7.3.2 Road Infrastructure

In Senegal, the main roads radiate from Dakar. In particular, the recent construction of the Dakar–M'boo and the Dakar–Thiés–Touba highways has dramatically improved travel time from the capital city of Dakar to the provincial cities. These highways have also played a significant role in increasing road capacity to accommodate the increasing traffic. The national roads are being paved. The N1 road, particularly from Dakar to Mali via Kaolack and Tambacounda, shifted Mali’s export and import cargoes from rail to truck. They were transported by rail in the past.

In the 1990s, approximately 80% of Mali's imports and exports went through the Port of Abidjan in Côte d'Ivoire, but the 2002 coup in Côte d'Ivoire triggered a shift to the Port of Dakar. By 2022, 80% of Mali's import cargoes go through Dakar, a significant increase (Source: ECDPM). By 2020, more than 1,000 trucks per day traveled on the Dakar–Bamako Corridor. Cargo traffic reached more than 2 million tons per day[34]. The road pavements have deteriorated due to higher-than-expected traffic volume and overloading. There are also problems with poor vehicle maintenance and frequent road accidents caused by drivers falling asleep at the wheel.

[34] Le360 Afrique https://afrique.le360.ma/senegal-mali/societe/2021/10/22/35805-senegal-mali-des-aires-de-repos-pour-reduire-les-risques-daccidents-sur-le-corridor-dakar

Source: Worldometer

Figure 7-28 Road Network in Senegal

Source: JICA Study Team

Figure 7-29 Trucks heading to Dakar

Source: JICA Study Team

Figure 7-30 Truck Accident Due to Poor Maintenance

Source: JICA Study Team

Figure 7-31 Deteriorated Road Pavement

7.3.3 Railway Infrastructure

(1) History and Current Situation

The meter-gauge railway lines in Senegal, excluding TER, were constructed by France during the colonial period. They were used mainly to transport crops produced in Senegal and Mali to the ports at the time. The 1000-mm gauge was chosen because France, at that time, proposed the metric system. Beginning with the opening of the Dakar–Rufisque line in July 1883, the Rufisque–Saint-Louis line opened in 1885, and a branch line was later constructed from Louga to Linguère. In 1904, a section was opened from Kayes, Mali, near the Senegal border, to Koulikoro, near Bamako, the capital city. Later, in 1923, the line from Thiès on the way between Dakar and Saint Louis to Kayes was constructed by branching off. As a result, Dakar and Bamako were connected by rail and the Dakar–Bamako Corridor became a key route in rail transportation.

Source: "Railways of the World", Japan Overseas Association for Railway Technical Cooperation (JARTS), with additions by the JICA Study Team

Figure 7-32 Operation Status of Railway Lines in Senegal

Railway construction has spurred trade, along with immigrants from Burkina Faso, Mali, Guinea, and elsewhere. Towns such as Thiés, Guinguineo, and Tambacounda have also developed along the railway lines. In 1960, the French colonial rule ended, and Senegal and Mali became independent. At the same time, the railways were divided into sections and managed by the two countries separately.

In the 1990s, Senegal and Mali had two passenger train services per week, and Senegal and Mali each had one train set. The tracks and civil engineering facilities were poorly maintained. In 2009, an aging rail ruptured near Goudiry, resulting in a derailment with casualties. Since then, the passenger train service from Senegal to Mali has been suspended until the rail tracks and civil engineering facilities can be rehabilitated. Freight transportation continued between Dakar and Bamako until the operation stopped in 2018, due to a decline in the level of rolling stock maintenance and political instability in Mali. Currently, two mining companies operate freight trains only in the sections from the mines owned by the companies to Dakar via Thiés.

Meanwhile, in the 2010s, the TER project began near Dakar. Since TER was constructed by widening the site of the existing meter-gauge line, the existing meter-gauge tracks had to be removed and replaced with a new meter-gauge line and a new standard-gauge line. Currently, only the section from Dakar Station to Diamniadio has been newly constructed.

Railway lines were established around the Dakar port from Bel-Air Station to each wharf. Among them, the lines that had been going from Dakar Station to the Third Wharf via the First Wharf and the Second Wharf had temporarily suspended operation when TER was being constructed. The lines were supposed to be redeveloped after the TER construction. However, due to the subsequent lack of funds and difficulty in coordinating the parties concerned, the situation has been neglected to the present day.

On the other hand, CFS and a Canadian entity are now planning to construct a new double-track standard-gauge line from Dakar to Tambacounda, but not much progress has been made in financing. Demand is expected to come from the transport of mineral resources. However, feasibility of this project is questionable since rehabilitation of the meter-gauge line is believed to be adequate, in terms of technology and cost-effectiveness.

(2) Transition of Railway Organizations

In 1960, Senegal and Mali gained independence. The Senegalese Railways Corporation (Régie des Chemins de fer du Sénégal, RCFS) was established and began operating the railways. However, the Senegalese government has prioritized funds for road development since then. This policy has led to insufficient funds being allocated to the management and maintenance of the railways and, as in other sub-Saharan countries, has resulted in the deterioration of railway infrastructure. Meanwhile, the Senegalese Railway Corporation was restructured into the Senegalese National Railways (Société Nationale des Chemins de Fers Sénégalais, SNCS) in 1989.

In 2001, government agencies in Senegal and Mali began working on concession-based PPPs for the Dakar–Bamako railway. In 2003, the CANAC-GETMA Consortium, led by Canadian companies, won a tender. The newly established Transrail signed a concession contract with the Senegal-Mali counterparts, thus taking over the operation and management of the Dakar–Bamako Railway. The concession agreement is for 25 years and includes not only the day-to-day operations but also 174 billion CFA funding for upgrading and modernizing railway facilities to enhance the railway’s competitiveness against road transport. However, due to the considerable deterioration of the facilities, frequent delays in transportation, shippers’ shift to road transport, and shift to a port in Abidjan, Transrail's finances deteriorated rapidly, and the necessary capital investment was not made. In 2007, the CANAC-GETMA consortium sold its shares to Advens France.

Since Advens France, which acquired the Transrail shares, lacked railway management experience, operation of the railway itself was entrusted to Vecturis SA of Belgium. However, the shippers’ shift away from the railway did not stop. The annual transportation volume, which had hovered between 400,000 and 500,000 tons until 2010, fell to 200,000 tons in 2015, and the concession contract was canceled by the end of 2015. The SNCS continued to exist after the start of the concession, owning some of the facilities. After reaching a financial impasse, it was liquidated in 2009. In 2016, operation of the Dakar–Bamako railway was transferred from Transrail to the publicly owned Dakar–Bamako Ferroviaire (DBF), which continued to operate freight trains for some time after the transfer. However, the operation ceased completely in 2018 due to the lack of funds to procure parts necessary for the maintenance of rolling stock.

In parallel with the construction and opening of the TER, the Senegalese government is currently pursuing a European model of vertical separation for the railway. In 2020, the ownership and management of the railway infrastructure was transferred to Senegal Railways (CFS). CFS incorporated the National Railway Agency (Agence Nationale des Chemins de Fer, ANCF), which was previously in charge of railway improvements under the MITTD. The maintenance and management of railway infrastructure was carried out with state funding.

CFS has four areas of jurisdiction: Cap-verb (around Dakar), Nbar-baol (in Saint Louis), Salum (in Guinguineo) and Niani (in Tambacounda). Although CFS is an independent organization responsible for the projects, it requires support from the Ministry of Transport when coordinating with other ministries and approval from the Ministry of Finance for its budget. CFS also manages the railways on port premises; APIX and PAD do not have the authority to develop railways in the port. Although CFS is a railway-infrastructure management company, it is currently working to restart the operation of freight trains. It is unclear at this time which organization will be responsible for the freight transport between Dakar and Tambacounda.

While the CFS is set up to own and manage railway infrastructure, the Grands Trains du Sénégal S.A. (GTS) was created as the operating company. The entity that operated the PTB in the past was reorganized as GTS. The PTB operation was terminated with the opening of the TER. GTS is now coordinating the operation of passenger and freight trains in Senegal. It entered into a MOU with Rail India Technical & Economic Services Ltd. (Rites), an Indian consulting firm, in June 2022 and it is preparing for the operation of passenger trains between Dakar, Thiés, and Tivouene.

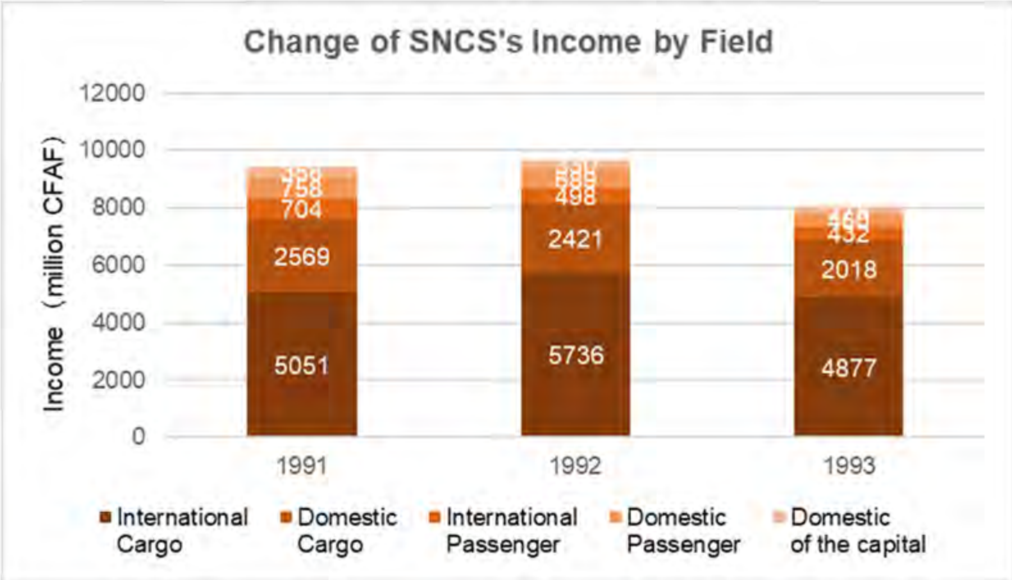
(3) Financial Condition of Railway Operators in Senegal

1) Operation and Financial Status of the Senegal National Railways in the 1990s

Before deterioration of the facilities could seriously interfere with train operations, the Senegal National Railways played an important role in cargo transportation within Senegal and between Senegal and Mali. Especially at that time, the main road between Tambacounda and Kidira was not paved. Since the main road would be submerged during the rainy season, freight transportation depended on the railway for a considerable part of the distribution.

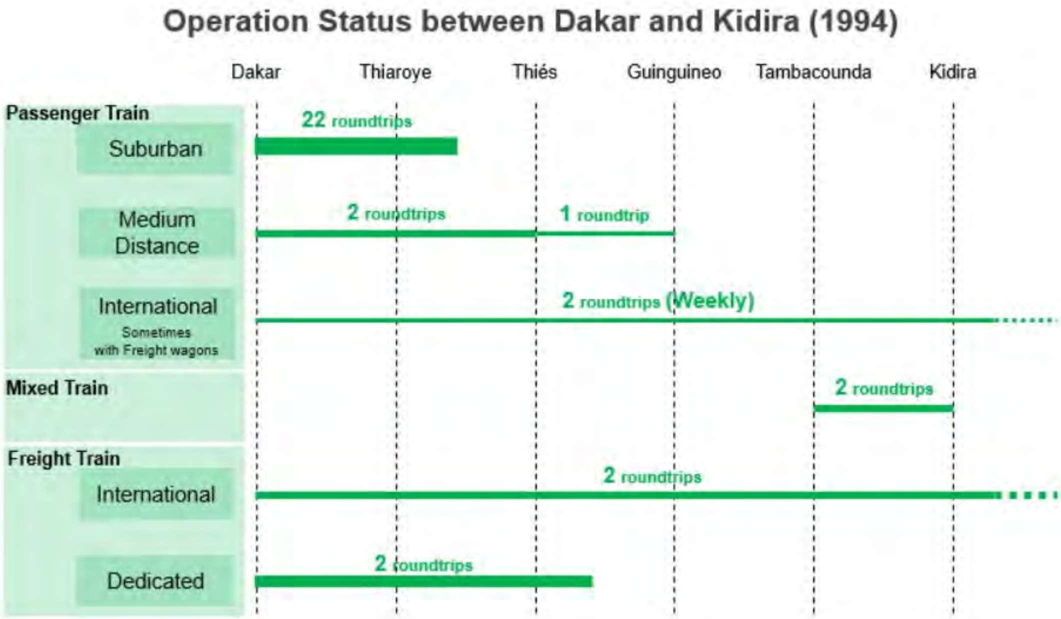
Figure 7-33 and Figure 7-34 show the revenue trends and operating conditions of the Senegal National Railways in the 1990s, respectively. At that time, more than 80% of Senegal National Railways' revenues were from freight transportation, and about one-third of the revenues were from international freight transportation with Mali. When compared per ton-kilometer, the unit price of international transportation is higher than that of domestic transportation. The railway was able to set higher prices in the eastern section of Tambacounda because there was no competition from road transportation.

The railway provided passenger transport near Dakar on a scale that played a certain part in urban transport, with 22 round-trips per day and 4 million passengers per day. Domestic and international long-distance transportation accounted for 80% of the revenues from passenger transportation. Since Senegal has many inland cities with large populations, considerable revenues are expected not only from the operation of freight trains but also from passenger trains after the rail services are restored.



Source: Prepared by JICA Study Team based on the "Report on the Project for Promoting the Formation of Rehabilitation Project between Dakar and Kidira Railways in Senegal (Japan Overseas Transport Cooperation Association)"

Figure 7-33 Changes in Revenues of the Senegal National Railways by Sector in the 1990s



Source: Prepared by JICA Study Team based on the "Report on the Project for Promoting the Formation of Rehabilitation Project between Dakar and Kidira Railways in Senegal (Japan Overseas Transport Cooperation Association)"

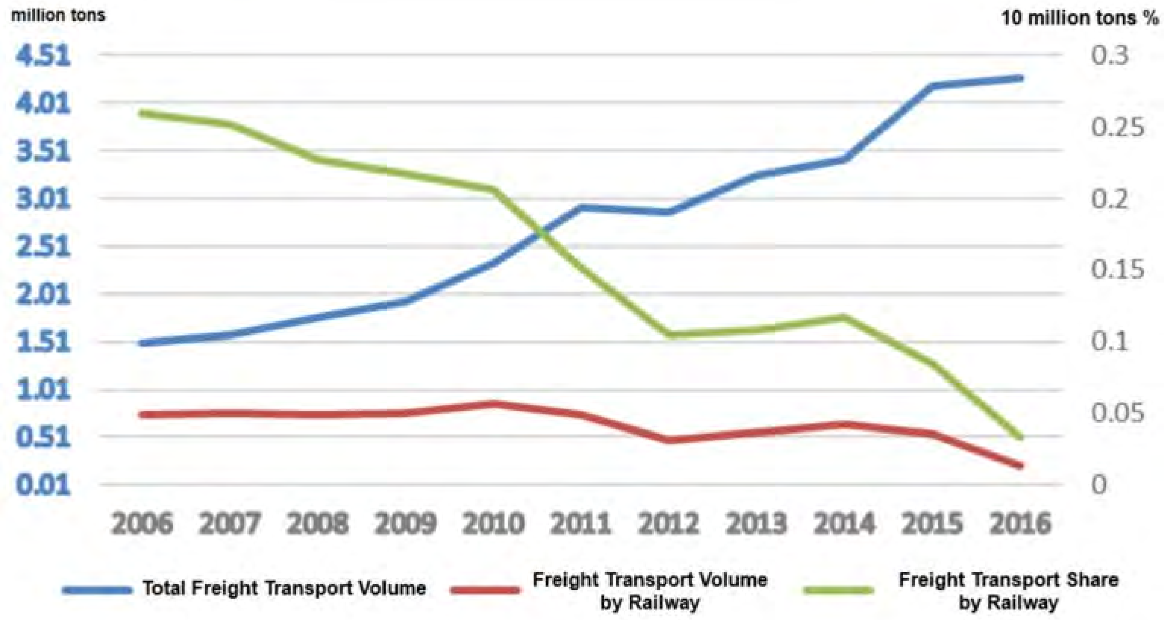
Figure 7-34 Train Operations between Dakar and Kidira (1994)

2) Challenges in Restarting Railway Operations

In the 1990s, the Senegal National Railways was in a marginally profitable position, partly because it was exclusively in charge of international freight transportation with Mali. However, the national road linking Tambacounda to Bamako is now in place, and the relative competitiveness of the railway has declined (Figure 7-35). In the 1990s, even if the company were able to raise sufficient funds for the maintenance, and capital investment that would otherwise have been necessary, the company would probably have suffered chronic losses.

Since a large amount of public money has been invested in road development, freight transportation by road and freight transportation by rail are not perfectly competitive from the viewpoint of service provision. In such case, an appropriate competitive environment shall be created by injecting an appropriate amount of external funds for the construction, capital investment, and operation of railways, in order to maximize social benefits. Any significant over- or under-subsidization from external subsidies or investment will result in over- or under-provision of transport services by rail, thereby reducing social benefits, and inappropriately distributing benefits. It is necessary to not only ensure the financial soundness of individual railway operators, but also examine and implement railway operation and maintenance schemes after thorough cost-benefit analysis to ensure that the railway infrastructure as a whole can provide adequate social benefits.

In Senegal, the operation of railways and ownership of infrastructure are separate. CFS, which owns and manages railway facilities on the meter-gauge lines, receives railway usage fees from the mining companies, which operate the trains. The fees have not changed since the Transrail era. They shall be revised to appropriate amounts, considering the modality of public subsidy for railway infrastructure and price competitiveness of the mining resources sector.



Source: World Bank

Figure 7-35 Changes in Freight Transport Volume by Mode between Dakar and Bamako

(4) Existing Freight Train Operators (ICS/GCO)

Two cargo trains are running to and from the Dakar port every day. The trains are owned by the mining companies Grande Côte Opérations (GCO) and Industries Chimiques du Sénégal (ICS). The trains transport a variety of minerals produced in inland mines. Due to the severe road congestion around the Dakar port, the trains do not operate during the day. Both trains are scheduled to depart and arrive at Dakar between 22:00 and 6:00. The train's 2400-horsepower locomotive hauls 32 freight cars with some traction margin. The two companies also own facilities for maritime transportation at the Dakar port. Each company handles the loading and unloading of cargoes on its own. Because the mining companies do not own certain sections, which are managed by CFS, between the destinations, they pay a usage fee to CFS. The mining companies employ the drivers and crewmembers, and CFS regulates, inspects, and manages them.

1) ICS (Industries Chimiques du Sénégal)

ICS is a mining company and chemical manufacturer under the umbrella of Indorama, a chemical industry company based in Singapore. In Sub-Saharan Africa, ICS is one of the major producers of phosphate fertilizer. ICS processes phosphate ore mined at Keur Mor Fall and Taiba Mine near Thiés into phosphate at the Darou Khoudoss plant, and transports it to the Dakar port by freight trains and exports it mainly to India. A freight train carrying phosphate from Darou Khoudoss operates on the CFS line from Tivaouane, via Thiés to Dakar. A portion of the mined phosphate is transported to a fertilizer plant in Mbao, via a siding branched from Pikin. Phosphoric acid fertilizer produced at Mbao's plant is shipped to various parts of West Africa and used to grow cotton, peanuts, vegetables, and other crops. ICS also produces sulfuric acid at the Darou Khoudoss plant. The raw sulfur is loaded onto freight trains at the Dakar port and transported on the opposite route to Darou Khoudoss.

2) GCO (Grande Côte Opérations)

GCO is a company that mines metal resources such as zirconium (silicate mineral of zirconium) and irmenite (titanium iron ore). It has mines and factories in Lompoul, about 80 km from Dakar. The 22-km section from the factory to Mékhé is a dedicated GCO line. It was constructed in 2011 with GCO funding. Cargo trains carrying ores pass through the GCO line from a factory in Lompoul and through the CFS line from Mékhé, which is a railway connection station to Senegal, to the Dakar port. Approximately 700,000 tons of ores were transported in 2021. The freight train is 328 meters long and can transport 1,218 tons of ores at a time. The company has 2 locomotives and 42 hopper cars. It has a maintenance base at Mékhé.

Source: Grande Côte Opérations website

Figure 7-36 Mineral Transportation Train Running on the GCO Dedicated Line

(5) Future Railway Plans

The main goals for developing Senegal's railways are to convert freight transport around Dakar from road to rail, ease road congestion around Dakar, increase the transport capacity and stability of domestic and international logistics, and reduce transport costs. To this end, Senegal is currently considering three main railway plans.

1) **Rehabilitation of existing meter-gauge railways**
2) **Construction of a new standard-gauge railway (between Dakar and Tambacounda)**
3) **Construction of branch lines (connection between Tambacounda, Kédougou and Casamance, connection with the new port in Dakar, etc.)**

Of these, only 1) is currently being implemented as a project. In this project, three locomotives have already been procured from South Africa. Preparations are under way to repair rail cars and restore rail tracks. Due in part to the political instability in Mali, restoration of the entire Dakar–Bamako railway line across the border is relatively difficult. Therefore, Senegal Railways (CFS) plans to restore the Dakar–Tambacounda meter-gauge line by first constructing a container terminal using Tambacounda as a logistics hub. CFS needs to repair its rolling stock, restore the railway and civil engineering facilities, and renovate the station buildings within the limits of its budget and technical capabilities. For this reason, external support in the forms of funding and technology will be necessary to ensure that the railway can be restored properly rather than using just stopgap measures.

As for 2), there is no prospect of raising funds for a new standard-gauge railway at this point, so it is uncertain if this plan will come to fruition. One of the reasons for planning (2) is that a standard-gauge railway is more suitable for transporting heavy freight. However, constructing a new standard-gauge railway is not practical from the perspective of cost-effectiveness for the next few decades, because the existing meter-gauge line can be sufficiently refurbished to accommodate increases in both the length of the train and in the number of train services. Besides, if a new standard-gauge line and a meter-gauge line coexist, the demand for transportation will be offset mutually. Participation of the private sector in this project, assuming in the form of a PPP, will be challenging from a financial standpoint. According to a guideline of the Economic Community of West African States (ECOWAS), railway development in West African countries shall use standard-gauge track. Therefore, standard-gauge track shall be used when constructing a new railway. However, if the railway infrastructure has already been developed to a certain extent, as in Senegal, restoring and expanding the meter-gauge lines by utilizing the existing infrastructure will be much more cost-effective. Although other African countries are constructing new railways using standard-gauge track, it is important to adopt a strategy for developing transportation infrastructure that is tailored to the actual conditions of the region, taking into consideration the financial situation of each project.

As for 3), since whether the branch lines should use standard gauge or meter gauge depends on the national network plan for the standard-gauge lines, development of the infrastructure linked to national economic development should be decided promptly and comprehensively.

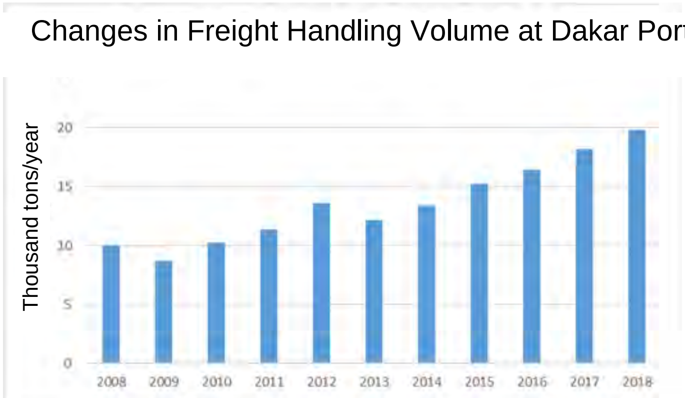
There are iron ore reserves in Kédougou, but there is little development at this point because the transportation infrastructure to the port is not developed. On the other hand, the reserves are not expected to produce a huge amount, as in Australia and Brazil, so it is necessary to consider the cost-effectiveness when developing a railway for transporting ores. As exemplified by the post-war prioritized production system in Japan and the economic development by constructing shipping and aviation infrastructures in the UAE and Dubai, concentrating the limited funds obtained from natural resources in infrastructure investment for the short term is an effective strategy during an economic growth period. From this point of view, the Senegalese government shall establish a plan that can generate considerable profits at the earliest possible stage. In other words, it is desirable to develop the branch lines by extending the existing meter-gauge railways and to increase transportation capacity with minimal investment.

7.3.4 Trends in Transport Demand

(1) Trends in Freight Transportation via the Dakar Port

The Dakar port currently handles approximately 26 million tons of cargoes per year. About 18 million tons are imports and of which, about 3 million tons/year are in transit to Mali. Figure 7-30 below shows the changes in the volumes of cargoes handled (exports and imports) at the Dakar port. The volume of cargoes handled at the Dakar port has been steadily rising, thanks to the economic growth of Senegal and Mali. The imported cargoes to Mali, in particular, are expected to increase significantly the volume of cargoes being transported. This increase is partly due to the shift of cargoes from the Port of Abidjan to the Port of Dakar because of the civil war in Côte d'Ivoire, and partly due to the development of paved roads between Tambaunda and Bamako.

Several rural cities in Senegal have population and economy substantial enough to generate demand for freight transport between these cities and the Port of Dakar. Touba, one of the most religious cities in Senegal, has demand for transporting about 3 million tons of freight. Kaolakk, where salt is produced at the adjacent Sam River coast, has transport demand for about 2.5 million tons. Tambacounda has transport demand for 3.5 million tons. Since these cities are located along the CFS line, restoration of the railway in the Dakar–Bamako Corridor will not only alleviate congestion on the main roads in Dakar and between cities, but also contribute to the alleviation of congestion in regional cities and the formation of multipolar decentralized national land.

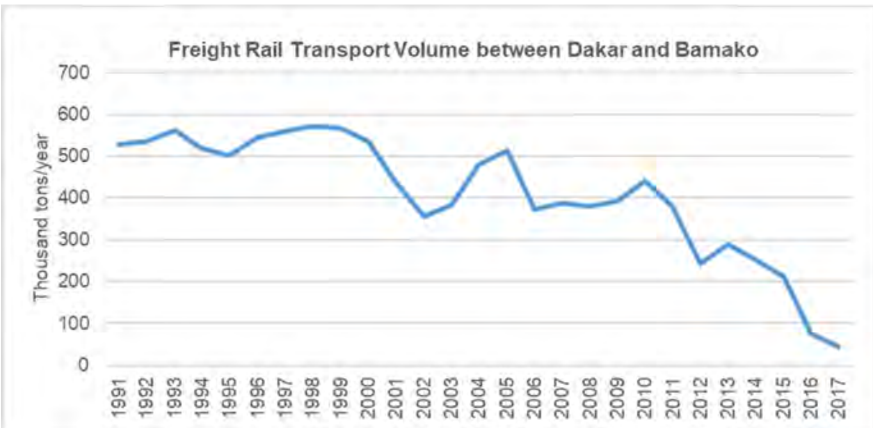


Source: Data from FEED THE FUTURE, the U.S. Government's Global Hunger & Food Security Initiative, FERTILIZER COST BUILD-UP AND PROCESS MAPS IN WEST AFRICA, PORT OF DAKAR, August 2019

Figure 7-37 Changes in Freight Handling Volumes (Export and Import) at the Dakar Port

(2) Freight Transportation Trends in the Dakar–Bamako Corridor

The transport volume between Dakar and Bamako of the Senegal National Railways was about 500,000 tons per year until around 2000. It decreased to about 400,000 tons in the 2000s, and then dropped sharply after 2010. Figure 7-38 shows the annual cargo transport volumes of the Senegal National Railways in the Dakar–Bamako Corridor.



Source: World Bank, ÉTUDES EN VUE DE LA REHABILITATION ET LA MODERNISATION
Prepared by JICA Study Team based on data from DU CHEMIN DE FER DAKAR-BAMAKO

Figure 7-38 Freight Transportation Volumes of the Senegal National Railways in the

Dakar–Bamako Corridor

The volume of freight transportation by road in the Dakar–Bamako Corridor was about 1 million tons per year in 2005, but exceeded 3 million tons in 2015, showing a rapid increase of about 11% per year. Given the increase in the volume of cargo transportation by automobiles at a pace far exceeding the decrease in the volume of cargo transportation by railway, it is probable that if the railway had been properly maintained, it would have contributed significantly to the reduction of road congestion and automobile accidents. Since the volume of transportation is expected to continue to increase as the economies of Senegal and Mali grow in the future, the railway infrastructure shall be restored and reinforced quickly and reliably to avoid excessive load on road traffic.

7.4 Master Plans and Upper-level Plans

Plans for public transport, including rail transport in Dakar, have been proposed at the city and national levels. An overview of the city-level and national-level priority plans is given below.

7.4.1 Master Plans for Urban Transport

At the city level, the CETUD (Conseil Executive des Transportations Urbans de Dakar) takes the lead in formulating upper-level plans with the support of donors, including JICA. The master plans on urban transport formulated in recent years are summarized below.

Table 7-5 List of Master Plans for Dakar Urban Transport in Recent Years

Item	Year of formulation	Plan name	Originator	Target year
1	2008	Dakar Urban Transport Master Plan	Dakar Urban Transport Executive Committee	2025
2	2016	Dakar Metropolitan Development Master Plan	JICA	2035
3	2022	Sustainable Urban Mobility Plan	EU, AFD, and others	2035

Source: JICA Study Team

(1) Dakar Urban Transport Master Plan (PDUD) and Dakar Metropolitan Development Master Plan (PDU)

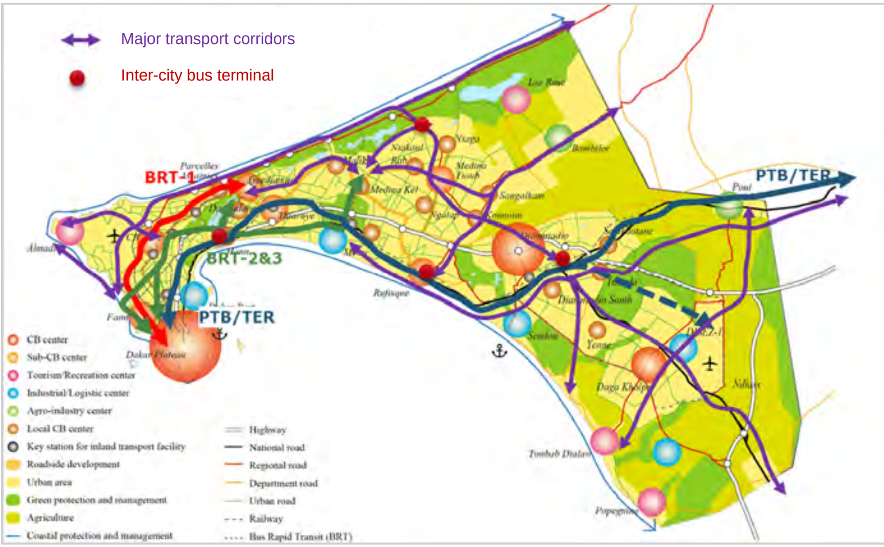
The Dakar Urban Transportation Executive Committee formulated the Urban Transport Master Plan (PDUD) in 2008. When JICA formulated the Dakar Metropolitan Development Master Plan (PDU) in collaboration with the Department of Urban Planning and Construction (DUA) under the Ministry of Urban Renaissance and Housing Environment in 2016, urban transportation was examined. The PDU follows the development policies and strategies set forth in the PDUD. The following have been proposed as policies for developing public transportation, including rail transportation:

Table 7-6 Policies for Public Transportation Improvement in PDU

Development policy	Development strategy
To provide an easy-to-use transportation means for people	- To improve the level of service of the existing public transportation systems - To establish a new large-capacity transportation system

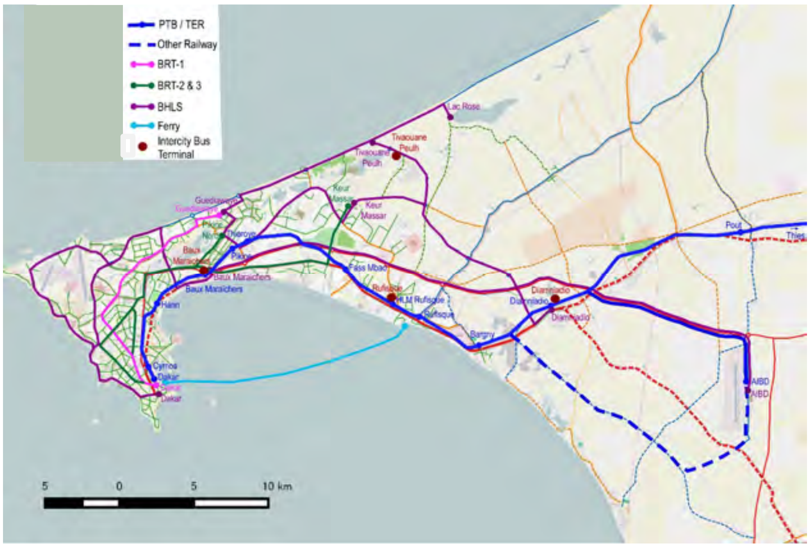
	- To maintain public transportation fares at an affordable level
To contribute to the sustainable development of the region	- To facilitate transit between different modes of transport through the development and improvement of transit facilities - To promote transit-oriented development (TOD) in public transport corridors, including subcenters

Source: JICA Study Team



Source: Ministry of Residential Urban Renaissance and Housing Environment

Figure 7-39 Major Proposals for Public Transportation Development in PDU



Source: Ministry of Residential Urban Renaissance and Housing Environment

Figure 7-40 Locations of Public Transportation Development Plans under Planning and Construction

(2) Sustainable Urban Mobility Plan (PMUD)

Since 2017, CETUD has participated in the MobiliseYourCity Partnership, which is active mainly in EU countries such as France and Germany, and developed a sustainable urban mobility plan. Upon formulating the plan, CETUD identified the following four areas of weakness in Dakar's transportation network and proposed improvement.

1) Approximately 70% of all trips are on foot, but the sidewalks are not maintained.

2) Despite 80% of the citizens are using public transport, public transport means in competition with each other led to chaotic operation, traffic congestion, and slower speeds.

3) Congested roads have a major impact on private cars and public transportation. Even though considerable investment has been made in recent years, continuous effort must be made to optimize road traffic. There are still many small paths on the east side of Dakar.

4) Since bicycle traffic is very low, PMUD proposed measures to promote bicycle use.

PMUD estimates that the 9 million trips per day in Dakar will reach approximately 145 million trips per day by 2035. It also estimates a doubling of travel by private vehicles.

7.4.2 Plan Sénégal Émergent

In 2014, the Senegalese government formulated the Plan Sénégal Emergent (PSE), which aims to make Senegal an emerging country by 2035. The PSE is subdivided into several 5-year priority action plans (Plan d'Actions Priorities, PAP). The first phase of the PAP was implemented from 2014 to 2018 and the second phase of PAP is from 2019 to 2023. Due to the coronavirus pandemic, the second phase of PAP was revised in 2020.

The second phase proposed the construction of TER and the development of BRT between downtown and the airport for urban transportation in Dakar. The first section of TER opened in December 2021. The BRT is under construction and is slated to open in 2023.

Apart from urban transportation, the first phase of PAP and the second phase of PAP also proposed rehabilitation of the railway connecting Dakar, Tambacounda, and Bamako as part of the development of the domestic and international distribution networks, including distribution hubs. The budget has been allocated, but the rehabilitation has yet to be implemented.

7.5 Initiatives by Other Donors

7.5.1 World Bank

The World Bank was once involved in the rehabilitation project for the Dakar–Bamako Railway. However, due to policy difference between the World Bank and Senegal, project formation did not materialize. The World Bank is not involved currently. The background and the views of the World Bank are described below.

