Chapter 5: Status of Urban Transport in the City of Kigali

5.1 Road Network and Infrastructure

5.1.1 Road Network

Kigali has a major radial road network. The major radial roads are RN1, RN3, RN4, and RN5.

Kigali is connected to Butare (Burundi) by RN1, Byumba (Uganda) and Rwamagana (Tanzania) by RN3, Ruhengeri (DRC) by RN4, and Bugesera (Burundi) by RN5.

The major road network is shown in the map below.

Table 5.1.1: Major Roads in Kigali and Connected Cities/Areas

Road Class	Road Name	Connected Major Cities	Remarks
National Highways	RN1	Butare (Burundi)	West direction of Kigali
	RN3	Byumba (Uganda)	North direction of Kigali
		Rwamagana (Tanzania)	East direction of Kigali
	RN4	Ruhengeri (DRC)	Northwest direction of Kigali
	RN5	Bugesera (Burundi)	South direction of Kigali

Source: JICA Survey Team

5.1.2 Road Classification

The Rwandan government has published Official Gazette No. 04 of 23/01/2012 to establish the law governing the roads in Rwanda. The road network comprises the following classifications:

(1) National Roads

National roads comprise the following categories:

- International roads that link Rwanda with neighboring countries.
- Roads that link districts or that link a district and Kigali City.
- Roads that link areas of tourist significance and facilities of national or international importance such as ports and airports.

(2) District and Kigali City Roads and Those of Other Urban Areas – Class 1

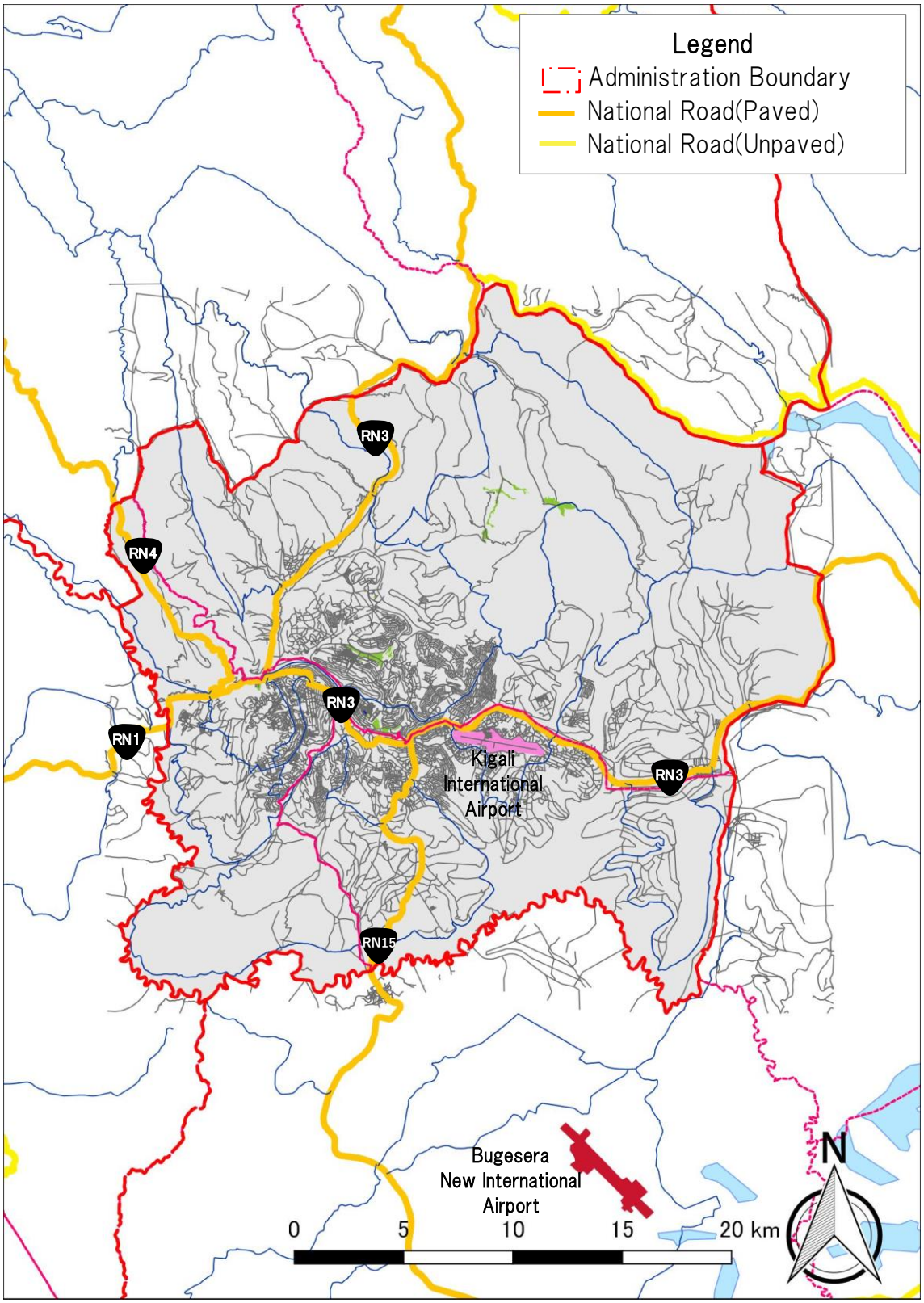
- Class 1 Roads are roads linking different sector's headquarters within the same district, or those roads that are used within the same sector.

(3) District and Kigali City Roads and Those of Other Urban Areas – Class 2

- Class 2 Roads are arterial roads that connect district roads to rural community center.

(4) Specific Roads

- Specific roads are constructed to connect national roads or district roads to Kigali City and other urban areas to the center for private sector's activities such as agricultural production, natural resources processing, or to tourist sites.



Source: JICA Survey Team

Figure 5.1.1: Major Road Network in Kigali

5.1.3 Road Condition

(1) Rwanda

The length of paved national roads increased from 1,205 km in 2010 to 1,355 km in 2016 in Rwanda. On the other hand, the earth roads are decreasing with peak in 2013.

Table 5.1.2: Classification of Roads in Rwanda

Year	2010	2011	2012	2013	2014	2015	2016
National paved road (km)	1,205	1,205	1,224	1,211	1,291	1,279	1,355
National and district earth roads (km)	3,493	3,493	3,474	5,386	5,289	5,298	5,212
District paved road Class 1 (km)				58	75	78	88
Total (km)	4,698	4,698	4,698	6,655	6,655	6,655	6,655

Source: Statistical Year Book 2017, National Institute of Statistics of Rwanda

(2) Kigali City

The current road network in Kigali City consists of 2,851 km of roads, only 16% of which is paved (Asphalt pavement: 418 km, Concrete pavement: 33 km).

Kigali City is well connected to other parts of Rwanda and beyond by a network of national roads. The central business district (CBD) forms the center of a radial network of paved roads, which connect Kigali to the neighboring countries, e.g., the Democratic Republic of Congo (DRC), Burundi, Tanzania, and Uganda.

There are 2,400 km earth roads. These unpaved roads become water-logged during the wet season and dusty during the dry season.

Table 5.1.3: Classification of Roads in Kigali City in 2018

Earth Road	Asphalt Pavement Road	Concrete Pavement Road
2,400 km	428 km	23 km

Source: JICA Survey Team based on Hearing from Kigali City

Source: JICA Survey Team based on Hearing from Kigali City

Figure 5.1.2: Road Condition

5.1.4 Transport Related Data

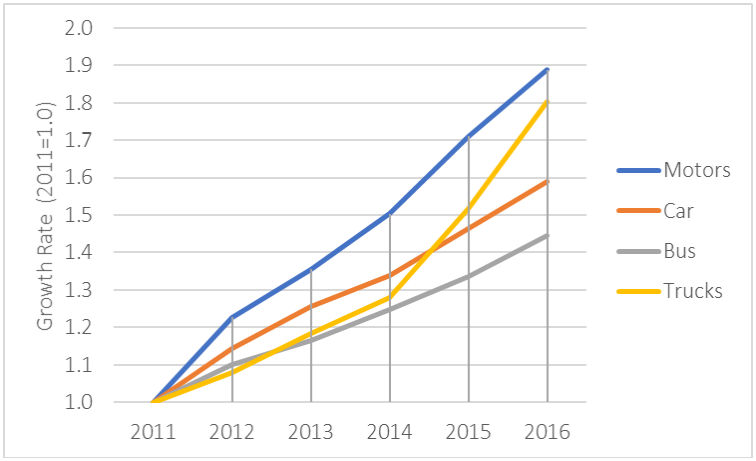
(1) Number of Registered Vehicles

The number of registered vehicles in Rwanda is constantly increasing year by year. In this regard, motorcycle records the biggest growth rate since 2011 while the growth of trucks is also relatively high since 2015, which has led to the amount of goods/cargoes to rapidly increase.

Table 5.1.4: Cumulative Number of Vehicles Registered by Categories

Category	2011	2012	2013	2014	2015	2016
Motorcycle	49,718	60,980	67,382	74,774	85,072	93,866
Car	45,671	52,191	57,358	61,167	66,916	72,617
Bus	5,597	6,164	6,527	6,980	7,473	8,092
Trucks	3,994	4,206	4,726	5,115	6,066	7,201
Others	565	702	831	976	1,366	1,927
Total	105,545	124,343	136,824	149,012	166,893	183,703

Source: Statistical Yearbook 2017, National Institute of Statistics of Rwanda (NISR)



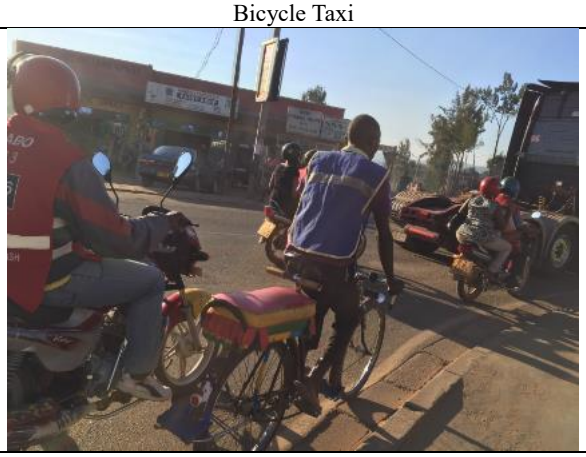
Source: JICA Survey Team

Figure 5.1.3: Growth Rate

5.2 Public Transport

There are public transports in Kigali City, such as bus, taxi, motorcycle taxi, and bicycle taxi, as shown in Table 5.2.1 below.

Table 5.2.1: Public Transports in Kigali City

Bus	Taxi Cab
	
Motorcycle Taxi	**Bicycle Taxi**
	

Source: JICA Survey Team

5.2.1 Public Transport Regulation

The Law No. 09/13 of 01/03/2013 gives Rwanda Utilities Regulatory Authority (RURA) the mandate to regulate transport services, namely, road and inland waterway transport of goods and persons.

Regarding public transport, RURA established the Passengers Road Transport Regulations (RURA, 2015). Under the regulations, each bus and mini bus is obliged to install the “Car Tracker” system in the vehicle. The speed and current location of the bus can be confirmed by the Car Tracker and the speed is monitored not to exceed 60 km/h.

In addition, bus companies which are responsible for the bus services under RURA are directed by RURA to report the bus route and the number of buses every Friday. RURA confirms whether it is sufficient service level.

5.2.2 Bus

(1) Public Transport Zones

Kigali City was divided into four public transport zones as shown in Table 5.2.2 below. Kigali Bus Service (KBS) operates Zone I. Royal Express operates Zone II. And Zone III and Zone IV are operated by Rwanda Federation Transport Cooperatives (RFTC). Three bus companies are awarded with a contract with five years license to operate in their respective zones.

Table 5.2.2: Summary of Four Exclusive Public Transport Zones

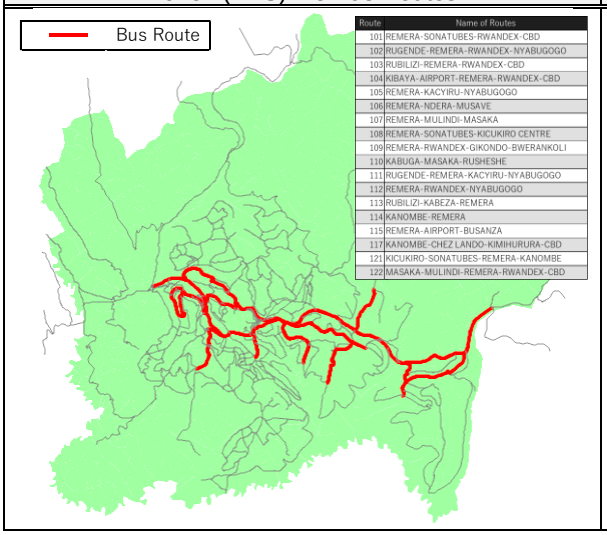
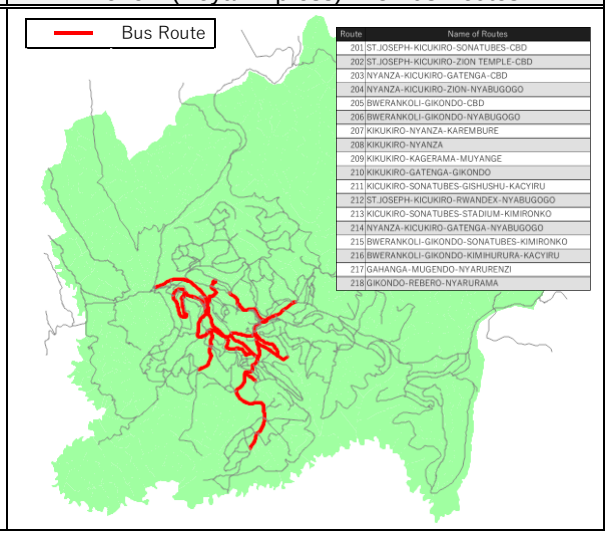
Zone	Company	Coverage Area
Zone I	Kigali Bus Service (KBS)	Remera, Kanombe, Kabeza, Nyarugunga, Rusororo (Kabuga), Masaka, and Ndera Sectors
Zone II	Royal Express	Niboye, Kicukiro (Sonatubes, Centre), Gahanga, Gatenga, Gikondo and Kigarama.
Zone III	Rwanda Federation Transport Cooperatives (RFTC)	Kimironko, Kinyinya (Kagugu & Dutchwelle), Gisozi, Kacyiru, New Gakinjiro, Batsinda, Kibagabaga, Kimihurura, Nyarutarama
Zone IV		Kimisagara, Nyakabanda, Nyamirambo, Mageragere, Kigali, Gatsata, Karuruma, Jabana, Nyacyonga

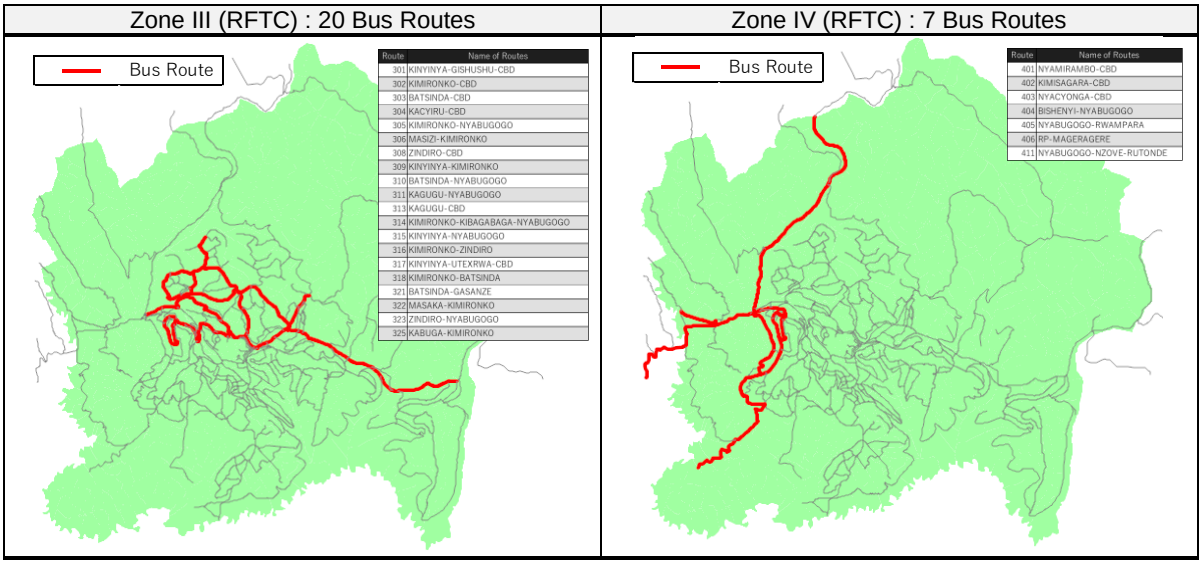
Source: Kigali City

(2) Bus Route

Since the official bus route map has not been established yet, the JICA Survey Team has prepared the bus route by zone as shown in Table 5.2.3 below (18 routes for Zone I, 18 routes for Zone II, 20 routes for Zone III, and 7 routes for Zone IV). There is no time schedule and bus users must wait for a destination bus without any pre-announcement.