(1) Historical Background

The World Bank, in collaboration with Senegal, initiated a review of the Dakar–Bamako Railway Improvement Program in 2014. It has been comparing the plans of improving the existing meter-gauge railway with constructing a new standard-gauge railway. In 2016, it conducted a survey to evaluate both plans. The study concluded that rehabilitation of the meter-gauge railway could meet transport demand for the next 20 years and that rehabilitation would be appropriate from a cost-effective perspective. However, because the Senegalese side wanted to build a new standard-gauge railway for several reasons, negotiations for the project were halted.

Subsequently, the Senegalese government coordinated with Turkish and Chinese companies to try to fund the new standard-gauge railway project; however, no agreement was reached. Then

Senegal changed its policy to restoring the meter-gauge railway, and approached the World Bank again in 2018. Preparations were made for a 500-million USD project. However, the negotiations between the newly established Senegal Railways (CFS) and the World Bank stalled again due to the reorganization of CFS and the political instability caused by the coup d'état in Mali. The World Bank completed its review at the end of 2021. On the other hand, the Senegalese government narrowed the scope of railway development to the area between Dakar and Tambacounda. It became interested in the new design of a 3-billion USD standard-gauge railway PPP project proposed by a Canadian-affiliated consortium. Pre-FS was conducted. At present, however, no specific plans or funding sources have been decided. Even if the project comes through, it is expected to take more than five to ten years. Therefore, CFS has decided to proceed with the rehabilitation of the meter-gauge railway in order to resolve the urgent issues of cargoes being held up at the Dakar port and road congestion. It has begun preparation for the procurement and maintenance of rolling stock.

(2) View of the World Bank

In the past, since the World Bank was unable to coordinate with Senegal about the contents of the project for a long time, it recognizes the importance of obtaining high-level agreements from the Ministry of Finance, the Ministry of Transport and Infrastructure, and others when formulating a railway development plan in the future.

The World Bank also assumes that the reasons for Senegal's desire to construct a new railway line on standard-gauge track are as follows:

1) ECOWAS's policy that new railway for the West African region shall use standard gauge

2) Increasing future demand for the transport of undeveloped mining resources in the interior of Senegal

3) Perception that standard-gauge railway is more advanced than the narrow-gauge (meter-gauge) railway

On the other hand, the World Bank's viewpoints on these issues are as follows:

1) The ECOWAS policy targets the construction of new railways. It does not apply to the rehabilitation of existing meter-gauge railways.

2) Increasing the length of the train, increasing the number of train services, and increasing the weight of axial loads by upgrading the rail tracks are measures that can be taken to increase the transport capacity of meter-gauge railways.

3) Standard-gauge railway tends to have an advanced image in Senegal because of the high quality of the newly constructed TER. There are many countries and railways that provide high-quality transport services on narrow gauge (meter gauge) so standard gauge is not the only option.

(3) Anticipated Future Developments

After many twists and turns, the Senegalese government currently intends to rehabilitate the meter-gauge railway as an urgent measure, and at the same time, proceed with the construction of a new standard-gauge railway line. As rehabilitation of the meter-gauge railway is in line with the World Bank's intent, financial assistance may be available in some cases. An exchange of information on an ongoing basis is desirable.

On the other hand, there are various issues regarding the construction plan of a new standard-gauge railway line. The same applies to Japan's shinkansen bullet trains—the high-speed trains in Japan, in that a new standard-gauge railway line was constructed separately from the existing narrow-gauge railway line. The original purpose for constructing the Tokaido Shinkansen—the first high-speed railway in Japan—was to supplement the Tokaido Main Line, which had reached its capacity due to increasing traffic volume. The Tokaido Shinkansen was not intended to be a substitute of the narrow-gauge Tokaido Main Line. In fact, many passenger trains and freight trains still operate on the Tokaido Main Line. In the case of Senegal, the transportation capacity of the meter-gauge line can still be greatly increased at this time. If both the meter-gauge line and the standard-gauge line coexist, there is a risk that supply may exceed demand and the economic benefits will be considerably lower than the investment amount. Therefore, construction of a new standard-gauge railway line shall be examined carefully. Section 7.5.2 shows contents of the current plan.

7.5.2 Project for the Development of a New Standard-gauge Railway

Besides the existing meter-gauge railway, Senegal is working on a project to construct a new double-track standard-gauge railway between Dakar and Tambacounda. While the outlook of the project in terms of cost-effectiveness and financing is uncertain, the project may have a major impact on the plan for the meter-gauge railway line. It should be monitored closely. However, since it is a PPP project and private companies are involved, availability of information is limited.

(1) Project Overview

The project, dubbed the Dakar Tamba Fast Track, is to construct a new standard-gauge double-track railway between Dakar and Tambacounda, in addition to the existing meter-gauge line. The scheme is expected to be PPP (Design-Build method) and the line will not be developed as a national railway. A 30–50 hectare dry port will be constructed in Tambacounda to facilitate connection between rail and truck transport. The site has been secured. The Pre-FS for the construction of the railway took nine months; it has now been completed. CFS is coordinating with the Canadian Commercial Corporation (CCC) to secure funding.

The Canadian side expects Japan and other G7 countries to participate in the project, and CFS shares the same view. The backdrop is the "Build Back Better World" (B3W), an initiative of infrastructure assistance for developing countries agreed upon at the G7 Summit in 2021. The B3W, a U.S.-led initiative, is designed to counter China's "Belt and Road Initiative," which includes an increase in credit lines for developing countries and expansion of private investment.

As CCC has concluded a MOU with CFS, the information that can be provided to a third country is limited. The approval of CFS is required.

(2) Implementation System

The standard-gauge railway construction plan is based on a partnership between the Canadian and Senegalese governments, which are represented by CCC and CFS, respectively, in the contract. The CCC's counterpart is CFS. CCC does not communicate directly with the central government of Senegal regarding the project. CCC also acts as the contact point for the project on the Canadian side but it is not the financing entity. The funds will be raised from the private sector. At present, Aecon is conducting a technical study.

(3) Financing and Schedule

The project cost is estimated to be about 3 billion USD for a double-track line and about 1.6 billion USD for a single-track line. Financing has been under consideration for nearly a decade. One of the problems is the guarantee deposits. PPP projects can take a variety of forms. In general, the sharing of risk related to revenue and expenditure when implementing a PPP project is determined in advance between the government and the private sector and stipulated in the contract. In principle, the government should bear a certain level of the revenue and expenditure risk for a high-risk project, such as subsidizing income and compensating for losses in a force majeure event. Formulating a PPP railway project is said to be much more difficult than formulating one for the other sectors because of the long duration of a railway project, difficulty in forecasting the transport volume, and limitation in one’s effort to make improvement. Therefore, feasibility of this project in Senegal is unclear.

The construction period is expected to be about 60 months. There are also proposals for early completion by carrying out construction simultaneously at multiple work sites.

(4) Anticipated Future Developments

Despite the desire to develop infrastructure, the governments of developing countries are often unable to raise sufficient funds, making it necessary to seek investment from private companies in the form of PPP projects. The cost-effectiveness of a project, however, does not change no matter the source of funding. Therefore, sound judgment is necessary to determine if a project should be implemented or not.

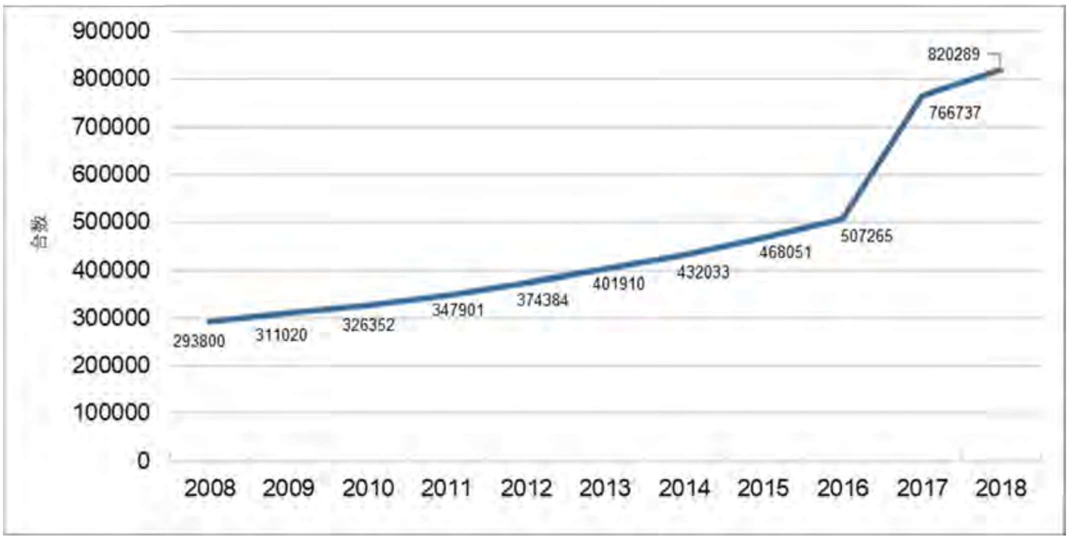
Senegal does not have a long-term policy that determines whether to rehabilitate meter-gauge railways or to construct new standard-gauge railways. Since no concrete projects have been implemented, the country's economic growth has been hindered, especially by the congestion at the Dakar port. Since rehabilitation of the meter-gauge railway can utilize most of the existing land and facilities, it is extremely cost-effective. From a short-to medium-term perspective, the existing meter-gauge railway should be rehabilitated. Then the need for constructing a new standard-gauge railway should be examined from a medium-to long-term perspective.

7.6 Extension of Freight Line to the Third Wharf

7.6.1 Overview

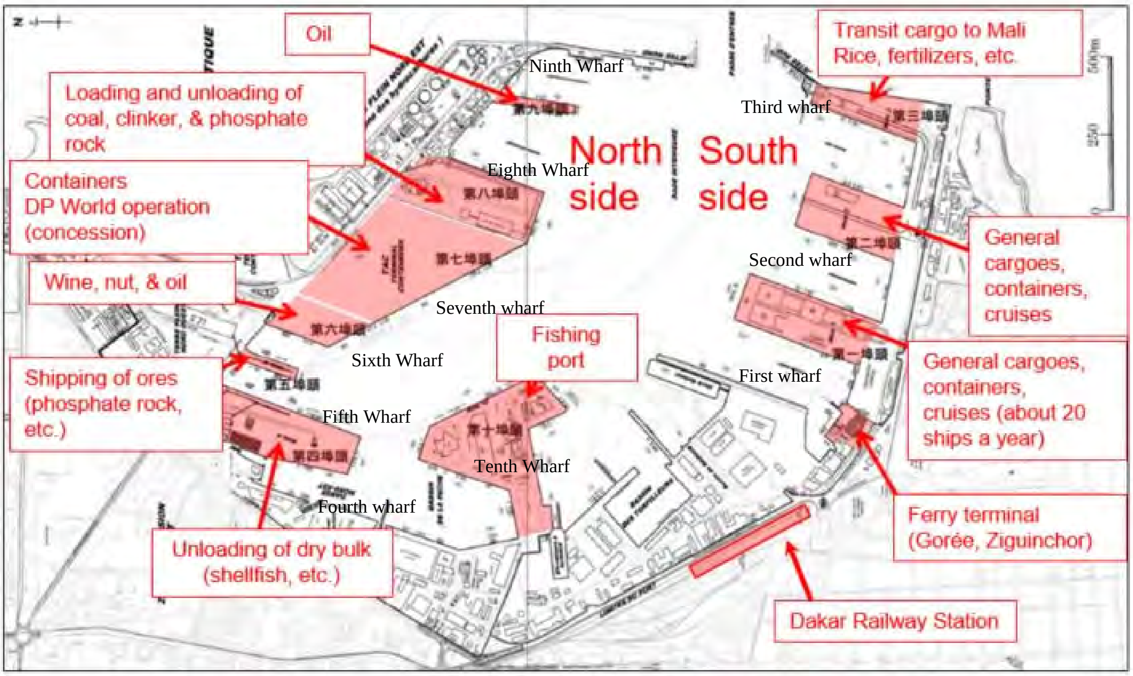
From the First Wharf to the Tenth Wharf at the Dakar port, they are used according to their purpose (Figure 7-42). The port is largely divided into the north side and the south side. The mining companies have rail lines going up to the warehouse in front of the Fifth Wharf on the north side for transporting ores. The Third Wharf is located on the south side and mainly handles cargoes (mainly grains and fertilizers) to Mali. The Third Wharf used to have rail freight but transportation has switched to trucks due to the aging tracks and government policy.

Increase in the volume of transportation accompanying economic growth has also increased the number of automobiles (Figure 7-41), thus worsening traffic congestion in the city. There is a growing momentum for the revival of freight transport in Senegal. In response, APIX and the other relevant organizations planned the construction of the TER and the revival of rail freight transportation at the Third Wharf. For the formulation of this project, the Study Team compared the APIX plan with the actual situation to identify issues that shall be addressed.



Source: National Agency of Statistics and Demography of Senegal (Agence Nationale de Statistique et de la Démographie, ANSD)

Figure 7-41 Trends in Vehicle Registration in Senegal

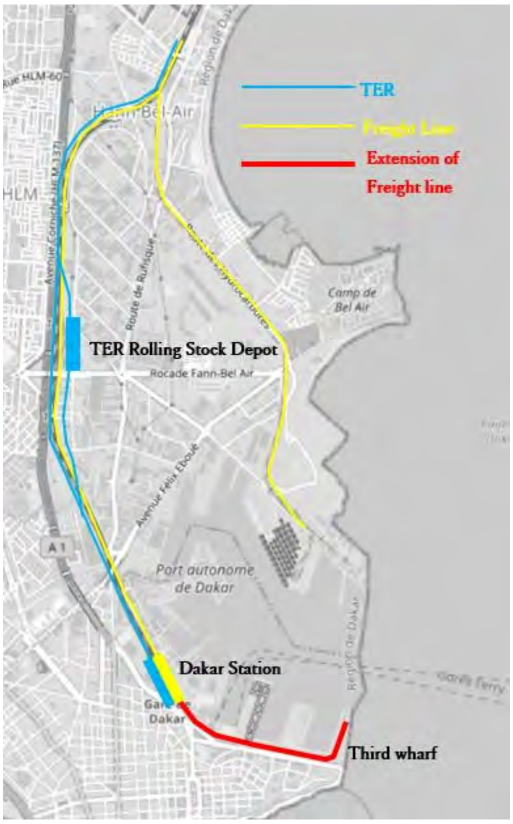


Source: Preparatory Study for the Project for Rehabilitation of Third Wharf in Dakar Port, Senegal (JICA)

Figure 7-42 Items Handled by Wharfs at the Dakar Port

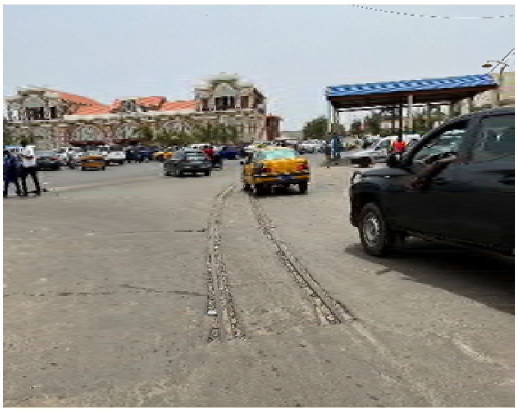
7.6.2 Target Section

When TER was constructed, the Diamniadio to Dakar Station section of the Mali to Bamako meter-gauge rail line was also reconstructed. However, about 1.5 km from Dakar Station to the Third Wharf has not been reconstructed. This section is out of service (Figure 7-43). This Study targets the reconstruction of this approximately 1.5-km section, freight handling lines, and freight handling facilities. Some of the tracks in the target section have been removed, and the remaining tracks are buried under asphalt pavements (Figure 7-44 and Figure 7-45).



Source: Prepared by JICA Study Team based on Open Street Map

Figure 7-43 Target Section



Source: JICA Study Team

Figure 7-44 Buried Railway Track

Source: JICA Study Team

Figure 7-45 Track Covered with Tiles

7.6.3 Current State

(1) History of the Decline of the Freight Line at the Third Wharf

In the past, the freight trains were operating two or three times a week from the Third Wharf to Mali as the main means of freight transportation to Mali. However, due to the declining service level, aging railway facilities, and the Malian government's policy of prioritizing truck transportation, freight transportation changed from rail to trucks and rail access to the Third Wharf was lost eventually. The rail line at the wharf was not used for a long time afterwards and the equipment deteriorated. Since Dubai Ports World and others involved in the development of ports and harbors prioritized the development of roads, the tracks were removed or buried.

(2) Condition of Use

Even though the Third Wharf no longer has rail freight, it still handles a large share of the unloading from cargo ships, at about 800,000 to 900,000 tons of cargoes per year. The main cargo is grains. However, logistical efficiency is declining due to congestion at the entries and exits of the port and in Dakar. Approximately 2000 to 4000 trucks/day are currently going in and out of the port. Although imported cars are also handled at the Third Wharf, they are unloaded from the ships at the Second Wharf and then transported to the Third Wharf.

At the Third Wharf, bagged cargoes are unloaded by a crane on the ship. Non-bagged cargoes, such as grains and fertilizers (dry bulk), are unloaded by grabs (like a shovel with claws on both sides that open and close) and placed into a bagging machine via a hopper. The hopper is transported by a forklift to where it is needed.

Source: JICA Study Team

Figure 7-46 Trucks Transporting Bagged Dry Bulk

Source: JICA Study team

Figure 7-47 Unloading of Dry Bulk Packaged in Bags

(3) Existing Facilities

- Third Wharf

The warehouse near the end of the wharf was used for rail transportation to Bamako in Mali. It is currently used as a temporary storage site for wharf improvement work and will be used by a Malian management company after completion. This warehouse was built about 80 years ago. A silo for storing grains ordered by a Malian private company is under construction next to the warehouse.

The wharf improvement work also included laying the foundation for the tracks near the quay. The foundation has been completed. Tie rod protection has been put in place at areas where the tracks will be laid. Part of the concrete floor is finished with asphalt pavement (5 cm) and crushed stone (40 cm). When laying the track, the asphalt can be removed easily.

The size of vessels able to berth at the Third Wharf is 10 meters in draft. For the berth improvement work, piles capable of reaching 12 meters in draught were used. If 2 meters of the sediment at the bottom of the sea is dredged, larger vessels can berth.

Source: JICA Financial Operations Division

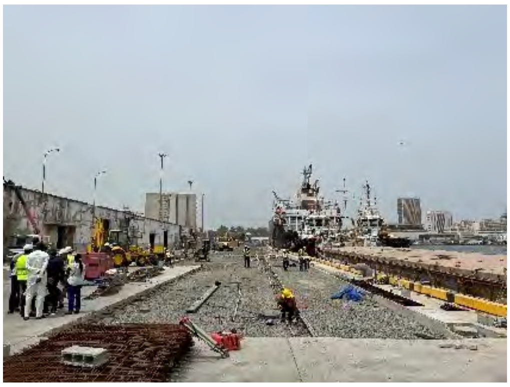
Figure 7-48 Full View of Third Wharf

Source: JICA Study Team

Figure 7-49 Silo under Construction

Source: JICA Study Team

Figure 7-50 Warehouse



Source: JICA Study Team

Figure 7-51 Improvement of the Third Wharf

- Bel-Air Station to Dakar Station to Third Wharf

  Part of the new cargo line, which was constructed at the same time as the TER, and the old cargo line is not connected near Hann (branch area between Dakar Station and Bel-Air Station). This section should be connected. At present, buffer stops are placed at the disconnected section. (Figure 7-52)

  A platform was built at the Dakar Station for the new freight line, with the expectation that the meter-gauge passenger trains will resume service in the future. The tracks from the platform in the direction of the Third Wharf are covered with buffer stops and tiles, which can be easily removed.

  On the north side of the port, two types of rails are used: Vignole Type (Flat Bottom Rail, Vignole) and Broca Type. Trucks can run on or across the Broca Type rail tracks. (Figure 7-53)

Source: JICA Study Team

Figure 7-52 Disconnected New Freight Line

Source: Supervisor at Toa Construction Works

Figure 7-53 Broca-type Rail

7.6.4 Extension Plan

Although the TER construction plan initially included an extension to the Third Wharf, the extension did not materialize due to insufficient funds. The extension was designed based on French standard specifications, but it can be constructed by any country following the same specifications.

The track layout from Dakar Station to the Third Wharf is designed along the old line. There is an intersection in front of Dakar Station in the direction of the Third Wharf (Figure 7-54). A fire station is next to the intersection, and then the port's parking lot (Figure 7-55 and Figure 7-56). Two tracks (double track) are planned for the wharf, one on the side of the quay and the other on the warehouse side. The track on the side of the quay has a sharp curve (Figure 7-57), but the radius of the curve is over 90 meters, according to the contract. There were originally three track layout plans. This plan was adopted because it would have the least impact on the existing warehouse for Mali and surrounding facilities. The selection was made through deliberations among APIX, CFS, and PAD.

Source: JICA Study Team

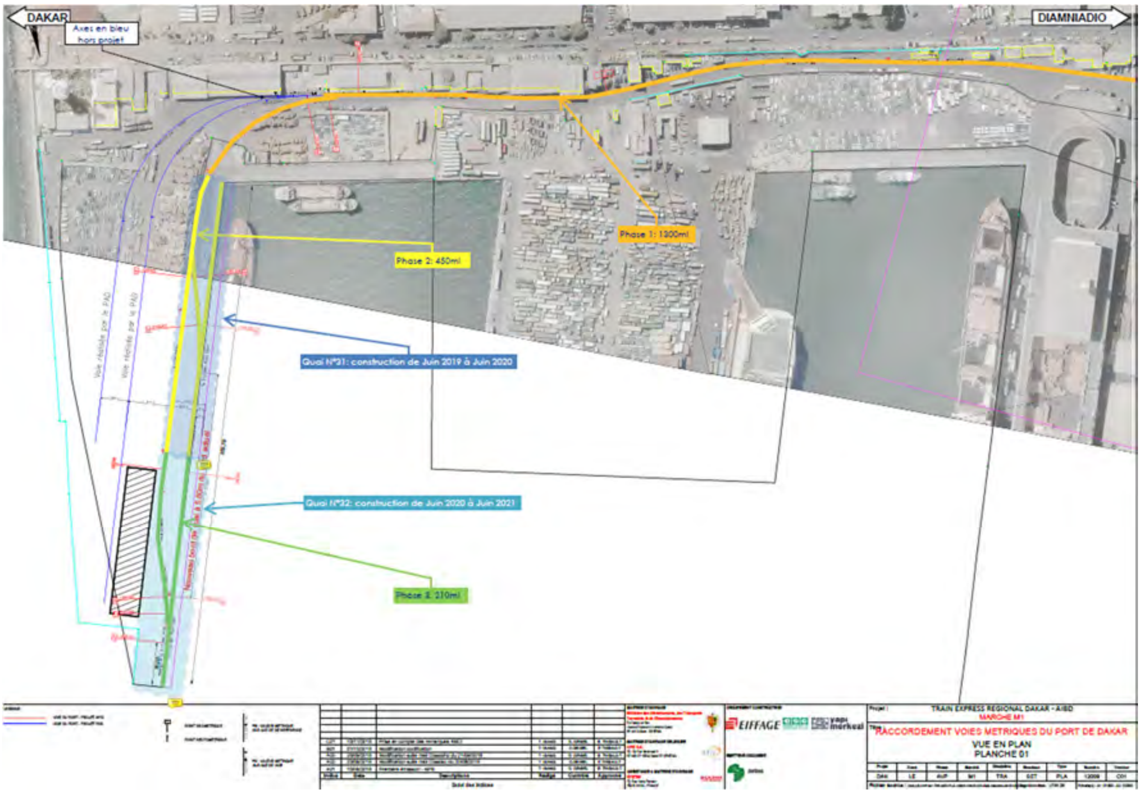
Figure 7-54 Intersection in front of Dakar Station

Source: JICA Study Team

Figure 7-55 Fire Department Parking Lot

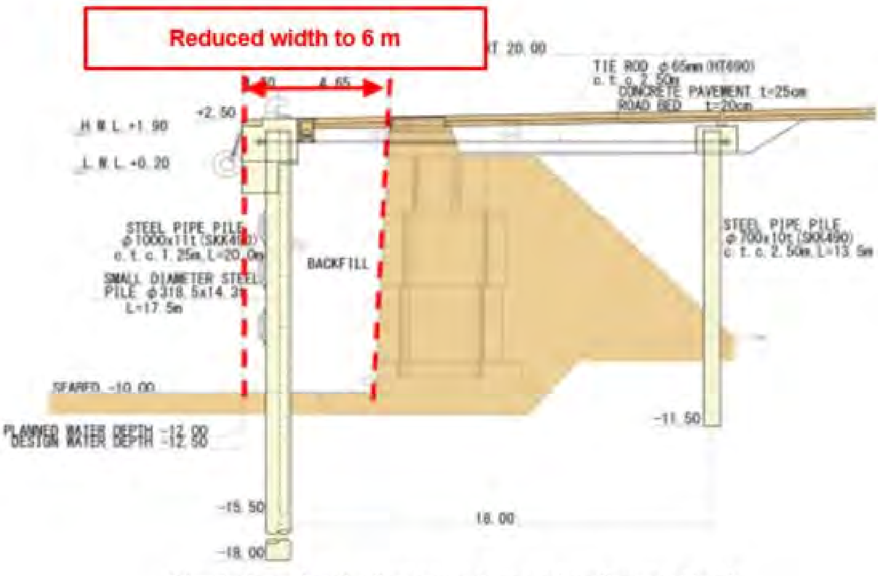
Source: JICA Study Team

Figure 7-56 Port's Parking Lot



Source: SETEC

Figure 7-57 Draft of Freight Line Extension Plan for Third Wharf



Source: JICA Financial Operations Division

Figure 7-58 Berth Plan for Third Wharf Improvement

7.6.5 Issues

The following is a list of issues pertaining to the plan to extend the freight line to the Third Wharf:

- The road and the railway are likely to intersect and block each other's traffic.

- The area is densely populated. Measures to prevent intrusions, such as level crossing safety devices and fences, shall be taken, no matter whether the locations are inside or outside the port.

- Appropriate design is needed to solve the drainage problem.

- The ground is good in general. However, since some areas used to be in the sea, a survey shall be conducted.

- Coordination among the related entities (CFS, PAD, APIX) is having difficulty.

- How to connect the two types of rails should be considered.

- There are buried objects on the ground of the planned route. In particular, power cables are buried east of the wharf. These cables are very dangerous. They are buried but not in protective cases.

- The following concerns regarding CFS shall be resolved:

- CFS shall not allow the construction of tracks unless safety of the intersection in front of Dakar Station is ensured. In the unlikely event of an accident, CFS can be held liable by placing tracks where safety is not assured.

- There are concerns about safety when operating the TER and the meter-gauge railway parallel to each other. At present, it is difficult to operate the freight trains during the hours when the TER is in operation.

- The fire station and the gas station adjacent to the intersection in front of Dakar Station shall be relocated.

- It is difficult to explain why CFS must construct the extension at this time.

7.6.6 Future Policy Proposals

The following strategies shall be pursued to underscore the need for the extension:

- To cope with the changes in demand due to the opening of the New Dakar Port

- To relocate important facilities along the line (firefighting facilities, gas station, fishing port facilities, ant others)

- To install level crossings to ensure safety at the intersection in front of Dakar Station, to elevate the railway line, or to construct the line underground

7.7 Current Status of the Railway between Dakar and Tambacounda

This section summarizes the current state and issues of railway facilities, such as track (including civil engineering structures), stations, rolling stock, signals, and others, in the section between Dakar and Tambacounda, where CFS plans to resume operation. Freight trains, which are maintained by CFS, are still operating between Dakar and Thiés. Seven to eight round trips per month (from 2009 onward only freight trains) were available from Thies to the Tambacounda/ Bamako direction until the service shut down in 2018. The freight train consists of 2,400-horsepower locomotive and 25 freight cars.

Source: Prepared by JICA Study Team from Open Street Map

Figure 7-59 Route Map of Dakar–Bamako Corridor

7.7.1 Civil Engineering and Tracks

Only four years have passed since the trains are out of service. The overall deterioration is relatively mild. However, the collapsed bridges and rail distortion will require large-scale repairs. The ballast level is generally low and the lateral resistance of rails is insufficient. Therefore, ballast spraying and compaction are necessary. Such repair can be done since CFS owns multiple tampers. The section between Dakar and Thiés is currently in operation. The track maintenance department under the direct control of CFS conducts daily visual inspections. Minor damage is repaired by the maintenance department directly. The rails currently in use are 36-kg rails imported mainly from the United Kingdom and France. The specification of the railway track was designed for 16 tons of axial weight and a maximum speed of 30 km/h. The sleepers are manufactured by CFS and the factory is located in Thiés. In 2017, the last year of production, the factory produced 5,000 pcs per month (about 200 pcs per day). The interval between sleepers is 65–70 cm, or 1500 sleepers/km. CFS also produces ballast. The quarry is about 30 km from Thiés. In the past, CFS also manufactured pandrol rail fasteners, but they are now imported from abroad.

Figure 7-60 shows the condition of the line, divided into four sections. Each of these four sections requires different level of repairs.

Source: “Railways of the World”, Japan Overseas Association for Railway Technical Cooperation (JARTS), with additions by the JICA Study Team

Figure 7-60 Condition of the Railway Line in Four Sections

- Between Dakar and Thiés (70 km)

Freight trains are still in service in this section. No major repairs are required. The section between Dakar and Diamniadio, which runs alongside TER, uses the UIC standard 54-kg rail, which enables the freight trains to operate at 70 km/h.

The condition between Diamniadio and Thiés is relatively good; no repair is needed. However, some parts do not have sufficient ballast. Thorough maintenance is needed to keep the tracks in better condition.

Source: JICA Study Team

Figure 7-61 Meter-gauge Track Next to the TER Track

Source: JICA Study Team

Figure 7-62 Track at Thiés Station

- Between Thiés and Guinguineo (133 km)

The railway line in this section has little damage. However, because the train service has stopped, the grass and trees have overgrown and sand has accumulated on the tracks. They have to be removed. The sediment deposits between 77 km and 129 km are especially dense. Trains can operate at a low speed of 15 to 20 km/h even in the current condition; however, some of the railway sleepers shall be replaced and ballast compacted to ensure safety and to improve the speed of transportation.

Source: JICA Study Team

Figure 7-63 Tracks with Sediment Deposits

Source: JICA Study Team

Figure 7-64 Embankments in Good Condition

- Between Guinguineo and Koungheul (133 km)

Flood damage is most severe in this section, and large-scale repairs are required. Part of the railway line has collapsed and it shall be reconstructed from the roadbed. New bridges shall be constructed in this section, and measures shall be taken to prevent the recurrence of bridge collapse. Other major repairs include restoring the detached fastening devices for 1 to 2 km, and others.

Source: World Bank

Figure 7-65 Flooded Embankment

Source: JICA Study Team

Figure 7-66 Trees Obstructing the Rail Track

- Between Kounghoul and Tambacounda (126 km)

This section requires replacement of the sleepers and rails, although there is no significant damage to the civil engineering structures. In particular, the wooden sleepers of a large 50-m bridge about 15 km from Tambacounda are rotten. They shall be replaced with new ones. The bridge itself has no structural problems. It only requires repainting. Although there is no problem with the roadbed or embankment in other parts of the section, the rail tracks are not well maintained and some sleepers are buried. The above improvements are prerequisites for the resumption of operation.

Source: JICA Study Team

Figure 7-67 Route with Low Ballast Level

Source: JICA Study Team

Figure 7-68 Bridge

7.7.2 Stations

There are 31 stations between Dakar and Tambacounda. Table 7-7 shows the specifications of each station. The Study Team inspected the main stations of Dakar, Bel-Air, Thiés, Dioulbel, Guinguineo, and Tambacounda. The current state of the stations is summarized below.

■ Dakar Station

Dakar Station is the terminal. It was upgraded along with the TER construction. The platform and station building are very clean. There is a parking lot for pickup and drop-off next to the station, which is functional. However, since many cars can pick up and drop off passengers directly at the roundabout in front of the station, they are one of the reasons contributing to the traffic congestion. At present, there are no meter-gauge freight trains or passenger trains operating between Dakar Station and the Third Wharf, only the TER facilities are being used.

Source: JICA Study Team

Figure 7-69 Dakar Station Building

Source: JICA Study Team

Figure 7-70 Freight Line Platform

Source: JICA Study team

Figure 7-71 Pick-up Vehicles Stopping at the Roundabout in front of the Station

■ Bel-Air Station

Freight cars and locomotives are collected from the wharfs and brought to the shunting yard here for sorting and stabling so part of the yard is still being used today. However, many facilities are dilapidated due to the decline of rail transport at the Dakar port, making it impossible for them to handle the increase in cargo volume. At present, only a small office and a single shunting line can be used. The rolling stock inspection and repair facilities, wheel lathes, and high-floor platforms for cargoes are not working. Restoration of these facilities requires minor repairs, such as removal of trees and replacement of consumable parts.

Source: JICA Study Team

Figure 7-72 Inspection and Repair Area

Source: JICA Study Team

Figure 7-73 Track Condition

■ Thiés Station

This is a junction station from Dakar to the Tambacounda/Bamako direction and to the Saint-Louis direction. Freight trains to the Saint-Louis direction still pass this station. At present, only one track is being used, and the remaining tracks are not used. Until around 2000, the signals and points of the interlocking system on the station premises could be controlled centrally from the station office. These devices remain but they no longer work. The station premises still have tracks, where many covered wagons are parked. The station building has been registered as a historical heritage site.

Source: JICA Study Team

Figure 7-74 Thiés Station Building

Source: JICA Study Team

Figure 7-75 Station Yard

■ Thiés Rolling Stock Depot

The depot is located about 500 meters from Thiés Station, adjoining the CFS Head Office. The large site has inspection and repair facilities, a rolling stock assembly plant, an inspection and repair workshop, and a factory for sleepers. The rolling stock assembly plant is currently used for bus assembly. The inspection and repair workshop and other factories are equipped for overhauling and maintaining rolling stock. Since they have not been used for a long time, minor maintenance is required, such as replacement of consumables. Utilities such as electricity and water are in place.

Source: JICA Study Team

Figure 7-76 Inside the Rolling Stock Depot

Source: JICA Study Team

Figure 7-77 Repair of Freight Car

Source: JICA Study Team

Figure 7-78 Bogie Inspection Equipment

Source: JICA Study Team

Figure 7-79 Lathes for Processing Parts

- Dioulbel Station

Dioulbel Station is a junction station to Touba, Senegal's second largest city (discussed later). It has eight lines, including stabling lines and sidings, laid on a vast piece of land. The effective length of the main line is 900 meters. Some surplus materials and waste materials have been retained when the rails were replaced a few years ago. The stationmaster's office is adjacent to the station building. The stationmaster still lives there today. The roof of the station building is partially damaged. The interior and exterior must be repaired before the station building can be used.

Source: JICA Study Team

Figure 7-80 Dioulbel Station Building

Source: JICA Study Team

Figure 7-81 View of Station Square

Source: JICA Study Team

Figure 7-82 Station Yard

Source: JICA Study Team

Figure 7-83 Material Storage Site

- Guinguineo Station

Guinguineo Station is a junction station to Kaolack (see later), where salt is produced. The 1120 meters × 150 meters site has 11 lines, including the main line, stabling lines, and sidings. In addition to the station building and platforms, there is also a small rolling stock workshop and a depot equipped for the maintenance of rail cars and locomotives. These buildings are dilapidated; repairs are needed before they can be used. On the other hand, the station building is kept in a relatively clean condition. It can be used with minor repairs such as cleaning. The office for staff next to the station building requires some repairs such as reroofing.

Source: JICA Study Team

Figure 7-84 Guinguineo Station Building

Source: JICA Study Team

Figure 7-85 Station Yard

Source: JICA Study Team

Figure 7-86 Workshop and Depot

Source: JICA Study Team

Figure 7-87 Inside of the Workshop

■ Tambacounda Station

Tambacounda Station is planned as a transit point to Bamako, as well as a transit point to the nearby mines currently in development. CFS plans to build a large-scale dry port about 3.5 km from the station in the direction of Bamako, and connect it to a new standard-gauge line. Even though the trains are not in operation now, the station has 20 to 30 staff members, including the stationmaster, track maintenance personnel, construction personnel, and drivers.

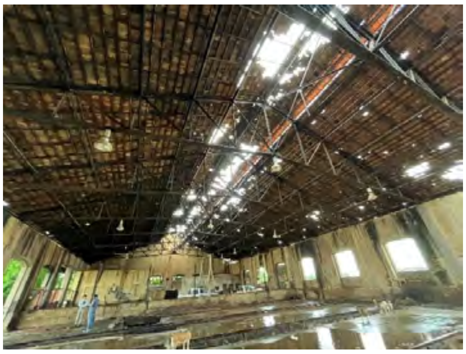
The site, like the other stations, is very large. It has eight lines, including the main line. The station building, platforms, and a depot are available, but they are not currently in use. Repairs of the exterior walls and roofs are necessary for the resumption of use. In addition to the station building, CFS operates a hotel near the Tambacounda Station, which is also closed currently.

Source: JICA Study Team

Figure 7-88 Tambacounda Station Building

Source: JICA Study Team

Figure 7-89 Station Yard



Source: JICA Study Team

Figure 7-90 Depot

Source: JICA Study Team

Figure 7-91 Hotel in Front of the Station

Source: JICA Study Team

Figure 7-92 Planned Dry Port Construction Site

Table 7-7 List of Stations

Station name	Km	Between stations (km)	Contact		Scale		Line length within station premises (m)		Quantity	
			Yes	None	Major station (Class 1)	Small station (Class 2)	Main line (Class 1)	Sub-main line (Class 2)	Stabling line	Turn-out
Dakar (Cyrnos)	0k000	Double track	✓			✓	600	-	-	4
Bel-Air	0k600	Double track	✓		✓		1.500	6.750	15	36
Hann	8k100	Double track	✓			✓	800	200	1	5
PK 13	13k000	Double track	✓			✓	700	-	-	6
Thiaroye	16k200	Double track	✓			✓	611	260	1	6
Mbao	24k100	Double track	✓			✓	308	300	1	2
Rufisque	29k600	Double track	✓			✓	882	3.700	7	14
Bargny	34k700	Double track	✓			✓	150	300	2	6
Sébikotane	44k600	Double track		✓		✓	-	-	-	-
Pout	54k600	Double track	✓			✓	325	525	2	5
Thiès	70k000	Double track	✓		✓		425	2.915	12	32
Thiénaba	85k800	15.80		✓		✓	-	-	-	-
Khombole	97k500	11.70	Some			✓	450	650	2	4
Dangalma	111k200	13.70		✓		✓	700	677	1	4
Bambey	123k856	12.66		✓		✓	-	-	-	-
Lagnar	137k500	13.64		✓		✓	-	-	-	-
Diourbel	148k400	12.70	✓			✓	910	3.136	5	17
Tocky	161k100	14.10		✓		✓	-	-	-	-
Gossas	175k200	14.10		✓		✓	-	-	-	-
Gagnick	194k300	19.10		✓		✓	-	-	-	-
Guinguineo	203k479	9.18	✓			✓	654	5.176	19	28
Birkilane	230k200	26.72		✓		✓	-	-	-	-
Kaffrine	251k800	21.60	✓				444	701	3	9
Maléme Hodar	280k800	29.00		✓			443	362	1	4
Maka Yop	310k300	29.50		✓		✓	-	-	-	-
Koungheul	336k000	25.70	✓			✓	576	1.101	5	10
Koupentoum	362k800	26.80	Some				511	344	1	2
Malem Niani	392k500	29.70		✓			-	400	1	1
Koussanar	417k600	25.10	✓			✓	750	1.000	2	4
Sinthiou M.	436k400	18.80		✓		✓	-	-	-	-
Tambacounda	462k200	25.80	✓		✓		900	4.389	10	29

Source: Prepared by JICA Study Team based on a World Bank report

7.7.3 Rolling Stock

CFS has its own locomotives and freight cars ready to resume operation in the Bamako direction. In addition to the locomotives currently in service, six locomotives can be leased from the Republic of South Africa. Three locomotives have already been delivered and are stored at the Dakar port. The lease contract includes training for 18 drivers. The training will be carried out from now on. Due to low horsepower, these locomotives will not be used for mineral transportation. No locomotives have been procured since 1985. At least four locomotives manufactured by a French company and the American General Electric (GE) have broken down and are kept in the Thiés Workshop. Due to the shortage of replacement parts, maintenance is not possible. Major maintenance is required to repair these locomotives.

There is a plan to prepare 120 container wagons, and 42 wagons have already been repaired. A container wagon (12 meters in length) can carry one 40-ft container or two 20-ft containers.

The outflow of maintenance staff with technical skills has begun, and the CFS president takes it seriously. As the facilities are also in poor conditions, many repairs are needed. Up until 2018 when the freight train to Bamako was still in service, visual inspections were carried out at major stations where maintenance shops were set up. Minor repairs were carried out at the maintenance shops when necessary. All major repairs were made in the Thiés Workshop. Bel-Air Station has a German wheel lathe but it has not been used since 2004. It is out of order. Power supply is available, but the oil lines and electrical circuits are defective and must be repaired. On the other hand, the Thiés Workshop has a wheel lathe that can be used for overlay welding.

Source: APA News

Figure 7-93 Leased Locomotive

Source: JICA Study Team

Figure 7-94 Repaired Wagons

Table 7-8 List of Rolling Stock Owned by CFS

Year	2010	2011	2012	2013	2014	2015	2016	2017
Locomotive for Main line								
Total	20	20	20	20	20	20	20	9
Number of locomotives available for operation	14	14	14	14	12	12	9	9
Number of spare locomotives (except during long-term service suspension)	11	8	7	8	6	5	1	1
Monthly vehicle km operated	8286	8131	8166	8630	8933	9143	9231	2760
Average daily vehicle operation time (h)	16	18	17	18	18	19	-	-
Average operating speed (km/h)	19	17	19	19	19	18	18	16
Freight wagons								
Total	551	577	535	528	528	450	386	386
Number of wagons available for operation	491	413	497	448	397	356	360	360

Number of towed wagons	942	968	684	926	786	765	297	297
Number of wagons operated per day	16	19	23	15	16	14	19	18.5

Source: Prepared by JICA Study Team based on a World Bank report

7.7.4 Signaling

Signaling facilities are available at major stations, where the stationmaster communicates with the stationmaster of the adjacent station regarding the train's arrival, departure, and passing. Track circuits are not used. The signals are managed by visual confirmation. Although some stations are equipped with interlocking devices, they are not currently in use. Maintenance of these devices is necessary before the resumption of use. The current number of trains in service does not pose any problem; however, as the number of trains in service increases in the future, improvement in signaling is necessary in order to ensure safe operation.

Source: JICA Study Team

Figure 7-95 Interlocking System at Thiés Station

Source: JICA Study Team

Figure 7-96 Interlocking Relay Circuits

7.7.5 Freight Terminals and Marshaling Yards

Since freight trains had been operating on meter-gauge lines in Senegal until recently, there are marshaling yards, and inspection and repair facilities for locomotives and wagons at various locations. Bel-Air Station, which is adjacent to the Dakar port, must provide a certain level of marshaling and inspection functions when the operation of freight trains resumes. The current situation is explained below.

(1) Overview of Bel-Air Station

Located adjacent to the Dakar port, the Bel-Air Station performs a marshaling yard function for freight trains, a locomotive/wagon inspection and minor maintenance function, and a traffic control function within a site of approximately 24 ha. The freight trains owned by the mining companies operate only for a limited time between 23:00 and 4:30 to avoid disrupting the TER operations. The maximum speed of train operation around Bel-Air Station is about 25 km/h. At present, minor renovations, such as change in the loading position, are carried out in preparation for the future operation of general freight trains. Figure 7-88 is an aerial view of the Bel-Air Station.

Source: Prepared by JICA Study Team using Google Map satellite photograph

Figure 7-97 Aerial View of Bel-Air Station

(2) Main Line and Stabling Lines

When the trains were operating from each wharf at the Dakar port, marshaling was carried out at Bel-Air Station. Although Bel-Air Station has a vast site, the freight trains operated by the two mining companies only pass the station now. Figure 7-98 and Figure 7-99 show the current state of the main line and stabling lines, respectively, at the Bel-Air Station.

Source: JICA Study Team

Figure 7-98 Main Line at Bel-Air Station (1)

Source: JICA Study Team

Figure 7-99 Main Line at Bel-Air Station (2)

The condition of the track is the same as that shown in Section 7.7.1. Since the level of maintenance is very low, the trains can barely run and there is a safety problem. There are traces of ballast spraying at various locations but the ballast is insufficient. Most sections of the track are installed directly on the roadbed. The ballast shall be reconstructed and maintenance shall be carried out on a continuous basis to ensure safe operation.

A station office of the CFS and a car inspection shop are located at the end of a stabling line on the side of the Dakar and Thiés stations. Although the equipment in the car inspection shop is obsolete, it can still be used for basic inspection. There are two inspection lines. Since only diesel locomotives were in operation, the pantograph inspection table was not installed.

Source: JICA Study Team

Figure 7-100 CFS Station Office (center left) and Inspection Shop (right)

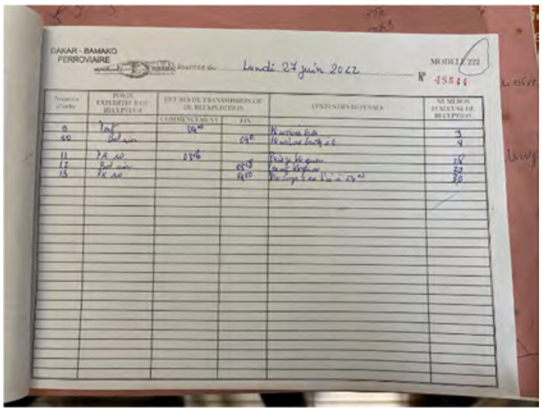
Source: JICA Study Team

Figure 7-101 Inside the Depot

The CFS station office is a conspicuously old building, but it is used as a center for managing the operation of freight trains of the mining companies. Mobile phones are used for communications regarding train operation, such as communication with train drivers. In the future, it will be necessary to install a signaling system as the number of trains increases.

Source: JICA Study Team

Figure 7-102 Traffic Control Document 1



Source: JICA Study Team

Figure 7-103 Traffic Control Document 2

The section connecting Bel-Air Station and the Dakar port is particularly dangerous due to poor track condition. Similar to other sections, defective joints (Figure 7-106) and joint gaps (Figure 7-107) are found at various locations. Many large trucks pass through the level crossings along the way (Figure 7-104). Asphalt pavement or concrete pavement with sufficient load-bearing property shall be installed to prevent track damage.

Source: JICA Study Team
Figure 7-104 Level Crossing between Bel-Air Station and Dakar Port

Source: JICA Study Team
Figure 7-105 Track Condition between Bel-Air Station and Dakar Port (1)

Source: JICA Study Team
Figure 7-106 Track Condition between Bel-Air Station and Dakar Port (2)

Source: JICA Study Team
Figure 7-107 Track Condition between Bel-Air Station and Dakar Port (3)

(3) Rolling Stock Maintenance Facilities, etc.

CFS has a large-scale rolling stock workshop in Thiés where the locomotives and freight cars are overhauled. Bel-Air Station, which is the base for Dakar Station, has some inspection and repair facilities but no cranes. This means that they are facilities for visual inspection and repairs only.

The inspection and repair facilities, excluding the aforementioned maintenance depot next to the main line, are located at the end of the siding branched out from the station office area. There is a manual turnout (Figure 7-108) in front of the station office, but it is not used currently because the general freight trains are not in operation. Some rail cars used in the past were left in place on the railway tracks at the rolling stock maintenance depot (Figure 7-109). The depot has an inspection pit and a wheel lathe, but the wheel lathe is currently not usable due to a minor problem.

Source: JICA Study Team

Figure 7-108 Turnout from the Main Line to the Rolling Stock Maintenance Depot

Source: JICA Study Team

Figure 7-109 Rolling Stock Maintenance Depot and Abandoned Wagons

Source: JICA Study Team

Figure 7-110 Inside the Depot

Source: JICA Study Team

Figure 7-111 Wheel Lathe

Large quantities of equipment are stored in the vehicle repair shop but there is room for staff to work. The deterioration and aging of the facilities affect efficiency and sanitation.

Source: JICA Study Team

Figure 7-112 Equipment at the Depot

Source: JICA Study Team

Figure 7-113 Staff Room at the Depot

Remnants of a former customs facility, from which goods used to be transported to and from the Senegalese hinterland and Mali, are at the far end of a siding.

Source: JICA Study Team

Figure 7-114 Customs Facility Used in the Past

7.7.6 Freight Handling Equipment

In the past, tracks from Bel-Air Station were extended to the First to Third wharfs at the Dakar port. However, they have been removed for the TER construction and the Third Wharf renovation. Previously, both covered wagons and container wagons were used. The loading and unloading of covered wagons were probably done manually. On the north side, a railway line connects the Eighth Wharf, but it is currently not in use. There used to be a railway line going to the container terminal of Dubai Ports World. However, the company removed the tracks to focus on trucking transport.

Since the Dakar–Bamako Railway handles the logistics between Dakar and Bamako, there is no large-scale freight handling facility in the inland areas of Senegal, except Dakar. Rail freight transportation shall be restored and utilized as a way to handle the increasing freight transportation volume. For this reason, freight handling facilities shall be set up at various locations to distribute the cargoes.

7.7.7 CFS Railway Development and Improvement Project

The Study Team interviewed CFS regarding the railway development and improvement plans currently under consideration. The interview is summarized below.

CFS has already reviewed a variety of improvement plans. There are two main types of projects: rehabilitation of the existing line (meter-gauge) between Thiés and Tambacounda, and construction of a new standard-gauge line between Dakar and Tambacounda. CFS prioritizes the rehabilitation plan. One reason is the need to switch the transportation of imported cargoes at the Dakar port from trucks to rail to alleviate road congestion around the port area as soon as possible. Another reason is CFS plans to utilize the existing line to transport materials and equipment for the construction of the new standard-gauge line. CFS also aims to resume freight train services between Dakar and Tambacounda, based on a plan to make Tambacounda a logistics hub. However, even if these projects do not materialize, CFS intends to resume service even if the destination is Guinguineo or Thiés temporarily. CFS plans to resume freight train operations to the inland areas with minimal capital investment, and use the revenues generated from the resumed freight operations to fund future improvements.

According to CFS estimate, rehabilitation of the Dakar–Tambacounda section will cost around €38 million (approximately 5.3 billion yen). However, since the estimate is based on outsourcing figures, the cost can be reduced to approximately €27 million (approximately 3.8 billion yen) if some CFS engineers and equipment are employed. A budget of 17 billion CFA francs (about 3.4 billion yen) has been secured by the end of this fiscal year. The remainder of the budget is being prepared within the government.

The improvement scheme is expected to include tracks, stations, and freight terminals. Although several facilities at the Bel-Air Station require renovation, CFS will prioritize facilities that will enable the resumption of freight train services and generate revenue. For example, although the wheel lathes at the Bel-Air Station do not work, the same type of wheel lathes is available at Thiés. Since CFS is able to procure parts and repair the wheel lathes on its own, the wheel lathes are of low priority to CFS.

7.7.8 Challenges for the CFS Improvement Plan

While CFS is making steady progress in its plan to rehabilitate the meter-gauge line, the project for constructing a new standard-gauge railway has little prospect currently. The issues related to the rehabilitation plan and new line construction plan are summarized below.

(1) Rehabilitation Plan

- The restart of operation is urgent, and rehabilitation needs to proceed at a rapid pace.

- The budget for this fiscal year is approximately 3.4 billion yen, which is short of the approximately 3.8 billion yen minimum amount required for the rehabilitation. Even this minimum amount may not be sufficient, given the need to ensure safe operation.

- There is a large outflow of engineers. It is necessary to secure human resources.

- Although GTS has indicated its intention to operate the freight trains, it has not confirmed yet.

- Measures shall be taken to prevent a recurrence of flooding between Guinguineo and Kounghoul that has damaged bridges and washed away embankments.

(2) New Railway Construction Project

- CFS has partnered with the Canadian CCC, but they are unable to reach an agreement on funding.

- The construction site has not been secured yet.

- According to a World Bank study, the demand is not sufficient for building a new standard-gauge railway.

- The prospect of procuring locomotives and freight wagons is uncertain.

- The TER line runs from Dakar to Diamniadio. However, it is not realistic, in terms of safety and train operation, to operate the TER and the new line in parallel or to have through operation between the two.

7.7.9 Future Policy Proposals

Improving the logistics domestically and internationally is a challenge for Senegal, especially from the perspectives of developing the regional economy and improving the living conditions of its people. Rehabilitation of the meter-gauge railway between Dakar and Tambacounda has attracted attention as an effective measure. It is also recognized as a top priority by CFS, which manages and operates the line, for its cost-effectiveness. On the other hand, the funds and technical capacity required for the rehabilitation of the meter-gauge line, as well as the knowledge to carry out sustainable maintenance and management are in short supply. Grant aid and technical cooperation projects are effective means to help CFS rehabilitate the railway and achieve greater cost-effectiveness. The policies are summarized below.

(1) Challenges in Senegal's Logistics

1) Domestic and international logistics in Senegal continues to increase in volume. Road transport is shouldering most of the logistical demand. Currently, rail freight is limited due to inadequate capital investment and lack of maintenance.

2) Increase in the number of trucks has led to serious traffic congestion, particularly in city centers, and many accidents due to poor maintenance. Overloading also caused the rapid deterioration of roads.

3) The strengths of rail freight services, such as the ability to transport large quantities of goods at low cost and at high speed, have not been utilized. The high costs of road transport have resulted in higher prices, thus hindering economic growth.

4) Heavy cargoes such as grains and construction materials are being transported by trucks, which are not energy-efficient, leading to higher emissions of carbon dioxide and air pollutants.

(2) Using Grant Aid and Technical Cooperation Projects

1) A solution to the above-mentioned problems is to rehabilitate the railway and increase the transport capacity to inland areas.

2) The lack of funds and the lack of technical capability are issues hindering rehabilitation of the railway. However, it is possible to use grant aid to help restore tracks and civil engineering facilities, and develop railway infrastructure that has high transport capacity and safety.

3) Senegal's railways have always had speed reductions and derailments due to deteriorating facilities. The maintenance and management standards must be improved in order to sustain the benefits of rehabilitation from the capital investment. Technical cooperation projects can help Senegal’s railway operators to improve the quality of maintenance using the technologies and experiences accumulated in Japan over many years, thereby enhancing the sustainability of railway operations.

(3) Estimated Benefits

1) Assistance in the forms of financing and expertise makes it possible to construct higher quality rail facilities and improve the level of maintenance and management to enhance the sustainability of operation.

2) A 25-car freight train making two round trips per day is the equivalent of transferring 200 of the 20-ft containers per day from trucks to rail. The transport capacity of railway can be further increased by making equipment upgrades, such as installation of a signaling system and double tracking. Increasing the share of railway in logistics will reduce congestion and accidents.

3) The expertise developed in Japan can be utilized in the development of railway infrastructure, including measures against flood damage, which has been a problem in

Senegal in recent years, and in cost-effective capital investment.

4) The provision of inexpensive and efficient logistical services in Senegal will lower transportation costs and improve competitiveness of the manufacturing sector.

5) The railway will help reduce the emissions of carbon dioxide and air pollutants.

7.8 Current State and Challenges of Railways in Other Sections

7.8.1 Kaolack Branch Line

The Kaolack Branch Line is a 22-km extension from Guinguineo to Kaolack. Kaolack is a major city of the Kaolack State. It is located along the salt-rich Salman River and has many production bases for salt and peanut oil. The Kaolack port, which faces the Salman River, used to have rail access. The possibility of shipping is being explored. Currently, there is a plan to dredge the sand in the Salman River so that some of the large vessels entering Dakar can access this port. Railway tracks up to 6 km from Kaolack downtown have been removed for the construction of commercial facilities. The remaining 14 km of tracks have little damage so they can be used after the trees and sand have been removed. The 30-kg rails are used for the tracks.

Source: JICA Study Team

Figure 7-115 Rail Line Towards Kaolack

Rehabilitation of the Guinguineo–Kaolack section only does not work; the Dakar–Guinguineo section must be restored first. The main service will be passenger transport. After rehabilitation of the Dakar–Guinguineo section has been completed, the remaining short section to Kaolack can be rehabilitated so passenger trains can reach Kaolack. This rehabilitation is highly cost-effective as a future project.

7.8.2 Touba Branch Line

The Touba Branch Line is a 47-km extension from Dioulbel to Touba. Touba is the sacred ground of the Muslim Moulid Church. It has the second largest population in Senegal. The church is responsible for the region's economy. Touba has great potential as an economic hub. It is expected to grow in the future.

Passenger trains are running during the annual pilgrimage period until 2017. During that time, the railway line was maintained (removing trees and sediments from the tracks) for 45 days, and the trains were in service. Currently, two km of tracks from Touba Station to the front of the mosque have been removed because the rails (30kg rail) used since 1930 had become unsafe due to deterioration. Restoration of the rails has been carried out since 2017. Primarily steel sleepers are used in this section. The trains were running at 30 km/h at the time of operation. The operations to Mbacké Station before Touba Station can be resumed by removing only the sand on the railway tracks. The vast space in front of Mbacké Station, currently used by citizens as a football and basketball field, is a CFS site. The 16-ha area measures 800 meters x 200 meters.

Source: JICA Study Team

Figure 7-116 Mbacké Station Building

Source: JICA Study Team

Figure 7-117 Scene at Mbacké Station

Source: JICA Study Team

Figure 7-118 Track Condition

Source: JICA Study Team

Figure 7-119 Mosque in Touba

Similar to the Kaolack Branch Line, no single rehabilitation is effective. Therefore, it is a prerequisite that the rehabilitation of the Dakar–Guinguineo be carried out first. Similarly, passenger trains will be in operation. After rehabilitation between Dakar and Guinguineo has been completed, the remaining short section to Touba shall be rehabilitated so that passenger trains can operate. Similar to the Kaolack Branch Line, the rehabilitation is highly cost-effective as a future project.

7.8.3 TER Extension Plan

The 19-km section of TER between Diamniadio and AIBD is currently under construction. This section is branched out from the meter-gauge line several km from Diamniadio to the Thiés direction. New sites will be secured for the construction to the airport.

APIX is also considering an extension from Diamniadio to Thiés and from AIBD to Saly, a national resort, as the third phase. Although the route has been selected for this plan, the funding sources have not yet been specified. APIX mentioned that it would like to have support from Japan for the extension section, especially in the field of signals. However, as the project relies heavily on France in terms of the rail system and funding, full-scale participation by Japanese companies in the extension section will be difficult.

7.8.4 Plan to Extend the Railway Line to the New Dakar Port

Due to limitations of the existing Dakar port, a new port, which will mainly handle containers, is currently under construction in Ndayane, on the outskirts of Dakar. Section 7.3.1 (3) gives details of the construction plan of the new port. In the construction of the new port, railway as well as truck transportation are planned as the means for transporting cargoes handled at the port to various places in the country. Although a railway is expected to be constructed, there is no specific plan at this point. A detailed study shall be conducted in the future, based on the results of the master plan for the area around New Dakar Port, which is currently being formulated by JICA. Since there is also a plan to extend the TER to the neighboring resort Saly, it is necessary to consider in a comprehensive manner how to improve the transportation infrastructure to meet the demand for the transportation of passengers and cargoes around Saly and Ndayane. A large amount of funds will be required for development of the related infrastructure. Loan aid shall be considered to accelerate Senegal's economic growth.

Source: "Senegal: Ndayane deep water port opened for global investment of $1.8 billion" (NewsBeezer)

Figure 7-120 Planning of New Dakar Port (Ndayane)

7.9 Selection of Target Project and Improvement Plan

7.9.1 Selection of Target Project

The Study Team conducted a survey to find out if extending the freight line to the Third Wharf can be a project eligible for grant aid, in response to a request from APIX, which is leading a domestic railway construction project. However, when the Study Team verified with CFS, which supervises operation and maintenance after a railway has been constructed, CFS indicated that rehabilitation of the existing line should be prioritized before extending the freight line to the Third Wharf. To examine the validity of the plan, the Study Team compared the extension plan of the Third Wharf with the rehabilitation plan between Dakar and Tambacounda, based on the information currently available (Table 7-9). The review found that assistance for a certain part of the Dakar–Tambacounda rehabilitation plan (between Thiés and Guinguineo) would be appropriate.

Table 7-9 Comparison of Projects

	Feasibility	Cost effectiveness	Future potential	Benefits to Japan	Total
Third wharf extension plan	1	2	2	3	8
Rehabilitation plan	3	3	3	2	11

Source: JICA Study Team
Ranking 1: Low, 2: Normal, 3: High

(1) Feasibility

The plan to extend the freight line to the Third Wharf scored only 1 point because the plan is very unlikely to materialize. There are many obstacles such as the intersection in front of the station, fire-fighting facilities, and a fishing port, not to mention the difficulty of coordinating the related parties.

Rehabilitation of the existing line between Thiés and Guinguineo requires only minor repairs. The project can likely be completed with minimal assistance, so the project scored 3 points.

(2) Cost Effectiveness

Although the cost of extending the freight line to the Third Wharf is not high (see Section 7.10), the freight line is not included in the CFS improvement plan. There is no prospect as to when the freight line will be used after completion of the project. On the other hand, given the fact that Malian companies are constructing silos and restarting the use of silos, the possibility of eventually using the freight line is high, so this project scored 2 points.

The section between Thiés and Guinguineo is long. Rehabilitation of the railway line can have a large social impact and the cost is relatively low. This section is also part of the CFS improvement plan. The line is expected to be used soon after the project is completed. Since there is still a high demand for trucks, some conversion to rail transport is anticipated. The effects will be immediate. For this reason, the rehabilitation project was given 3 points.

(3) Future Potential

The plan to extend the freight line to the Third Wharf is dependent on the cargo demand to Mali. The demand is expected to increase in the near future, when Senegal lifts the economic sanctions. On the other hand, impact of the extension on the logistics in Senegal is expected to be small and limited. This project is not expected to have further effects, unlike the other projects. For this reason, this project was given only 2 points.

Rehabilitation between Thiés and Guinguineo is an important part of the logistical backbone in Senegal. It is the foundation for freight and passenger transport throughout Senegal, as well as to Mali. Even after completion of this project, the rehabilitation will likely lead to the formation of other projects, such as assistance in the maintenance and rehabilitation of other sections. Therefore, this project scored 3 points.

(4) Benefits to Japan

Extension of the freight line to the Third Wharf is expected to enhance the significance of Japan's support, partly due to the synergy effect from the current construction under the Project for Rehabilitation of the Third Wharf in Dakar Port. There is a high possibility that the extension will mitigate traffic congestion around Dakar Station. For this reason, 3 points were given because the citizens of Dakar, who may not be involved in logistics, can still benefit from the improvements made with Japan’s support.

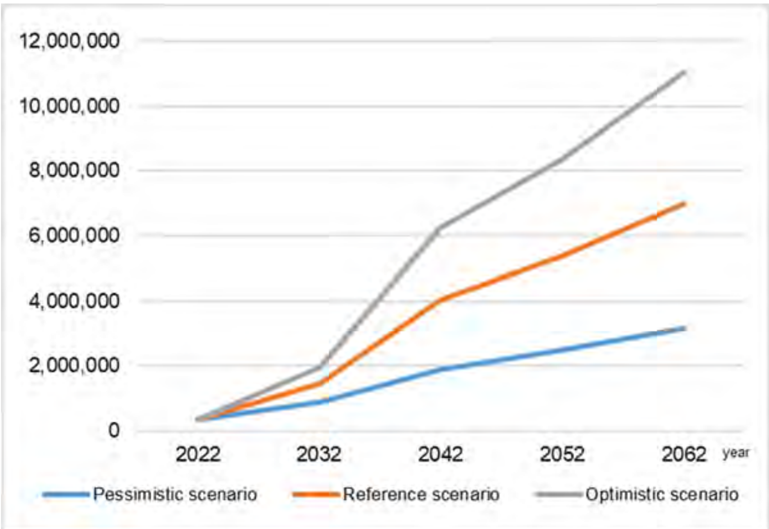
Rehabilitation of the line between Thiés and Guinguineo scored 2 points. Although support for the Senegal’s national plan can make Japan's presence known to the Government of Senegal and

CFS, the citizens of Senegal may not connect benefits of the rehabilitation directly with Japan's support. Efforts shall be made to heighten awareness.

7.9.2 Basic Policy of the Improvement Plan

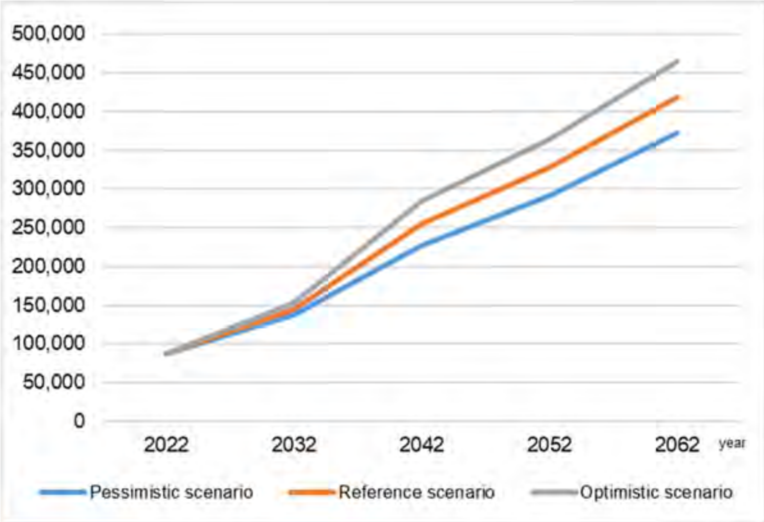
(1) Rehabilitation between Thiés and Guinguineo to Improve Logistical Efficiency

If rail freight transportation between the Dakar port and Guinguineo becomes available, a portion of the freight from the Dakar port to the inland areas, including to Mali, will be transported by rail instead of trucks, as trucks have problems such as accidents and damage to roads. Consequently, logistical efficiency will be improved. The freight trains can also be used in the future to transport materials and equipment to Tambacounda and Bamako to facilitate rehabilitation work, making early completion of the rehabilitation plan possible. Moreover, if the rail line goes to Tambacounda and Bamako, there will be more demand for freight and passenger transport. The World Bank conducted a study on the rehabilitation and modernization of the Dakar–Bamako railway (Études en vue de la Rehabilitation et la Modernisation du Chemin de Fer Dakar–Bamako) in 2021. According to the report, if rail transport from Dakar to Bamako is resumed, freight transport on the rail line (including some sections) is estimated to increase from the current level of approximately 350,000 tons/year to approximately 7 million tons/year in the following 30 years (see Figure 7-121). The study also estimates that demand for passenger transport will increase by approximately 420,000 passengers by 2062 (see Figure 7-122).



Source: World Bank

Figure 7-121 Projected Volume of Cargoes Handled When Rail Transport is Resumed



Source: World Bank

Figure 7-122 Projected Number of Passengers When Rail Transport is Resumed

(2) Outline of Rehabilitation Plan

Rehabilitation work in the section between Thiés and Guinguineo, selected in the preceding paragraph, will be carried out. The goals are to enable trains with axle loads of 17 tons to operate at 60 km/h or higher, and to have maintenance carried out steadily. To this end, the main task will be the repairs of civil engineering structures and tracks. A freight terminal will be constructed at Guinguineo Station to transport freight from Guinguineo to the Tambacounda and Mali direction, as well as to Kaolack and other neighboring cities. The details are explained in the improvement plan for each item in the next sections. Additional construction works were also considered in order to increase the effectiveness of this project, such as connection between the Bel-Air Yard and the Seventh Wharf, where containers are currently being loaded and unloaded, and the Eighth Wharf, where ore shipments are expected to increase in the future.

(3) Technical Cooperation Project to Maintain the Effectiveness of Grant Aid

CFS will need support for operation and maintenance after the resumption of operations with grant aid. JICA implemented a technical cooperation project in Myanmar to help restore ruined tracks and maintain rolling stock in cooperation with a Japanese railway operator and others. Based on this experience, similar technical cooperation projects can be developed for CFS to create synergy with the grant aid project and to support CFS in building a sustainable railway operation system after the rail line has been rehabilitated.

7.9.3 Civil Engineering and Track

The section between Thiés and Guinguineo does not have damaged civil engineering structures. The trains can operate after the trees and sediments have been removed, and small improvements made to the roadbed and tracks. The broken rails and sleepers on the track shall be replaced, and ballast shall be sprayed and compacted in areas where the ballast is insufficient. The rehabilitation plan assumes Japanese rails will be used but confirmation is necessary. CFS is expected to provide the sleepers and ballast.

(1) Roadbed

The roadbed needs to have the property to ensure safe train operation. High quality soil and other such materials shall be compacted to provide sufficient bearing capacity. There are different types of roadbeds: concrete roadbed, asphalt roadbed, and crushed stone roadbed. The current sections have crushed stone roadbeds, which can meet the target axle load of 17 tons and the design speed of 60 km/h. Therefore, crushed stone roadbed will be used for this project. The construction of roadbeds shall not be carried out during the rainy season in order to avoid changes in water content during spraying.

The condition of the roadbed during the previous train operation is not known due to the lack of construction records on the roadbeds for the relevant sections. By looking at the condition of the filling, the Study Team confirmed that ballast spraying and compaction have been carried out and concluded that compaction using multiple tie tampers is sufficient.

The Japanese design standard for railway structures (earth structures) is based on K values. K30 ≥ 70 MN/m3 is required at a minimum for the construction and maintenance of roadbeds. Figure 7-123 is an example of the roadbed construction, and Figure 7-124 is an example of the density test using sand replacement after the roadbed has been compacted.

Source: JICA Study Team

Figure 7-123 Example of Roadbed Construction

Source: JICA Study Team

Figure 7-124 Example of Roadbed Test

Source: JICA Study Team

Figure 7-125 CFS Freight Car

Source: JICA Study Team

Figure 7-126 Multiple Tampers Owned by CFS

(2) Track

The rails and sleepers will be reused after their condition and strength have been checked. The partially damaged parts will be replaced with new ones supplied by CFS. CFS has a factory that can produce sleepers. Some damaged rails and iron sleepers can be reused as earth retaining materials. Since CFS will supply the ballast, the construction shall be planned in such a way so that the ballast will be brought in according to the progress of the construction.

Ballast will be sprayed in all the sections, and compacted (Figure 7-128) to restore the tracks. Spraying of the ballast shall start from the Thiés side, where hopper cars can enter. Railway cranes or UNIC cranes will be used to load and unload the damaged rails and sleepers that have been removed. The rest of the track construction will be done manually. Rail replacement requires rail jacks, hand tie tampers, and other equipment, which should be prepared in advance.

Source: JICA Study Team

Figure 7-127 Sleeper Factory in Thiés

Source: JICA Study Team

Figure 7-128 Ballast Compacting Work

Source: JICA Study Team

Figure 7-129 Tracks Manufactured in Thiés

Source: JICA Study Team

Figure 7-130 Concrete Agitator for Making Sleepers

7.9.4 Rolling Stock

The locomotives and freight cars currently owned by CFS will be used. As noted above, CFS is leasing six locomotives from South Africa with its own funds. The rolling stock workshop in Thiés is currently working on container wagons and locomotives, which can be put into service after maintenance.