Table 5.2.3: Bus Route

Zone I (KBS): 18 Bus Routes	Zone II (Royal Express) : 18 Bus Routes
	



Source: JICA survey team

(3) Bus Company

Table 5.2.4 below shows the general information of each bus company obtained through interview surveys with bus operators. The biggest bus company is RFTC, which owns buses about five times more than the other companies and has an advantage in terms of employees' working environment such as their salary.

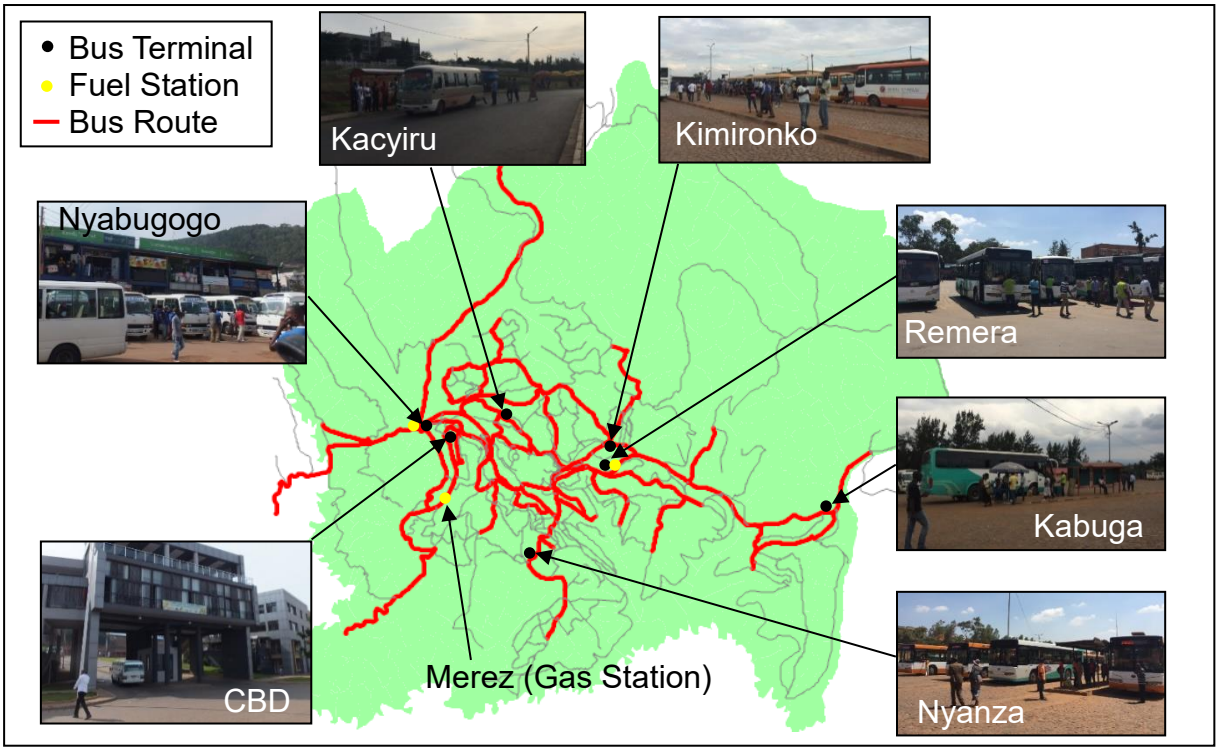
Table 5.2.4: Summary of Bus Company

	KBS	Royal Express	RFTC
Company Formation	KBS is established as bus operation company in 2006.	Royal Express is established as bus operation company in 2006.	RFTC is established in 2013 with 12 cooperatives by driver and bus owners and 4 unions.
Number of Bus Driver	- 121 drivers	No data	- 514 drivers
Number of Bus	- 115 buses (82 buses are working)	No data (big bus: , mini bus:)	- 270 buses (Smart card: 257, Manual: 13)
Bus Driver Working System	- 3 days cycle (2 days work / 1 day off)	No data (days work / days off)	- 4 days cycle (2 days work / 2 days off)
Salary of Bus Driver	- Net: RWF 179,600/month - Gross: RWF 254,000/month	- Coaster: RWF /month - Big bus: RWF /month	- Coaster: RWF 147,000/month - Big bus: RWF 166,000/month - Bonus payment according to target achievement
Bus Operation Time	from 5:30 to 23:00	No data	from 4:30 to 23:00

Source: JICA Survey Team

Figure 5.2.1 below shows the bus terminals and the designated fuel stations. There are seven bus terminals and three designated fuel stations. RFTC (JALI Real Estate Company) is investing in these bus terminals, and currently 80% of Rwanda's bus terminals are owned by RFTC.

Since RFTC is a bus operation company, other business activities are restricted under the Corporate Law. Therefore, RFTC established a holding company called JALI Holdings. JALI Transport Company, JALI Real Estate, and JALI Microfinance are affiliated.



Source: JICA Survey Team

Figure 5.2.1: Main Bus Terminal

(4) E-ticketing System

Bus passengers ride a bus using a smart card (so called “Tap & Go”).

A smart card can be purchased at the bus depot store. The smart card that is pre-charged with RWF 500 is sold at RWF 1,000. When the charge is exhausted, it must be re-charged in order to be used again and recharging store is located at the bus depot. When a passenger gets on the bus, he or she swipes the card on a card reader inside the bus to pay the designated fare.

The smart cards and card reader were developed by AC Group. AC Group, the system vendor, earns 5% commission off the gross revenue collection per bus.

Under the cooperation of Rwanda government and bus company, the smart cards and card reader were developed by AC Group. AC Group is under the umbrella of DMM Group in Japan and is the system vendor. Before, bus operators had to collect cash fee, so it was necessary to hire conductors. However, revenue leakage to the crews was a problem. As a countermeasure, bus operators introduced the automated payment system with smart card. As a result, it is reported that bus owner’s revenues have increased by 50%. AC Group earns 5% commission off the gross revenue collection per bus.

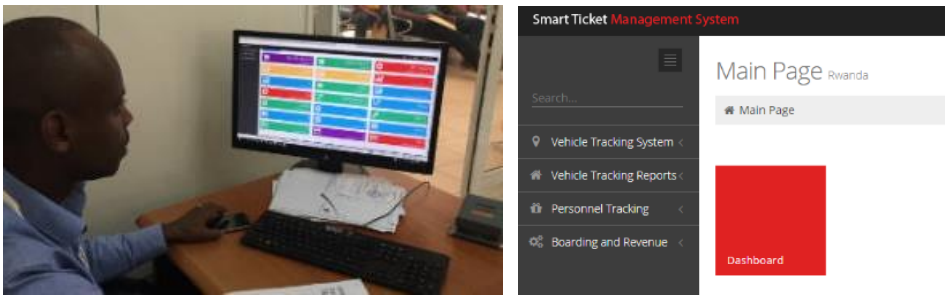
Source: JICA Survey Team

Figure 5.2.2: E-Ticketing System

(5) Smart Ticket Management System

RURA uses Smart Ticket Management System to manage the location information of bus and the number of passengers and amount collected per bus and each bus route. However, the system has not been updated according to the changes of bus routes. Therefore, accurate useful data which reflects the actual bus operation cannot be obtained.

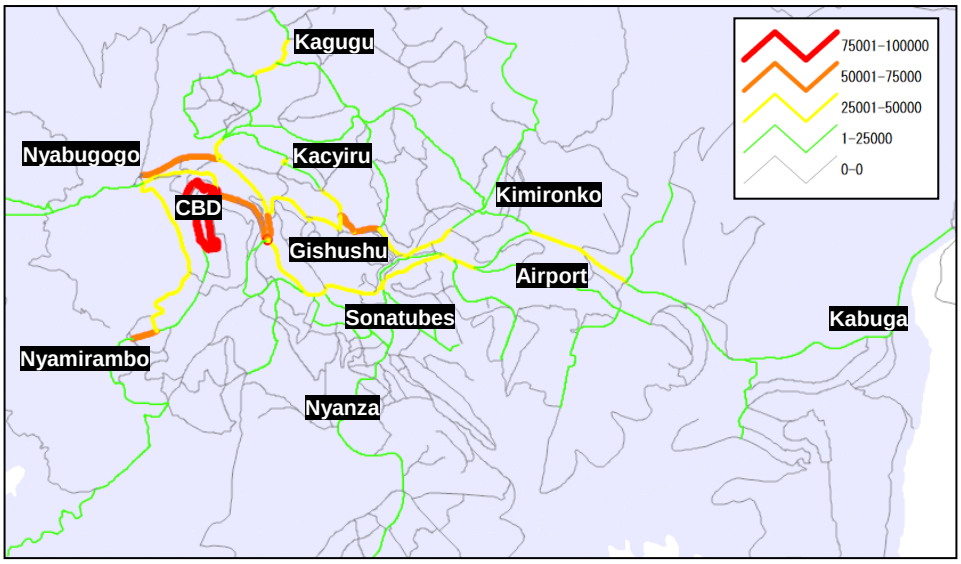
The Smart Ticket Management System is developed by Akilli Bilet in Turkey, and AC Group and Akilli Bilet jointly introduce the system.



Source: JICA Survey Team

Figure 5.2.3: Smart Ticket Management System (RURA Transport)

Figure 5.2.4 shows the results of bus passenger data for each route from the Smart Ticket Management System provided by RURA. The passenger buses mainly transit to the CBD. There are many passenger buses on the road that goes to the CBD, while rural areas are characterized by few passenger buses.



Source: JICA Survey Team

Figure 5.2.4: Number of Daily Bus Passengers (Unit: people/day)

5.2.3 Planned BRT

Currently, a long waiting queue is regularly observed at bus terminals in Kigali City and this is because the supply of bus fleet during peak hours is not sufficient to meet the demand of passengers. A sustainable urban development is therefore necessary as the demand is projected to increase based on the rapid population growth that is expected in the future.

Under such conditions, a bus rapid transit (BRT) system is planned as a solution to attain the sustainable development of Kigali City. There are five main objectives of the BRT plan: (1) improvement of access to public transportation, (2) short travel time, (3) control of air pollution, (4) improvement of amenity and safety, and (5) collection of the population.

(1) BRT Plan

BRT is proposed in Kigali City Master Plan (CoK 2013) and Transportation Master Plan (CoK 2013).

Currently, Kigali City has conducted a feasibility study and submitted the “Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali Second Interim Report ” .

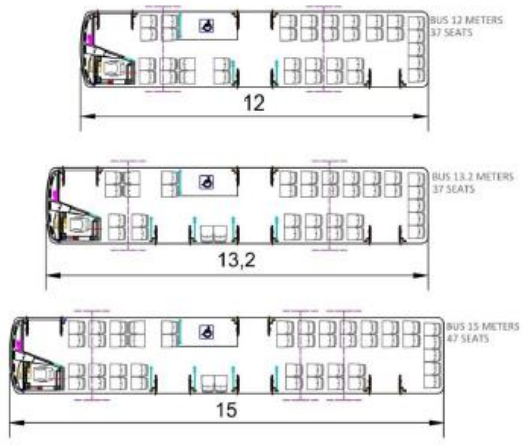
Table 5.2.5: Summary of BRT Plan

Plan	Summary
Kigali City Master Plan (CoK 2013)	- Guidelines on future urban planning based on population forecast until 2040 in Kigali City. - A plan to construct a BRT network of about 97 km is described.
Transportation Master Plan (CoK 2013)	- A plan for transportation consisting of road network, public transportation, and airport until 2040 in Kigali City. - Route plan of BRT is described.
City Development Plan (CoK 2013)	- Development plan from 2013 to 2018 in Kigali City. - Preparation of BRT route of 17 km from 2017 to 2018 is described.
Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali. (CoK 2017～)	- Design concepts, route planning, and coverage and profitability of BRT system were studied.

Source: JICA Survey Team

(2) Design Concept of BRT

An articulated bus is not recommended in the plan since the coupler section will become weak due to steep slope. Introduction of standard bus fleet of 12 m, 13.2 m, and 15 m bus is recommended in the plan.



Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali

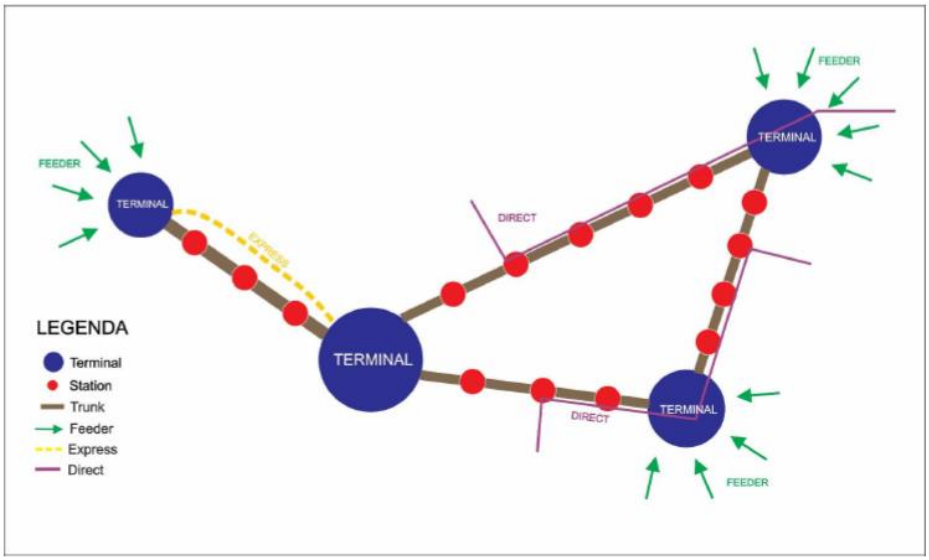
Figure 5.2.5: Recommended Vehicle Standard for BRT

The design concept of BRT route is summarized in Table 5.2.6 below.

Table 5.2.6: Design Concept of BRT Route

Plan	Summary
Trunk services	- Trunk services operate only inside the main corridors preferably with dedicated lanes. These services will operate mainly between main transfer terminals.
Feeder services	- Feeder services collect passengers in the communities and drive them to the transfer terminals or transfer stations. - Operate with smaller buses.
Direct services	- Buses operate inside and outside the main corridors. The intention is to serve routes with high demand without making passengers transfer to other bus. - This minimizes transfer and service.
Express services	- Go directly from one point with high number of origins and go directly to a zone with high number of destinations. - It follows the fastest route and does not necessarily need to be on a dedicated infrastructure.
Local services	- Buses that run on normal traffic on normal streets to give better coverage of the transit system.

Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali (Second Interim Report)



Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali

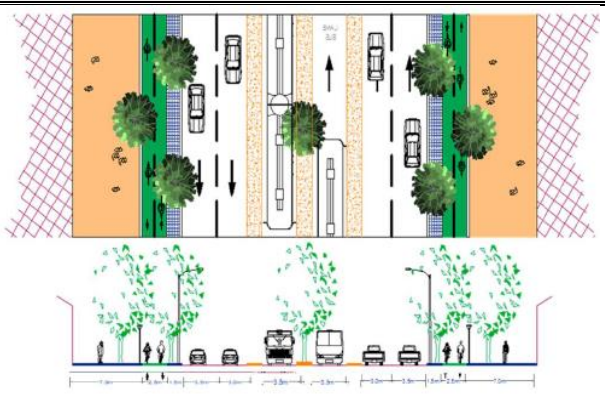
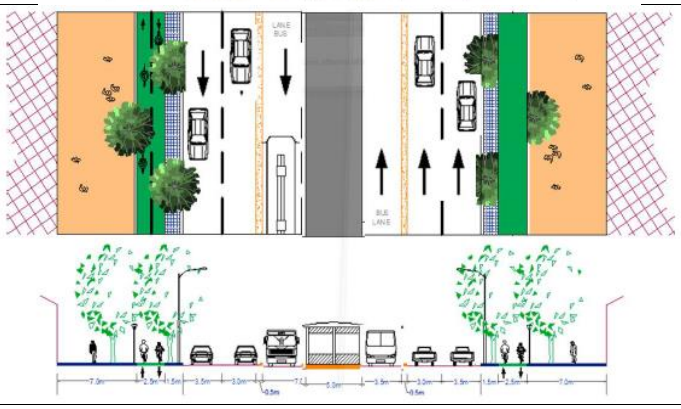
Figure 5.2.6: Design Concept of BRT Route

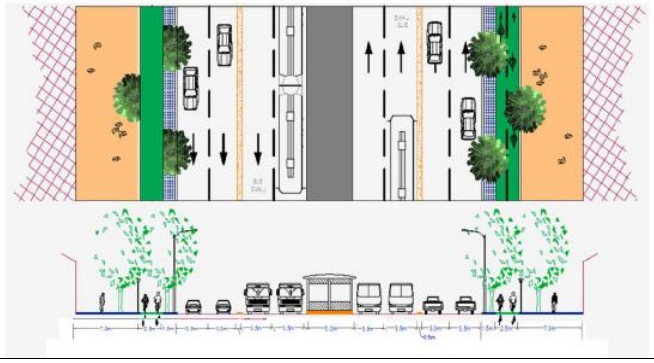
(3) Road Structure of BRT Route

The proposed bus lane of BRT system is median-aligned busway.

In terms of operation, (1) road width of at least 26 m is required, (2) when constructing a station, the required road width will be 31 m, (3) when constructing an overtaking lane at a station, the necessary road width required is 38 m.

Table 5.2.7: Layout of BRT Busway

Types	Cross Sections
(1) Typical cross section without station 26 m = (Bus lane: 3.5 m * 2 = 7 m) + (2 lane: 7 m * 2 = 14 m) + (sidewalk: 2.5 m * 2 = 5 m)	
(2) Typical cross section of median-station with single BRT lane 31 m = (1) + (Station: 5 m)	

(3) Typical cross section of median-station with BRT overtaking lane 38 m = (2) + (Bus lane: 3.5 m × 2 = 7 m)	

Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali (Second Interim Report)

(4) Fare Collection System of BRT

Since the current bus fare is a distance-charged system, the fare collection system of BRT is also proposed to be distance-charged. The proposed fare is designed based on the following formula and this base fare is proposed to be modified depends on the future circumstances.

$$\text{Fare} = (100 + k * \text{distance})$$

Table 5.2.8: Fare Collection System of BRT

Distance (km)	Fare = (100 + k * d)			
	2025 RWF 20/km	2030 RWF 22/km	2040 RWF 26/km	2050 RWF 30/km
5	200	210	230	250
10	300	320	360	400
15	400	430	490	550
20	500	540	620	700
25	600	650	750	850
30	700	760	880	1000

Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali (Second Interim Report)

(5) Service Plan

In order to keep consistency with the development progress of other related infrastructure such as road improvement plans, stage-wise development scenarios of BRT routes have been proposed for 2025, 2030, and 2040.

Table 5.2.9: Scenarios for BRT

Scenarios	Planning BRT Route
(1) Scenario for 2025 The scenario for 2025 does not include the construction of BRT infrastructure for: ・Corridor I - from Station I/10 to Station I/17, ・Corridor I – from KN59 to City Center ・Corridor II – from KN1 Ave to City Center terminal ・Corridor IV - from KN8 to Nyabugogo,	

(2) Scenario for 2030 The scenario for 2030 does not include the construction of BRT infrastructure for: ・Corridor I - from Nyamirambo to KN59, ・Corridor II – Gahanga to Nyanza; ・Corridor III – from Kabagendwa to Station III/26; ・Corridor IV – from Corridor II to Corridor I	
(3) Scenario for 2040 The scenario for 2040 does not include the construction of BRT infrastructure for: ・Corridor I - from Rudashya to Kimironko, ・Corridor III - from Gitaraga to Kabagendwa, ・Corridor III – from Station III/26 to the intersection with Corridor I; ・Corridor IV - from Gitaraga to Nyanza, ・Corridor IV – from KG2 roundabout to KN3 Rd.	

Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali (Second Interim Report)

5.2.4 Other Public Transport

The number of motorcycle taxi is overwhelmingly larger than the number of taxi (Table 5.2.10). Therefore, many motorcycle taxis are seen in town, but taxis are rarely noted in transit.

Table 5.2.10: Registered Fleet in the City of Kigali

Type of vehicle	Registered Fleet
Taxicab	1,152
Motorcycle taxi	12,382

Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit (BRT) System for the City of Kigali (First Interim Report)

1) Taxicab

The number of licensed taxicab companies operating in Rwanda as of September 2017 was 55 companies with 1,257 vehicles (Source: Statistics in Transport Sector as of September 2017, RURA).

The taxi fare is calculated by taxi meter. The base fare charged is RWF1,500 for 1 km distance and thereafter, RWF 500 is added on the fare for every additional 1 km.

Source: JICA Survey Team

Figure 5.2.7: Taxicab and Taxi Meter

2) Motorcycle Taxi

There are 147 authorized motorcycle cooperatives operating in the whole country consisting of 31,050 motorcycles (Source: Statistics in Transport Sector, as of September 2017, RURA).

Each motorcycle taxi has a helmet for a passenger. The fare is usually negotiable and it is always agreed upon between the rider and passenger before departure. In general, a trip inside the city costs between RWF 1,000 and RWF 2,000.

Many motorcycle taxis are parked around the bus stops and terminals waiting for passengers. They function as a feeder transportation system supplementing the bus network.

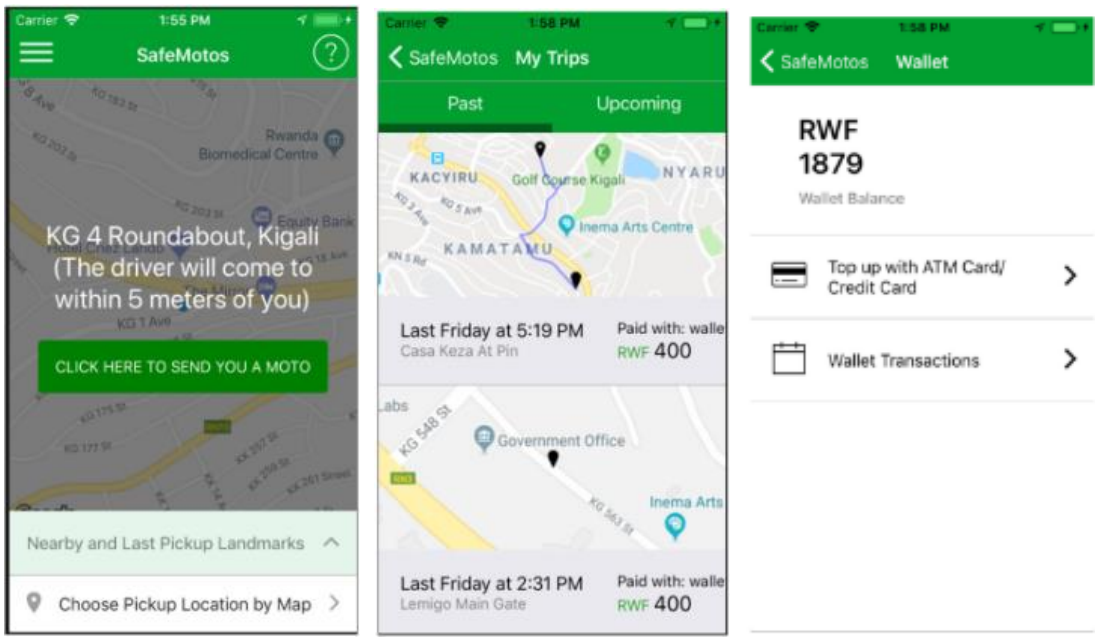
Source: JICA Survey Team

Figure 5.2.8: Motorcycle Taxi

In Rwanda, motorcycle taxi service using SafeMotos, which is a smartphone application, is spreading from 2015.

Using SafeMotos, users are able to get picked up by a motorcycle taxi from any location. SafeMotos users can easily pay fee from their SafeMotos wallet which can be connected to mobile money, cash, and credit cards.

Prices are determined by distance driven. Drivers have sometimes inexpensively responded to negotiations to acquire users, which has led to a decline in revenues. However, the revenue of drivers is increasing by using SafeMotos.



Source: Smartphone application "SafeMotos"

Figure 5.2.9: Screen of Smartphone Application "SafeMotos"

3) Bicycle Taxi

In addition to the above, there is bicycle taxi. Bicycle taxi operator belongs to a bicycle taxi cooperation registered in Rwanda Cooperative Agency (RCA) and is carrying out business.

New bicycle price is RWF 70,000. In some bicycle taxi companies, bicycle usage fee of RWF 700 per day is collected from each driver. Therefore, profit comes out from 100 working days. Driver's earnings on the day is as low as RWF 3,000 but licenses are not necessary, and anyone can do it.

Commercial cycle was outlawed by Rwanda Police in 2012 because it allegedly caused traffic congestion in the city. The ban on bicycle transport in the CoK was lifted by President Paul Kagame in 2014.

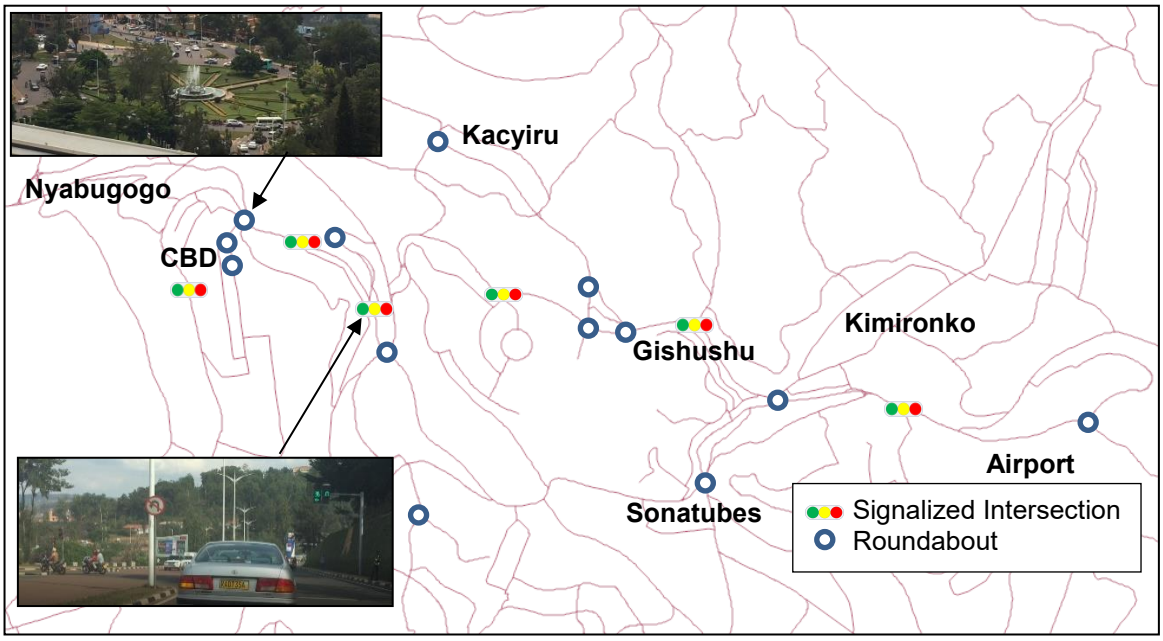
Source: JICA Survey Team

Figure 5.2.10: Bicycle Taxi

5.3 Traffic Management

5.3.1 Existing Traffic Management Systems

Some traffic management systems such as traffic signals and roundabouts can be found in the urban areas. The locations of traffic signals and roundabouts are shown in Figure 5.3.1 below. Currently, most of the intersections in the city have not been signalized yet.



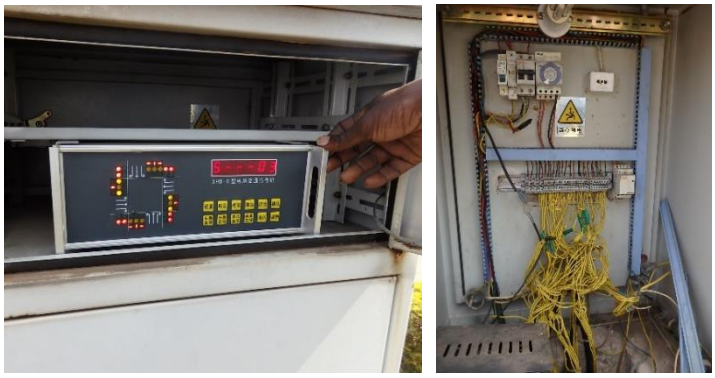
Source: JICA Survey Team

Figure 5.3.1: Locations of Signalized Intersection and Roundabout

(1) Traffic Signal

There are six signalized intersections in the city (Giporoso, Gishushu, Kabean, Sopetrad, Peage, and Gakingiro) which operate on fixed timing. Each is a standalone signal with no communication between each signal. In the nighttime from 10:00 p.m. to 6:00 a.m., the system is switched into a flashing signal. The Rwanda National Police (RNP) usually controls the traffic flow using hand signal at the congested intersections during peak hours.

All of the signal devices such as signal controller, pole, light, and cable are made in China.



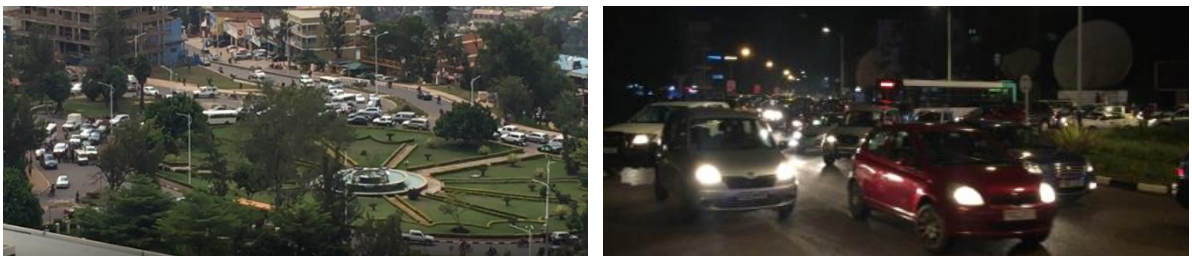
Source: JICA Survey Team

Figure 5.3.2: Signal Controller and Cable

(2) Roundabout

There are 12 roundabouts in Kigali City. The roundabout adjacent to the convention center is partially closed due to security concerns.

Traffic capacity is insufficient during peak hours in some of the roundabouts and it becomes a cause of traffic congestion.



Source: JICA Survey Team

Figure 5.3.3: Traffic Congestion at the Roundabout

(3) Humps

Humps are used to reduce the speed of vehicles around places where many pedestrian crossing is expected (i.e., school, hotel, recreation, etc.).

Since humps are installed even on major arterial corridors and steep slopes, unexpected speed reduction sometimes leads to falling or damage of cargo. These cause traffic congestion and traffic accidents. Considering the future increase of the traffic demand, current hump operation will need to be changed or improved.

Source: JICA Survey Team

Figure 5.3.4: Humps

5.3.2 Traffic Safety

(1) Characteristics of Traffic Accidents

The results of traffic accident related articles in 2017 in Rwanda are shown in Table 5.3.1. The characteristics of traffic accidents in Rwanda are as follows:

- Accident occurrences are high in Kigali City compared with countryside highways. The major cause of accidents is that there are many motorcycle taxis in Kigali City. The traffic accidents by motorcycles account for 60% of total traffic accidents, which is a problem in the urban area.
- Death rates are higher in the countryside than in Kigali. The reason being that there are few crackdowns by police and thus, vehicles move at high speed and in addition, sidewalks are not installed in the countryside. The death of pedestrians by accident accounts for 46% of total death by accidents, and improvement is necessary.
- The number of traffic accidents is decreasing because speed governors are being installed.

Table 5.3.1: Traffic Accident Related Articles

Traffic Accident Related Articles	Source
Percent of Fatalities (Between August and October 2017) - Pedestrians: 46.0% - Motorcyclist: 18.5% - Cyclists: 17.0% - Others: 18.5%	Rwanda National Police News (9 November 2017) https://www.police.gov.rw/news-detail/?tx_ttnews%5Btt_news%5D=10752&cHash=86b3c5ed4c6b5d2833f69da15eb67f9b
- Previous measures such as introduction of speed governors have been instrumental in curbing fatalities to at least 65% in the last eight months, compared with the same period last year	
Total Crashes Registered (Between August and October 2017) - Countryside: at least 76%	
254 Serious Injuries Registered (Between August and October 2017) - Motorcyclist: 28% - Cyclists: 23% - Public Service Vehicle: 23% - Pedestrians: 21%	
Cause of Road Accident (in nine months) - Motorcycles: 60% - Buses: 27% - Articulated lorries: 10% - Trailer trucks: 1% - Others: 2%	Taarifa (12 October 2017) (According to Commissioner of Police) https://taarifa.rw/2017/10/12/rwand-police-rura-to-enforce-gps-installation-in-public-transport-vehicles/
- Accident occurrences are high in Kigali City compared with countryside highways. - However, death rates are higher in rural areas than in Kigali. - Some drivers relax while on countryside routes where they know that there is no Traffic Police.	KT Press (14 November 2017) (According to Chief Inspector of Police) http://ktpress.rw/2017/11/rural-rwanda-more-prone-to-road-accidents-police/
- 369 people died in road accidents and 685 sustained injuries in 2017. - 34% of lives that perished in road accidents were pedestrians, 22% were motorcycle drivers and 14% were bicycle riders. - Road accidents of public transport reduced by 32% compared in 2016, attributing the improvement to road safety measures, mainly the introduction of speed governors in passenger vehicles	Igihe (14 December 2017) (According to Rwanda National Police) http://en.igihe.com/news/road-accidents-claim-369-lives-crimes-drop-by-5.html

Source: JICA Survey Team

(2) Speed Governor and GPS Tracker

The speed governor is a device that limits vehicles to a top speed of 60 km/h and trims down the speed to 25 km/h when the vehicle attempts to exceed the designated maximum speed.