7.9.5 Freight Terminals and Marshaling Yards

(1) Maintenance Policy for Freight Terminal and Marshaling Yard

When transporting freight by rail from the Dakar port, the cargoes must be transported by truck from the freight terminal to the final destination, necessitating a transshipment. The transshipment of cargoes from covered wagons and open wagons is done manually, making it inefficient. A more logical transportation system is for rail freight to concentrate on container transport and leave cargoes that require manual loading and unloading to truck transportation. In Japan, covered and open freight cars were used for traditional freight rail operation. However, container transport is more efficient because it does not require transshipment to trucks nor the labor to shunt freight cars. For this reason, container transport accounts for most of Japan’s domestic rail freight today. In Senegal, container transport accounts for about half of all freight trains in service. When constructing a new freight terminal, the facilities shall be designed prioritizing container transport.

The track layout of a freight terminal for container transport is slimmer in design because the freight handling operation is smaller in each of the handling processes than in the case of covered or open wagons. The containers are loaded and unloaded using freight handling equipment such as forklifts or reach stackers. Container platforms at the same height as the track will be constructed, instead of high platforms like those used for truck transport. Rather than ordinary asphalt paving, the platforms shall be constructed to withstand heavy loads. However, because the platforms do not need roofs, the total cost will be lower.

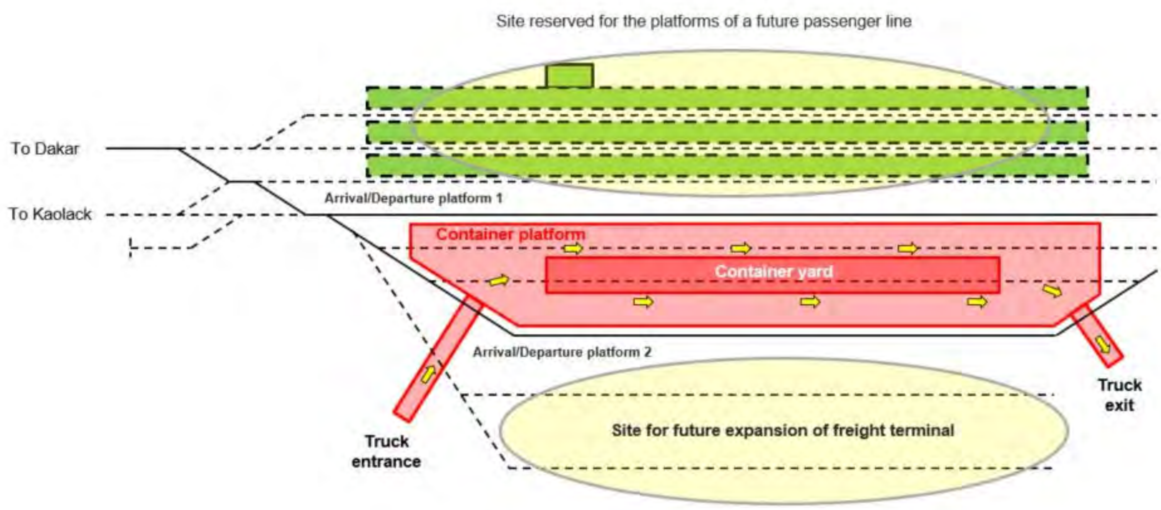
Source: JICA Study Team

Figure 7-131 Forklift Used for Loading and Unloading Containers at the Container Platform

(2) Freight Terminal at Guinguineo Station

Figure 7-132 shows the overall plan of the freight terminal at Guinguineo Station. The solid and dotted portions of the current track layout represent the target and non-target portions of this rehabilitation plan. The existing tracks will be removed where the container platform will be installed. Guinguineo Station was one of Senegal's rail hubs in the past. The site has plenty of space. The platform in the northeast will be used for the departure and arrival lines of passenger trains in the future. The freight terminal will be in an adjacent location (southwest side). For the efficiency of train operation and customer service, a site for three platforms and three tracks will be secured from the current track layout, with a view to upgrading to a track layout of two platforms and four tracks in the future.

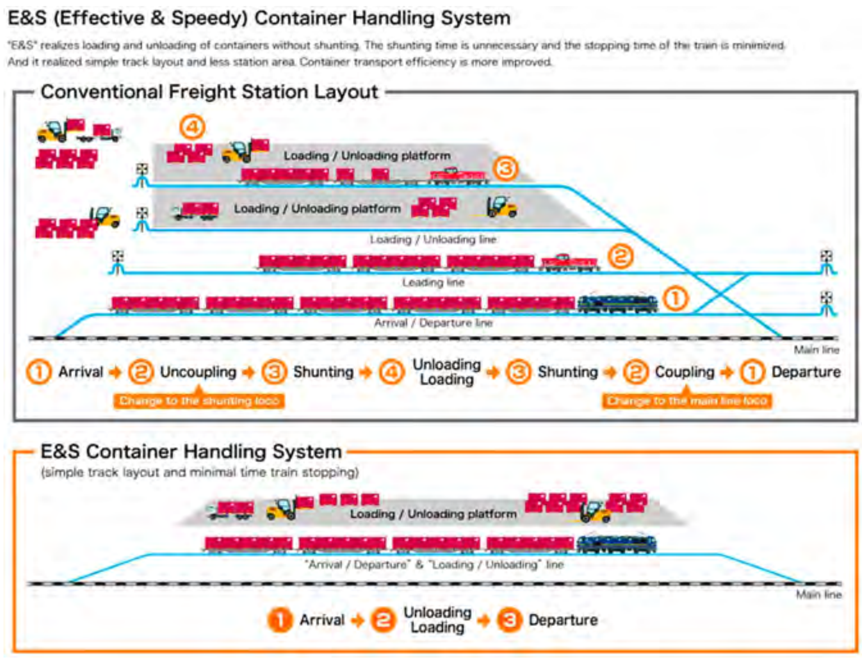
Stabling lines and a water tower used in the past remain on the southwest side of the section to be developed into a freight terminal. The area can be utilized for the expansion of the freight terminal in the future.



Source: JICA Study Team

Figure 7-132 Overall Plan of the Guinguineo Station Freight Terminal

The freight terminal will adopt the track layout of the Effective & Speedy Container Handling System (E&S System). The E&S System enables loading or unloading on the same line where the freight train departs or arrives, while traditionally loading or unloading is carried out at a line different from the line where the freight train departs or arrives. In Japan, the E&S System has been adopted actively in recent years by small- and medium-sized freight terminals where marshaling is not carried out. Figure 7-133 gives an overview of the E&S System.



Source: Japan Freight Railway Company

Figure 7-133 Overview of E&M System

In a conventional freight terminal for truck transport, each of the freight handling processes is carried out at a different location, such as the arrival and departure line, loading and unloading line, stabling line, and shunting line. In the case of container transport, the freight can be handled directly at the arrival and departure line of the freight terminal, where only containers are loaded and unloaded and no shunting is necessary. This greatly improves operation efficiency. The freight terminal at Guinguineo Station is small. It has one platform and two tracks. An efficient system that can handle the cargoes at the arrival and departure line, without the need for shunting freight cars, was considered. Such system will ensure smooth operation after the rehabilitation between Guinguineo and Tambacouda has been completed. Even if marshaling is needed at the Guinguineo Station in the future, a new sorting line and loading/unloading line can be constructed on the adjacent site for expansion. Therefore, this plan will not require any rework.

A detailed study shall be conducted to determine how to construct the roads for trucks to arrive and depart. Since Guinguineo Station is located in the middle of the downtown area, it is desirable to have a plan to prevent trucks from staying near the station as much as possible.

(3) Bel-Air Station Development

The Bel-Air Station shall be equipped with a minimum of marshaling and inspection functions if freight services were to resume.

Some marshaling is expected to take place at the freight terminal maintained by Dubai Ports World. However, CFS also needs to have facilities for coupling, decoupling, and shunting for the inspection of locomotives and freight cars, as well as for the transport of these vehicles to and from inspection. The Bel-Air Station is a large site, including the existing stabling lines. Developing a part of this area will provide the necessary functions. The plan of the Dubai Ports World shall be reviewed to determine the extent to which the stabling lines in Bel-Air Station shall be restored.

Figure 7-134 summarizes the inspection system for locomotives and rail cars at Japan Freight Railway Company, JR Freight. The contents and the cycles of vehicle inspection differ depending on railway operators. The inspections are divided into multiple stages, from simple inspection, such as checking the functions and replacing consumables once every few days, to large-scale inspections, in which the vehicle is disassembled to the parts level and inspections and maintenance are carried out. The Bel-Air Station was equipped with an inspection shop and a maintenance shop, where inspections and simple repairs (daily inspection and regular inspection) were carried out. The overhaul, in which the vehicle is disassembled to the parts level, is carried out at the rolling stock workshop in Thiés. As the rehabilitation plan aims mainly at resuming freight train operation, regular inspection and overhaul are expected to be carried out at the workshop in Thiés, and only daily inspection will be carried out at the Bel-Air Station. Although the existing inspection shop located in Bel-Air Station on the side of Dakar and Thiés stations will be used, upgrading the car repair shop is not necessary. In order for Bel-Air Station to perform the daily inspection function, the track to the car inspection shop and the turnout shall be rehabilitated. Large-scale renovation is not required because the inspection shop is already equipped with the minimum functions.

Outline of Rolling Stock Inspection at JR Freight

○ Inspection of Electric Locomotives

Inspection type		Daily inspection	Regular inspection	Inspection of important parts (or Bogie inspection)	General inspection
Inspection cycle	New locomotive (Class EH500)	Within 96 hours	Within 90 days	Within 48 months or within 600,000 km	Within 96 months
	Old locomotive (Class ED79)	Within 72 hours	Within 90 days	Within 36 months or within 400,000 km	Within 72 months
Main inspection contents		This is a general inspection of locomotive functions, mainly the replacement of consumables such as pantograph sliding plates, brake shoes, etc.	This inspection mainly checks the mounting condition, wear condition, operation, and function of each equipment in the actual condition.	In this inspection, the main equipment, such as bogie and traction motor, are removed and inspected. The function of each equipment is checked comprehensively.	This inspection disassembles all parts of the vehicle to restore their functions.

○ Inspection of Freight Wagons

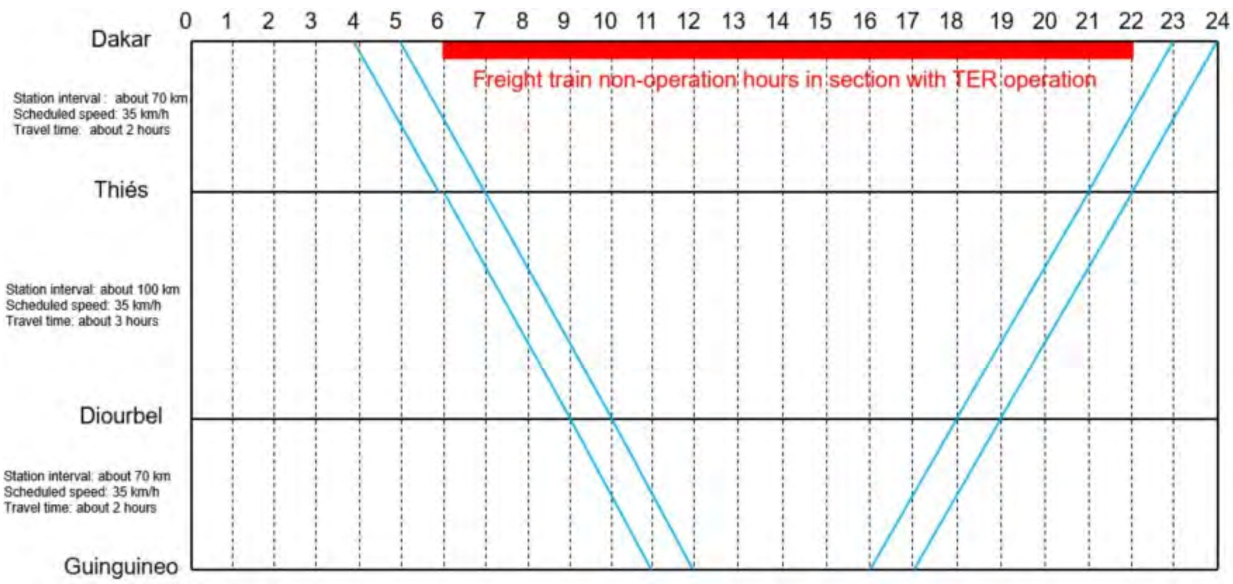
Inspection type	Daily inspection	Regular inspection	Regular inspection (replace parts)	General inspection
Inspection cycle	Implement according to the freight wagon operation diagram	Within 90 days	Within 30 months	Within 60 months
Main inspection contents	This is a general inspection of the condition of each device.	This inspection mainly checks the mounting condition, wear condition, operation, and function of each equipment in the actual condition.	In this inspection, the main equipment, such as the bogie and control valve, are removed and inspected. The function of each equipment is checked comprehensively.	This inspection disassembles all parts of the vehicle to restore their functions.

Source: Interview Materials of the Shinkansen Subcommittee (Japan Freight Railway Company)

Figure 7-134 Overview of Rolling Stock Inspection at JR Freight

(4) Freight Train Operation Plan

Figure 7-135 is an example of the freight train operation schedule.



Source: JICA Study Team

Figure 7-135 Example of Dakar–Guinguineo Operation Schedule

The average speed between Thiés and Guinguineo when the freight train was in service was about 35 km/h. Assuming that the speed after rehabilitation would be the same, the time required for each section was estimated. A train operation schedule was compiled, assuming that the freight trains would operate two round trips per day and that they would not run in parallel with TER during the hours 6 to 22. Although 5 hours each were planned for the freight handling at Dakar and Guinguineo, it would be shortened due to the time required to allow the passing of an inbound train and an outbound train of the mining companies at a station between Thiés and Guinguineo. Since a conventional freight train has 25 freight cars and each loaded with two 20-ft containers, the transport capacity per day is assumed 200 TEU.

As this plan aims at the resumption of freight train operation, the transport capacity will be limited. However, it is possible to increase the transport capacity in the future by upgrading the facilities. There are two ways to increase capacity: increasing the number of rail cars per train set and increasing the number of train services. The following are issues pertaining to each method:

- Increasing the Number of Rail Cars per Train Set

  When the freight train was running in the past, the train set was limited to 25 cars (length of train set: 15 m × 25 cars = 375 m). The limitation was due to the performance and maintenance conditions of the couplers and brakes of the cars. With appropriate improvements, the number of cars per train set can be increased. Since the stabling lines have sufficient length, the ground facilities will not be a bottleneck when extending the train set.

- Increasing the Number of Train Services

  When increasing the number of train services, a signaling system shall be installed to ensure safety. However, due to the long route length and low traffic density, a signaling system with a track circuit, which is mainly used in Japan, will require considerable investment. A signaling system that utilizes GPS is being considered, given the fact that there are no tunnels on this route.

  As the number of train services increases, an inbound train and an outbound train may pass each other at a station, making it necessary to install a signaling system and passing facilities. When the number of train services exceeds a certain level, the doubling of tracks shall be considered. At present, however, constructing facilities to enable trains to pass each other is more cost effective.

  CFS cannot operate freight trains in parallel with TER during the TER operation hours. When the Dakar–Bamako Railway was in operation, there were more than 100 derailments per year. It would be dangerous for the freight trains to run alongside the high-speed passenger trains under such conditions. Theoretically, derailments should not occur. The facilities and rolling stock shall be maintained at a level adequate to ensure safe operations so that the freight trains can run in parallel with the TER without problems, even during the daytime hours. The freight train schedule shall be adjusted flexibly.

7.9.6 Freight Handling Equipment

(1) CFS Plan

Each major inland station has a site area of about six hectares owned by CFS. Freight handling platforms shall be installed to upgrade the freight terminals so that the transshipment to trucks will be easier. In particular, since the transshipment to trucks bound for Mali is carried out at Tambacounda Station, a freight terminal will be built there on a five-hectare site to transfer cargoes. The railway operator does not operate the freight terminals nor handle freight; these functions are consigned to other organizations or companies. A dry port (30–50 ha) will be constructed near Tambacounda, according to the construction plan of the new standard-gauge railway.

(2) Plans of Other Organizations and Institutions

Dubai Ports World plans to revive rail transport to ease congestion and facilitate port logistics. It plans to construct tracks inside the container terminal and to connect to the Senegal Railways. Coordination with Dubai Ports World is necessary in order to understand the specifics of its improvement plan, including track layout. It is unlikely that the railway operator will need to develop freight handling facilities.

(3) Improvement Plan

The freight terminal at Guinguineo Station will need freight handling facilities for the loading and unloading of containers. There are various types of freight handling systems and their performances are different. The 20-ft and 40-ft containers are mainly used for rail freight transport in Senegal, and top lifters and reach stackers are used for handling. In the past, the top lifter was mainly equipped with a mast that moves the container vertically, but in recent years, including Japan, it has been replaced with a reach stacker equipped with a boom similar to that of a crane car. Reach stackers are preferred because of good visibility and safe structure.

Source: Japan Freight Railway Company Website

Figure 7-136 Example of a Top Lifter

Source: Suzuyo Motor Transport Website

Figure 7-137 Example of a Reach Stacker

7.9.7 Issues Associated with the Improvement

Detailed planning is required to transport materials and equipment, and to operate maintenance vehicles efficiently since the construction area is so wide. Wildlife intrusions and level crossings made by citizens shall be handled with care.

When constructing a freight terminal, the roads shall be designed taking into consideration the traffic flow of the arriving and departing trucks. The Guinguineo Station is surrounded by a large urban area. One-way traffic and other measures shall be taken to ensure that the movement of trucks will be as smooth as possible in order to avoid disrupting traffic flow or degrading the living environment.

7.10 Evaluation Index and Effects

Rehabilitation of the section between Dakar and Guinguineo in the Dakar–Bamako Corridor and resumption of train operations have the following effects, as described in items (1) to (3) below.

Table 7-10 Effects of Rehabilitation of the Dakar and Guinguineo Section and Restart of Train Operation

Item	Description
(4) Effects on service users	The effects on service users, i.e., freight railway users after the resumption of service between Dakar and Guinguineo, are direct service improvements, such as shortening the required time, alleviating congestion, and reducing transportation costs.
(5) Effects on service provider (railway operator)	The effects on the railway operator are increase in transportation volume and increase in revenue.
(6) Effects on society as a whole	Railway projects are expected to have not only effects on users and service providers, as described in (1) and (2), but also effects on the society as a whole. The effects can be subdivided into five categories, as shown in Table 7-15 below.

Source: JICA Study Team

Table 7-11 Evaluation Items and Effects on the Society from the Restart of Train Operation between Dakar and Guinguineo

Evaluation items for the effects on society as a whole	Effects
People's lives	Alleviating traffic congestion by reducing the number of trucks in road traffic, increasing the types and quantities of daily necessities available to people, and increasing disposable incomes by lowering retail prices
Regional economy	Improving the capacity of ports and harbors to facilitate growth of the national economy, increasing the volume and improving the efficiency of freight transportation to increase productivity in the region, increasing the locations and scale of businesses, and reducing road maintenance costs by reducing the number of heavy trucks on the road
Local communities	Revitalizing the cities along the existing railway line, and lowering hurdles for the operation of long-distance passenger trains
Environment	Reducing CO_2 emissions due to the reduction in automobile traffic caused by a shift from the use of trucks to rail and restriction on the number of new trucks in operation; and changing the emissions of air pollutants, such as NOx (nitrogen oxides) and SPM (suspended particulate matter), on roads along the rail line
Safety	Shift from trucks to freight trains reduces the volume of automobile traffic on the roads and reduces traffic accidents, mechanization of freight handling reduces the danger of loading and unloading work

Source: Prepared by JICA Study Team based on MLIT's Railway Project Evaluation Methodology Manual (revised in 2012)

(1) Effects on Service Users

1) Shortened Required Time

The volume of cargoes being handled at the Dakar Port has increased, thanks to the economic growth of Senegal and its neighboring countries. However, the port has not been able to fulfill its expected role due to the bottleneck caused by the retention of unloaded cargoes near the port. Developing a freight railway from the container wharf through this project can increase the capacity to unload and process the container freight stuck at the port, thereby shortening the transportation time of not only the container freight but also all the cargoes being handled at the port. A freight train is as fast as a truck, but it can operate without being affected by the severe traffic congestion around Dakar, thus reducing transportation delays.

2) Increased Freight Transportation Options

At present, the transporting of cargoes from the Dakar port to inland areas is limited to automobiles. Restoration of the railway will offer a new option. Rail freight has the advantage of being able to transport large volumes of heavy cargoes at low cost and in a timely manner, as compared to trucks. Rail freight and trucks can be used differently according to the types of goods being transported. In addition, the speed and the number of freight trains can be increased in the future.

3) Reduced Transportation Costs

The transportation costs are expected to go down, especially in the case of large and heavy cargoes. Furthermore, rail freight is expected to be a new player in the logistics industry, which is currently dominated by truck transport. Competition between the two modes will further lower costs and raise service level.

(2) Effects on Service Providers (Railway Operators)

1) Increase in Transport Volume

When the Dakar–Guinguineo section is restored, assuming that freight trains with 25 container wagons pulled by a diesel locomotive will operate in the same way as before the service was suspended, about 73,000 TEU of freight will be transported by rail annually. The current plan assumes two round trips per day. By installing signaling systems and facilities to enable trains to pass each other, the number of train services and the volume of freight can be increased further in the future.

2) Increase in Transportation Revenues

While increase in rail freight users will increase transportation revenues, the operation of trains and the inspection and maintenance of facilities will also incur expenses. Revenues from freight will be generated in proportion to the increase in freight volume. Utilizing the surplus personnel who continue to be employed after the suspension of railway services can minimize the expenses.

(3) Effect on the Society as a Whole

1) People’s Lives

Due to the rapid population growth and economic development in recent years, Dakar has become increasingly congested. Although TER and BRT have been developed, the increase in transport capacity has not kept pace with the increase in demand. Since the Dakar port, which is one of Senegal's leading international ports, is located in the center of the city, a large number of trucks are flowing into the city, causing traffic congestion.

Under these circumstances, the resumption of rail freight transportation, which had been suspended for a long time, can reduce the inflow of trucks and alleviate traffic congestion. Rail freight has a larger transportation capacity than trucks. It can transport more goods at lower costs, especially to inland areas, thus contributing to the narrowing of economic gap between the inland and urban areas.

2) Regional Economy

Increasing the volume of freight handled at the port can contribute to the economic development of not only the areas around Dakar but also Senegal as a whole. Improving the efficiency and volume of freight transportation will also help reduce the transportation costs of companies that produce and process various products, and enhance their competitiveness. Transferring heavy freight to rail transportation will reduce the number of trucks carrying heavy loads that adversely affect road pavements, reduce road maintenance costs, and reduce traffic accidents caused by damaged roads.

3) Local Communities

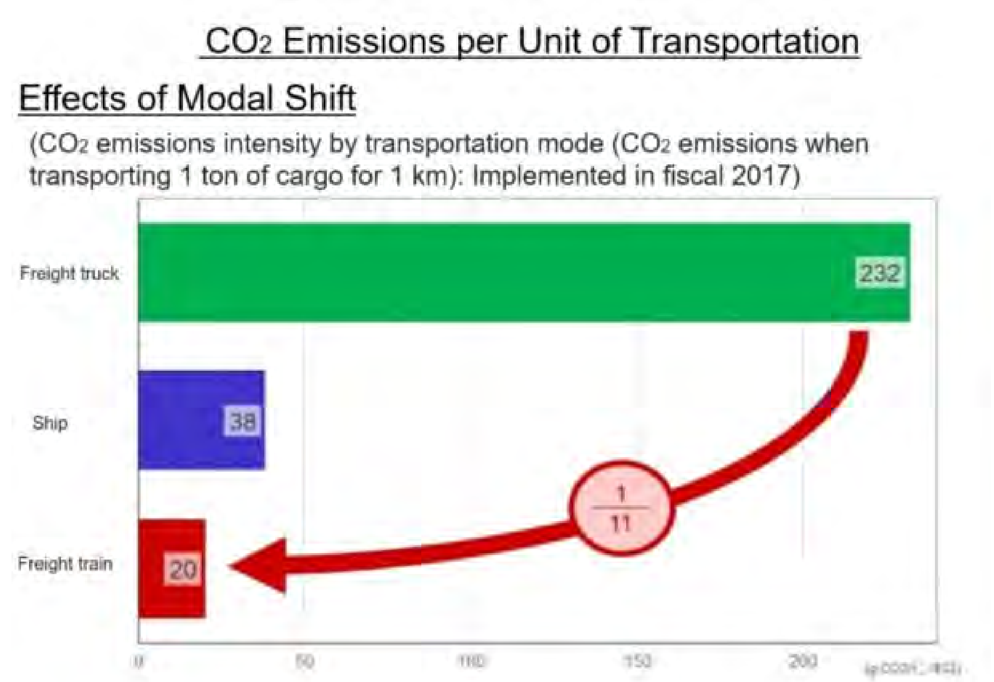
Senegal has many towns developed thanks to the development of railway stations. At present, railway operation has been suspended and the related facilities are left unattended. Resumption of railway operations will not only contribute to the economic development of the city but also improve the image of the station as a symbol of the city and revitalize the communities.

The rail tracks developed for the operation of freight trains can also be used for passenger trains. Long-distance passenger transport shall be enhanced to prevent over-concentration in Dakar. Improving the facilities for the operation of freight trains will also pave the way for the resumption of passenger train services.

4) Environment

The resumption of rail freight transport between Dakar and Guinguineo is expected to shift some of the demand for automobile transportation to the Dakar port and the interior of Senegal as well as to Mali. As a result, the emissions of CO_2, NOx, SPM, etc. from automobiles will be reduced.

The difference in CO_2 emissions intensity between the railway and automobiles is used to calculate the amount of CO_2 reduction by switching from automobiles to the railway. Figure 7-138 shows the CO_2 emissions intensity per unit by transport mode. The switch from trucks to the railway results in 212 g-CO_2/ton-kilometer reduction of CO_2 emissions. Assuming that the average loading weight per 20-ft container is 14.4 tons, according to the Global Economy and Logistics Conditions of National Institute for Land and Infrastructure Management, the annual CO_2 reduction is 14.4 tons × 200 TEU × 365 days × 240 km (estimated extension between Dakar and Guinguineo) × 212 g-CO_2/ton-kilometer) = 53,485 tons/year.



Source: Environmental Perspective of Freight Railway (Ministry of Land, Infrastructure, Transport and Tourism)

Figure 7-138 CO_2 Emissions per Unit of Transportation

5) Safety

In Senegal, road traffic accidents occur frequently both within the cities and between cities. Transferring transport demand to the railway will reduce traffic accidents to a certain extent. Strengthening container freight transportation will accelerate the mechanization of freight handling operations and reduce dangerous operations, such as the loading and unloading of heavy cargoes manually, not to mention that freight handling will be more efficient.

(4) Others (Contribution to the SDGs)

This project will help alleviate the serious traffic congestion in Dakar, and mitigate air pollution and climate change. It will contribute to Goal 9, “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation,” Goal 11, “Make cities and human settlements inclusive, safe, resilient and sustainable,” and Goal 13, “Take urgent action to combat climate change and its impacts,” among the 17 SDGs adopted by the UN General Assembly in 2015.

7.11 Conclusion

The results, issues, and future assistance policies of this Study are summarized in (1) to (5) below.

(1) Current State of Railways in Senegal

In Senegal, the development of railways—a mass rapid transit system for both urban and inter-urban transportation—has become an urgent task in light of the growing demand for transportation accompanying economic development and population growth. In urban areas, particularly in the Dakar metropolitan area, the development of public transportation is making progress one project after another, with TER leading the way. On the other hand, transport between cities, particularly between the Port of Dakar, which is an international port representing Senegal, and the inland hinterland areas, continues to rely on automobiles for the bulk of transport demand. The Port of Dakar is one of the major ports of the West African region. It has the potential to play an important role in the development of the whole region in the future. However, due to the lack of transport capacity and road congestion, the cargoes cannot be transported smoothly in and out of the port, creating a bottleneck that hampers growth of the country and the region.

Although the CFS rail lines were expected to provide a drastic solution to the abovementioned transportation problems, they were constructed by France from the end of the 19th century to the beginning of the 20th century, when Senegal was under the colonial rule. The railway connecting Dakar, Tambacounda and Bamako, which is particularly important from the viewpoint of trade with neighboring Mali, has been transporting imported and exported goods between Senegal and Mali for many years even after their independence in 1960. Unfortunately, due to the aging of facilities and the declining competitiveness of the railway against road transport, the volume of rail freight gradually declined. Operation of this line has been suspended since 2018.

(2) Railway Challenges in Senegal

The biggest challenge that CFS has faced so far is a financially unsound business scheme and the resulting lack of capital investment. In order for the railway to compete on equal terms with the trucks and buses, which are provided with land infrastructure (roads) practically free of charge, the railway should also be given some support from the national or local government in the form of public funds. However, if the scale of the support is too large, there can be a variety of harmful effects, including pressure on the private sector such as the truck and bus businesses, and lowering the incentive for railway companies to strive to be self-sufficient. On the other hand, in the case of Senegal, the support was too low. Even though the railway could bring positive social benefits, the company could not sustain itself financially. In the 1990s, the Senegal National Railways had almost balanced the revenues and expenditures of its operations. However, it was forced to cut investment in equipment and facilities that were vital for business continuity. Insufficient capital investment led to a decline in maintenance level and service level, such as delays and accidents. The gradual loss of customers further lowered revenues. The company fell into a vicious circle in which it had no more resources to make capital investment.

(3) Extension of the Meter-gauge Line to the Third Wharf (Grant Aid)

Formulating a sustainable business scheme, making appropriate investment in equipment and facilities, and maintaining and managing them are the major challenges for CFS. APIX, an entity that carries out infrastructure projects in Senegal on behalf of the government, proposed a cargo line (meter-gauge) from Dakar Station to the Third Wharf. The Third Wharf mainly handles cargoes for Mali. The main purpose of connecting a freight line to the Third Wharf is to facilitate the loading and unloading of cargoes. At present, this proposal is not cost-effective because the freight trains from Dakar Station to the inland areas have been suspended. It will also require the construction of a level crossing in the extremely congested area in front of Dakar Station. For this reason, the extension to the Third Wharf is not considered an appropriate target of capital investment for CFS.

(4) Rehabilitation of the Railway between Dakar and Tambacounda (Grant Aid)

Rehabilitation of the railway from Dakar to the inland and to Mali is the most cost-effective target for CFS to make capital investment. It will also have a large impact. The rehabilitation is in line with the PSE, a development plan of Senegal. It will help move the cargoes that are stuck at the Dakar port. Passenger trains are expected to resume services to the major inland cities of Touba and Kaolack. Since rehabilitation of the Dakar–Guinguineo section will have developed the ground facilities for most of the sections, the benefits of rehabilitating this railway will not be limited to freight transportation.

In addition to Japan's grant aid, CFS also intends to invest its own funds in the development. When formulating the project, it is desirable to coordinate closely with CFS to determine the division of maintenance sections, contents of maintenance, priorities, and other factors so that maximum effect can be achieved with minimum investment.

(5) Implementation of Technical Cooperation Projects in Parallel with Grant Aid

Assistance for the railways in Senegal will be implemented mainly through grant aid projects, such as capital investment (rehabilitation of a freight line to the inland), the provision of know-how on how to formulate a business scheme, and technical assistance for improving the maintenance of facilities that have been developed. For the railways in Senegal to forge a path for growth, all the challenges shall be resolved at the same time and in a comprehensive manner. With regard to the former, Japan has rich experience and expertise in regulations and operations necessary for the continuation of the railway business, including development of the Shinkansen bullet train, the operation of third-sector railways, and fare regulations that take into account the efforts of railway companies to be financially self-sufficient. As for the latter, there is much room for improvement especially in terms of the level and system of track maintenance, due to the frequent derailments in the past. In Japan, the facilities are maintained in accordance with the actual conditions of the line section and the location, resulting in an extremely high level of safety. It is possible for Japan to contribute to the sustainable development of railways in Senegal by utilizing its strengths in the railway sector, as described above. It is desirable for Japan to provide assistance in regulations and operations, as well as track and civil engineering technologies through technical cooperation projects.

Chapter 8 Conclusion

8.1 Proposals for Improving Conventional Urban Railways in African Countries Using Grant Aid

An overview of the proposals made in this Study is given below. Details on the rail technology sectors are given in Section 8.2, and details on each of the cities surveyed are given in Section 8.3.

(1) Measures to Increase Transportation Capacity of Conventional Railways

Routes with civil engineering and track problems shall be rehabilitated. Routes with insufficient signaling and security facilities shall install the necessary systems and increase transportation capacity by increasing the number of trains in operation.

(2) Measures to Build a Sustainable System

Japan will provide assistance for the development of railway facilities, as well as the know-how for railway operations, maintenance, management, and human resources development, which will focus on capacity building through technical cooperation projects.

(3) Measures to Improve Stations and Station Surroundings

Stations have various functions, for the embarking and disembarking of passengers, collection of fares, and connection with other means of transportation, and so on. Various measures will be taken, such as the installation of easily accessible platforms and rotary for buses, to enhance the convenience for passengers and promote railway use.

(4) Potentials and Challenges of Increasing Transport Capacity through the Transfer of Secondhand Rolling Stock from Japan

The transfer of secondhand rolling stock from Japan will have a direct impact on the railways of African cities that have a shortage of rolling stock. There are several issues. Besides the fact that their railway networks must use the same gauge (1067 mm) as the Japanese conventional railways, the transportation costs to the recipient countries will be high and the recipient countries must be able to carry out maintenance on a continuous basis.

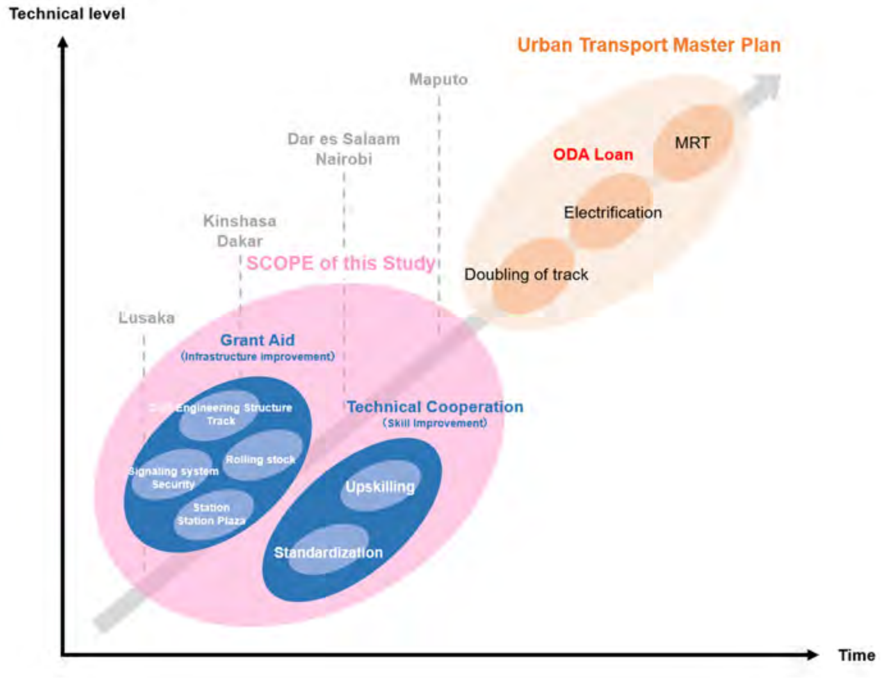
(5) Participation of Japanese Companies and Issues

Many Japanese construction companies, manufacturers, and other companies are interested in making inroads into the African market, due to its expected growth. On the other hand, if the scale of the project is too small, the companies will be less willing to participate. Striking a good balance in the project contents is important. There are also cases in which a Japanese company entered the African market through cooperation with a South East Asian company or companies in other countries.

Table 8-1 List of Assistance Proposed in the Study

City / Domain	Dar es Salaam (Tanzania)	Nairobi (Kenya)	Kinshasa (Democratic Republic of the Congo)	Dakar (Senegal)
Civil Engineering & Track	○		○	○
Rolling stock	○	○	○	
Station & Station plaza	○	○	○	○
Signal & Security	○	○	○	
Passenger Service	○	○		
Freight Terminal				○
Secondhand Railcar from Japan			○	

Source: JICA Study Team



Source: JICA Study Team

Figure 8-1 Railway Development Flow and Present Position of Conventional Railways in Target City

8.2 Railway Technology: Challenges and Proposals

(1) Civil Engineering Structures and Track

Except for the parts of Dar es Salaam that have already received assistance from other donors, the civil engineering structures and tracks of almost all the countries and routes have severely deteriorated and are in poor condition. It is difficult to say that proper maintenance and management have been carried out. There is insufficient awareness of the level of maintenance and management needed to ensure safe and smooth railway operation, and there is a lack of technical know-how to achieve such operation. It has also become common practice for railway operators to implement what can be done within a predetermined budget, rather than requesting a budget necessary for the maintenance and management from a technical standpoint. For this reason, it is necessary to not only provide technical know-how but also help railway operators to change their mindset about railway operation, reform the organizational structure, and establish regulations at the same time. Since urban railways usually do not have long bridges or tunnels that require advanced civil engineering technology, restoration of the civil engineering structures and tracks of the existing railways can be achieved using relatively simple construction methods and at low cost. However, if proper maintenance and management are not carried out, it is highly likely that the restored facilities will fall back into their former conditions. Therefore, it is necessary to provide assistance so that the railway operators can acquire technical capability and operational capability to maintain the status quo at a minimum and, if possible, make voluntary improvements in an organized and continuous manner.

(2) Rolling Stock

Essentially, the target routes do not have enough rolling stock. Currently, trains consist of a locomotive and passenger cars are used for commuter service in most cities. The locomotives and passenger cars are not maintained properly due to technical and financial problems. The lack of funds has made it difficult to purchase parts for repairs. These cities will need assistance not only in improving technical capabilities for the introduction and maintenance of new fleets but also in enhancing capabilities for long-term planning and strategy formulation, such as prioritizing the types of rolling stock to use and to repair, in order to increase operational efficiency. As with civil engineering structures and track, reform is also necessary in budgetary allocation. Participation of top-level institutions in the reform is essential.

(3) Station

Although stations have various functions, for the embarking and disembarking of passengers, collection of fares, and connection with other means of transportation, many stations in the target cities do not even have platforms in place. Their passengers embark and disembark directly at the track. Compared to rolling stock and railway track, which are essential for the provision of transportation services, station facilities are not necessarily required. Consequently, investment in their maintenance and repairs tends to be of a lower priority. However, Maputo is an example of the efforts made to improve the convenience for passengers. It has installed simple stairways and ramps to facilitate boarding and disembarking. It is necessary to invest in railway track and rolling stock, which are directly related to safety and transportation capacity, and to improve the maintenance and management standards. At the same time, efforts shall be made to continue adding and improving station functions in order to increase the number of passengers and revenues.

(4) Signaling and Security Systems

The development of signaling and security systems in all the countries is at an extremely low level. Many cities, such as Nairobi and Kinshasa, rely only on radio communication. In Lusaka, the GPS equipment onboard the locomotive provides location information. It is used for traffic control only, not sufficient to assure safety. Compared with the current situation, installation of alarms at level crossings is a useful investment in the short term to improve safety. In the long term, however, a signaling system with interlocking devices and block equipment shall be installed throughout the route as the numbers of trains and passengers increase in the future. Since huge investment is required for installing a signaling system and it is difficult to modify the system partially, the policy to install a signaling system must be reviewed carefully, taking into consideration the long-term railway development plan, in order to avoid rework as much as possible.

(5) Railway Operation

Whereas most urban railways in the developed countries operate at an interval of minutes, most urban railways in this Study operate on a round-trip basis per day. Although the number of trains for commuter service is small, the trains are very crowded, showing that there is considerable demand for railway use in each city. Increasing railway transport capacity is urgent, in order to alleviate overcrowding in the trains and road congestion in urban areas. It is necessary to enhance operational stability and transport capacity by improving the maintenance standards of railways and installing security devices. Long-term railway development plans that take into account the operation system shall be formulated and implemented.

(6) Passenger Services

Along with the development of railway infrastructure, such as rolling stock and station facilities, improving passenger services can enhance the convenience for passengers and improve the profitability of railway companies. Such services include highly efficient and convenient fare collection systems, provision of information on train operation status, and information about transfers to other means of transportation. Currently many railway lines have ticket inspectors onboard trains to sell tickets and to prevent fare evasion. This approach makes it difficult to collect fares from all the passengers, especially during the rush hour. It will likely become a barrier to the introduction of any complex but rational fare schemes, such as distance-based fares. Conventional methods, such as the installation of ticket gates at stations, and new payment systems utilizing IT shall be introduced to improve fare collection. As installation of these systems will require large investment and coordination with other transport operators, ongoing assistance shall be provided from the early stage of planning. Ideally, the plan will lead to technical as well as financial assistance.

(7) Maintenance

The railway facilities shall be maintained properly, and the maintenance and management standards shall be satisfied to ensure safe and stable railway operations. It is common practice in the countries surveyed to deal with the problems after accidents and malfunctions have occurred on the routes. These countries need assistance in acquiring technical know-how to maintain and manage the various railway facilities, as well as cultivating a mindset to carry out maintenance and management properly. It is important to transfer the technical know-how through practical training and to provide assistance for enhancing technological capabilities throughout the organization, developing standards and regulations, and creating manuals. In particular, Japanese railways have accumulated a wide range of technical knowledge and experiences over many years, making Japan uniquely qualified to provide practical technical assistance using its own experience.

8.3 Target Cities: Challenges and Proposals

(1) Dar es Salaam (Tanzania)

At present, the number of trains running on the Pugu Line is extremely low. The trains are crowded and the demand is expected to rise. Adding more trains and improving the track layout will increase transport capacity and stabilize train operations. At present, one train goes back and forth between terminals. By adding a locomotive, two trains can be in service. To improve safety, an interlocking device will be installed at Karakata Station, where a siding will be added to allow the passing of trains.

In Dar es Salaam, BRT is currently being developed, but it is only a short- to medium-term solution. An urban railway shall be developed for the long term in order to meet the growing demand for public transportation. Currently a new standard-gauge railway is being constructed parallel to the Pugu Line. This new railway is developed mainly for freight and long-distance passenger services. In terms of transportation capacity, it is rational to construct lines for commuter service and for suburban service separately, as in the case of Japan. It is desirable to strengthen the functions of the existing meter-gauge lines so they can function as urban railways.

(2) Nairobi (Kenya)

In terms of demand, improving the transportation capacity of Line 1 has the highest priority. More rolling stock shall be deployed and a signaling system shall be installed to increase the number of trains in operation. Similar to Dar es Salaam, an additional locomotive will enable two trains to operate. At the same time, interlocking devices and block equipment shall be used to improve safety. Since the station facilities are inadequate and the connectivity with secondary transport is weak, platforms shall be installed and access roads shall be constructed between the stations and the main roads.

BRT has been operating in Dar es Salaam for several years. Nairobi has a plan for several BRT routes but only one route is under construction. A monorail loop line and a metro were planned in the past, but none of them has been constructed. Under such circumstances, upgrading the existing railways is likely to be an important step towards the development of urban transport in the future, as upgrading the existing railways is highly effective and at a low cost.

(3) Kinshasa (Democratic Republic of the Congo)

The Airport Line in Kinshasa is currently out of service due to the deterioration of infrastructure. It is expected to be restored soon to help alleviate congestion on the main roads along the line and to ensure smooth access between the city center and the airport. Damage on the civil engineering structures and tracks of the Airport Line in Kinshasa is more severe than in the other cities. Parts of the embankment and roadbed have to be reconstructed. Comprehensive support will be needed to facilitate the transition from road transport to rail. Along with the resumption of operations, safety measures such as the construction of level crossings and installation of fences shall be carried out. Station facilities and station plazas shall be developed.

Kinshasa is one of Africa's most populous cities. At present, road congestion is worsening and urgent countermeasures are required. Given the size of the city, a metro shall be developed in the future. It is sensible and cost-effective, however, to restore the existing railway facilities to increase transportation capacity. It is hoped that restoration of the Airport Line will help improve the operation, maintenance, and management capabilities of the railway operator so that it will continue to make capital investment and improve maintenance and management capabilities voluntarily.

(4) Maputo (Mozambique)

The railway in Maputo was developed mainly for freight transportation along the inland and coastal areas. The railway track and rolling stock are maintained at a certain level because freight trains are in operation. Although not large in scale, voluntary improvements are being made, such as the construction of new platforms and the installation of new boarding facilities. In addition, Metrobus, a private railway company operating buses in the Maputo suburban areas, has entered the commuter railway service market, making Maputo one step ahead of the other cities, especially in terms of connectivity with secondary transportation.

Maputo does not have an urgent need to develop urban railways, because road congestion is not serious and the railway operators are making capital investments proactively. However, Japan can contribute in many aspects, such as safety measures, construction of station facilities, and extension of the existing lines to urban centers. Therefore, the situation in Maputo shall be monitored on an ongoing basis.

(5) Lusaka (Zambia)

Zambia is a landlocked country surrounded by multiple countries, and the capital city of Lusaka is an important hub for land transportation. Freight has been traditionally the focus of railway transport through Lusaka. Passenger trains currently in service are limited to a few long-distance trains per week. In the past, passenger trains were also used for commuter service. A lack of rolling stock and other factors have led to the suspension of commuter service for a long time now.

Development of commuter train service will become necessary as the economy grows and road congestion worsens. However, since there have not been any regular commuter train services, huge investment will be needed to acquire the rolling stock and build station facilities necessary for the commuter rail service. A Swedish consortium is currently working on a large-scale assistance plan for freight transport. As the plan also includes development of a new signaling system, information about details of the plan shall be gathered. The specific contents of the development shall be examined in detail to determine how the infrastructure can be adapted for an urban railway in the future.

(6) Dakar (Senegal)

Dakar, the gateway to logistics in West Africa, is situated adjacent to a central urban area and an international port at the tip of the peninsula. The increase in the number of passenger cars and motorcycles accompanying economic growth and the influx of trucks and other vehicles for logistical functions, have combined to worsen the traffic congestion. The existing meter-gauge railway network extends from Dakar to the interior of Senegal and to Mali. Not much time has passed since the railway was taken out of service in 2018. The operations can be resumed with relatively minor repairs. In the meantime, construction of a freight terminal inland, where containers can be loaded and unloaded, as well as the construction of tracks and a marshaling yard, can help ease traffic congestion in the Dakar city center, revive Senegal's railway operations, and revitalize logistics with neighboring Mali.

Along with economic development, special economic zones are being developed in the inland areas of Senegal. The extraction of oil, natural gas, and other natural resources is also in the works. Development of an efficient wide-area logistical network is imperative for sustaining the anticipated economic growth in the future. In particular, the railway to Tambacounda, which connects major cities in the country, is an important trunk line for freight and passenger services. A growing momentum is building for this railway to resume operations, with the support of the Senegalese government.

8.4 Technical Issues Common to All Target Cities

(1) Difference in Track Gauge

The gauge is one of the most important factors when considering the construction of a railway. The gauges of the existing railways in the African cities surveyed in this Study are 1000 mm or 1067 mm. They are similar to that of the conventional railways in Japan (1067 mm). On the other hand, the newly constructed railways in Kenya and Tanzania, and the TER in Senegal, are standard-gauge railways. The track gauge is 1435 mm, which is about 40 cm wider than the narrow gauge. In Japan, the shinkansen (bullet train) network and some private railways use standard gauge. Generally, narrow gauge has smaller structure and lower construction cost, whereas standard gauge can support train operation at a higher speed and accommodate heavier axial loads. In principle, it is preferable that new railways use standard gauge, in terms of rolling stock manufacturing and transportation capacity. However, if a narrow-gauge railway has already been established to a certain extent, it will be very expensive to modify the civil engineering structures and tracks, and to replace the rolling stock in order to convert the railway to standard gauge. Once the gauge is determined, it cannot be reconstructed easily. Therefore, the cost-effectiveness shall be analyzed carefully when selecting the gauge. In Senegal, too much time has passed for gauge selection, while the situation that hinders operation of the existing railway deteriorated. Gauge selection is an important decision that can have long-term impact. It also requires high degree of expertise in forecasting demand and calculating the cost-effectiveness. Assistance in the selection of gauges is effective in some cases.

(2) Dedicated Lines by Demand (Passenger and Freight)

In African cities, many passenger and freight trains run on the same track. The speed and the number of stops for passenger trains are different between commuter service in cities and long-distance service between cities. There is no problem when there are only a few trains on the route. However, it is preferable to separate the railway lines for different types of train services as much as possible, when the number of trains in operation increases. The transportation capacity will be higher when only the same type of trains operates on the line. In Japan, the Tokaido Main Line and the suburban sections of the Tohoku Main Line operate with a mix of passenger and freight trains. In central Tokyo, however, the freight line and the express line are constructed in parallel. In many cases, operation on these lines is separated by train type. Although it is difficult to predict accurately the changes in future demand, it is desirable to consider the separation of train operations when formulating urban master plans and railway development plans for routes that will require significant increases in transportation capacity in the future.

(3) Connection with Other Modes of Transportation

The railway, unlike automobiles, is not a convenient mode of transportation for the entire trip between two points. Therefore, it is important to secure transportation facilities for secondary transportation (including walking) between the departure and destination locations, and the station. As in the case of Maputo, a single operator can run both railways and buses simultaneously, creating synergies. Unfortunately, many cities in Africa are still struggling with the maintenance and operation of the railways, and have not given due consideration to connections between the railway and other transportation means. The connection with secondary transportation can be facilitated through infrastructure, such as the development of functional station plazas and a public transportation network starting with the stations, as well as through passenger services, such as offering discounted fares when combining different public transportation modes and improving the convenience of reservations and payments. Rather than simply constructing railway infrastructure, developing an efficient and high-quality transportation system for public transportation as a whole is essential in order to achieve the original objectives of alleviating road congestion and facilitating movement in the development of transportation infrastructure.

(4) Methods of Fare Collection

In a business sense, securing revenue is extremely important for railway operation. Fare collection is directly linked to revenue. No matter how the increase in transportation capacity or improvement in convenience has increased the transportation volume, the investment cannot be recouped without the proper collection of fares. In fact, failure to do so can jeopardize railway operation. In recent years, various fare collection systems have been developed, thanks to advances in information and communication technology. It is no longer the case where there is a uniform solution, such as the installation of automatic ticket gates at each station. On the other hand, payment systems, such as the M-PESA in Kenya, are convenient because the initial investment is limited. However, the settlement process can be time consuming when the usage is high. Since making a huge investment to improve the rate of fare collection is not the goal, it is important to understand the local situation and technological advances when selecting a fare collection system.

(5) Increase in Transportation Costs

As of October 2022, the transportation costs of various goods are still high, due to the coronavirus pandemic, the soaring fuel price, and other factors. Many of the project plans proposed in this Study were based on the assumption that construction materials would be transported from Japan. For this reason, the transportation costs are directly linked to the project costs. On the other hand, soaring fuel prices and other factors have occurred many times in the past, because of changes in social conditions. If the project costs are overestimated due to the rising transportation costs and other factors, there is a risk that the scale of the grant aid projects will become too small and their effectiveness lessened. Therefore, it is necessary to consider grand aid projects with a certain degree of optimism and practicality, despite the fact that there will be factors difficult to predict.

8.5 Conclusion

(1) Support Combining Grant Aid and Technical Cooperation

This Study examined the current state of existing railways in six African cities, identified and analyzed the issues, and reviewed what improvements are needed to enable those railways to become the key transportation system in the cities in the future, and what kind of assistance is effective for that purpose. The situations that many of these cities face in railway operation are dire, such as aging civil engineering structures and tracks, and shortage of rolling stock. In such a situation, making infrastructure improvements, such as the restoration of railway facilities and the supply of rolling stock, can have direct effects. On the other hand, even if such improvements were made, without proper maintenance and management, the service level would immediately decline, making the assistance futile. Therefore, it is important to provide assistance not only in capital investment, but also in building capacity for the operation, maintenance, and management of railways at the same time, in order to ensure the sustainability of railway operations.

(2) Proposal to Support the Establishment of a Permanent Urban Transport Review Organization

Once a certain level of capital investment has been made and the operational and maintenance capacity has been improved, rail transport services can be provided in a stable manner. By further developing the routes and establishing connections with other modes of transport, the commuter railway service can play a role in improving the quality of life for residents and supporting the economic growth of the city. Infrastructure is an area in railway development that will require especially large-scale investment. The review of development plans and the decisions shall be made very carefully. Long-term railway development plans shall take into consideration the division of transportation as well as cooperation with other transportation systems, particularly road transport. For example, in the Tokyo metropolitan area of Japan, the Transport Policy Council, established within the Ministry of Land, Infrastructure, Transport and Tourism, develops long-term master plans for urban transport on a regular basis. Many transport infrastructure projects are implemented in accordance with the plans. Projects that supported the development of various master plans for African countries were carried out, but there were cases in which the master plan never materialized into a project and another master plan had to be formulated after a while. As a solution, it is conceivable to support the establishment of an organization, such as the Transport Policy Council of Japan, in the target country to review urban transport plans and formulate master plans. It is also a meaningful form of assistance to have the target country formulate its own urban transportation plan utilizing Japanese know-how, and create a system for implementing the specific projects.

(3) Establishment of Financial Schemes for the Operation and Maintenance of Railways

The lack of capital investment and the inadequate operation and maintenance of railways in each city is due not only to technical issues but also to the budget shortage of the railway operator. When developing infrastructure, not just railways, the costs and benefits must be carefully examined in advance to determine if the project will have sufficient social benefits. Then, it is important to put in place schemes to ensure that the project will be financially viable, including the systematic implementation of subsidies to supplement shortfalls or vertical separation to reduce fixed costs. It should be noted that a project may bring significant benefits but operationally unsound or financially not viable, or a project may be financially viable but have negative benefits. Such projects will not bring social benefits, no matter how much technical assistance is provided. Japan is also experiencing similar issues today. Such issues require careful consideration especially when providing assistance to African countries.

(4) Need for Urgent Response to the Worsening Traffic Congestion

Rail-based transportation has not been sufficiently developed in all the cities surveyed in this Study. Road congestion will worsen as the economy develops in the future, causing a variety of problems. As a city grows and the population density rises above a certain level, automobile transport alone cannot meet the transportation demand adequately. Building a railway in the urban areas may not be cost-effective because the expropriation of land and the construction will be very expensive. In Japan, there was a time when the commuting rush became a social problem. It is not difficult to imagine if railway development had been delayed any further, the extreme congestion would have paralyzed road traffic and the situation would have been worse. Kyoto, Naha, and other cities, where the development of rail transportation systems has been delayed due to various reasons, are still struggling with traffic congestion and inconvenience of movement inside the cities. To avoid similar situation in the African cities in the future, to create a driving force for improving the quality of life for residents, and to achieve sustainable economic growth, the development plans for urban transport shall be formulated for as long-term as possible and rail infrastructure shall be developed actively prior to the development of urban areas.

Briefing Material for Target Countries

Japan International Cooperation Agency (JICA)

Data Collection Survey on Improvement of Urban Transport Utilizing Conventional Railways in African Countries

Dar es Salaam (Tanzania)

October 2022

Japan International Consultants for Transportation Co., Ltd. (JIC)

Oriental Consultants Global Co., Ltd. (OCG)

Nippon Koei Co., Ltd. (NK)

Table of Contents

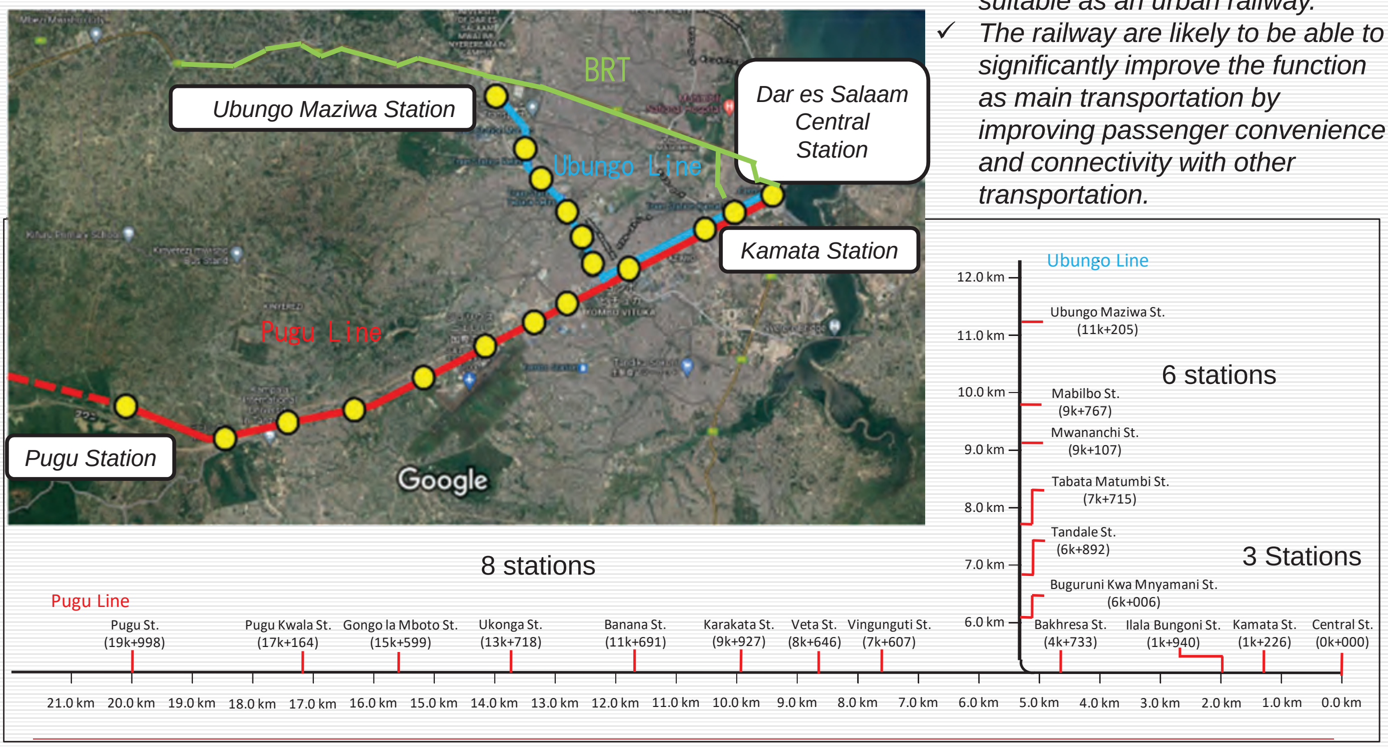
1. Background and Objective of the Study

- *As described in the Revised Urban Transport Master Plan by JICA made in 2018, the role of the existing urban railway is important to mitigate deteriorating traffic congestion and air pollution.*
- *The objective of the study is to investigate the existing railways and propose the measures to improve the urban transport by improving the existing railway facilities.*
- *The objective of this presentation is to give feedback based on the site survey and discussion and propose the improvement plan of the railway to Tanzania Railways Corporation (TRC).*

2. Current Status of the Existing Commuter Trains

Route Map and Station Location

- ✓ *Interval between stations is suitable as an urban railway.*
- ✓ *The railway are likely to be able to significantly improve the function as main transportation by improving passenger convenience and connectivity with other transportation.*



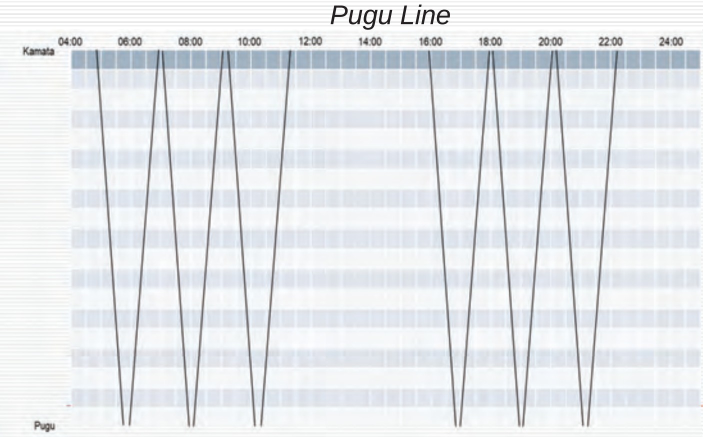
2. Current Status of the Existing Commuter Trains

Current Status of Railway Facilities and Operation

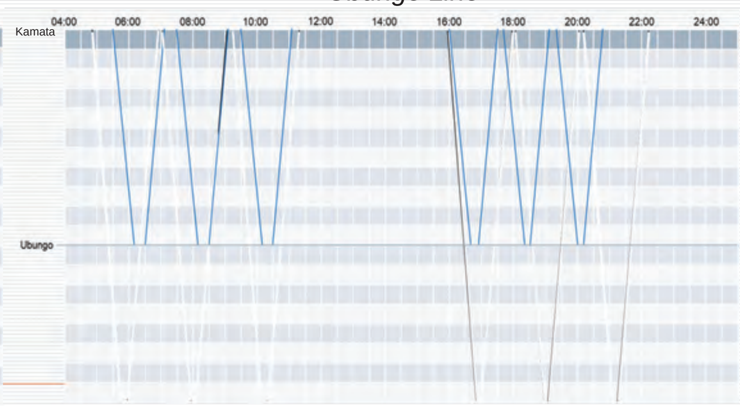
Railway Operator：(Tanzania Railway Corporation）

Line	Route Length and Others	Remarks
Ubungo Line	Approximately 12km (Dar es Salaam Central Station – Ubungo Maziwa Station) Single Track, Non-electrified	• Commuter Trains: 3 round trips in the morning and 3 round trips in the evening (except weekend and holiday)
Pugu Line	Approximately 20km (Dar es Salaam Central Station – Pugu Station) Single Track, Non-electrified	• Commuter Trains: 3 round trips in the morning and 3 round trips in the evening (except weekend and holiday) • Long-haul Trains: Two trains per week

Pugu Line



Ubungo Line



1) Current Status of Existing Track

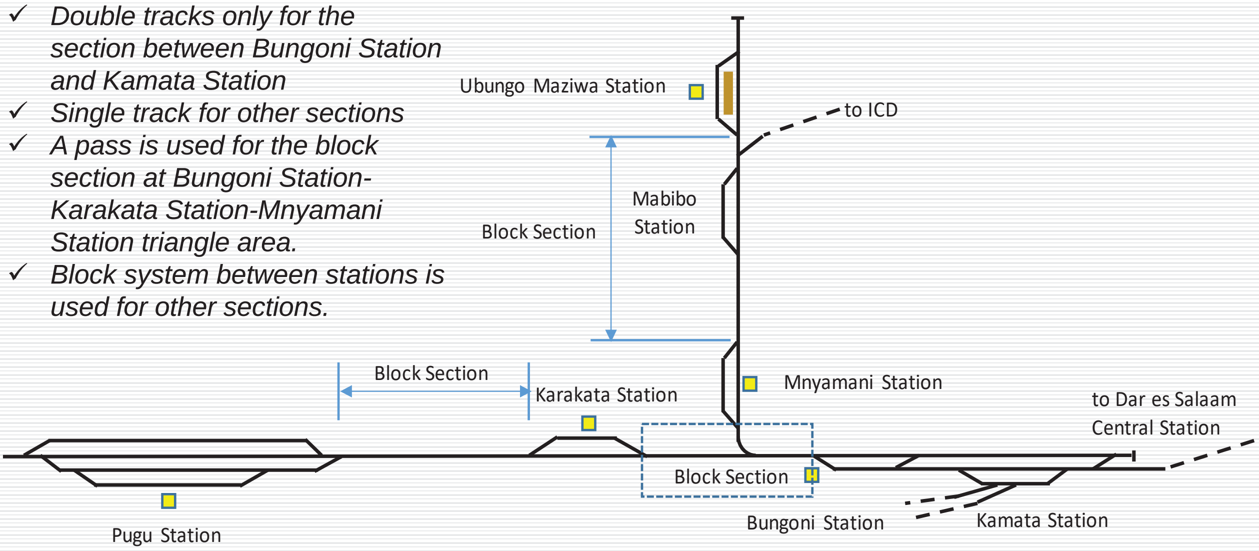
Pugu Line	Ubungo Line
	
	
Good Condition	Poor Condition

Item	Specification
1)Track Gauge	1,000 mm
2) Track Structure Type	Ballasted Track
3) Rail	56 lb/yd, 60 lb/yd, 80 lb/yd
4) Sleeper	Steel Sleeper
5) Fastening Device	Pandorol PR Clip

- ✓ Track rehabilitation for the section between Pugu station and Ilala yard has been completed by Tanzania Intermodal and Rail Project (TIRP).
- ✓ The other hand, the track of Ubungo line is not good condition.

2) Current Status of Existing Signal System (1)

- ✓ *Double tracks only for the section between Bungoni Station and Kamata Station*
- ✓ *Single track for other sections*
- ✓ *A pass is used for the block section at Bungoni Station-Karakata Station-Mnyamani Station triangle area.*
- ✓ *Block system between stations is used for other sections.*



2) Current Status of Existing Signal System (2)

Signal Cabin

A Signal Cabin Which is Located at Bungoni

Handover of a Pass to Enter the Block Section at the Triangle Area

Switch of Turnout

State before Switching Turnout

State after Switching Turnout

- ✓ *A pass is used for the block section at Bungoni Station-Karakata Station-Mnyamani Station triangle area.*
- ✓ *Point of turnout is switched by hand.*

2) Current Status of Existing Signal System (3)

	Pugu Line	Ubungo Line
Level Crossing		

- ✓ *A security staff receives information on train approaching over transceiver and controls road traffic at main level crossings .*

3) Current Status of Existing Rolling Stock (1)

	Year 2021/22			
	January	February	March	Total / Avr.
No. of Serviceable Locomotives				
Shunting	14	14	14	14
Mainline	40	40	43	41
Total	54	54	57	55
Actual No. of Locomotives Available for use				
Shunting	10	12	10	11
Mainline	25	24	25	25
Total	35	36	35	35
Overall Mainline Locomotive Availability (%)	58	59	60	60
Passenger Coaches Holding Fleet:				
Passenger Coaches	105	105	105	105
Actual Number Available for Use:				
Passenger Coaches	62	64	66	64
Overall Coaches Availability (%)	59	61	62	61

- ✓ *Locomotives availability and coaches availability are approximately both 60%.*
- ✓ *The reason why the availability is low is decrepitude and lack of spare parts.*
- ✓ *A lot of rolling stocks own by TRC are deteriorating, and procurement of new rolling stocks and rehabilitation for existing rolling stocks are required.*

3) Current Status of Existing Rolling Stock (2)

	Locomotive	Passenger Coaches	Train Configuration
Pugu Line			16 to 17 coaches per train
Ubungo Line			4 to 6 coaches per train

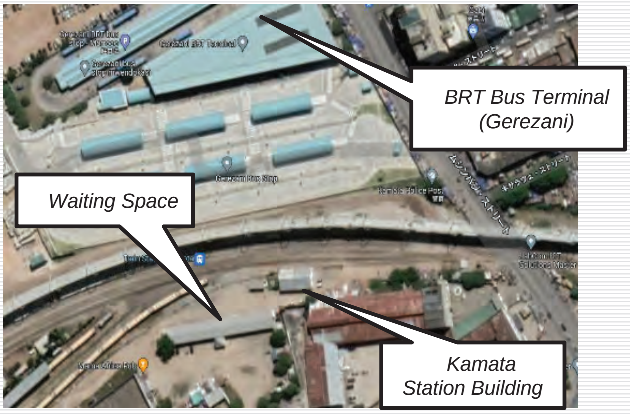
4) Current Status of Existing Stations (1)

- ✓ Kamata Station, Ilala Bungoni Station, Bakhresa Station are used for both Pugu line and Ubungo line and in addition to three stations there are 8 stations for Pugu line and 6 stations for Ubungo line.

①	Dar es Salaam Central	⑪	Vingunguti
②	Kamata	⑫	Kipawa
③	Ilala Bungoni	⑬	Karakata
④	Bakhresa	⑭	Banana
⑤	Buguruni	⑮	Mombasa
⑥	Tandale	⑯	Gongola Mboto
⑦	Tabata Matumbi	⑰	Pugu Kwala
⑧	Relini	⑱	Pugu
⑨	Mabibo		
⑩	Ubungo Maziwa		

4) Current Status of Existing Stations (2)

Kamata Station



- ✓ No platform except Ubungo Maziwa Station and Relini Station
- ✓ No waiting space except main stations
- ✓ No station plaza

Dar es Salaam Central Station	Kamata Station	Pugu Station	Ubungo Maziwa Station
			

5) Current Status of Existing Depot and Workshop

	
Wheel Lathe	Wheel Lathe

- ✓ Inspection schedule for locomotives and other rolling stocks are as follows;
  - Locomotives: Weekly, Monthly, Quarterly and Yearly Inspections
  - Other RSs: Monthly, Quarterly, Semiannually, Yearly and Every Three Years
- ✓ Inspection for locomotives are conducted at Gerezani DSM and Morogoro workshops.
- ✓ Inspection for other rolling stocks are conducted at DSM workshop and Kamata depot.
- ✓ Wheel lathe and some other maintenance equipment are working at DSM workshop, but TRC does not have enough maintenance equipment.