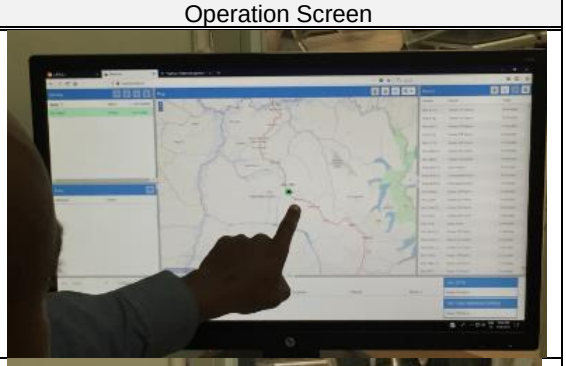
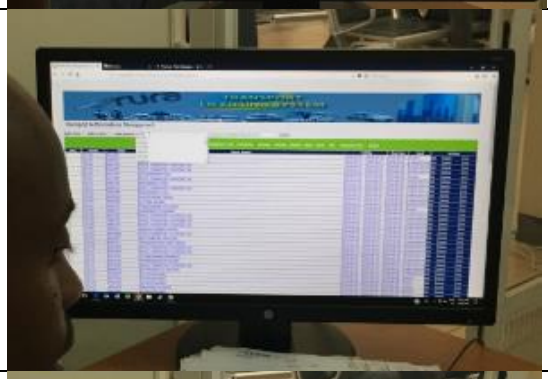
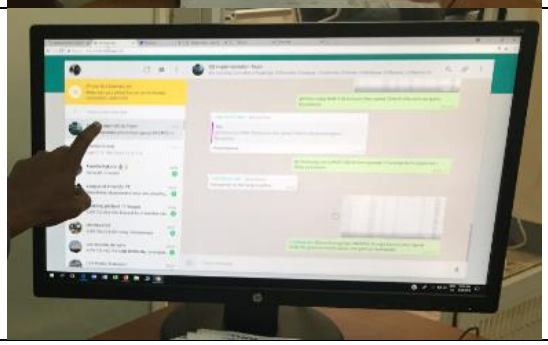
The installation of speed governors is mandatory for public bus and commercial vehicles such as trucks.

As aforementioned, the number of traffic accidents is decreasing because of the installation of speed governors in public bus and commercial vehicles.

Apart from installing speed governors, they are also able to place a GPS tracker into vehicles to enable owners to monitor their vehicles from their office.

RURA uses these devices to monitor excessively speeding vehicles, as shown in Table 5.3.2, as follows: (1) Extract over-speeding vehicles using GPS tracker, etc., (2) Obtain driver's information using transport license system, and (3) Provide driver's position and contact information to RNP using short message service (SMS).

Table 5.3.2: Monitoring of Excessively Speeding Vehicles by RURA

Operation Contents	Operation Screen
(1) Extraction of over-speeding vehicle The person in-charge of RURA extracts the position of the excessively speeding vehicle and the vehicle ID using system.	
(2) Obtain driver's information The person in-charge of RURA identifies driver from vehicle ID and obtains contact information using Transport Licensing System.	
(3) Provide driver's information to RNP <Short Message Service> The person in-charge of RURA provides driver's position and contact information to RNP using SMS.	

Source: JICA Survey Team

(3) Road Safety Week

Every year, RNP carries out a nationwide campaign for all categories of road users on traffic rules and regulations to promote road safety in the country.

For example, at Amahoro National Stadium in Kigali City, the State Minister for Transport urged owners and leaders of motorcycle cooperatives to help enforce road safety standards by taking internal measures against errant drivers or motorcyclists.

The road safety week also includes radio and TV talk shows on road safety and other forms using online and print media platforms.

5.3.3 Traffic Control Center

Closed-circuit television(CCTV), Vehicle Enforcement System, and Traffic Control Center are installed and operated by RNP.

(1) CCTV

CCTV was installed in Kigali City two years ago for monitoring traffic accidents and crime prevention. There are 190 CCTVs installed in 52 locations. There are two kinds of camera, namely, fixed camera and pan tilt zoom (PTZ) camera.

(2) Vehicle Enforcement System

The Vehicle Enforcement System is a system that consists of speed detectors and cameras, and detects excessive speeding and also signals ignoring vehicles. This system also includes Track Management System which monitors violating vehicles using information on license plates captured by cameras installed at several places. Thirty-six cameras are planned to be installed, and five are currently in use. The remaining 31 cameras will be installed in 2018.

In case of speeding violation, the police can identify the driver from the information on the license plate and send SMS to the mobile phone. Offender who receives SMS message shall pay a penalty charge through the mobile money system or to the bank account of RNP.

(3) Traffic Control Center

At the Traffic Control Center stationed at the RNP, the police officers use the cameras shown above to monitor the speed violations and traffic accidents on a 24-hour schedule.

At least 21 screens are installed at the Traffic Control Center. There are two police officers to monitor traffic violations, and 13 police officers to monitor crime. In addition, 12 officers are stationed in the call center to provide guidance to the field sites. It is noted that the center of RNP is not responsible for traffic management such as control of the traffic signal system but responsible for the enforcement of crime including traffic-related violations.

5.3.4 Parking

(1) Parking

Parking spaces are installed in commercial facilities such as shopping malls and hotel, and public facilities such as government offices. There are public parking lots between road and buildings in the city. When the driver parks, Kigali Veterans Cooperatives Society (KVCS) staff collects the parking fee. Many vehicles are parked on the street in central urban area because the parking lot is insufficient.

Source: JICA Survey Team

Figure 5.3.5: Parking Space

(2) Parking Fee

The parking fee is set according to Presidential Order N25/01. As shown in Table 5.3.3 below, parking fees are paid per category of vehicles either per hour, per day, or per month.

Table 5.3.3: Fees Charged on Parking

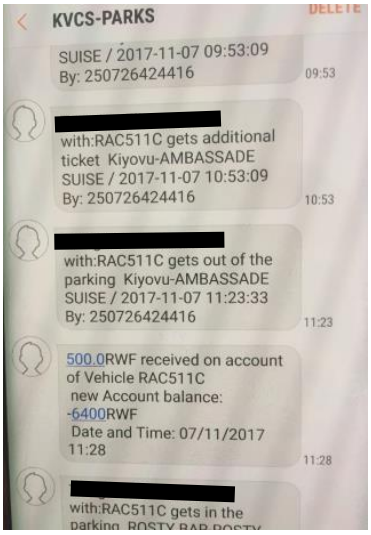
	Per Hour (RWF)	Per Day (RWF)	Per Month (RWF)
Small vehicles and motorcycles	100	500	10,000
Small lories and minibuses	200	1,000	12,000
Heavy truck without trailer, big bus and tractors	400	2,000	15,000
Vehicles with a trailer and heavy machine used for construction works and road construction	1,000	5,000	20,000

Source: Presidential Order N25/01 of 09/07/2012 (http://www.rra.gov.rw/index.php?id=67)

(3) Kigali Car Street Parking System

Kigali car street parking system is installed in Kigali City. Kigali car street parking system is a system where the parking fee is paid by mobile money.

Once parked, a short message service (SMS) will be sent to mobile phone notifying driver that car is being checked-in at a parking lot at a specified location, and the driver is charged RWF 100 per hour. If the driver fails to pay for parking within seven days, one is fined with RWF 10,000.



Source: JICA Survey Team

Figure 5.3.6: Notification by Short Message

5.4 Traffic Survey

5.4.1 Overview

To understand the traffic condition in Kigali City, a traffic survey was conducted. The traffic survey consisted of several components as shown in the following Table 5.4.1.

Table 5.4.1: Traffic Survey Components

Survey Component	Objective, Method	Location	Survey Date
Traffic Count Survey – Intersection	To grasp traffic volume at main intersection and cross section	7 locations	6th June, 6:00-22:00
Traffic Count Survey – Cross section		5 locations	7th June, 6:00-6:00 10th June, 6:00-20:00
Roadside Interview Survey	To grasp trip behavior of car users Stop the vehicle at roadside and interview	8 locations	7th June, 6:00-20:00 12th June, 6:00-20:00
Travel Speed Survey	To identify congested routes	12 routes, 2 times running in morning and evening peak hour	19th – 21st of June
Bus Terminal Interview	To interview about trip behavior of bus users Interview with intercity and urban bus users for 1000 samples	Nyabugogo Bus Terminal Downtown Bus terminal	13th June, 6:00-20:00

Source: JICA Survey Team

5.4.2 Methodology

(1) Traffic Count Survey

Traffic volume was counted using the seven classifications listed in Table 5.4.2. Traffic count survey for intersection was conducted for 14 hours in one weekday and traffic count survey for cross section was conducted for 24 hours in one weekday and 14 hours in one weekday.

Table 5.4.2: Type of Vehicle

No.	Vehicle Type
1	Motorcycles/Moto-taxi and scooters
2	Car/Taxi-cars
3	Minibuses and Pax Vans 9-16 seats
4	Buses and Coaches 26 or more seats
5	Light goods vehicle
6	Heavy goods vehicle
7	Others

Source: JICA Survey Team

(2) Roadside Interview Survey

This survey targeted interviewing vehicle drivers and passengers in roadsides to collect information about origin and destination, trip purpose, etc. Vehicles were flagged down for an interview, and drivers were asked some questions in this survey. The roadside interview survey was carried out for 16 hours (6:00- 22:00) during weekday. Questionnaire particulars are listed in Table 5.4.3.

Table 5.4.3: Roadside Interview Items

Category	Interview Items
Personal Attributes	Vehicle classification Occupancy including driver Type of interviewee Gender Age Occupation Car ownership Monthly income
Trip Information	Purpose of trip Trip frequency Origin and destination of current trip Willingness to pay Questions to truck drivers only Type of loading Tonnage of cargo Container size Type of commodity

Source: JICA Survey Team

(3) Bus Terminal Interview

Bus terminal interview survey is conducted to interview bus users and collect trip information including general attributes, origin and destination, and trip purpose. Interview was carried out at the Nyabugogo Bus Terminal and Downtown Bus Terminal in one weekday. Interview was collected from 1,000 samples in total for intercity bus and urban bus users. Questionnaire was the same as in the roadside interview survey.

(4) Travel Speed Survey

This survey is used to collect travel speed information of a sedan car in morning peak hours and evening peak hours along 12 major roads for both directions. The survey was conducted during weekday period.

(5) Survey Location

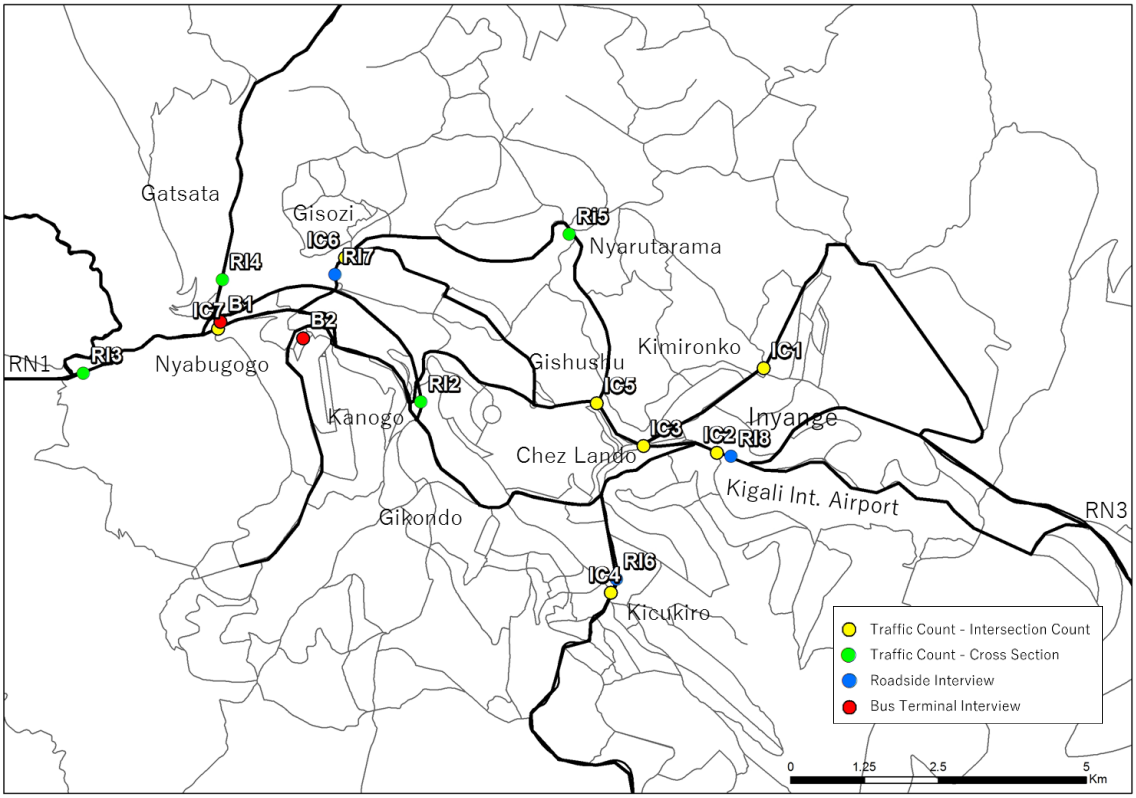
Survey locations are indicated in Table 5.4.4 below.

Table 5.4.4: Traffic Survey Location

Survey Component	Location ID	Location Name
TRAFFIC COUNT AT INTERSECTION Yellow pin in the following map	IC1	Kibagabaga
	IC2	Giporoso
	IC3	Chez Lando
	IC4	Kicukiro
	IC5	Gishushu
	IC6	Gisozi
	IC7	Nyabugogo
TRAFFIC COUNT AT CROSS SECTION Green pin	RI1	Towards Inyange
	RI2	Kanogo (Car Wash)
	RI3	Giticyinyoni
	RI4	Gatsata
	RI5	Nyarutarama
ROADSIDE INTERVIEW	RI1	Towards Inyange
	RI2	Kanogo (Car Wash)

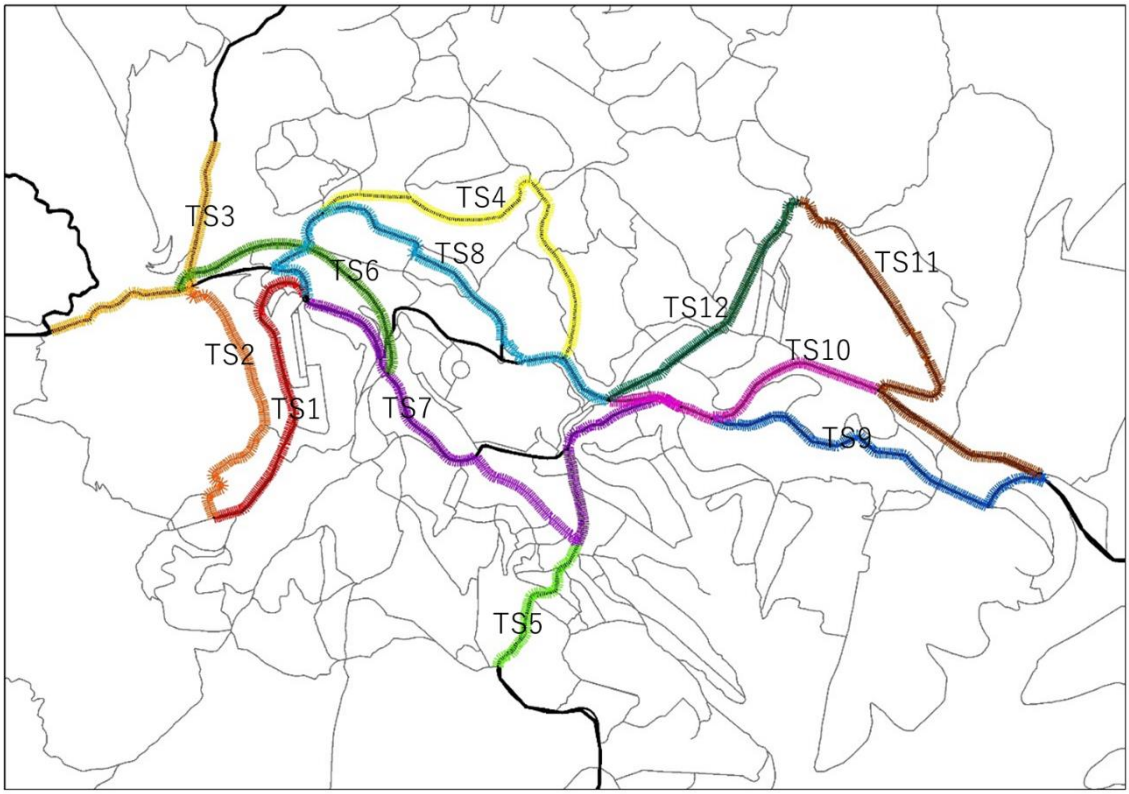
Green pin and Blue pin	RI3	Giticyinyoni
	RI4	Gatsata
	RI5	Nyarutarama
	RI6	Kicukiro
	RI7	Gisozi
	RI8	Giporoso
TRAVEL SPEED SURVEY	TS1	CBD Roundabout-Nyamirambo (Terminus)
	TS2	Nyamirambo-Nyabugogo
	TS3	Kobil-Giticyinyoni
	TS4	Gisozi-Kibabagaba (BP)
	TS5	Nyanza-Sonatube
	TS6	Mirimo Station-Kanogo
	TS7	City Center-Sonatube
	TS8	CBD Roundabout-Chez Lando
	TS9	Cyamitsing-Mulindi
	TS10	KSEFZ-Chez Lando
	TS11	Mulindi-Kibagabaga Market (KCB)
	TS12	Chez Lando-Kibagabaga Junction
BUS TERMINAL INTERVIEW Red pin	BI1	Nyabugogo
	BI2	Downtown

Source: JICA Survey Team



Source: JICA Survey Team

Figure 5.4.1: Traffic Survey Location Map



Source: JICA Survey Team

Figure 5.4.2: Travel Speed Survey Location Map

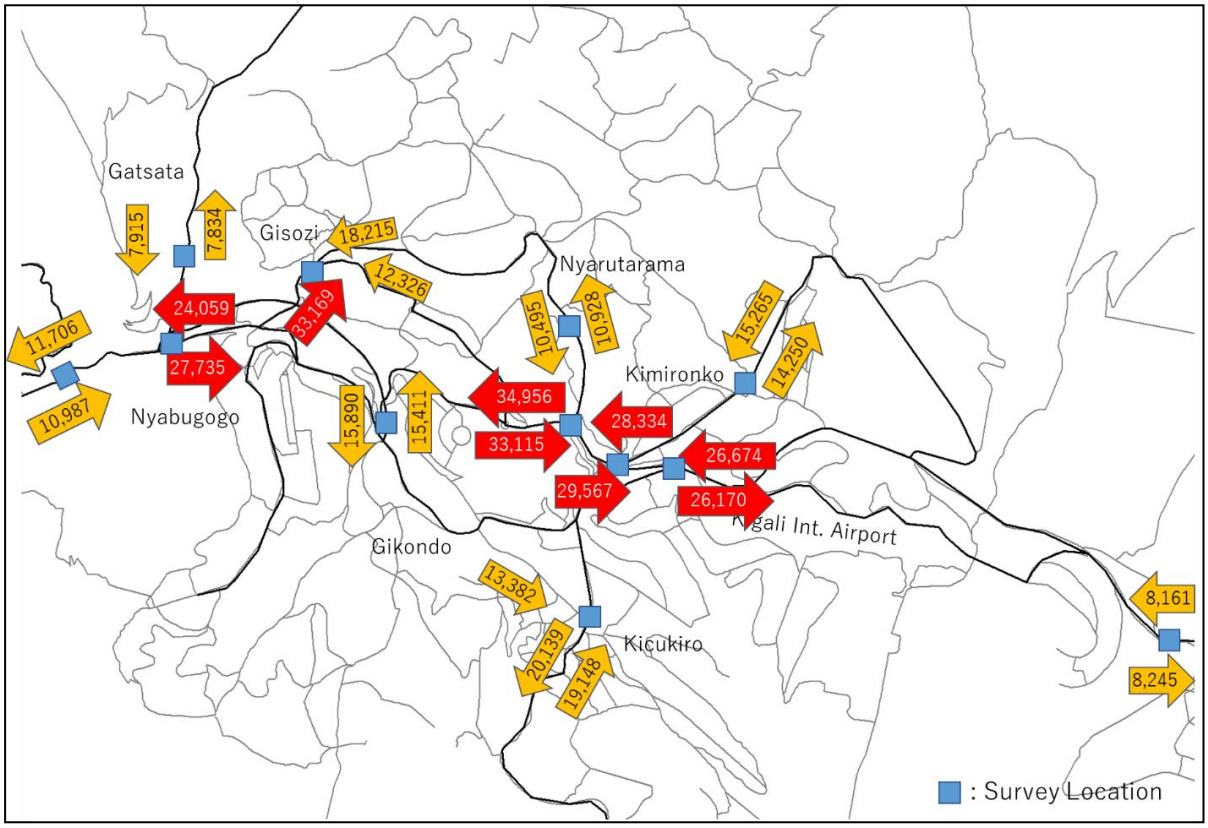
Source: JICA Survey Team

Figure 5.4.3: Picture of Traffic Survey Implementation

5.4.3 Survey Result

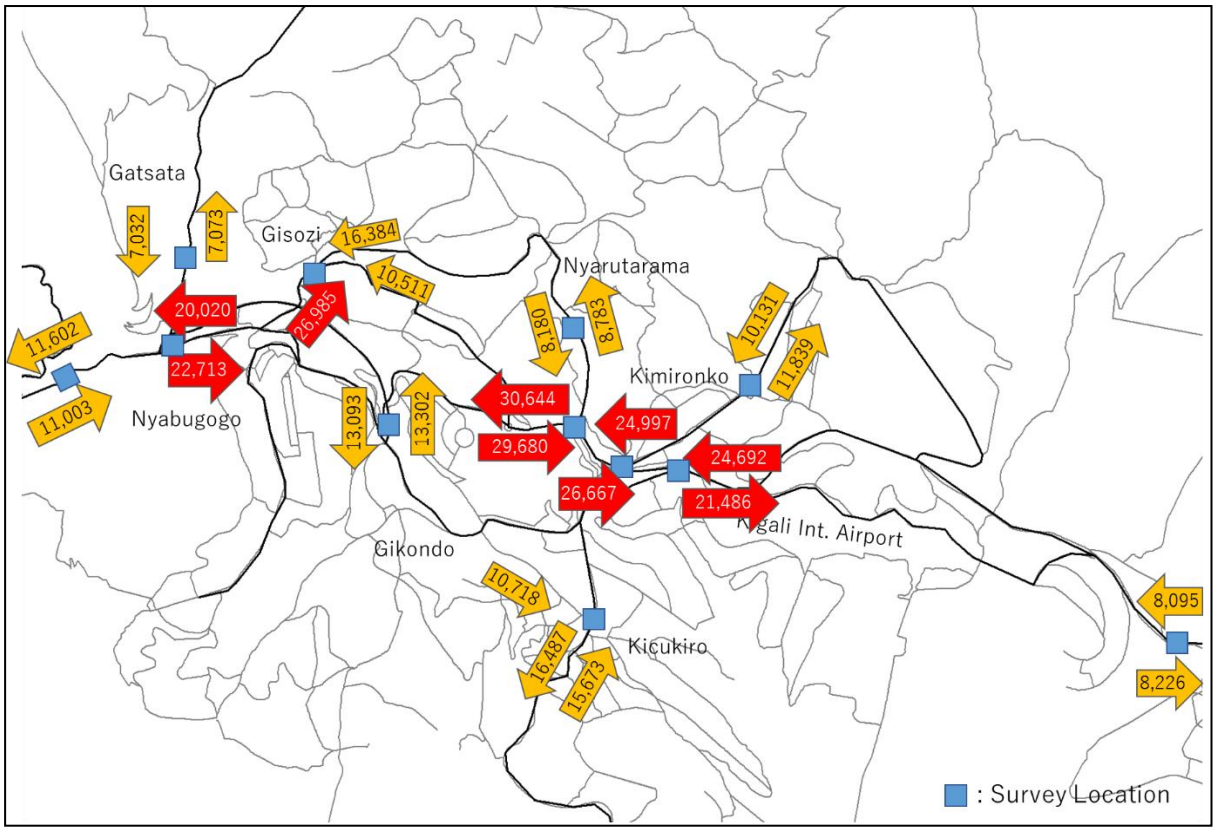
(1) Traffic Volume Counting

Figure 5.4.4 shows the result of traffic count survey during weekday period. The high traffic volume was observed in Chez Lando, Giporoso, Gishushu, Nyabugogo, and Gisozi intersections. Traffic volume was observed to be high especially in the east-west direction. It can be seen that RN3 is the main traffic corridor for people going to the east and west direction. Figure 5.4.5 shows traffic volume in passenger car unit (PCU). PCU factor for each vehicle type was referred from Rwanda Feeder Road Standards. Value of PCU/day is less than traffic volume (volume/day) in all locations since motorcycle occupies high ratio in all locations. PCU factor of motorcycle is 0.5; therefore, value of PCU/day is less than volume/day.



Note: Figures were calculated in volume/day. Intersection counting was conducted for 16 hours. Conversion from 16 hours to 24 hours used daytime and nighttime ratio captured in cross section counting.
Source: JICA Survey Team

Figure 5.4.4: Traffic Count Survey Result (Volume/Day)



Note: Figures were calculated in volume/day. Intersection counting was conducted for 16 hours. Conversion from 16 hours to 24 hours used daytime and nighttime ratio captured in cross section counting.
Source: JICA Survey Team

Figure 5.4.5: Traffic Count Survey Result (PCU/Day)

Figure 5.4.6 shows the traffic survey result for intersection counting. All intersections and roundabouts have the peak time in the morning and evening. Peak hour ratio is 7%-8% in all intersections and highest traffic volume was observed in the evening peak hour.

Kibagabaga Intersection is not signalized intersection. Northwest direction and southeast direction are not connected by a straight alignment. Many traffic flew in the northeast and southwest direction.

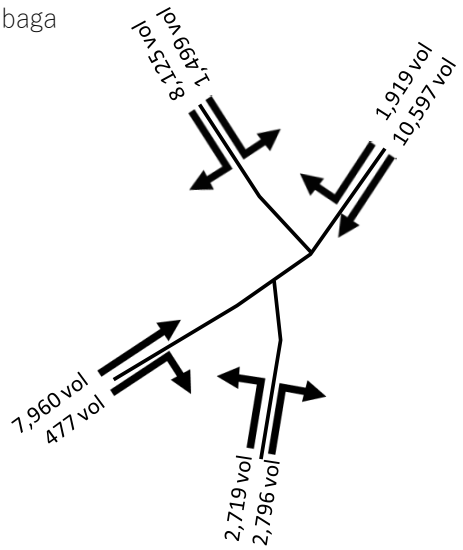
Nyabugogo Bus Terminal is located in the north east of the Nyabugogo Intersection. Many buses flow into the intersection and therefore, large vehicle ratio is high. The traffic flow in the east direction is observed to be high volume. Nyabugogo Intersection is currently unpaved and is under construction for improvement and signal control device has not been installed.

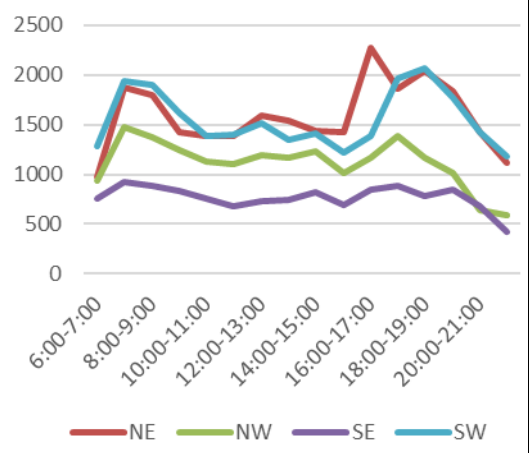
At Giporoso Intersection, east-west direction has one of the major arterial roads named KN5. East-west direction has high traffic volume. Remera Taxi Park is located in the north of the Giporoso Intersection. Traffic related to the taxi park uses Giporoso Intersection and therefore, large vehicle ratio is higher. Giporoso Intersection is a signalized intersection.

At Chez Lando Roundabout, east-west direction has high traffic volume compared with the traffic volume in the north and south. KN5 road is crossing the Chez Lando Roundabout in the east and west direction.

At Gishushu Intersection, KN5 road is crossing in the east and west direction and it has high traffic volume compared with the south and north direction. Gishushu Intersection is a signalized intersection.

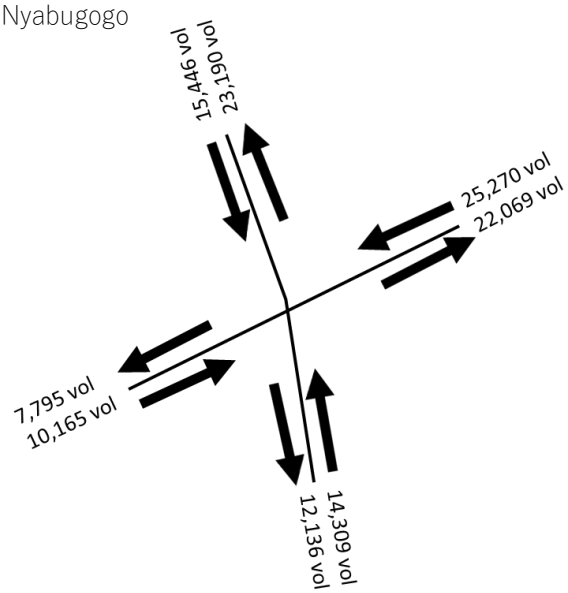
Kibagabaga

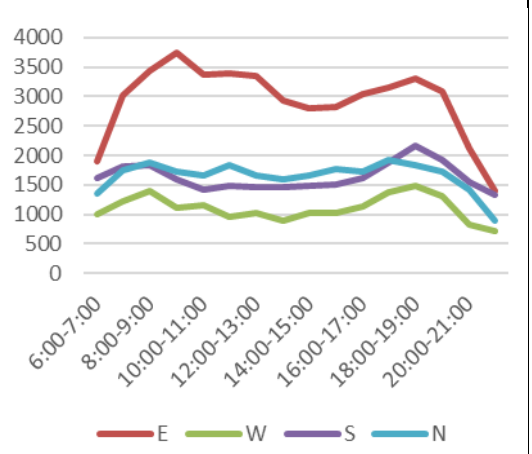




Large Vehicle Ratio: 2.71%
Peak Hour Ratio: 7.79%

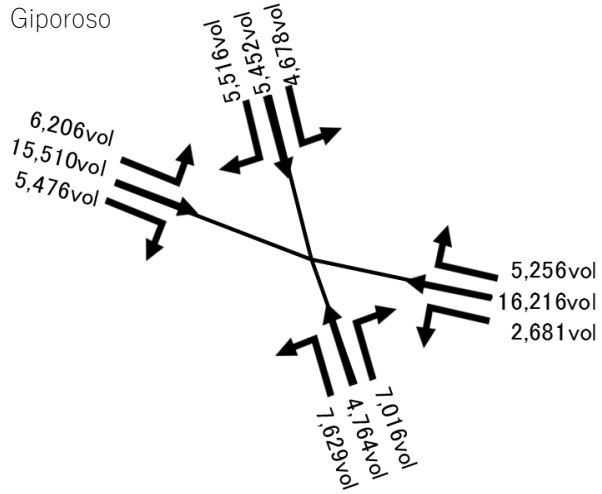
Nyabugogo





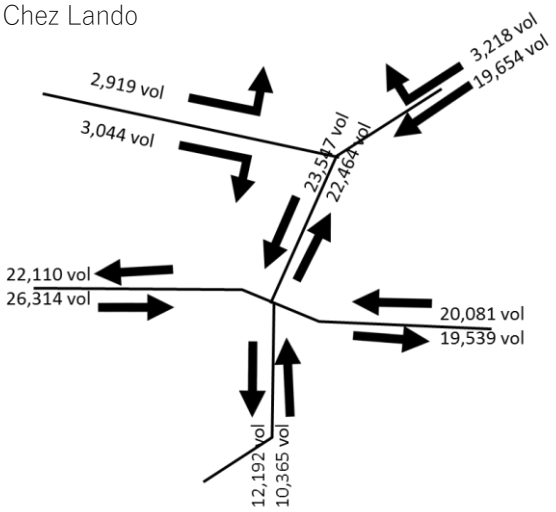
Large Vehicle Ratio: 9.32%
Peak Hour Ratio: 7.50%