6) Current Status of Existing Passenger Volume

FOR THE MONTH OF FEBRUARY, 2022									
		UGO				PUG			
S/N	DATE	ADULTS	AMOUNT	STUDENTS	AMOUNT	ADULTS	AMOUNT	STUDENTS	AMOUNT
1	1.2.2022	1,214	485,600	492	49,200	8,512	4,316,700	3,065	306,500
2	2.2.2022	840	336,000	253	25,300	8365	4,261,700	3359	335,900
3	3.2.2022	919	367,600	467	46,700	8318	4,597,700	3166	316,600
4	4.2.2022	945	378,000	482	48,200	8153	4,027,300	2915	291,500
5	7.2.2022	705	282,000	357	35,700	7877	4,269,100	2589	258,900
6	8.2.2022	875	350,000	524	52,400	8270	4,312,100	3087	308,700
7	9.2.2022	485	194,000	333	33,300	8946	4,633,000	3583	358,300
8	10.2.2022	541	216,400	392	39,200	7807	4,320,300	3858	385,800
9	11.2.2022	567	326,800	375	37,500	6884	4,068,300	4549	454,900
10	14.2.2022	498	199,200	579	57,900	8145	4,744,500	3959	395,900
11	15.2.2022	677	270,800	323	32,300	6518	3,864,800	4806	480,600
12	16.2.2022	665	266,000	364	36,400	7761	4,156,800	3429	342,900
13	17.2.2022	526	210,400	328	32,800	5794	3,003,100	2724	272,400
14	18.2.2022	614	245,600	317	31,700	7009	3,772,800	4068	406,800
15	21.2.2022	710	284,000	337	33,700	8740	4,548,700	2559	255,900
16	22.2.2022	622	248,800	275	27,500	8270	4,320,400	3799	379,900
17	23.2.2022	539	215,600	260	26,000	5932	4,536,100	3929	392,900
18	24.2.2022	639	255,600	277	27,700	7175	3,945,800	3278	327,800
19	25.2.2022	587	234,800	407	40,700	9042	4,721,200	3386	338,600
20	28.2.2022	645	258,000	412	41,200	10302	5,182,100	3206	320,600
	TOTAL	13,813	5,625,200	7,554	755,400	157,820	85,602,500	69,314	6,931,400

FOR THE MONTH OF MARCH 2022									
		UGO				PUG			
S/N	DATE	ADULTS	AMOUNT	STUDENTS	AMOUNT	ADULTS	AMOUNT	STUDENTS	AMOUNT
1	1.3.2022	645	261,600	297	29,700	8,254	4,835,900	4,425	442,500
2	2.3.2022	633	253,200	321	32,100	7894	4,634,400	4850	485,000
3	3.3.2022	674	269,600	283	28,300	8237	4,869,900	4200	420,000
4	4.3.2022	529	211,600	286	28,600	8246	4,747,400	4232	423,200
5	7.3.2022	709	283,600	310	31,000	8117	4,803,100	4245	424,500
6	8.3.2022	633	253,200	413	41,300	8754	4,707,800	3111	311,100
7	9.3.2022	563	225,200	185	18,500	8868	4,567,700	4474	447,400
8	10.3.2022	510	204,000	315	31,500	8557	4,549,700	3427	342,700
9	11.3.2022	583	233,200	388	38,800	8447	4,490,300	3509	350,900
10	14.3.2022	704	281,600	215	21,500	10482	5,284,100	3270	327,000
11	15.3.2022	826	330,400	237	23,700	8574	4,458,200	3034	303,400
12	16.3.2022	685	274,000	254	25,400	8737	4,581,000	3539	353,900
13	17.3.2022	857	342,800	253	25,300	8434	4,471,400	3209	320,900
14	18.3.2022	803	321,200	471	47,100	7483	4,320,000	2658	265,800
15	21.3.2022	747	298,800	139	13,900	7696	4,410,300	4036	403,600
16	22.3.2022	792	316,800	371	37,100	10306	5,369,500	3080	308,000
17	23.3.2022	730	292,000	242	24,200	9257	4,696,400	3343	334,300
18	24.3.2022	818	327,200	244	24,400	9701	5,062,300	2844	284,400
19	25.3.2022	827	330,800	223	22,300	9117	4,946,100	3244	324,400
20	28.3.2022	785	314,000	275	27,500	11120	5,929,000	3922	392,200
21	29.3.2022	750	300,000	266	26,600	10142	5,352,100	3510	351,000
22	30.3.2022	691	276,400	342	34,200	8215	4,417,400	2416	241,600
23	31.3.2022	720	288,000	193	19,300	9595	5,193,700	2843	284,300
	TOTAL	16,214	6,489,200	6,523	652,300	204,233	110,697,700	81,421	8,142,100

- ✓ *The number of passengers on Pugu line is about 11 times the number of passengers on Ubungo line.*
- ✓ *Volumes of entrainment and detrainment are high at Kamata station, Tabata Matumbi station, Relini station, Kipawa station and Gongola Mbot station.*
- ✓ *The section between Kipawa and Banana on Pugu line is very high congestion*

①	Dar es Salaam Central	⑪	Vingunguti
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⑤	Buguruni	⑮	Mombasa
⑥	Tandale	⑯	Gongola Mboto
⑦	Tabata Matumbi	⑰	Pugu Kwala
⑧	Relini	⑱	Pugu
⑨	Mabibo		
⑩	Ubungo Maziwa		

3. Issues to be Improved

- **Track**
  - *Since there are shortage of ballast and track irregularity for Ubungo line, track rehabilitation of Ubungo line is required.*
- **Signal System**
  - *Installation of interlocking device and level crossing signal are required to increase frequency of train operation.*
- **Rolling Stock**
  - *Since locomotives and coaches availability is not high due to decrepitude and lack of spare parts, increase of the availability is required.*
- **Station & Station Plaza**
  - *Since almost all stations have no platform, no waiting space and no station plaza, the construction of these station facilities is required to secure safety for passenger to be easy to transfer to other transport system.*
- **Depot and Workshop**
  - *Since there is not enough maintenance equipment, the procurement of the maintenance equipment is required.*
- **Passenger Volume (Congestion)**
  - *Since the congestion of Pugu line is very high, it is necessary to ease the congestion.*

4. High Priority on Improvement of Pugu line

- Priority Line to be Improved
  - ***High demand on Pugu line***
    The demand for the Pugu line is about 10 times that of the Ubungo line, and the congestion rate of the Pugu line is very high. And the demand for the Ubungo line is currently not as high as the Pugu line.
  - ***Necessity of Railway and BRT against the high demand on Pugu direction***
    BRT is scheduled to open on Nerele Street in Phase 3, but it is about 300m away from the Pugu Line, and it is necessary to increase the transportation capacity of the Pugu Line in order to meet the increasing traffic demand year by year.
  - ***Issues on Ubungo line and its proposed extension***
    Although there are requests for the extension of Ubungo line to Mwenge, Tegeta and Bagamoyo, huge construction cost is required because it will be a grade separation structure to cross Morogoro street.
  - ***Pugu line*** *is tentatively proposed as higher priority line for the above reasons.*

5. Necessity of the Improvement

- *Necessity of the Improvement*
  - *In addition to the issues listed in each item, it is necessary to improve facilities and services that can transport the ever-increasing demand. Regarding demand, it is expected that the current service will exceed the transportation capacity by 2028 for the Pugu line according to a rough estimate.*
  - *The 14th Joint Transport Sector Review (JTSR 2021) July, 2021 also emphasizes the importance of commuter line in Dar es Salaam.*

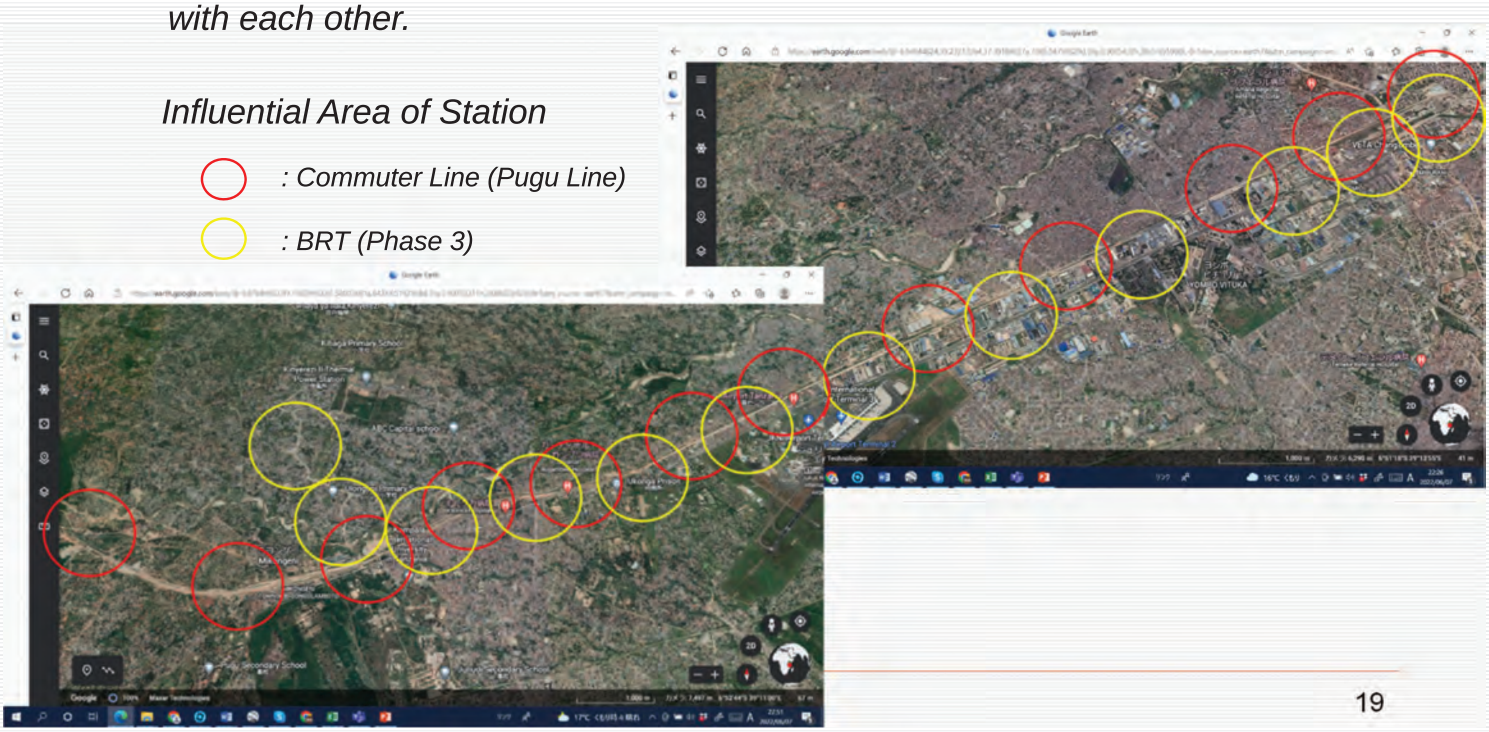
5. Necessity of the Improvement

- Drawing influential area of station for the BRT on Nerele Street which are scheduled to operate in Phase 3 and Ubungo Line, it can be understood that these two transportation systems efficiently share the overall demand, rather than competing with each other.

Influential Area of Station

: Commuter Line (Pugu Line)

: BRT (Phase 3)



6. Tentative Proposal for Future Improvement

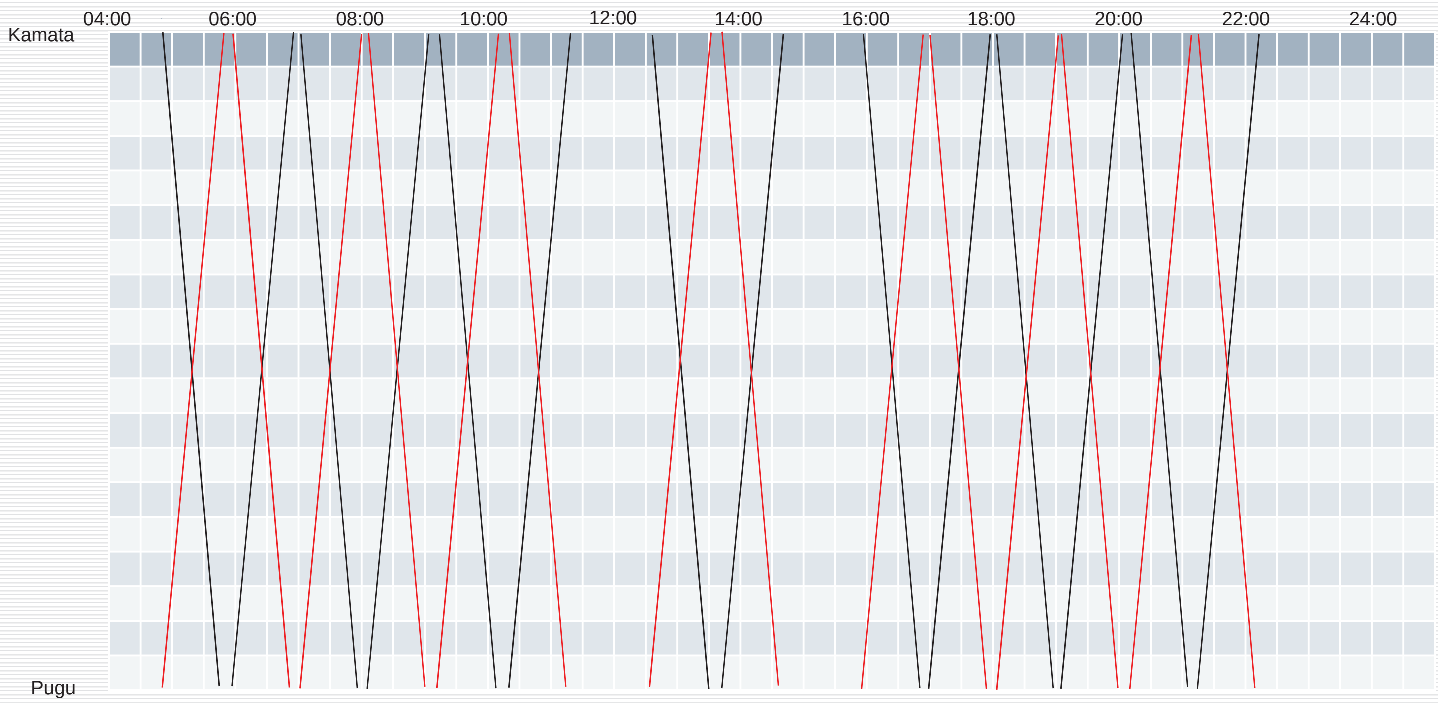
Field	Scope of Tentative Proposal
1) Train Operation	The current daily operation of 6 trains will be increased to 12 trains to increase transportation capacity.
2) Rolling Stock	Another train is required in order to conduct the above additional train operation.
3) Track Work	With the increase in the number of trains mentioned above, a new track will be constructed at the section between Bungoni station and Karakata station for the purpose of improving safe operation.
4) Signaling	An interlocking device will be installed at Karakata Station in the middle of the Pugu Line. The interlocking device controls the course of trains in stations and make a mutual relationship between signal lights and turnouts to ensure the safety of train running. With the interlocking only at Karakata station, an electric point machine will be installed for automatic conversion. In addition, level crossing signal will be installed at the main level crossing.
5) Station/ Station Plaza	Kamata station: The station square in consideration of the convenience of transferring to BRT, other transportation, and road transportation will be constructed. Kipawa station :A new platform will be constructed as a simple station so that elementary and junior high school students can get on and off safely and safely. Karakata station :From the viewpoint of strengthening the function as the nearest station to the international airport, the station facilities and the station square will be constructed as a medium-sized station.

1) Additional Train Operation

※ The trains of black line is currently being operated.

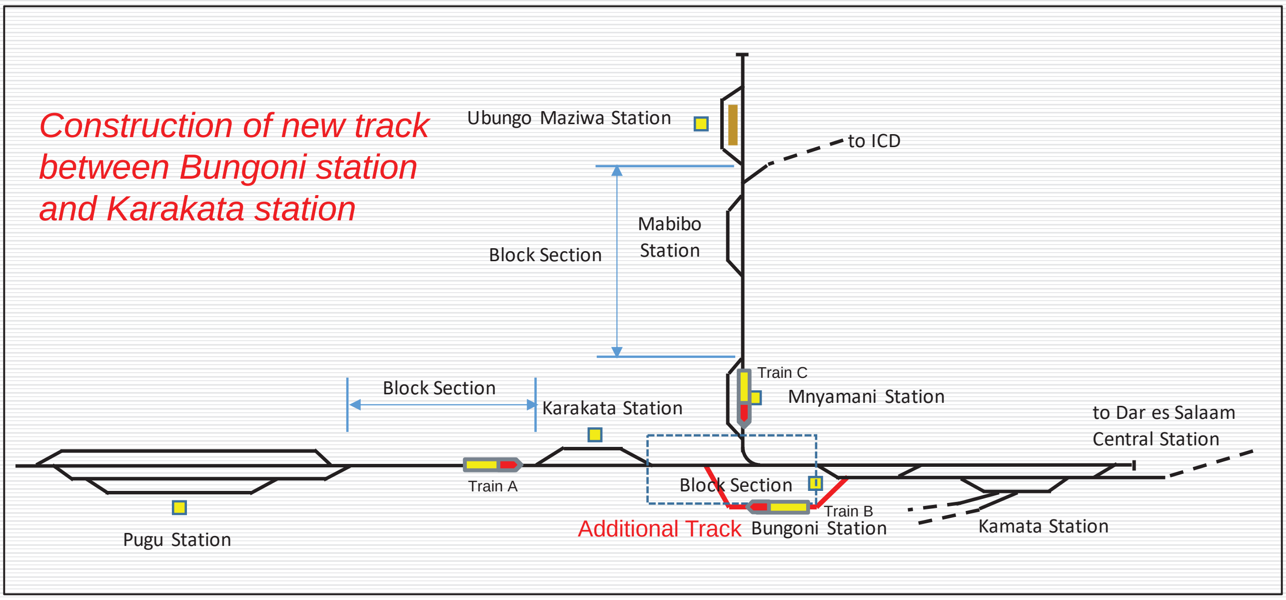
Additional train operation in red is proposed.

Train Operation Diagram for Pugu Line

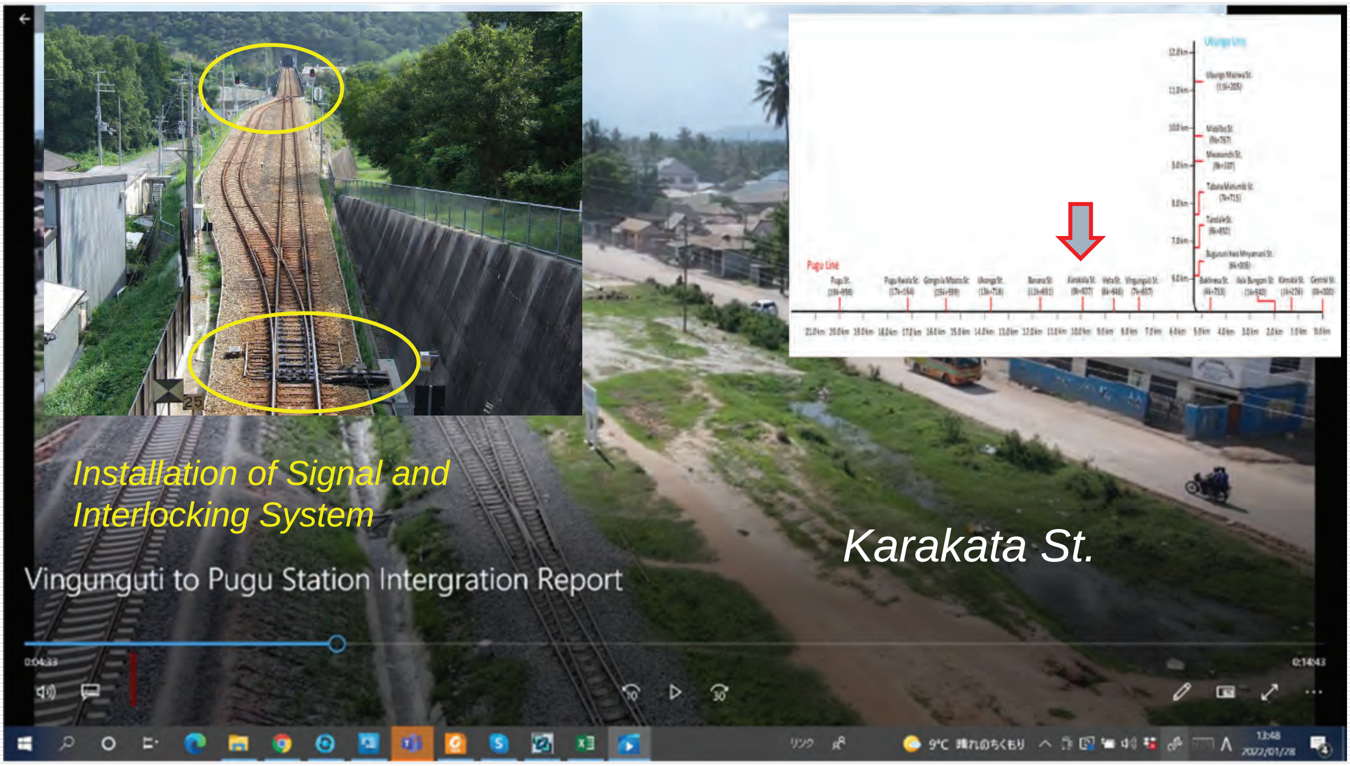


One more train set is required in order to increase frequency of train operation. (from 6 trains per direction per day to 12 trains per direction per day)

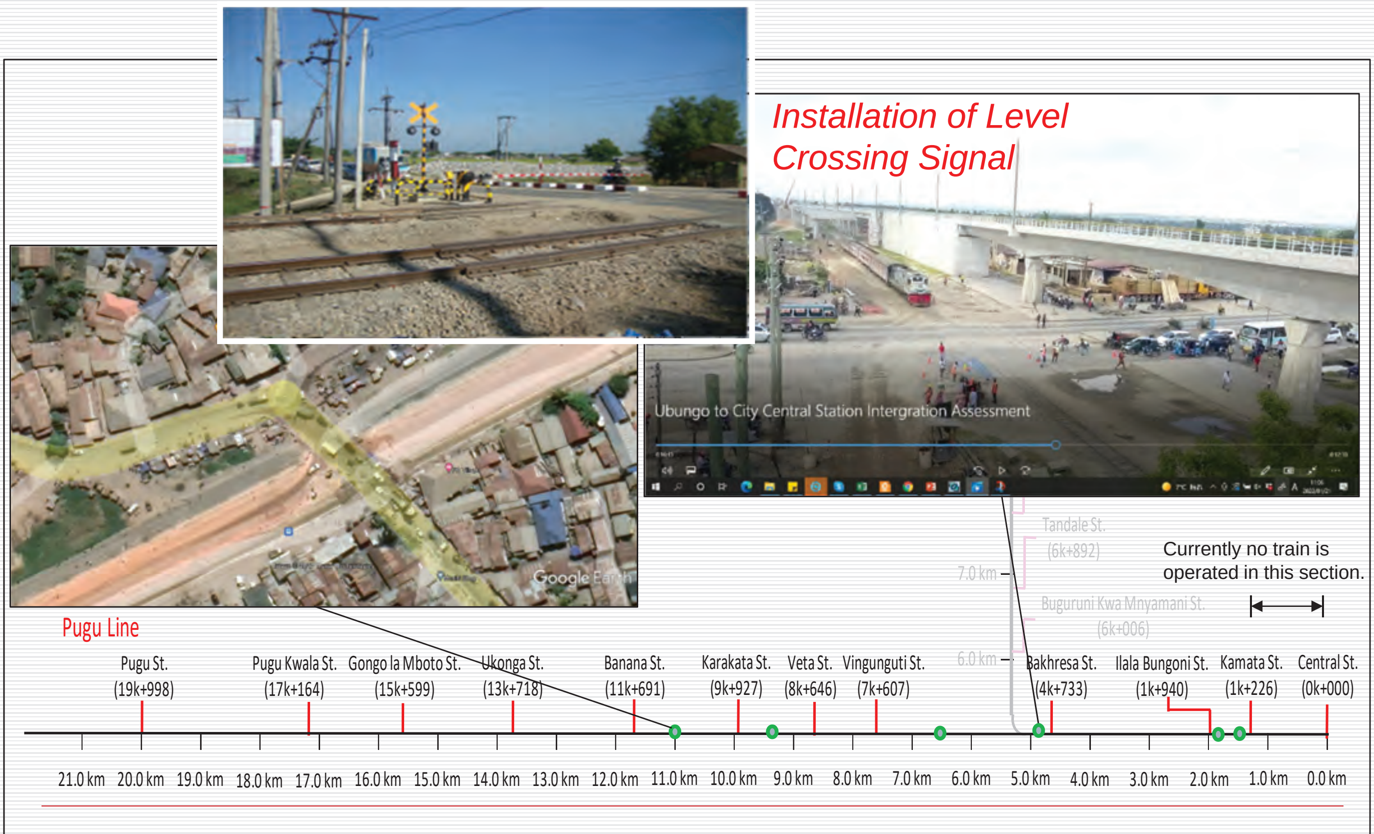
2) Additional Track



3) Installation of Signal and Interlocking System



4) Installation of Level Crossing Signal



5) Construction of Station and Station Plaza

Karakata Station

Kipawa Station

- ✓ *From the viewpoint of convenience and safety, we propose to develop station facilities at Kipawa Station and Karakata Station.*
- ✓ *Since Karakata station is close to the airport and is in an important location for transportation planning, we propose to improve the station square as well.*
- ✓ *Kipawa station has elementary and junior high schools in front of station and has many users. We want to improve the platform so that children can use it safely.*
- ✓ *We propose to construct a station square like the one in the image at Kamata station.*
- ✓ *TRC has sufficient RoW and we understand that construction are feasible.*

Japan International Cooperation Agency (JICA)

Data Collection Survey on Improvement of Urban Transport Utilizing Conventional Railways in African Countries

Nairobi (Kenya)

October 2022

Japan International Consultants for Transportation Co., Ltd. (JIC)

Oriental Consultants Global Co., Ltd. (OCG)

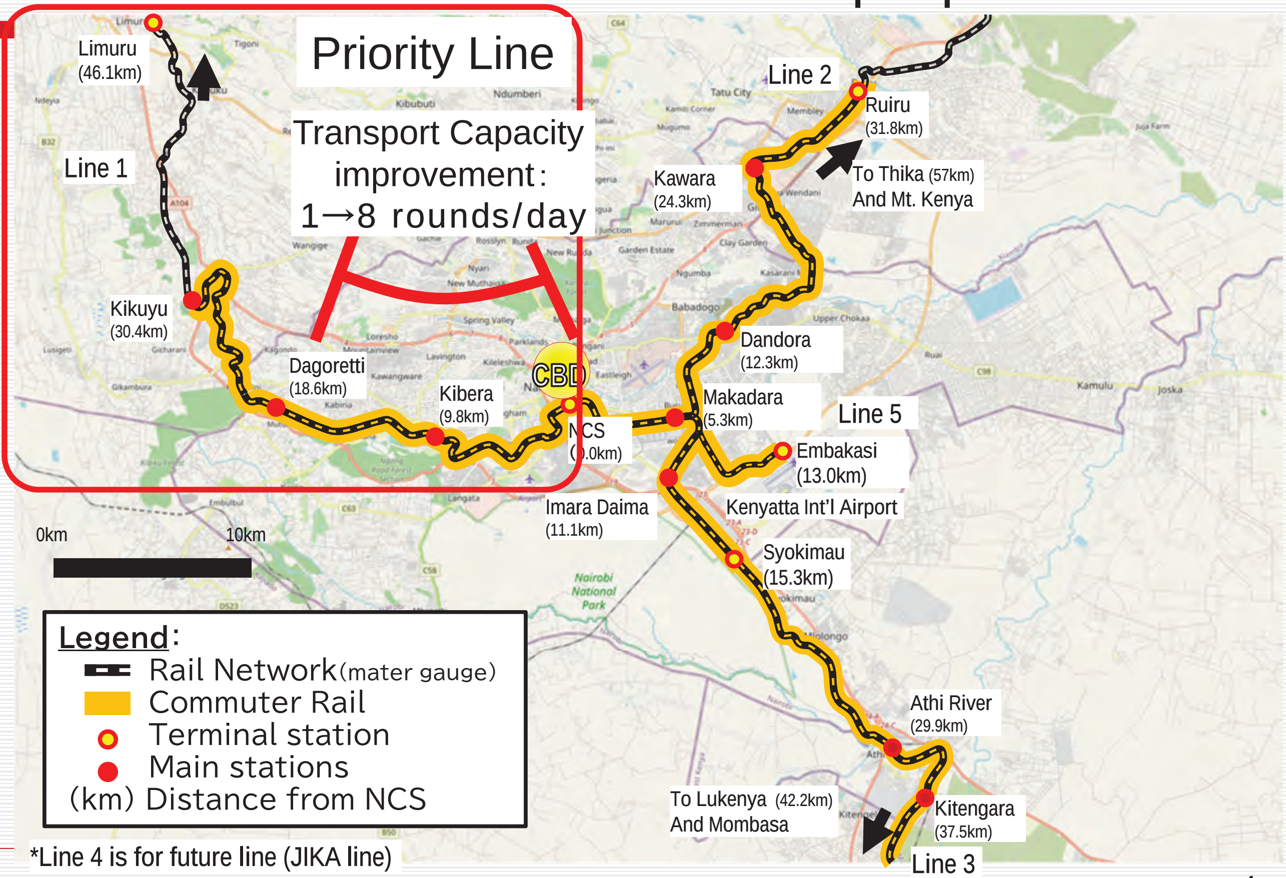
Nippon Koei Co., Ltd. (NK)

Table of Contents

1. Background

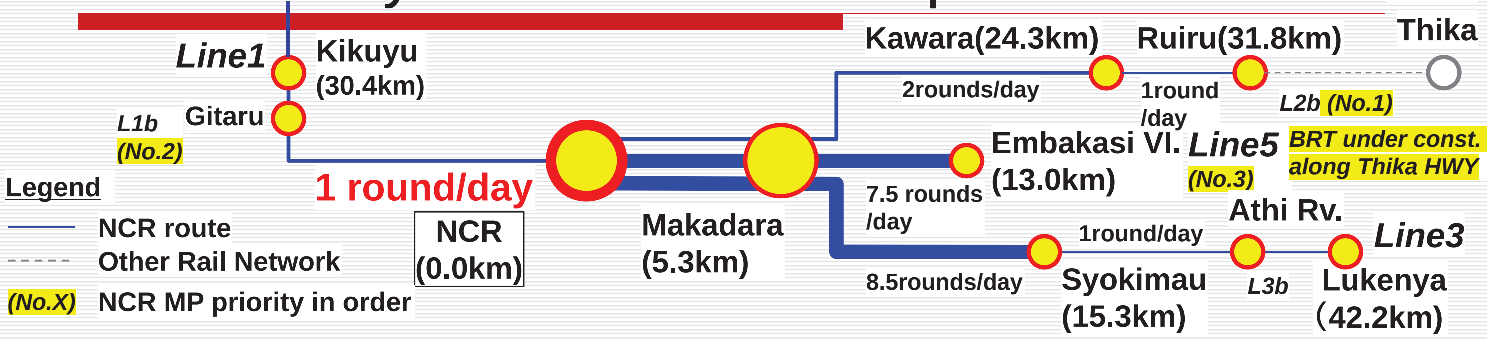
- Existing railway can play a key role in solving urban transportation issues by utilizing and upgrading existing facilities quickly.
- Mitigate transport congestion and lessen GHG.
- More frequent and punctual.
- Barrier free and safe facility for women, children, elder people and people with disabilities.

2. Commuter Rail Network and proposed line



*Line 4 is for future line (JIKA line)

3. Priority Line for NCR improvement



Line	Route	Nos. trains/day	Demand Forecast in peak hour* JICA survey('30)	Demand Forecast in peak hour* NCR MP('45)	Priority line	Reason
Line1	Kikuyu ~ NCS 30.4km	1 round /day	5,600 (2nd Ranked)	15,484 (2nd ranked)	✓	Lowest nos. train operation but 2nd ranked demand expected. Executive line for line 1 easy to develop
Line2	Ruiru ~ NCS 31.8km	2 rounds /day	8,200 (1st Ranked)	19,252 (1st ranked)		Highest demand expected but BRT along Thika HWY is under const. which runs nearby terminal station
Line5	Embakasi ~ NCS 13.0km	7.5rounds /day		10,668 (3rd ranked)		Short length might save const. cost. But 3 lines in operation section (NCR~Makadara), which makes difficult to development
Line3	Syokimau ~ NCS 15.3km	8.5rounds /day	3,700 (3rd Ranked)	4,181 (5th ranked)		The lowest demand among 4 lines

*Maximum Passenger demand in Peak Per Hour Per Direction

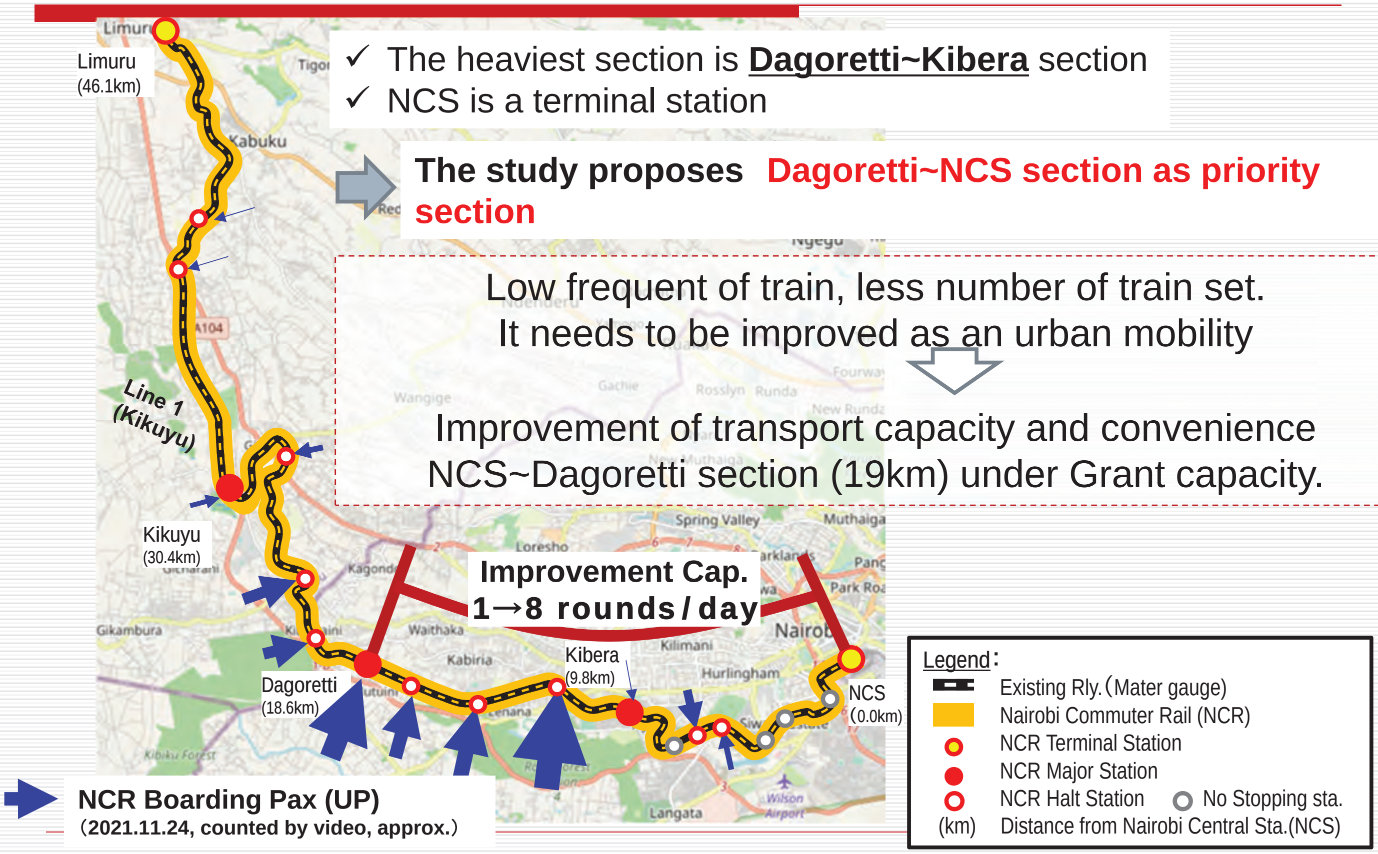
4. Priority section and development concept

- ✓ The heaviest section is **Dagoretti~Kibera** section
- ✓ NCS is a terminal station

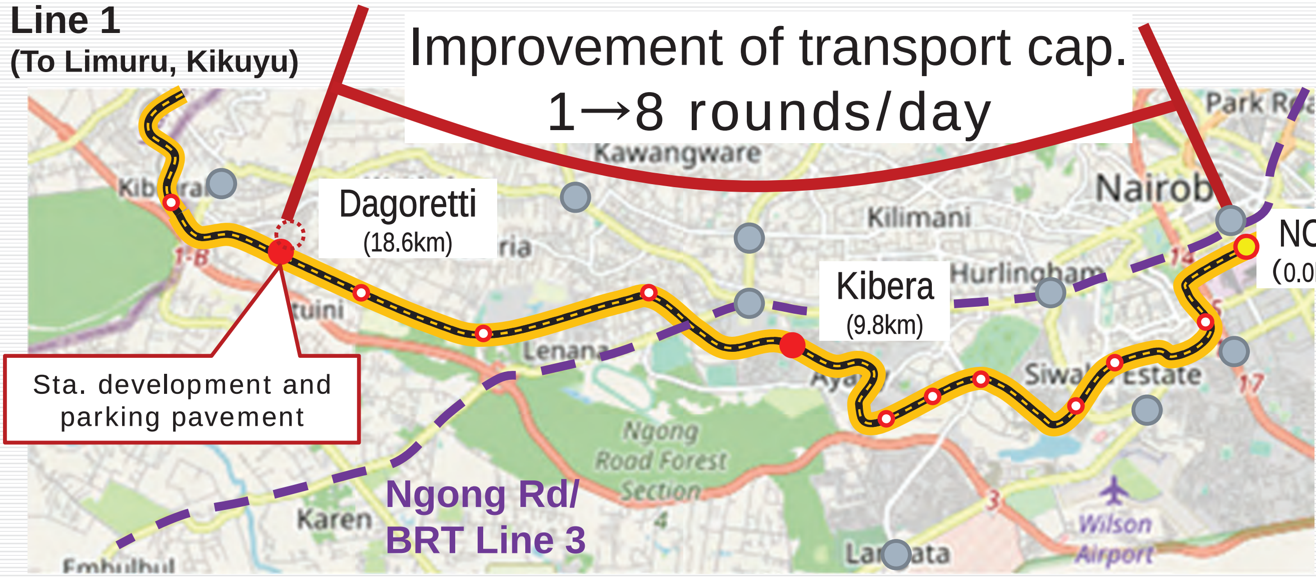
The study proposes Dagoretti~NCS section as priority section

Low frequent of train, less number of train set.
It needs to be improved as an urban mobility

Improvement of transport capacity and convenience
NCS~Dagoretti section (19km) under Grant capacity.