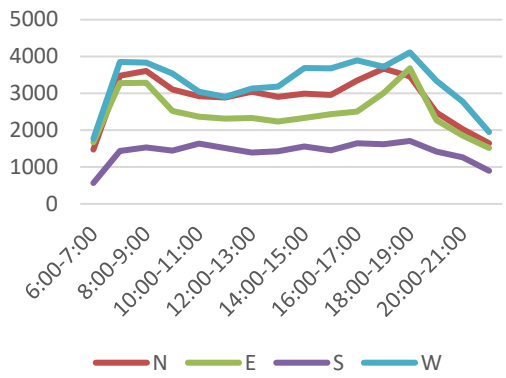
Giporoso



Large Vehicle Ratio: 7.50%
Peak Hour Ratio: 7.93%

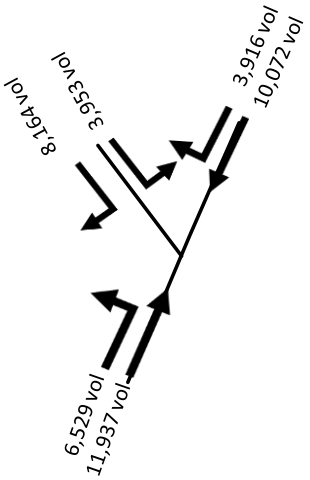
Chez Lando

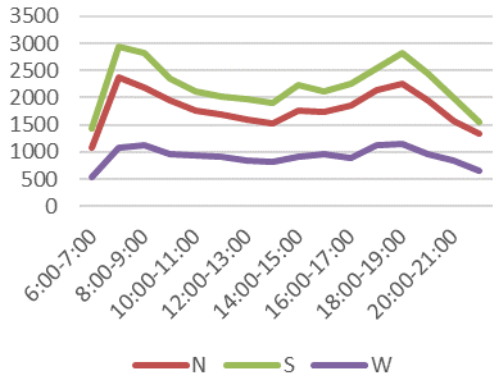




Large Vehicle Ratio: 2.03%
Peak Hour Ratio : 8.07%

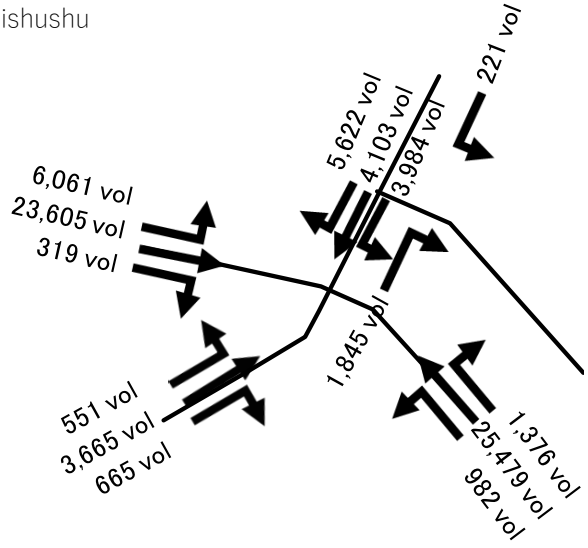
Kicukiro

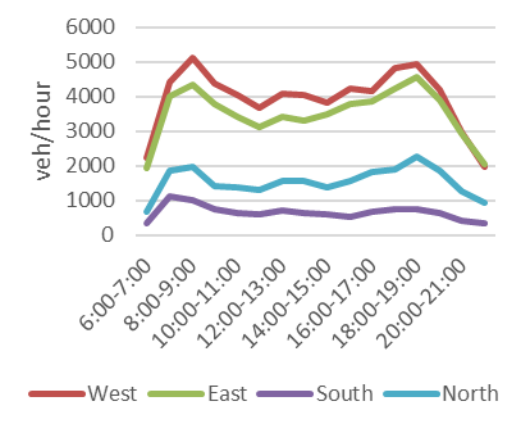




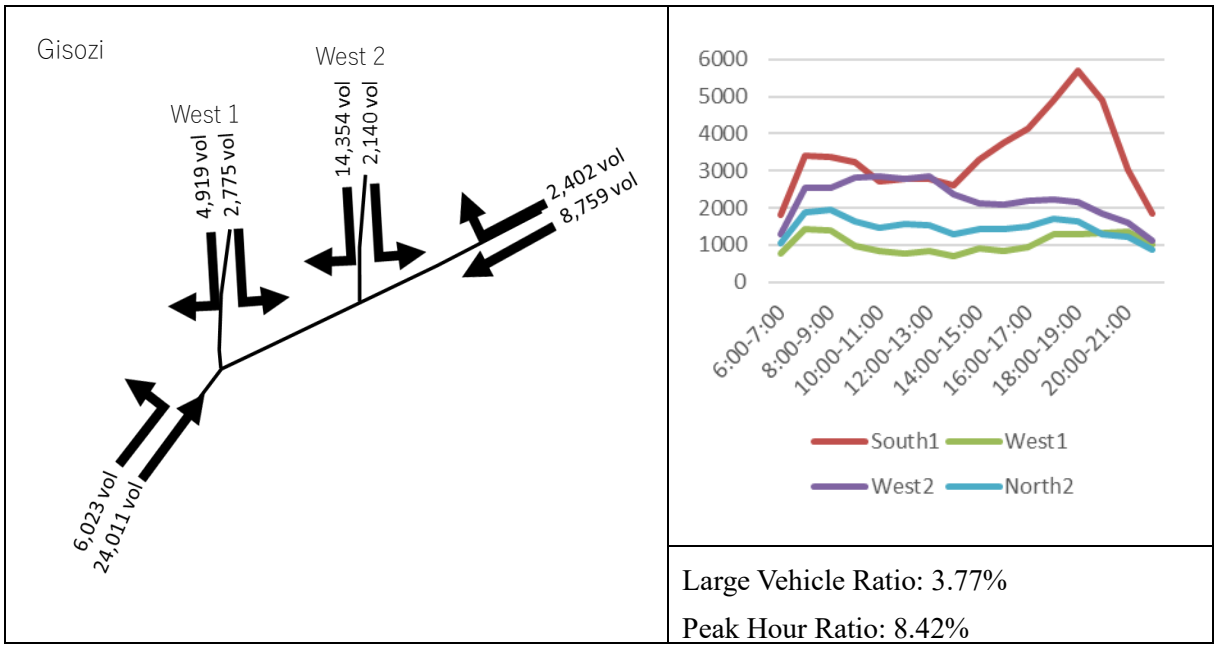
Large Vehicle Ratio: 2.50%
Peak Hour Ratio: 8.30%

Gishushu





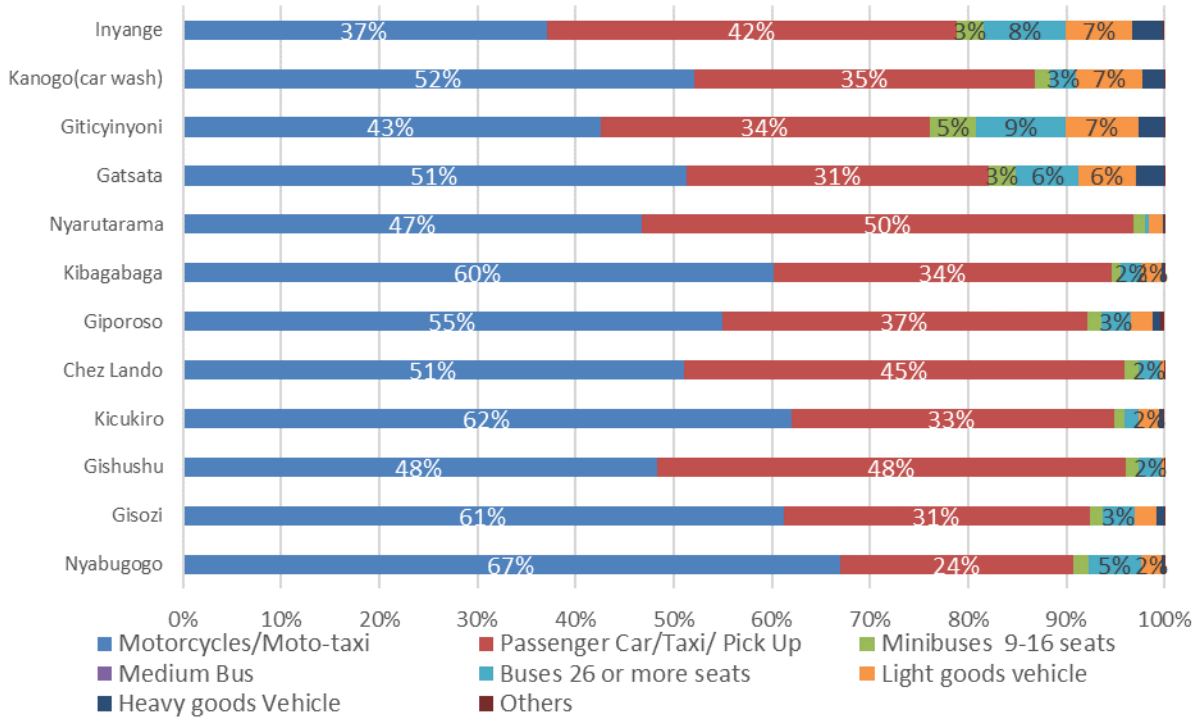
Large Vehicle Ratio: 1.93%
Peak Hour Ratio: 8.11%



Source: JICA Survey Team

Figure 5.4.6: Traffic Volume at Intersection (Volume/16 hours)

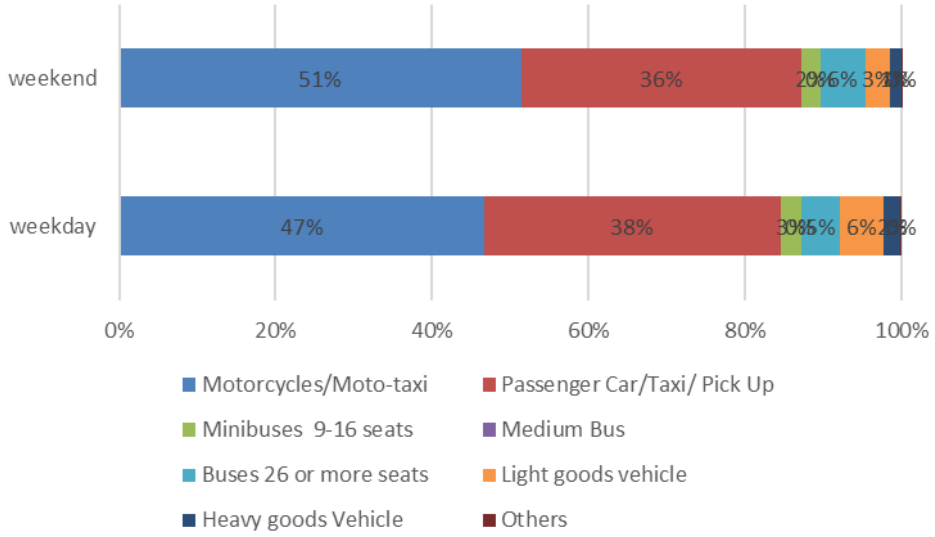
Figure 5.4.7 shows the vehicle composition in each survey location. Motorcycle and passenger car occupy more than 70% of total traffic volume. Gatsata and Inyange have high truck ratio compared with the other locations. These locations are outside of the city center. Many trucks passed the RN3 to enter the city from the east part, and RN1 to enter the city from the west part. Furthermore, the inland depot is located outside the city, therefore, truck volume was observed higher in those two locations. In those locations, many intercity buses were observed.



Source: JICA Survey Team

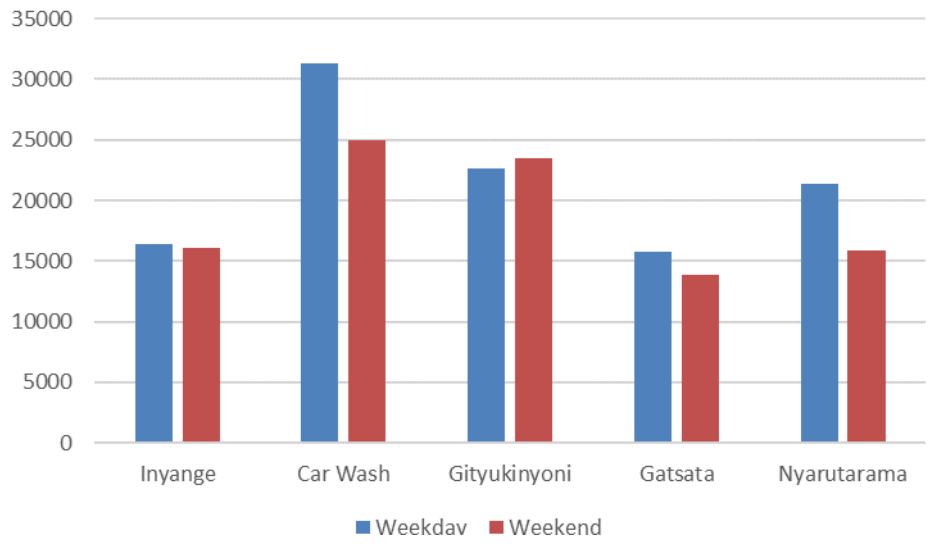
Figure 5.4.7: Vehicle Composition at Each Location

Figure 5.4.8 shows the vehicle composition during weekday and weekend. Weekday has more bus and truck volume than in the weekend. Figure 5.4.9 shows the total traffic volume at several survey locations. Weekday traffic volume is higher than that of weekend in most of the survey locations. The total traffic volume is higher during weekday than during weekend; weekday traffic volume is more than 1.4 times of weekend traffic volume. Weekday and weekend traffic volume ratio is around 1.41 (weekday traffic volume/weekend traffic volume).



Source: JICA Survey Team

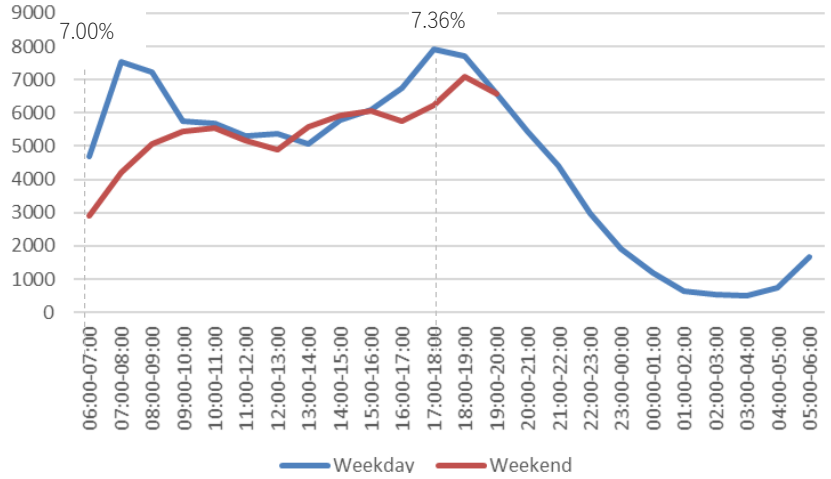
Figure 5.4.8: Vehicle Composition in Weekday and Weekend



Note: Traffic volume in the weekend was amplified from 14 hours to 24 hours using daytime and nighttime ratio
Source: JICA Survey Team

Figure 5.4.9: Traffic Volume in Weekday and Weekend

Time variation is shown in the following Figure 5.4.10. The peak hours were observed at 7:00-8:00 in the morning and 17:00-18:00 in the evening. During the nighttime, traffic volume became lower than during daytime; daytime and nighttime ratio is around 1.1044 (ratio of traffic volume in entire day/daytime). In the weekend, traffic volume was surveyed for 14 hours. There was no morning peak as shown in Figure 5.4.10, but traffic volume increased in the evening.



Source: JICA Survey Team

Figure 5.4.10: Time Variation during Weekday and Weekend

Table 5.4.5 and Table 5.4.6 show the traffic survey results for cross section counting. Large vehicle ratio was observed to be higher in the outer area of Kigali City than in the city center. Peak hour ratio was observed in the morning peak and evening peak during a weekday. On the other hand, peak hour was observed only in the evening during the weekend.

Table 5.4.5: Cross Section Count Result on Weekday

No.	Location	Survey Hours	Total Traffic Volume (vol/day)	Peak Hour	Peak Hour Ratio	Large Vehicle Ratio	Factor D
RI1	Inyange	6:00-6:00	16,320	17:00-18:00	7.21%	15%	54.5%
RI2	Kanogo (Car Wash)	6:00-6:00	26,394	17:00-18:00	7.73%	12%	52.4%
RI3	Giticyinyoni	6:00-6:00	22,605	18:00-19:00	7.69%	19%	55.5%
RI4	Gatsata	6:00-6:00	14,104	7:00-8:00	6.68%	15%	66.1%
RI5	Nyarutarama	6:00-6:00	16,963	7:00-8:00	8.25%	1%	50.1%

Note: Factor D is the ratio of higher directional volume and total traffic volume
Source: JICA Survey Team

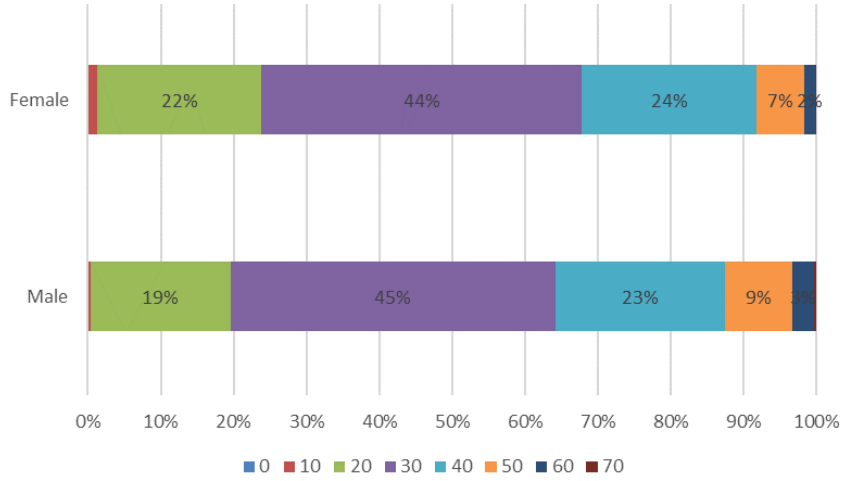
Table 5.4.6: Cross Section Count Result on Weekend

No.	Location	Survey Hours	Total Traffic Volume (vol/14 hours)	Total Traffic Volume (vol/24 hours)	Peak Hour	Peak Hour Ratio	Large Vehicle Ratio	Factor D
RI1	Inyange	6:00-20:00	12,796	16,136	18:00-19:00	7.68%	15%	54.7%
RI2	Kanogo (Car Wash)	6:00-20:00	20,992	24,900	18:00-19:00	7.36%	9%	55.1%
RI3	Giticyinyoni	6:00-20:00	18,729	23,486	18:00-19:00	7.35%	14%	59.5%
RI4	Gatsata	6:00-20:00	10,905	13,850	19:00-20:00	7.12%	12%	60.2%
RI5	Nyarutarama	6:00-20:00	13,074	15,874	18:00-19:00	8.42%	1%	59.5%

Note: Traffic volume was counted for 14 hours on a weekend, thus peak hour ratio was calculated using daily traffic volume which is estimated from daytime and nighttime ratio of weekday.
Source: JICA Survey Team

(2) Roadside Interview Survey

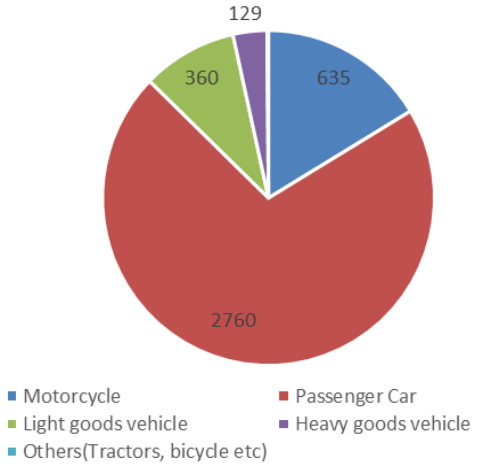
Gender and age of interviewees are shown in Figure 5.4.11. Total number of interviews is 4,000 samples.