5. Target Section and Proposed Menu (Tentative)



Legend：

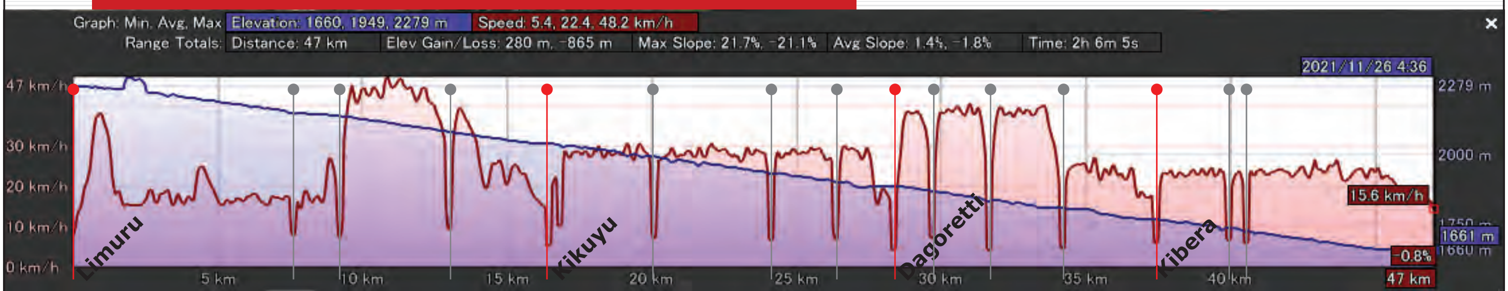
- Existing Rly.（Mater gauge）
- Nairobi Commuter Rail (NCR)
- NCR Terminal Station
- NCR Major Sta. / NCR Halt Sta.
- Bus/Matatu Terminal
- (km) Distance from Nairobi Central Sta.(NCS)

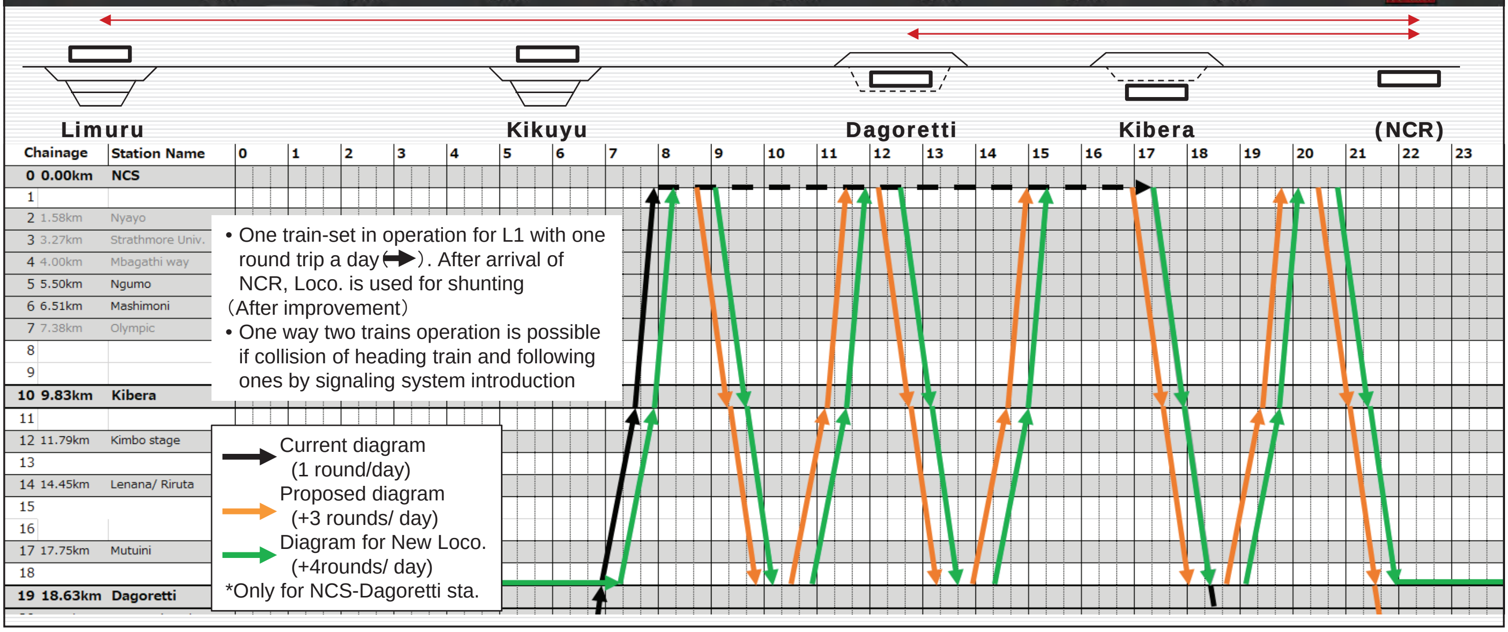
Tentative Menu for the Project

- Diesel Locomotive procurement (1 unit)
- Signaling system (20km)
- Level Crossing Warning device (2 places)
- Introduction of platform and parking pavement (Dagoretti)

＋JICA Technical cooperation

Reference: Proposal of train diagram





6. Component outline (tentative)

As-is		Outcome in short term
Low frequent of train operation and Lack of train set. Not function as urban transport	1 round/day (NCS-Kikuyu-Limuru:47km) Transport Cap: 1,548 PPHPD*	Frequent improvement (NCS-Dagoretti) 8 rounds/day Make double the transport capacity in peak hour (1 train/hr → 2 trains/hr) Transport cap.: 3,096 PPHPD* (NCR MP 10,962PPHPD(30'))

Note: Assuming 6-car train, passenger car traction, and 150% peak occupancy.
PPHPD: passengers per Hour per Direction

Sec	Issue	Components	Impact
RS	Lack of Locomotives Available for Line1	【Grant】Diesel Locomotive Procurement (1 unit) 【TC】Capacity building on Train ope., management, maintenance improvement	Increase of nos. of train, Demand enhancement, modal shift
Track	Lack of material for track and consciousness of safety	【TC】Capacity building on track maintenance (including provision of maintenance tool)	Prevention of derailment, improvement of train ride comfort
Signaling	To operate with several train sets, signaling system is mandate for safety	【Grant】Signaling system (20km), LX waring system (Excluding NCR) (2 Nos.) 【TC】Operational structure, signaling maintenance	Prevention of collision
Sta.	Sta. facilities development is necessary for improvement of transport network	【Grant】Improvement of existing sta. (Dagoretti)	Provision of accident in boarding/ alighting, modal shift

7. SPECIAL CONSIDERATIONS WITH JAPANESE KNOW-HOW

Contribution to KRC's masterplan

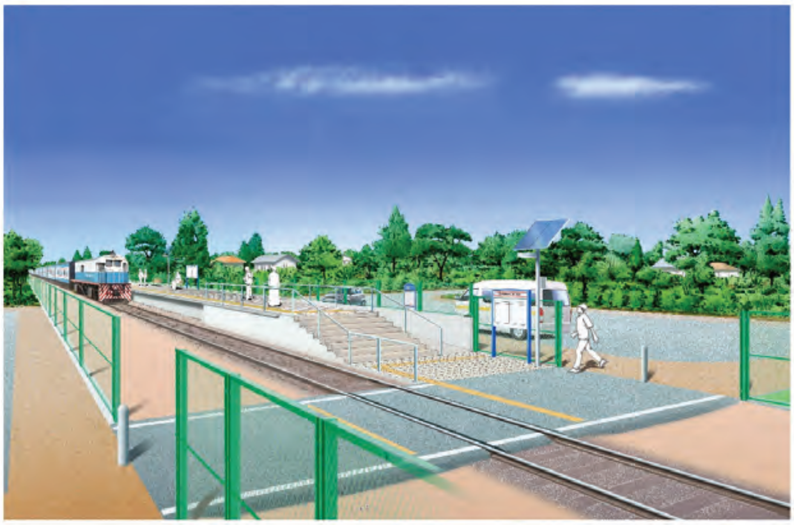
☐ Progress: Nairobi Commuter Rail Master Plan (KRC 2019, supported by WB) Quick win

No	NCR MP Proposal (Quick win)	Note	Cost	Progress as of September 2021
1	Improvement of Halt to Mini-station (sta. building, toilet, platform, boundary wall const. parking and dredging)	20 stations	$5 Mil.	2 mini-station under const. (Mukuru and satelite) The other stations (18) are design stage
2	Procurement of parts for Rolling Stock	-	$6 Mil.	**No Progress**
3	**Track improvement such as ballasting, tamping**	65km (entire route)	$2 Mil.	**Progressed: 81.5%** Line1(Kikuyu):69%, Line2(Thika): 91% Line3(Lukenya):77%, Line4(Emb.V.):94%
4	**Enhancement of drainage**	10km (3 locations)	$2 Mil.	
5	Development of loop line	Imara Daima sta	$1 Mil.	**No Progress**
6	Station (+station plaza) Development	NCR	$6 Mil.	Station building renovation and wash room, platform, perimeter wall, guard house, carpark and drainage system completed

Improvement at Station Hub

✓ Efficient station hub design based on long history experience and know-how

Easy-to-ride station facilities



Safe and comfortable for Social Vulnerable

- Possibility of Designated coach for women
  - Q: The girls were asked: Are you safe at home, schools or at the bus stage?
  - A: A majority 23 per cent (132) reported experiencing indecent touching.
    The perpetrators included fathers, uncles, teachers, **<u>matatu touts</u>** and classmates.

allAfrica.com

Kenya: Nowhere to Run, Nairobi School Girls Are Not Safe!

The perpetrators included fathers, uncles, teachers, matatu touts and classmates. Rape cases. Twenty two per cent (122) of the girls reported...

2021/11/01

Agence japonaise de coopération internationale (JICA)

Etude de collecte de données relatives à l'amélioration des transports urbains en Afrique par le chemin de fer existant

Kinshasa (République Démocratique du Congo)

Octobre 2022

Japan International Consultants for Transportation Co., Ltd. (JIC)

Oriental Consultants Global Co., Ltd. (OCG)

NIPPON KOEI Nippon Koei Co., Ltd. (NK)

Table des Matières

1. Chemins de fer et lignes ferroviaires cibles à Kinshasa

Lignes ferroviaires	Distance	Etat actuel
Ligne Matadi	45km	・ 1 aller-retour par jour entre la gare de Kinshasa Est et la gare de Kasangulu ・ Locomotive diesel +8 voitures voyageurs
Ligne Aéroport	20km ∗	∗ Les 7 km entre les gares de Kinshasa Est et Limete sont exploités en commun par la ligne Matadi ・ Cette ligne est mise hors service depuis 2015
Ligne de Kintambo	9km	・ Cette ligne est mise hors service depuis 2007

2. Génie civil et voies ferrées

Emprise de la gare de Kinshasa Est et la gare de Limete (Section en commun avec la ligne Matadi)

Mauvaises herbes
poussant sur la voie ferrée

Aiguillage immergé dans
l'emprise de la gare

Caractéristiques : Beaucoup d'herbe poussant sur la voie ferrée et de nombreux endroits mal drainés

Problématiques : Reconstruction de la voie ferrée et entretien continu

Entre la gare de Limete et l'ancienne gare de Petro Congo

Plate-forme qui s'est détachée et habitations attenantes

Rails ensevelis sous un sol mal drainé

Caractéristiques : Habitations trop proches des voies ferrées, effondrement de la plate-forme, ensevelissement des rails, etc.

Problématiques : La réinstallation des populations, les routes dédiées aux travaux de construction et la réparation de grande envergure des voies ferrées sont nécessaires.

Entre l'ancienne gare de Petro Congo et la gare de Tshenke

Effondrement important d'un talus

Effondrement de la plate-forme

Caractéristiques : Certains secteurs présentent des effondrements importants, notamment des effondrements de talus et de plates-formes ferroviaires et des voies ferrées ensevelies.

Problématiques : La réinstallation des populations, les routes dédiées aux travaux de construction et la réparation de grande envergure des voies ferrées sont nécessaires.

Entre la gare de Tshenke et l'entrée du cimetière

Zones où le drainage est mauvais

Amas d'ordures et effondrement de talus (Enorme quantité d'ordures et hauteur de l'amas d'ordures inconnue)

Caractéristiques : Zones où le drainage est mauvais, tas d'ordures et effondrements de talus

Problématiques : Travaux de drainage, enlèvement des ordures et reconstruction du talus

Entre l'entrée du cimetière et l'aéroport de N'djili

Tronçon où la voie ferrée est cachée par les mauvaises herbes

Voie ferrée proche d'une pierre tombale

Caractéristiques : Cimetière trop proche de la voie ferrée et zone en friche à proximité de l'aéroport

Problématiques : Une partie du cimetière doit être relocalisée.

2. Génie civil et voies ferrées

Récapitulatif de la situation actuelle et propositions pour y remédier

	Section	Caractéristiques	Mesures prises	Remarques	Projet d'application
1	Gare de Kinshasa Est - Gare de Limete (Section en commun avec la ligne de Matadi)	▪ Beaucoup d'herbes sur la voie ferrée ▪ Mauvais drainage autour de la gare	▪ Entretien des voies et des zones environnantes ▪ Mesures de drainage, etc.	Comme il s'agit d'une ligne existante, les mesures peuvent être lancées dès que les différentes dispositions auront été prises.	Projet de coopération technique
2	Gare de Limete – Gare de Petro Congo	▪ Effondrement de la plate-forme ▪ Ensevelissement de la voie ferrée	▪ Reconstruction de la plate-forme et de la voie ferrée ▪ Travaux de drainage	Quelques obstacles et besoin de relocalisation.	Projet de coopération financière non remboursable
3	Gare de Petro Congo – Gare de Tshenke	▪ Effondrement de talus ▪ Effondrement de la plate-forme et autres	▪ Reconstruction de talus, de plate-forme et de voie ferrée	Quelques obstacles et besoin de relocalisation.	
4	Gare de Tshenke – Entrée du cimetière	▪ Mauvais drainage ▪ Amas d'ordures et effondrement de talus	▪ Travaux de drainage ▪ Reconstruction de talus, de plate-forme et de voie ferrée	Enlèvement des ordures préférablement pris en charge par le gouvernement RDC	
5	Entrée du cimetière – Aéroport de N'djili	▪ Cimetière trop proche de la voie ferrée ▪ Pas de problème près de l'aéroport	▪ Entretien des voies et des zones environnantes	Le projet peut être lancé près de l'aéroport.	

3. Signalisation ferroviaire

Equipements de signalisation et passages à niveau

Des équipements de signalisation existent mais ne fonctionnent pas.

Les opérations ferroviaires sont gérées par communication sans fil entre les gares et les données sont notées sur papier.

Il y a des passages à niveau avec croisement de route mais où il n'y a pas de barrières ni de dispositifs d'avertissement.

A certains passages à niveau à fort trafic, des agents de la circulation font le trafic.

Proposition d'installation de dispositifs d'avertissement au niveau des passages à niveau

Eléments	Détails
Spécifications	Installation de dispositifs d'avertissement, de barrières au niveau des passages à niveau, etc.
Emplacement d'installation	1) Au niveau du PK360+600 depuis la gare de Matadi (largeur de la route : 24m) 2) Point éloigné de 200m du point ci-dessus (largeur de la route : 8m) 3) Au niveau du PK0+100 depuis la gare de Limete (largeur de la route : 16m)
Fonctionnement	Des agents au niveau des passages à niveau assureront manuellement le fonctionnement du dispositif d'avertissement et des barrières.
Alimentation électrique	Installation de petits groupes électrogènes dédiés en raison de l'instabilité de la fourniture d'électricité par la SNEL (Société National d'Electricité).

Exemple de l'introduction d'un dispositif d'avertissement japonais au niveau d'un passage à niveau à l'étranger (Myanmar)

Détails de l'emplacement des installations d'un dispositif d'avertissement au niveau des passages à niveau

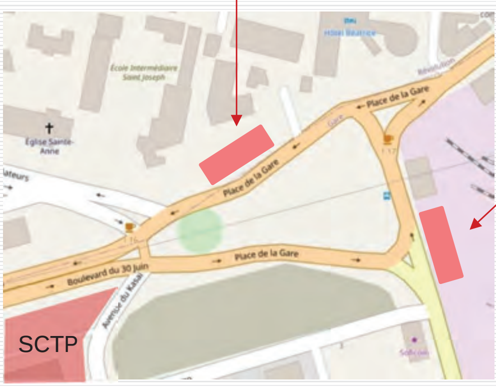
Gare de Kinshasa Est(1)

Bien qu'il y ait un guichet dans le bâtiment de la gare, il n'est pas utilisé et les billets sont vendus devant le portail sur le côté du bâtiment de la gare.

L'accès aux quais se fait en traversant les voies ferrées. La toiture du quai a été construite avec l'aide de l'UE.

La plateforme présente de nombreux trous et des flaques d'eau se sont formées. Des déchets sont également jetés un peu partout.

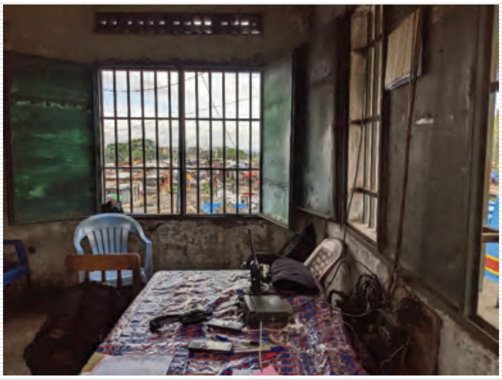
Gare de Kinshasa Est(2)



Devant la gare, il y a une gare routière (pour les lignes de bus partant de la gare de Kinshasa Est) (photo de gauche) et un arrêt de bus/station de taxis (photo de droite).

Gares de N'dolo et de Funa


Gare de N'dolo

Gare de Funa

Gares de N'dolo, Funa, Limete et Tshenke


Gare de N'dolo


Gare de Funa


Gare de Limete


Gare de Tshenke

Il n'y a pas de guichets ni autres installations pour les passagers dans les gares intermédiaires.

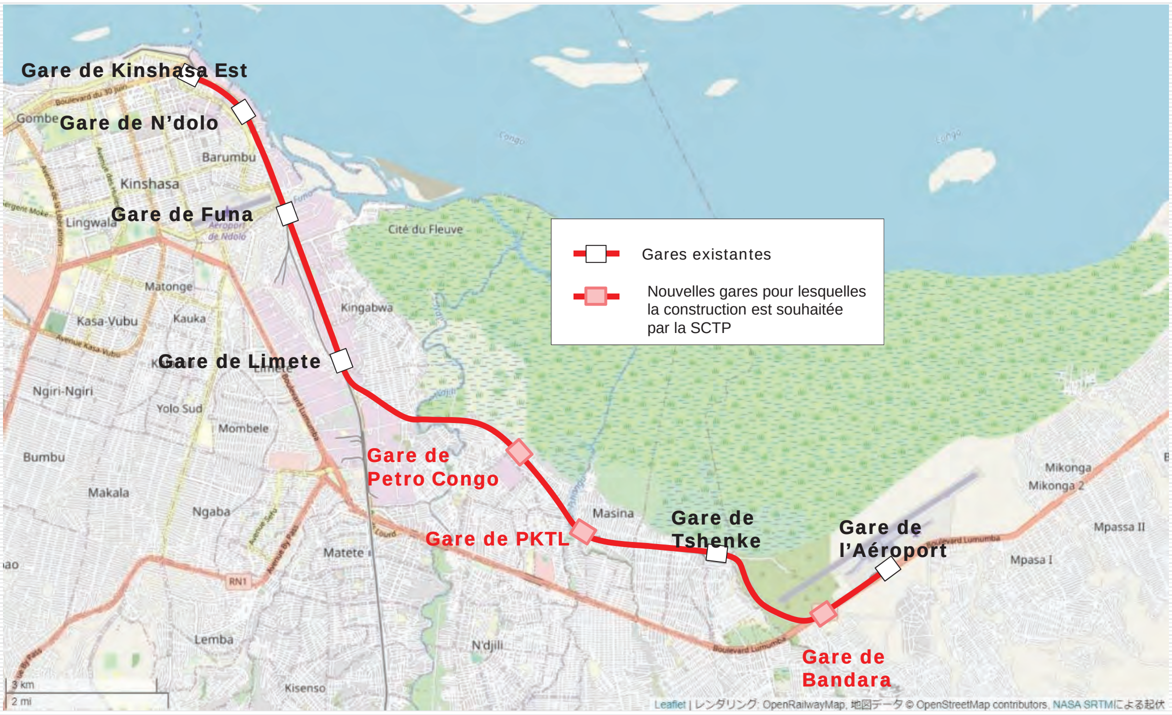
Le bâtiment des gares sert d'installation pour la gestion des opérations ferroviaires et comme logement de fonction pour le personnel de la SCTP, notamment la famille du chef de gare.

Gare de l’Aéroport

Emplacement prévu pour le parvis de la gare

Bien qu’il y ait un quai, ce quai n’étant pas couvert, une mise au point est nécessaire.
Il y a suffisamment de terrain pour aménager un parvis de la gare, et il y a également des connexions pratiques de bus.

Gares existantes et nouvelles gares pour lesquelles la construction est souhaitée par la SCTP



Récapitulatif de la situation actuelle

Nom des gares	Bâtiment de la gare	Quai(s)	Toiture au niveau des quais	Correspondance	Mentions spéciales
Kinshasa Est	○	○	○ (Aide de l'UE)	○	▪ Des guichets pour la vente de billets de train existent mais ne sont pas utilisés et les billets sont vendus à l'extérieur du bâtiment de la gare. ▪ Les quais doivent être mis au point (hauteur des quais, couloirs de la gare). ▪ Quatre lignes de bus desservent la gare.
N'dolo	○	×	×	×	
Funa	○	×	×	×	
Limete	○	×	×	×	
Petro Congo	×	×	×	×	▪ Gare dont la reconstruction est souhaitée ; une gare existait auparavant mais elle n'existe plus actuellement.
PKTL	×	×	×	×	▪ Gare pour laquelle une nouvelle construction est souhaitée.
Tshenke	○	×	×	△	▪ Existence d'un terminal de minibus près de la gare
Bandara	×	×	×	×	▪ Gare dont la reconstruction est souhaitée ; une gare existait auparavant mais elle n'existe plus actuellement.
Aéroport	○	○	Armature uniquement	○	▪ Les quais doivent être mis au point (toiture et longueur du quai) ▪ Quatre lignes de bus desservent la gare.

- Le bâtiment de la gare intermédiaire existante ne remplit que des fonctions de gestion des opérations ferroviaires et aucune installation de service aux passagers, comme un guichet.
  Par ailleurs, le bâtiment de ces gares intermédiaires est également utilisé comme logement de fonction pour le personnel de la SCTP, abrite la famille du chef de gare et autres plusieurs familles.
- Les billets de train sont vendus en espèces sous forme de billets en papier. Les billets peuvent être achetés à la gare et à bord des trains.

Propositions pour y remédier

Nom des gares	Bâtiment de la gare	Quais	Toiture au niveau des quais	Correspondance
Kinshasa Est	Réparation	Mise au point	Mise au point non nécessaire	Mise au point du point de correspondance existant
N'dolo	Reconstruction	Nouvelle construction	-	-
Funa	Reconstruction	Nouvelle construction	-	-
Limete	Reconstruction	Nouvelle construction	-	-
Petro Congo	Nouvelle construction	Nouvelle construction	-	-
PKTL	-	-	-	-
Tshenke	Reconstruction	Nouvelle construction	-	Installation de panneaux d'information
Bandara	-	-	-	-
Aéroport	Réparation	Mise au point	Mise au point	Mise en place du parvis de la gare

- Le bâtiment de la gare intermédiaire existante sera reconstruit et des installations supplémentaires de services aux passagers, y compris des guichets, seront ajoutées.
  Les détails, tels que la fonction actuelle du bâtiment comme logement de fonction, seront discutés à part avec la SCTP.
- Concernant la nouvelle construction du bâtiment des gares, seul le bâtiment pour la gare de Petro Congo sera étudié, en raison de problèmes budgétaires et de disponibilité de terrain.

Nombre insuffisant de voitures (wagons)

Pour la banlieue : 7 voitures sur 13 sont utilisées entre Kinshasa et Kasangulu. Au départ, toutes les 13 voitures étaient utilisées pour Kasangulu.

Utilisation longue distance :
9 voitures utilisées sur la ligne Kinshasa-Matadi.
Les places assises varient en fonction de la classe, avec un wagon-restaurant et un bar.
L'intérieur n'est pas réellement endommagé.
La SCTP n'est pas favorable à leur utilisation pour desservir les banlieues.

Utilisation longue distance :
10 voitures sont disponibles mais elles ne sont pas utilisées. Trois raisons suivants expliquent cette situation.
1) Les portes ne peuvent être ouvertes ou fermées en raison de problèmes électriques, la climatisation ne fonctionne pas et les fenêtres sont scellées.
2) La consommation de carburant du wagon d'alimentation en énergie est élevée et le train longue distance n'est pas rentable.
3) L'équipement sous la caisse étant placé trop bas, le ballast projeté vient frapper l'équipement.

Wagon à bagages :
une voiture est connectée à la place d'une voiture voyageurs entre Kinshasa et Kasangulu.
Il n'y a ni sièges ni mains courantes, mais les passagers peuvent monter à bord.

Pour pouvoir rétablir la ligne de l'aéroport, il est nécessaire de disposer d'un nombre suffisant des voitures voyageurs

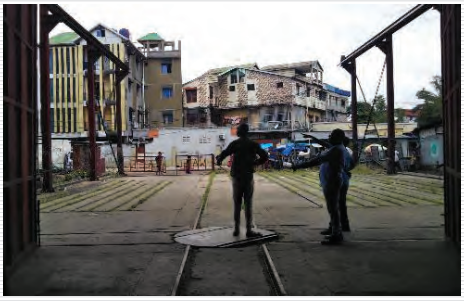
Visite des installations d'inspection et de réparation des matériels roulants

- Dépôt de locomotives de Limete

- Les crics, grues et tours à métaux sont fonctionnels si l'électricité est disponible.
- Il y a de l'eau dans la fosse et pas d'électricité (Le plan de restauration est en place).
- Il n'y a pas d'entrepôts de matériaux et toutes les pièces achetées sont utilisées sur-le-champ.

Visite des installations d’inspection et de réparation des matériels roulants

- Atelier d’entretien des voitures voyageurs et essieux de Limete



- Bien que certaines installations soient hors service, un certain nombre d’équipements * fonctionnent.
  (＊tour à roue, assemblage d’essieux, grue, cric, machines de traitement du métal et du bois, etc.)
- Un certain nombre de voitures voyageurs sont en attente de réparation en raison d’un manque de budget.
  (ex : une voiture voyageurs dont la réparation était prévue et qui a été laissée à l’abandon pendant 5 ans, une voiture voyageur avec une fissure importante au niveau du tablier due au vieillissement, etc.)
- L'accès par des personnes autres que le personnel de l’atelier et les vols se produisent.
- Une partie des lignes de raccordement au réseau public sont inutilisables en raison d’une occupation illégale.

Visite des installations d’inspection et de réparation des matériels roulants

- Atelier de Mbanza-Ngungu

- Bien que certaines installations soient hors service, un certain nombre d’équipements fonctionnent.
- Les couloirs sont bien dégagés, mais il y a des zones qui doivent être nettoyées pour des raisons de sécurité.
- Tous les dossiers de gestion des matériaux et d’inspection et de réparation sont gérés sur papier.
- Les travailleurs sur le site sont confrontés à des problèmes tels que la pénurie de main-d’œuvre, la pénurie de pièces de rechange et le vieillissement des équipements.

Récapitulatif de la situation actuelle et propositions pour y remédier

■ Préparation des voitures ou wagons en nombre suffisant

Mesures proposées :

1) Réparation des voitures voyageurs en panne et ré-examen de l'attribution des voitures voyageurs à des lignes ferroviaires
2) Réparation ou modification des voitures voyageurs de longue distance non utilisées
3) Augmentation des voitures voyageurs (fourniture de voitures neuves ou d'occasion en provenance du Japon ou d'un pays tiers)
4) Approvisionnement d'autorails diesel d'occasion du Japon

➡ Suite à l'examen du budget et aux discussions menées avec la SCTP, etc., il résulte que :
Si le financement est fourni, la SCTP peut réaliser «(1) La réparation des voitures voyageurs en panne», et peut s'assurer des voitures voyageurs qui peuvent être utilisées pour le transport suburbain, y compris les trajets sur la ligne Aéroport.

■ Amélioration du système de gestion et de la maintenance du matériel roulant

Les dépôts de locomotives et les ateliers d'entretien sont insuffisamment équipés, notamment en raison d'un manque de budget, et les compétences techniques des travailleurs doivent être rehaussées.
On pourrait penser à l'avenir à améliorer l'environnement de travail et à améliorer les capacités techniques grâce à des projets de coopération technique.

6. Orientations d'amélioration

❑ **Réhabilitation de la ligne vers l'aéroport : augmentation de la capacité de transport (nombre de ligne ferroviaire en service : actuellement 0 → 5 allers-retours)**

❑ **Coopération financière non remboursable**

- Voie ferrée, travaux de génie civil (gare de Limete - gare Aéroport)
- Installation de dispositifs d'avertissement au niveau des passages à niveau (3 endroits)
- Réparation des voitures voyageurs (9 voitures)
- Mise au point des bâtiments de gares (2 gares), reconstruction (4 gares), nouvelle construction (1 gare)
- Meilleur point de correspondance(1 gare), mise en place d'un nouveau point de correspondance (1 gare)

❑ **Projet de coopération technique : en collaboration avec la coopération financière non remboursable**

- Maintenance des voies ferrées (Gare Kinshasa Est-Gare de Limete)
- Maintenance du matériel roulant (2 ateliers de Limete)
- Service passagers

Agência de Cooperação Internacional do Japão (JICA)

Estudo de recolha e confirmação de informações sobre a melhoria dos transportes urbanos utilizando os caminhos-de-ferro convencionais regionais africanos

Maputo (Moçambique)

Outubro 2022

Japan International Consultants for Transportation Co., Ltd. (JIC)

Oriental Consultants Global Co., Ltd. (OCG)

NIPPON KOEI Nippon Koei Co., Ltd. (NK)

Tabela de Conteúdos

1. Objectivo do Estudo

Os objectivos do Estudo são:

- ☐ Objectivo 1: Propostas de plano de desenvolvimento e roteiro para os caminhos-de-ferro convencionais com base no plano director dos transportes urbanos em 2014
- ☐ Objectivo 2: Propostas de plano de desenvolvimento considerando o estado actual e problemas dos caminhos-de-ferro, utilização da tecnologia japonesa e colaboração com outros doadores
- ☐ Objectivo 3: Proposta de plano de melhoramento com base no quadro da Grant Aid e da Cooperat Técnica.

2. Rotas Ferroviárias na Área Metropolitana de Maputo

Rota	Descrição	Motivo da sua selecção como projecto prioritário
Maputo～Machava～Matola Gare	20km 4 pares/dia	・Rota importante que liga à África do Sul ・A MTC e a CFM dão prioridade ao desenvolvimento desta via. Além disso, a construção de plataformas e vedações, etc., estão em curso.
Maputo～Marracuene	35km 2 pares/dia	
Maputo～Boane	27km 2 pares/dia	

3. Estado da ferrovia Matola Gare

Carris

Condição da ferrovia na Estação da Matola Gare

Danos nos carris

Parece que a manutenção básica da ferrovia esteja a ser levada a cabo, mas como se podem ver danos no carril e depressões nas juntas dos carris, a manutenção da ferrovia não tem sido feita com atenção suficiente aos detalhes.

3. Estado da ferrovia Matola Gare

Passagem de nível (Carris)

Condições da Passagem de Nível

Danos no Pavimento da Passagem de Nível

Há muitos buracos, que criam obstáculos para o trânsito rodoviário. E, os carris antes e depois das passagens de nível são enterrados na areia das áreas circundantes. Tais condições tornam-se um elo fraco no transporte.

3. Estado da ferrovia Matola Gare

Passagem de nível (Equipamento)

Luz de Aviso de Passagem de Nível

Luz de Aviso em Acção

As passagens de nível têm ou um sinal, ou um sinal e uma luz de aviso, mas não têm barreiras de passagem de nível.

Há sempre porteiros estacionados nas passagens de nível principais. Quando o porteiro recebe a notificação de que um comboio se está a aproximar, activa a luz de aviso e o sinal sonoro para alertar os utentes da estrada.

3. Estado da ferrovia Matola Gare

Equipamento de Manutenção de Carris

Compactador de Balastro
Múltiplo Tie Tamper

Compactador de Balastro

A Empresa CFM adquiriu um compactador de balastro múltiplo (fabricada na África do Sul) e outro equipamento para melhorar a eficiência da manutenção dos carris.

Actualmente, o equipamento e as peças sobressalentes necessárias são suficientes.

3. Estado da ferrovia Matola Gare

❑ Material Circulante（CFM, Carruagens de Passageiros Existentes）

Comboios Metropolitanos dos CFM

Assentos desgastados

Os comboios urbanos operados pela CFM não são adequados para o serviço de deslocação pendular porque os assentos estão virados uns para os outros e o seu número é limitado. Demora mais tempo a sair do comboio devido aos pequenos conveses em ambas as extremidades da carruagem.

A carruagem não está bem conservada e os assentos estão desgastados..

3. Estado da ferrovia Matola Gare

❑ Material Circulante（CFM, Carruagens de Passageiros e DMU novas）

Novos comboios DMU

Novas Carruagens de Passageiros

Desde 2021, teve início a introdução de DMU e carruagens de passageiros fabricadas na Índia. Em Abril de 2022, ainda não tinha começado a funcionar, mas 30 carruagens em 5 comboios serão eventualmente introduzidos, prevendo-se a sua utilização em 3 rotas na Área Metropolitana de Maputo.

As carruagens de passageiros serão utilizadas principalmente para o transporte de passageiros de longa distância.

3. Estado da ferrovia Matola Gare

Material Circulante (Metrobus)


Comboio DMU da Metrobus


Interior do Comboio DMU

A Metrobus adquiriu 16 comboios DMU da Nova Zelândia e tem operado dois comboios de 6 carruagens desde 2018.

Os comboios vão de manhã a Maputo e partem de Maputo à noite, nos dias de semana.

Os comboios estão estacionados na Matola Gare e Boane à noite e aos fins-de-semana.

3. Estado da ferrovia Matola Gare

Entreposto (CFM)


Interior do Barracão das Locomotivas (1)


Interior do Barracão das Locomotivas (2)

Depósito (barracão de locomotivas) para inspecções de rotina perto da Estação de Malanga está equipado com convés, fossos e pontes rolantes. A revisão é efectuada noutro local.

O edifício não é suficientemente longo para a montagem de um comboio de 6 carruagens, a montagem do comboio tem de ser feita três carruagens de cada vez.

3. Estado da ferrovia Matola Gare

❑ Entreposto (Metrobus)

Exterior do Barracão de Inspecção

Exterior do Barracão de Inspecção

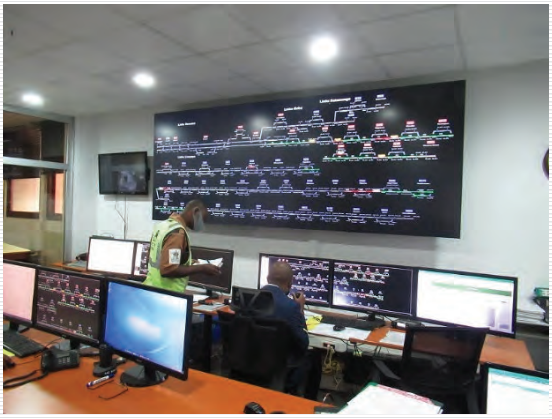
O Barracão de inspecção localizado perto da estação de Maputo é alugado da CFM.

Não dispõe de maquinaria de grande porte para além de um macaco para levantar o veículo. Uma vez que o barracão tem pouca iluminação, a inspecção só pode ser feita durante o dia.

O uso deste barracão de inspecção será abolido aquando da construção da nova plataforma na Estação de Maputo. Em seguida, o depósito será relocalizado perto da Estação da Machava.

3. Estado da ferrovia Matola Gare

❑ Sistema de Controlo de Tráfego e Outros



Centro de Controlo de Operações

Monitor de Câmaras de Vigilância

Um despachante no CCO verifica a posição actual do comboio e concede autoridade de operação ao condutor através de mensagens de texto.

O OCC está também equipado com monitores de câmaras de vigilância, a fim de monitorar constantemente a situação nas instalações da estação.

3. Estado da ferrovia Matola Gare

Estação de Maputo (1)

Plataforma

Passageiros durante as Horas de Ponta de Manhã

A estação tem três plataformas de piso baixo, todas elas são plataformas abertas. Apenas uma plataforma no meio tem telhado.

As plataformas e a entrada/saída da estação estão ao mesmo nível, pelo que não são necessárias escadas.

3. Estado da ferrovia Matola Gare

Estação de Maputo (2)

Algumas carruagens param fora da plataforma

Degraus temporários e rampa para comboios DMU

A plataforma é demasiado curta para o comboio. Três das suas carruagens ferroviárias param atrás, fora da plataforma. Os passageiros destas carruagens podem descer directamente nos carris ou caminhar para a frente do comboio para descer na plataforma. Estão a ser construídas novas plataformas na zona norte da plataforma existente.

Degraus provisórios são estabelecidos na plataforma onde os comboios Metrobus DMU chegam e partem para reduzir a diferença de nível entre o piso da carruagem e a plataforma.

3. Estado da ferrovia Matola Gare

❑ Estação de Malanga

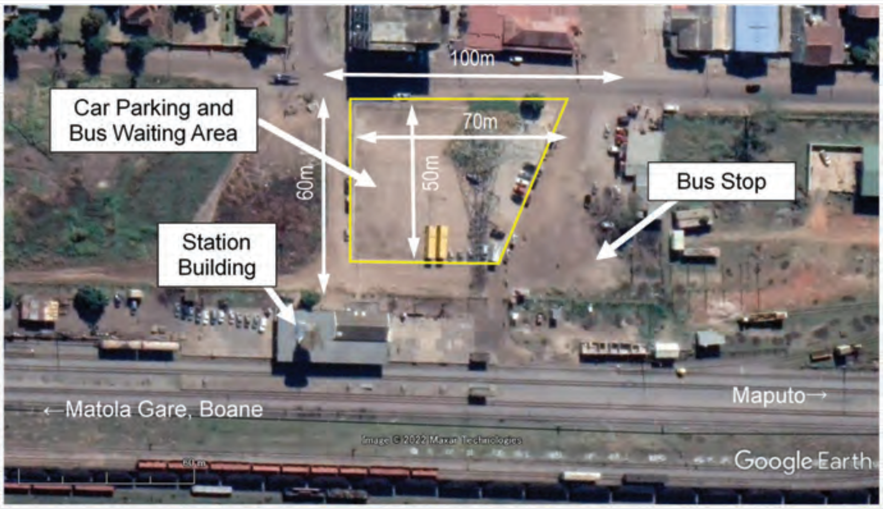
Edifício da Estação

Plataforma de Piso Elevado
(Em Construção)

A construção de plataformas de piso elevado iniciou-se em Abril de 2022.

3. Estado da ferrovia Matola Gare

❑ Estação da Machava (1)



Na praça da estação, são providenciados pelo Metrobus um parque de estacionamento e a área de espera para autocarros.

Os autocarros partem em sequência, acompanhando as ligações com os comboios de Metrobus.

3. Estado da ferrovia Matola Gare

❑ Estação da Machava (2)

Transferência de Passageiros do Comboio de Metrobus para um Autocarro

Entrada para o Estacionamento

O bilhete de autocarro está integrado com os cartões de comboio e de embarque. Assim, só é possível ler o cartão ao entrar no autocarro.

É instalado um leitor de cartões na entrada e saída do parque de estacionamento. O portão abre-se após a leitura do cartão de comboio. Da mesma forma, não parece ser possível utilizar apenas o parque de estacionamento.

3. Estado da ferrovia Matola Gare

❑ Estação da Matola Gare (1)

Edifício da Estação

Degraus e rampa temporários para comboios DMU

Esta estação não tem plataformas, apenas degraus temporários para os comboios DMU.
Não há iluminação nas instalações, incluindo nas proximidades dos degraus temporários.

3. Estado da ferrovia Matola Gare

❑ Estação da Matola Gare (2)

Praça da Estação

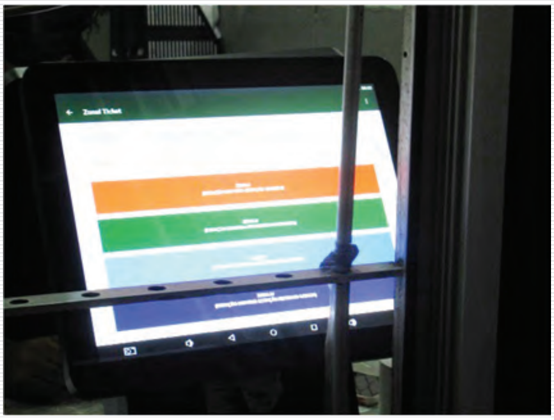
Vedação de Entrada da Estação

A Praça da Estação não é pavimentada, e os autocarros do Metrobus entram directamente na praça da estação.

São instaladas vedações no perímetro da Praça da Estação.

3. Estado da ferrovia Matola Gare

❑ Sistema de Cobrança de Tarifas (CFM)



Máquina estacionária de venda automática de bilhetes

Máquina portátil de venda automática de bilhetes

Os passageiros compram os bilhetes na bilheteira da estação ou a um membro da tripulação com uma máquina portátil de venda de bilhetes. A máquina portátil de venda automática de bilhetes pode emitir não só bilhetes mas também cartões pré-pagos (registo de bilhete de identidade, etc.).

3. Estado de Outras Ferrovias

Estação de Boane e Estação de Marracuene

Estação de Boane

Estação de Marracuene

Boane	O edifício da estação está a envelhecer, requerendo reconstrução ou renovação urgente. Os minibuses de Maputo para Boane são mais baratos e demoram menos tempo. Por conseguinte, o transporte ferroviário tem poucos utilizadores
Marracuene	Os comboios não circulam durante as horas convenientes para os deslocamentos diários, e os autocarros para o centro de Maputo levam menos tempo e são mais baratos, pelo que há poucos utilizadores do comboio. Não há iluminação nas instalações, e há questões de gestão da segurança.

5. Políticas básicas para a melhoria

- <u>Aumentar a Capacidade de Transporte</u>

  Aumentar o número de comboios de manhã e à noite, e aumentar a capacidade de transporte dos serviços ferroviários durante o dia de acordo com a procura de deslocações para o trabalho e para a escola

- <u>Melhoria do Conforto e da Segurança de Viagem</u>

  Melhorar o conforto de viagem, aumentar a fiabilidade das operações ferroviárias, e aumentar a segurança para os utilizadores dos caminhos-de-ferro e das estradas nas passagens de nível

- <u>Melhoria das Facilidades de Trânsito entre os Caminhos-de-Ferro e Outros Modos de Transporte (BRT)</u>

  Melhorar as instalações de trânsito entre os caminhos-de-ferro e outros modos (como o BRT) nas estações onde o Metrobus liga os caminhos-de-ferro e os autocarros.

- <u>Melhoria do Serviço ao Passageiro.</u>

6. Plano de melhoria da linha férrea da Matola Gare

Área	Plano de melhoria
Ferrovia	• Melhoria da Passagem de Nível • Melhoria da tecnologia de manutenção da ferrovia e do ambiente de trabalho, fornecendo equipamento para a melhoria do conforto de viagem
Sinalização	• Instalação de Barreiras de Passagem de Nível
Material Circulante	• Utilização de material circulante existente
Estação	• Mínima renovação do edifício da estação existente, construção de plataforma • Manutenção de parques de estacionamento, manutenção de pavimentos • Desenvolvimento de nós como a Estação de Maputo (autocarros)
Praça da Estação	• Desenvolvimento e pavimentação do Estacionamento • Desenvolvimento de nós como a Estação de Maputo (autocarros)
Sistema de Cobrança de Tarifas	• Introdução de cobrança de tarifas com cartões IC. • Observação: Devido à baixa penetração de telemóveis, a introdução de pagamentos móveis é precoce.

7. Desafios e Condições para o Plano de Melhoria(1)

❑ <u>Aumentar a Capacidade de Transporte</u>

➢ Há escassez de material circulante, sendo assim, é difícil aumentar a capacidade de transporte com o material circulante existente

➢ Em caso de introdução de material circulante em segunda mão proveniente do Japão, é necessário rever o seguinte:

- Diferenças em bitolas de construção e bitolas de material circulante entre Moçambique e Japão
- O acoplamento e a circulação com locomotivas de segunda mão e material circulante existente (renovação do acoplador, sistema de travagem, etc.)
- Manutenção com equipamentos e sistemas de inspecção existentes.

7. Desafios e Condições para o Plano de Melhoria(2)

❑ Melhoria do Conforto e da Segurança de Viagem

- **Melhoria do Conforto de Viagem**

⇒ Embora o estado dos carris não seja bom, o equipamento de manutenção dos carris é substancial

- **Melhoria da segurança do tráfego ferroviário e rodoviário nas passagens de nível**

⇒ Foram instalados alarmes, mas ainda não foram instaladas barreiras

Os painéis de passagem de nível estão em mau estado e precisam de reparação.

7. Desafios e Condições para o Plano de Melhoria(3)

❑ Melhoria da interacção com outros modos de transporte (BRT)

⇒ A Metrobus já introduziu autocarros de ligação, incluindo *park-and-ride*, de acordo com os horários dos comboios.

❑ Melhoria do Serviço ao Passageiro

⇒ A introdução de pagamento de bilhetes sem numerário está a avançar

E a campanha de promoção das Viagens está em curso.

⇒ A construção de plataformas de piso elevado e a instalação de câmaras de vigilância nas instalações da estação estão a avançar

⇒ É necessário montar iluminação nas instalações da estação para garantir a segurança dos passageiros que entram e saem à noite.

8. Conclusões

- No que diz respeito ao transporte de passageiros em Maputo e cidades próximas, existe o risco de o congestionamento do trânsito nas estradas, especialmente nas estradas principais se agravar à medida que a população cresce e a posse de automóveis aumenta. Uma vez que o caminho-de-ferro é a principal solução para satisfazer a forte procura de transporte pendular, será necessária a melhoria das instalações ferroviárias
- A praça da estação, que é o ponto de transição entre os caminhos-de-ferro e os autocarros, será uma instalação importante no contexto da futura cooperação técnica em matéria de autocarros. Também do ponto de vista da acessibilidade, serão tomadas medidas para melhorar a facilidade de utilização para os passageiros.

Japan International Cooperation Agency (JICA)

Data Collection Survey on Improvement of Urban Transport Utilizing Conventional Railways in African Countries

Lusaka (Zambia)

October 2022

Japan International Consultants for Transportation Co., Ltd. (JIC)

Oriental Consultants Global Co., Ltd. (OCG)

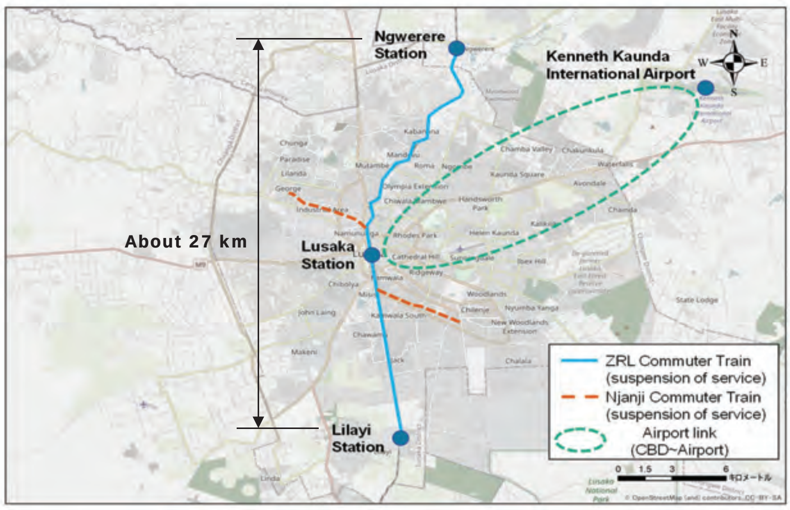
Nippon Koei Co., Ltd. (NK)

Table of Contents

1. Objective

- The objective of the study is to investigate the status of the existing railways in terms of understanding the possibility of improving the existing railways as part of the urban transportation improvements

2. Selections of Target Routes



Route	Remark	MTC/ZRL's Priority	Reason	Conclusion of the Study Team
ZRL (Ngwerere~Lilayi)	approx.27km Suspension of service (Infrastructure is in use by freight service and Intercity passenger service)	◎	･Compared to other routes, there is a possibility of grant aid ･The track need to be rehabilitated ･Ease congestion on Cairo Rd and Kafue Rd	◎
Njanji Commuter Train	approx.16km Suspension of service	○	･The track has been removed ･Residents occupy railroad property and must be resettled	○
Airport Link (CBD~Airport)	Extension unknown (approx.22km)	○	･New construction is necessary	△

3. Current Status of ZRL(Track)

Technical Specifications

Type	Technical Specifications
Gauge	1,067mm
Track Type	Ballast Track
Rail	40 kg、45 kg
Sleeper	PC sleepers, partially mixed with steel ties
Fastening device	Pandorol

Status of the Track


Disrupted Electrical Switch


Rail Wear Points


Roadbed Conditions


Track Conditions and Pedestrians

- Since the condition of the track across the entire target section is poor such as shortage of ballast and wear of rails, freight service and inter-city service operate at the maximum speed of 15 km/h
- Some facilities are not available due to vandalism
- The track is used as a living road for local residents, and there are many places where the land in the railway track is illegally occupied

3. Current Status of ZRL(Track)

Track Maintenance Equipment


Multitier Tamper


Ballast Transport Motor Car


Motor Car


Maintenance Equipment Warehouse at Lusaka Station

- ZRL introduced two multi-tampers in 2015
- Most of the sections are short of ballast, and maintenance work is carried out on those sections by hand
- The maintenance warehouse at Lusaka Station is not equipped with equipment such as titanium tampers, and it is assumed that there is a shortage of many maintenance equipment.

Maintenance and Control System

- A track maintenance team near Lusaka is in charge of the Lilayi to Karubwe section, with one track supervisor and one permanent inspector based at Lusaka station
- Cooperatives were organized in communities along the railroad, and track patrols are conducted daily.

3. Current Status of ZRL（Signaling System）

☐ Technical Specifications

Type	Technical Specification
Signal	Not installed
Switch	Point lever with counter-weight type or electric point machine
Block system	Staff & ticket block system
The Operation management method	Centralized dispatch system
Train detection equipment	Not installed
Level crossing warning equipment	Not installed, only road sign post

☐ Current Status of level Crossing

・In the past, level crossing warning lights and bells had been installed. Due to the influence of vandalism, the ZRL removed all alarm devices.

・Only road sign posts are installed, however, those are not installed at some level crossings

・Since the road traffic side, vehicles and passersby have no duty to stop at level crossings, the train decelerates just before the level crossing

・Some railroad crossings have cracks on the railway crossings, which are bottlenecks to road traffic

Road Sign Post near Chisango Road

Level Crossing near Makishi Road

3. Current Status of ZRL（Signaling System）

☐ Operation Control Center（OCC）

Operation Command Room

Train GPS Information

Train Operation System

Electrical Signal System Not in Use

・The Zambian Railway Operation Control Center is located in Kabwe and manages the operation of the entire Zambian Railway line

・Until the 1990s, the train operation management system produced by Siemens had been operated in combination with the electrical signal system

・ The train dispatch system is a procedure that a dispatcher in the OCC commands a train driver by telephone, and a driver fills in its acknowledgment in compliance with the command from a dispatcher in the form. These procedures are time consuming.

・The block sections of the target routes are located at the section between Ngwerere and Lusaka and between Lusaka and Lilayi. Only a train is allowed to enter in each of two sections in the above-mentioned.

・There exist pass-by facilities at the boundary stations, Ngwerere, Lusaka, and Lilayi, of block sections

3. Current Status of ZRL (Rolling Stock)

Rolling Stock, Yard, and Inspection Facilities


Passenger Cars Formerly Used for Commuter Service


Inside the Passenger Coach


Heavy Inspection Equipment for Locomotive


Spare Parts

- 54 passenger coaches are owned, of which about 25 are operable
- The coaches formerly used for commuter service had a capacity of 88 passengers and are currently used in economy class on intercity service
- There are 25 locomotives, however, there are a number of failed and not in operation. Parts have been in short supply for several years, and although there is a maintenance budget, it is not generating enough revenue to provide the necessary budget.
- The depot is located at Kabwe. The simple maintenance equipment of the locomotive is located in Kitwe, Ndola, Kabwe, and Livingstone, while the heavy inspection equipment for overhauling the locomotive is located in Kabwe
- Locomotive refueling facilities are located at Kitwe, Ndola, Kabwe, Kafue, and Livingstone, with no refueling facilities at Lusaka station.

3. Current Status of ZRL (Station Facilities)

Station Facilities


Lusaka station crowded with passengers getting off the train


The Platform Dedicated to Commuter Service


Crossing Train (Lilayi Station)


Mazyopa Station

Stops at the Time of Commuter Service Operation

- The three stations of Ngwerere, Lusaka, and Lilayi still function as inter-city service boarding and disembarking
- When the commuter railway was in operation, there were intermediate stations
- No station facilities exist at Ngwerere Station and Lilayi Station
- Lusaka station had a dedicated platform and station building for commuter service

3. Current Status of ZRL（Station Facilities）

□ Station Plaza

Lusaka Station


Lusaka Station Front Parking Lot


Lusaka Station Plaza


Access to Lusaka Station


Open Space of Zambia Railway in front of Lusaka Station

- Lusaka Station is paved in the station plaza and parking lots are also maintained
- Lusaka City has a bus network with minibuses, but there is no connection between the station and the minibuses.
- In front of Lusaka Station is a vast open space owned by Zambia Railway
- The land of Zambia Railway is 50m left and right (100 m in total) from Zambia Railway, but many of the premises are illegally occupied

3. Current Status of ZRL（Station Plaza）

Ngwerere Station


Ngwerere Station


Access Road to Ngwerere Station


Market around Ngwerere Station

- The station plaza in Ngwerere Station is not in place, and access roads from the main road to the station are not currently in place

Lilayi Station


Lilayi Station


The Center of Lilayi where the Minibus Arrives and Departs


Access to Lilayi Station


Residence Built on the Zambia Railway Site near Lilayi Station

- The station plaza in Lilayi Station is not in place, and the access road from the main road to the station is not currently in place

- The premises of the Zambia Railway to the east of Lilayi Station are lined with houses that have been illegally constructed

3. Current Status of ZRL(Passenger Service)

Passenger Service


Passenger Tickets


Transit Sales Terminals


Portable Terminals for Ticket Sales


Ticket Sales Counter

- In the current inter-city service by Zambia Railway, trains are booked by telephone and tickets are purchased at the station counter. Cash and credit cards are available for payments
- There are two conductors who own portable terminals for ticket sales on inter-city service, and passengers who ride at stations without station facilities purchase tickets using these terminals
- Zambia Railway hopes to introduce a system that allows people to book trains and purchase tickets on the Internet

3. Current Status of ZRL(Passenger Service)

Conditions at the Time of Commuter Service Operation

- Between May 2015 and September 2016, the Zambian Railway operated commuter service between Ngwerere and Lilayi
- Commuter service started in response to requests for such service due to worsening road congestion in Lusaka
- Commuter service is operated by one locomotive and three passenger coaches, with a total of three round trips/day from Ngwerere to Lusaka, and two round trips/day from Lusaka to Liayi, mainly in the morning and evening
- The fare was set at about 79 yen for Ngwerere-Lusaka and 63 yen for Lusaka-Lilayi.*[1]
- Commuter service was in constant use, with more than 50,000 people using it in the busiest months.
- According to the interview with Zambia Railway, the main reasons for the suspension of commuter service were as follows
  - There are no rolling stock such as diesel multiple unit suitable for commuter service
  - No locomotives exclusively used for commuter service
  - No locomotives or passenger cars to increase during peak hours
  - No station facilities (waiting rooms, toilets, etc.) for passengers

*[1] 1USD = 7.67 ZMW (Zambian Central Bank's exchange rate in July 2015) converted using 1 USD = 121 yen (Bank of Japan's base exchange rate in July 2015)

4. Basic Policy for Improvement

Operation Status and Improvement Plan for ZRL

- The current status of infrastructure facilities such as railway tracks and signals on Zambia Railway is not properly maintained and managed, which interferes with the safe operation of trains
- As freight transportation revenues account for approximately 90% (2020) of Zambia Railway revenues, ensuring the safe operation of freight transportation, which is the main source of revenues, is a top priority
- With the support of the Team Sweden Consortium, a project on track, signal and rolling stock of the Zambian Railway is underway, and these projects are currently in the data collecting stage

→Given that JICA's grant aid project in Zambia is difficult to formulate as soon as possible, it is desirable to consider the development of infrastructure for commuter service when the ongoing project for improvement of Zambia's railway system is completed.

4. Basic Policy for Improvement

Current Situation of Urban Traffic in Lusaka

- In Lusaka's CBD, traffic congestion occurs routinely during morning and evening peaks and lunch hours
- The number of automobiles owned in Zambia has been increasing year by year, reaching approximately 820,000 in 2019
- It is expected that traffic congestion in urban areas will deteriorate further due to future economic development. However, as shown in the results of the Travel Speed Survey conducted by JICA in the "Collection and Confirmation Survey on Urban Development and Urban Transportation in Lusaka City", the number of places where the travel speed is decreasing during the morning and evening peaks is limited.

→ The traffic congestion situation in Lusaka is not so serious as to make the introduction of track transportation system essential. However, as traffic congestion occurs near the CBD at peak, it is necessary to continue to conduct surveys and studies with an eye to the introduction of track transportation system

4. Basic Policy for Improvement

The resumption of commuter service by Zambia Railway is not an urgent measure because of the operation status and improvement plan of Zambia Railway as well as the present situation of urban transportation in Lusaka City. It is desirable that the resumption of commuter service should be considered in a medium-to long-term span, taking into account the progress of the ongoing project in Zambia Railway and the present situation of urban transportation in Lusaka City.

5. Conclusion

In 2009, JICA formulated Comprehensive Urban Development Plan for the City of Lusaka. However, more than 10 years have passed since the urban development plan was formulated, and the urban situation is constantly changing. Therefore, JICA is focusing its efforts on surveys for the formulation of a new comprehensive development plan and road development projects to alleviate traffic congestion in Lusaka. On the other hand, traffic congestion is occurring around the main roads of Lusaka CBD during peak hours. Therefore, the introduction of new public transport means such as railway transport is essential.

In light of these circumstances, it is necessary to select candidate routes for development and conduct surveys related to the demand forecast of candidate routes for the introduction of track transportation system.

Agence japonaise de coopération internationale (JICA)

Etude de collecte de données relatives à l'amélioration des transports urbains en Afrique par le chemin de fer existant

Dakar (Sénégal)

Octobre 2022

Japan International Consultants for Transportation Co., Ltd. (JIC)

Oriental Consultants Global Co., Ltd. (OCG)

Nippon Koei Co., Ltd. (NK)

Table of Contents

1. Présentation de l'étude

Objectifs

- Suite à une requête faite par l'APIX, le gouvernement du Japon a mené la présente étude dans le but d'examiner la faisabilité de la mise en place d'une voie ferrée pour le transport de marchandises (ligne de fret ferroviaire) jusqu'au môle 3 actuellement en cours de réhabilitation avec l'aide du Japon.
- D'autre part, l'étude visait également à savoir où en était le projet de réhabilitation de l'axe Dakar-Bamako (Mali), axe majeur au Sénégal, et à examiner la possibilité d'une aide de la part du Japon.

Extension vers le môle 3

Axe Dakar-Bamako (Mali)

1. Présentation de l'étude

Eléments d'étude

(1) Projet d'extension de la ligne de fret jusqu'au môle 3
- Etude sur l'état actuel des installations existantes (équipements de manutention des marchandises, état des voies ferrées, alentours des voies ferrées)
- Etude des projets d'amélioration existants (plan directeur du SETEC)
- Examen des besoins et identification des problématiques
- Formulation d'orientations d'amélioration

(2) Projet de réhabilitation de l'axe Dakar-Bamako (Mali)
- Etude sur l'état actuel des installations existantes (voies ferrées, système de signalisation, matériel roulant, gares)
- Etude des installations et systèmes de maintenance
- Etude des projets d'amélioration existants (Plan directeur de la Banque mondiale)
- Examen des besoins et identification des problématiques
- Identification des plans d'amélioration entrepris par d'autres institutions et suivi de leur état d'avancement
- Collecte d'informations sur le transport ferroviaire de passagers intra et interurbain
- Formulation d'orientations d'amélioration
- Effets attendus

2. Projet d'extension de la ligne de fret jusqu'au môle 3

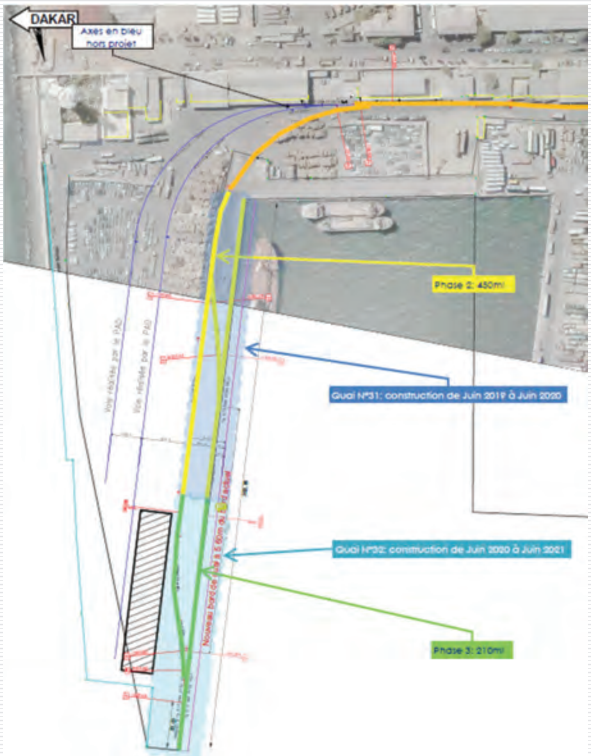


Illustration du câblage au môle 3.

Résultats de l'étude

Il n'est pas encore temps d'entreprendre l'extension de la ligne de fret jusqu'au môle 3 avec l'aide du Japon au vu des conditions de trafic local ainsi qu'en termes d'impact du projet.

Principales raisons

Conditions de circulation devant la gare de Dakar

- Le volume important de camions et autres véhicules autour de la gare de Dakar même pendant la nuit risque d'aggraver la congestion routière.

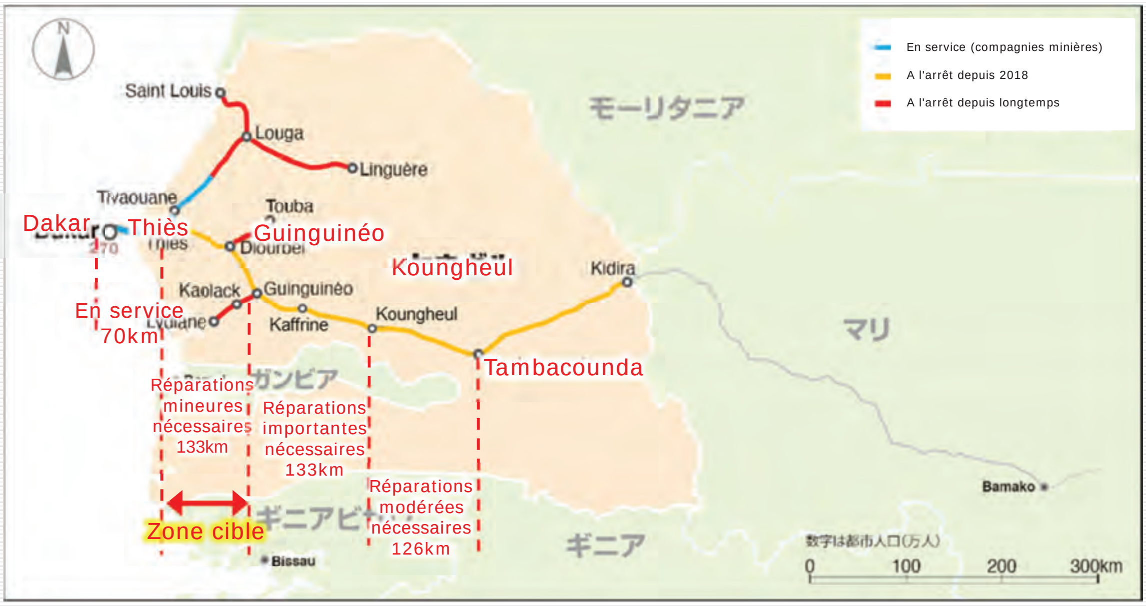
Rentabilité du projet

- La voie ferrée desservant l'intérieur du pays et reliant le Mali n'étant pas en service, même si une voie ferrée portuaire est aménagée, le transport vers l'intérieur du Sénégal ne sera pas possible.
- Si un croisement à niveaux différents est aménagé face à la gare de Dakar, les coûts de travaux de construction seront élevés, et il sera également nécessaire de prendre en considération le plan général de développement de la zone autour de la gare de Dakar.

3. Projet de réhabilitation de l'axe Dakar-Bamako (Mali)

Résultats de l'étude

Le Japon pourrait apporter son aide au Sénégal pour la rénovation de son vaste réseau ferroviaire en réhabilitant les équipements de certaines sections et en fournissant un savoir-faire en matière de maintenance et de gestion.



・・・L'aménagement minimal requis entre Thiès et Guinguinéo où les dégradations soient réduites, semble faisable dans le cadre de l'aide financière non remboursable.

3. Projet de réhabilitation de l'axe Dakar-Bamako (Mali)

■Principales raisons

Les avantages sociaux du transport ferroviaire sont très élevés, contrairement au transport par camion, qui est souvent problématique et se trouve à la limite de sa capacité de transport.

- Les marchandises importées et exportées du Mali sont principalement traitées au port de Dakar et au port d'Abidjan en Côte d'Ivoire, dont le port de Dakar représente 4,37 millions de tonnes, soit 68.8% (données en 2013)
- Les trains de marchandises entre Dakar et Bamako présentent depuis longtemps des problèmes notamment de lenteur et d'horaires difficilement prévisibles, et depuis 2018 l'ensemble de la ligne n'est plus en service en raison d'une pénurie de pièces de locomotives.
- Les routes principales du Sénégal sont relativement bien entretenues, mais la détérioration de la chaussée due à l'augmentation du volume de transport de marchandises lourdes et les accidents fréquents constituent un problème.

Camions roulant vers le Mali


Accidents causés par un mauvais entretien des camions


Revêtement de la chaussée dégradé

4. Orientations d'amélioration

■ Réhabilitation entre Thiès-Guinguinéo : reprise du service des trains de fret

■ Aide financière non remboursable :

- Réhabilitation des voies ferrées et travaux de génie civil (Thiès à Guinguinéo)
- Réhabilitation des voies ferrées au port de Dakar (raccordement avec la gare de triage de Bel-Air, le môle 7 et le môle 8)
- Mise en place d'un terminal à conteneurs (Guinguinéo)
- Introduction de machines de manutention de marchandises (fabricants japonais envisageables)

■ Projet de coopération technique

- Gestion et maintenance des voies ferrées
- Formation des ressources humaines

5. Effets attendus

Effets	Explications
Effets sur les utilisateurs des services	Les effets sur les usagers du fret ferroviaire (utilisateurs de services) après la remise en service de la ligne Dakar-Guinguinéo seront directement liés à l'amélioration des services pour les usagers des services de transport, telle que la réduction des temps de trajet, la réduction des embouteillages et la réduction des coûts de transport.
Effets sur les prestataires de services (opérateurs ferroviaires)	Les effets sur les opérateurs ferroviaires, en l'occurrence les Chemins de Fer du Sénégal (CFS), devraient comprendre une augmentation des volumes de transport et une augmentation des recettes et des coûts de transport.
Effets sur la société dans son ensemble	Le projet ferroviaire devrait apporter des avantages non seulement sur les utilisateurs et les prestataires de services, comme précisé dans les points ci-dessus, mais également à la société dans son ensemble. Plus précisément, les effets peuvent être subdivisés en cinq domaines présentés dans le Tableau de la dispositive suivante.

5. Effets attendus

Eléments d'évaluation sur les effets sur l'ensemble de la société	Détails
Vie des populations	Atténuation de la congestion du trafic par la réduction du trafic routier notamment celle des camions, l'augmentation du revenu disponible grâce à l'élargissement des variétés et des quantités de produits quotidiens disponibles et à l'abaissement des prix de détail, etc.
Economie locale	Croissance de l'économie nationale grâce à l'augmentation de la capacité portuaire ; augmentation de la productivité régionale grâce à l'amélioration et à l'expansion de l'efficacité et des volumes de transport de marchandises ; augmentation des possibilités d'implantation d'entreprises et du développement de leur taille ; réduction des coûts d'entretien des routes en réduisant le nombre de poids lourds en circulation, etc.
Communautés locales	Réapparition des villes le long de la ligne ferroviaire qui s'étaient développées jusqu'à nos jours grâce au chemin de fer, réduction des difficultés vis-à-vis de l'exploitation future des trains de passagers longue distance, etc.
Environnement	Réduction des émissions de CO_2, modification du volume des émissions de polluants atmosphériques tels que les oxydes d'azote et les particules en suspension sur les routes le long de l'itinéraire, etc., résultant de la diminution du trafic de véhicules liée à un passage du transport de marchandises par camion au transport ferroviaire ou à une maîtrise du nombre de nouveaux camions circulant sur routes.
Sécurité	Réduction des accidents de la circulation résultant de la diminution du trafic de véhicules liée au passage du transport de marchandises par camion au transport ferroviaire, réduction des opérations de chargement et déchargement dangereuses grâce à la mécanisation de la manutention des marchandises, etc.