Source: JICA Survey Team

Figure 5.4.11: Gender and Age

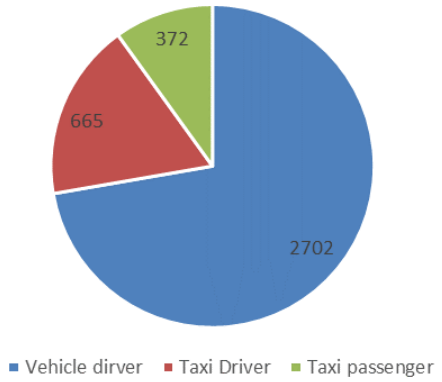
Types of interviewees are shown in Figure 5.4.12. Passenger car users have the highest ratio among all types of vehicles. Most of the motorbikes are operated as mototaxi, and few motorbikes run for private use.



Source: JICA Survey Team

Figure 5.4.12: Vehicle Classification of Interviewees

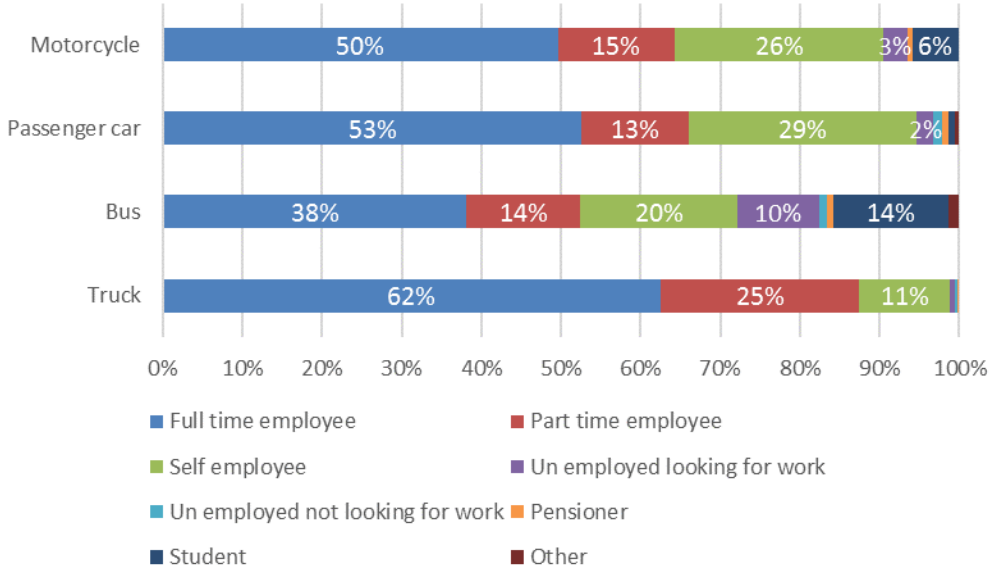
Regarding classification of passenger or driver, vehicle drivers occupy over 70% of the total interviewees. Interview was conducted with taxi drivers and passengers for motorcycle and sedan as well.



Source: JICA Survey Team

Figure 5.4.13: Type of Interviewees

Occupations of interviewees were summarized in Figure 5.4.14. Full time employee has the highest ratio in all types of vehicles. Bus interviewees were composed of many students and unemployed persons compared with other vehicle types.



Note: Motorcycle and bus are focused only on passengers and do not include drivers.
Passenger car and truck include drivers in the total.
Source: JICA Survey Team

Figure 5.4.14: Occupation of Interviewees by Vehicle Type

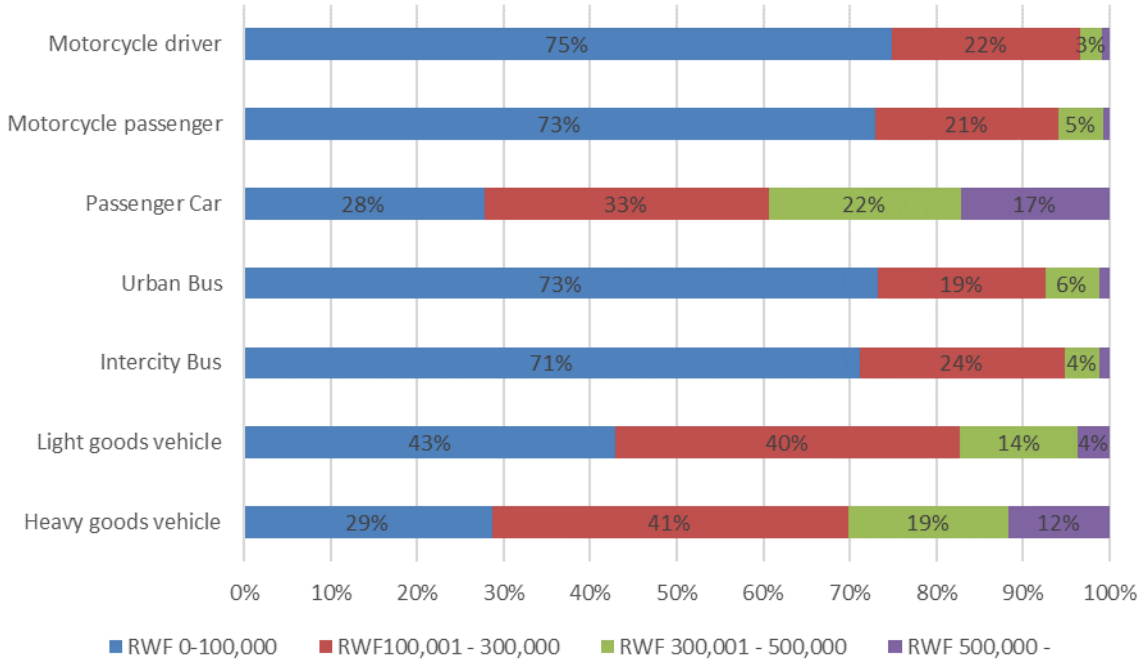
As for vehicle ownership, most of motorcycle, bus, and truck users do not own passenger car. In particular, over 80% of motorcycle users and 90% of bus users do not own any type of vehicle.

Table 5.4.7: Vehicle Ownership

		Motorcycle User	Passenger Car User	Bus User	Truck User
Motorcycle	No	82%	98%	96%	98%
	Yes	18%	2%	4%	2%
Passenger Car	No	97%	43%	97%	91%
	Yes	3%	58%	3%	9%
Truck	No	100%	98%	100%	91%
	Yes	0%	2%	0%	9%

*Note: Motorcycle user does not include motorcycle driver, only motorcycle passenger
Source: JICA Survey Team

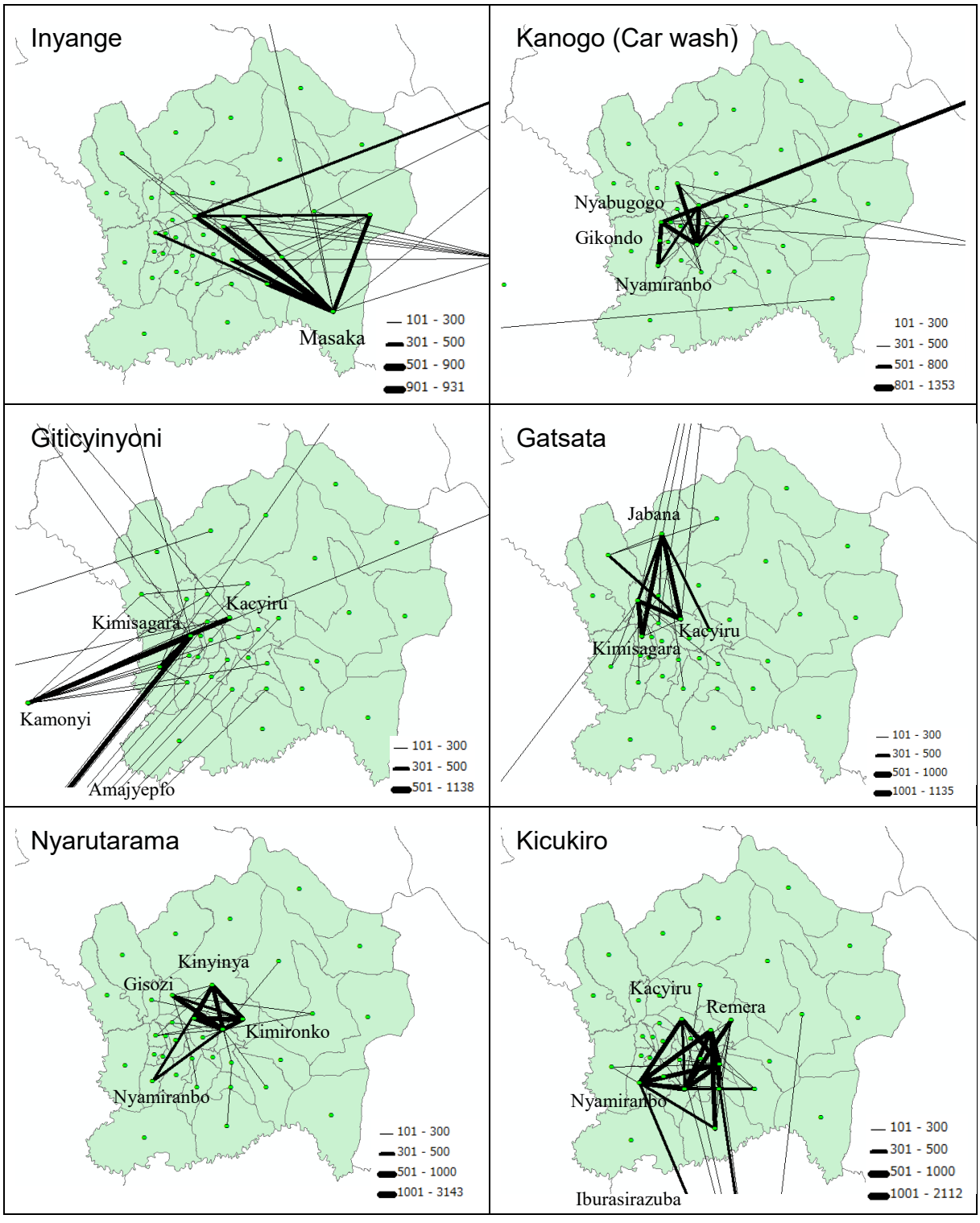
Average monthly wage was asked from the interviewees. Passenger car users earn much more wage than motorcycle, bus, and truck users. Motorcycle driver and passenger and bus users have similar tendency. In general, vehicle ownership ratio has correlation with income level. Vehicle ownership increases as income increases. If motorcycle users and bus users will increase their wage, vehicle ownership will become high and it will affect the traffic situation in the city.

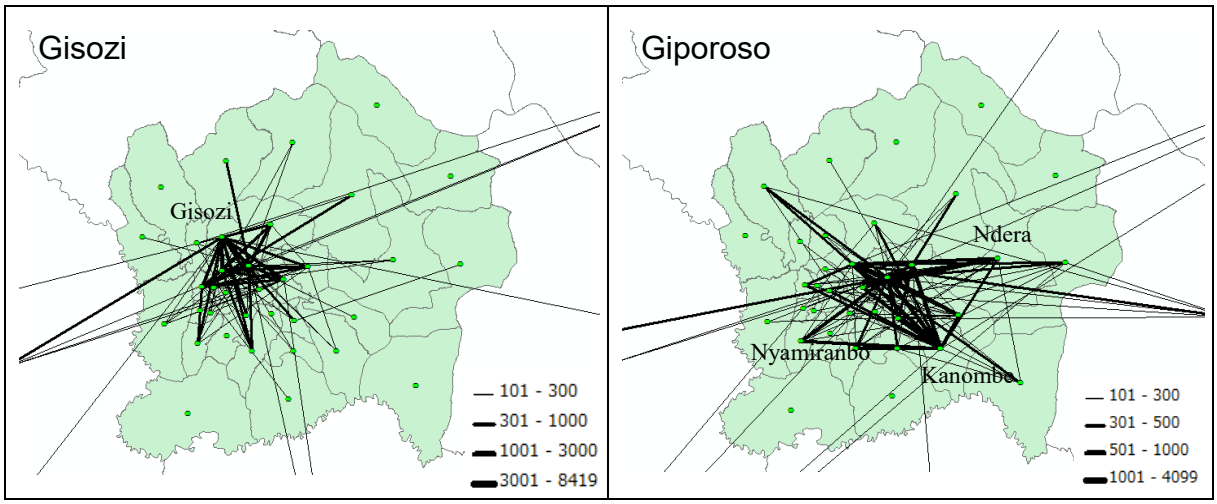


Source: JICA Survey Team

Figure 5.4.15: Average Monthly Wage by Vehicle Type

Regarding trip information, the roadside interview result is shown in Figure 5.4.16. Origin and destination (OD) shows the desire line for each survey location. In Inyange, many trips are generated and attracted at Masaka Sector in Kicukiro District and east of Kigali City is also the main origin and destination. In Kanogo (Car Wash), many trips were generated and attracted in Nyabugogo, Gikondo, and Nyamiranbo. Giticyinyoni is located on RN1 Road in the west boundary of Kigali City. Most of the traffic in the west direction use RN1. Therefore, OD indicated this tendency.


Inyange
Masaka
101 - 300
301 - 500
501 - 900
901 - 931
Kanogo (Car wash)
Nyabugogo
Gikondo
Nyamiranbo
101 - 300
301 - 500
501 - 800
801 - 1353
Giticyinyoni
Kacyiru
Kimisagara
Kamonyi
Amajyepfo
101 - 300
301 - 500
501 - 1138
Gatsata
Jabana
Kacyiru
Kimisagara
101 - 300
301 - 500
501 - 1000
1001 - 1135
Nyarutarama
Kinyinya
Gisozi
Kimironko
Nyamiranbo
101 - 300
301 - 500
501 - 1000
1001 - 3143
Kicukiro
Kacyiru
Remera
Nyamiranbo
Iburasirazuba
101 - 300
301 - 500
501 - 1000
1001 - 2112

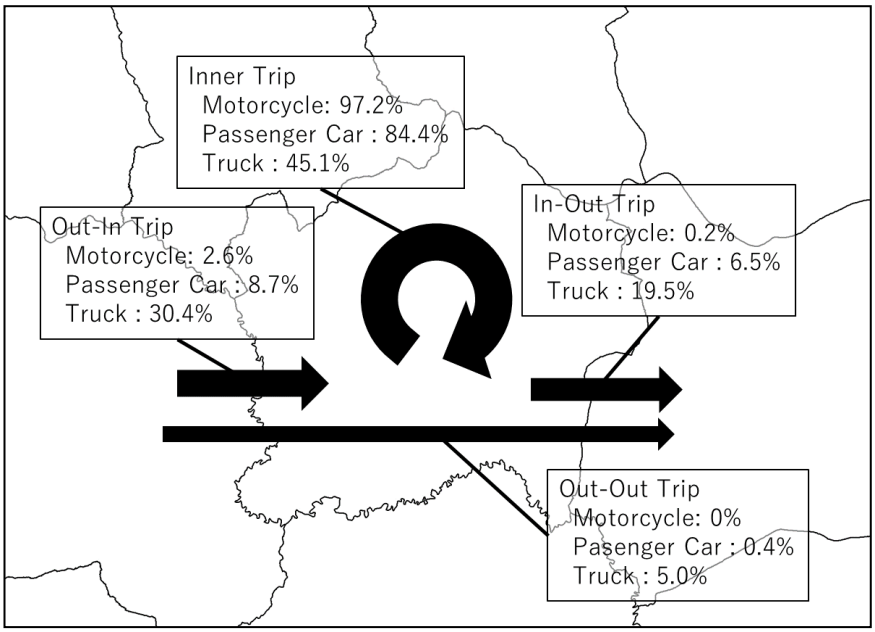


Source: JICA Survey Team

Figure 5.4.16: OD Distribution by Survey Location

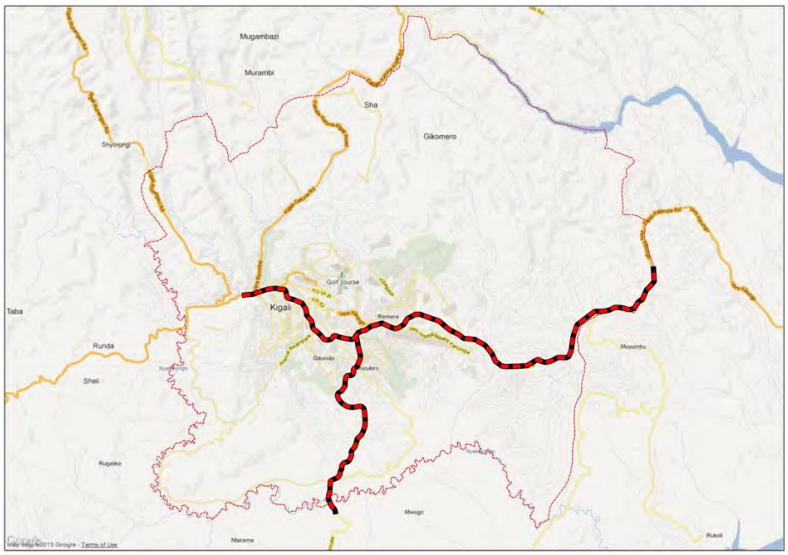
The JICA Survey Team has analyzed trip information collected from the interview. Since interview samples were not equally collected from all types of vehicles, calibration was conducted using traffic volume data and interview result. From the analysis result, it was found that most of the trips start and end inside Kigali City, and especially, motorcycle users come and go inside the city. Around 45.1% of truck users had their trips inside the city, but many trucks enter or pass through the city. Some of the truck users directly come from or go to outside Rwanda, such as Uganda, Kenya, Congo, Burundi, or Zambia. It can be considered that agreement of cross border transport helps international logistic movement.

Figure 5.4.18 shows the existing freight route through Kigali City. The Kigali City Transportation Master Plan stated that through freight traffic passes arterial major road in the city and needs to be decreased. Roadside interview also revealed a certain degree of through freight traffic as well, and their route should be changed by developing bypass to decongest the bottleneck points inside the city and also to improve road safety.



Source: JICA Survey Team

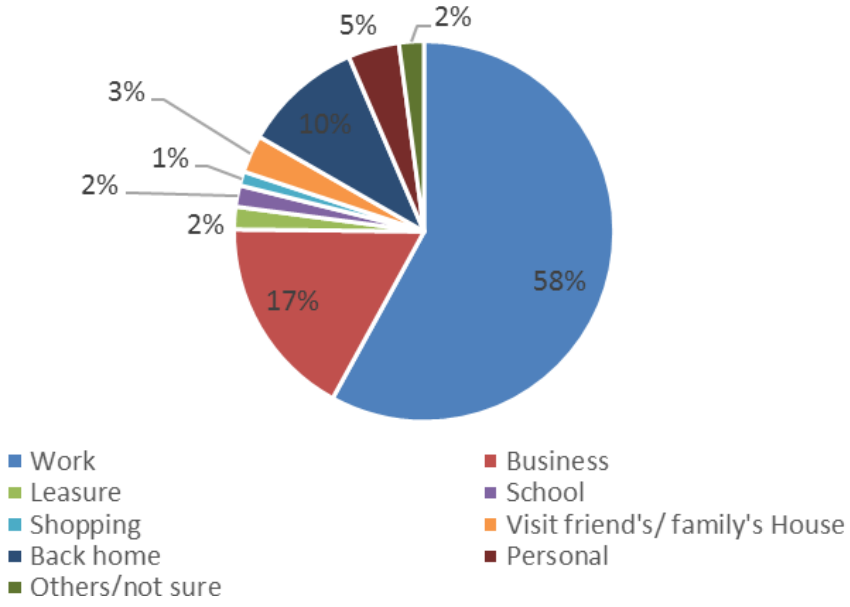
Figure 5.4.17: OD Distribution in 2018



Source: Kigali City Transportation Master Plan

Figure 5.4.18: Existing Freight Route through Kigali

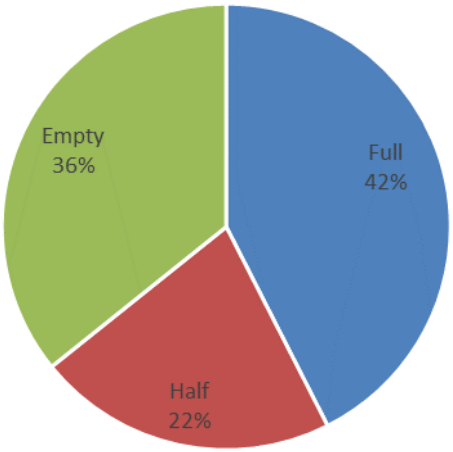
Trip purpose is shown in Figure 5.4.19 below. “Work” has the highest ratio of trip purpose. The second largest is “Business”. “Back home” has 10% in total. Roadside interview survey was conducted from 6:00 to 20:00. After 20:00, the ratio of “Back home” seems to be high.



Source: JICA Survey Team

Figure 5.4.19: Trip Purpose

Cargo loading situation is shown in Figure 5.4.20 below. Full loading has around 42% share in total. On the other hand, empty truck has 36% share. Many trucks operate with empty loading.

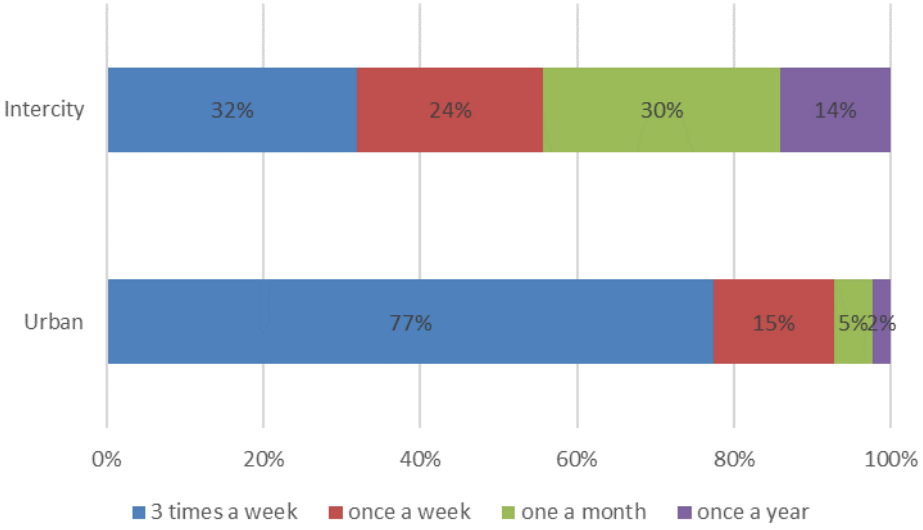


Source: JICA Survey Team

Figure 5.4.20: Loading Situation of Logistic Vehicle

(3) Bus Terminal Interview

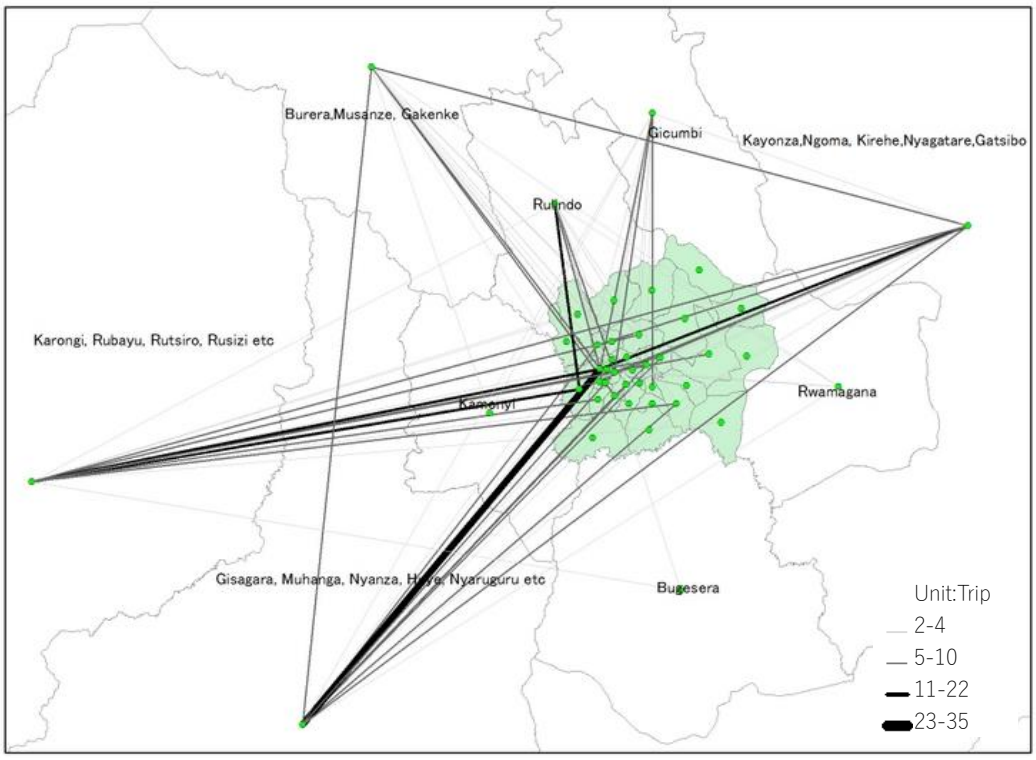
Trip frequency is shown in Figure 5.4.21 below. Urban bus users use bus service more than intercity bus users.



Source: JICA Survey Team

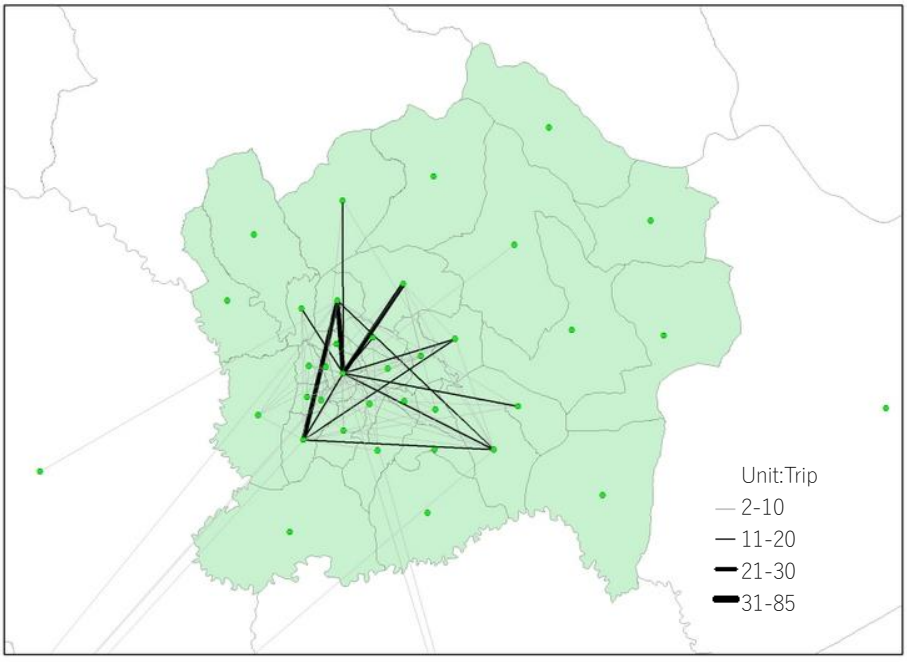
Figure 5.4.21: Trip Frequency of Intercity Bus and Urban Bus

Major OD for intercity bus is shown in Figure 5.4.22 below. Major destinations are Karongi, Muhanga, Rulindo, and Gicumbi. These four locations comprised over 30% of trips of intercity bus users. As for urban bus users, trip pattern is shown in Figure 5.4.24. Nyabugogo Bus Terminal is used for both urban bus and intercity bus operation. On the other hand, Downtown Bus Terminal is used for urban bus operation only. OD pattern is different between these two bus terminals. Many users from outside Kigali used urban bus from Nyabugogo Bus Terminal, but Downtown Bus Terminal is the desired line inside the city.



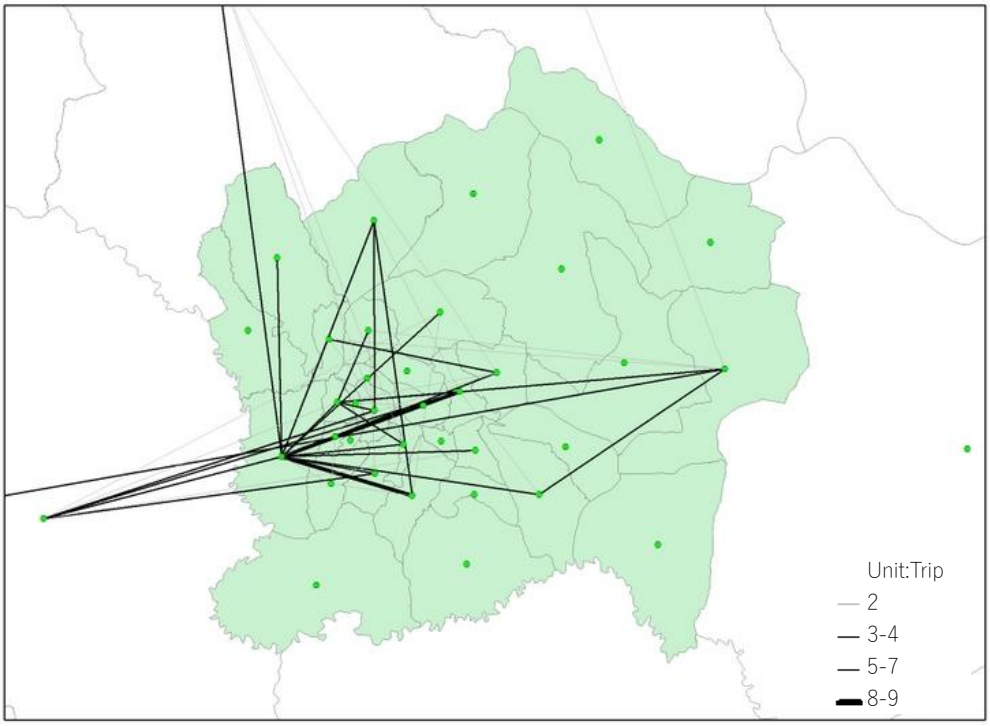
Source: JICA Survey Team

Figure 5.4.22: OD Pattern for Intercity Bus Users



Source: JICA Survey Team

Figure 5.4.23: OD Pattern for Urban Bus Users (Downtown Bus Terminal)

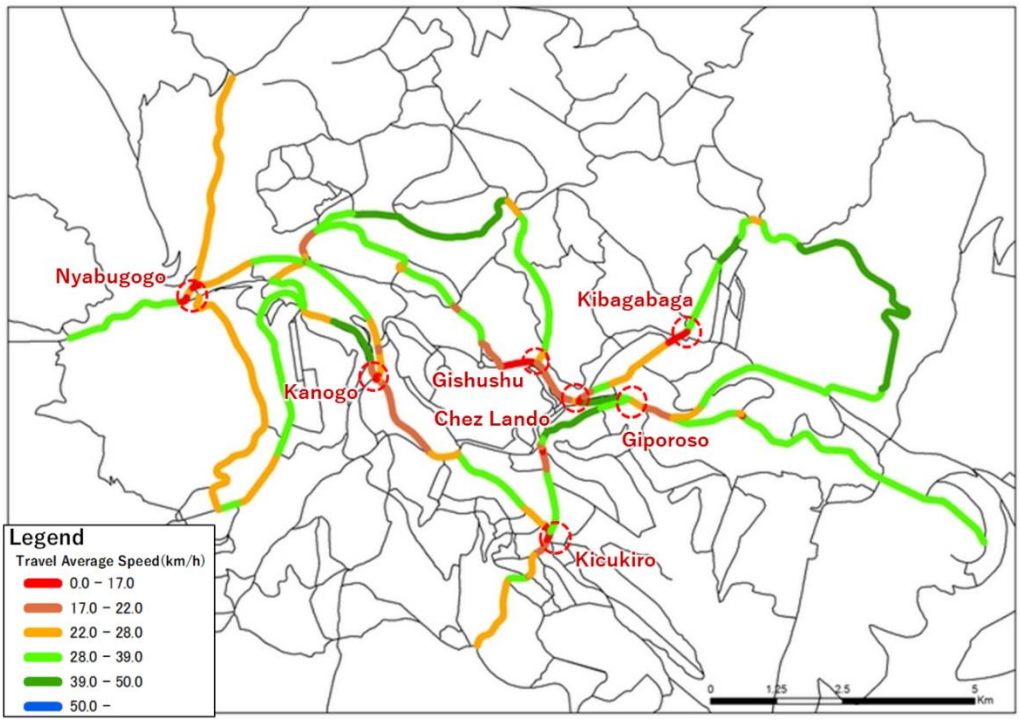


Source: JICA Survey Team

Figure 5.4.24: OD Pattern for Urban Bus Users (Nyabugogo Bus Terminal)

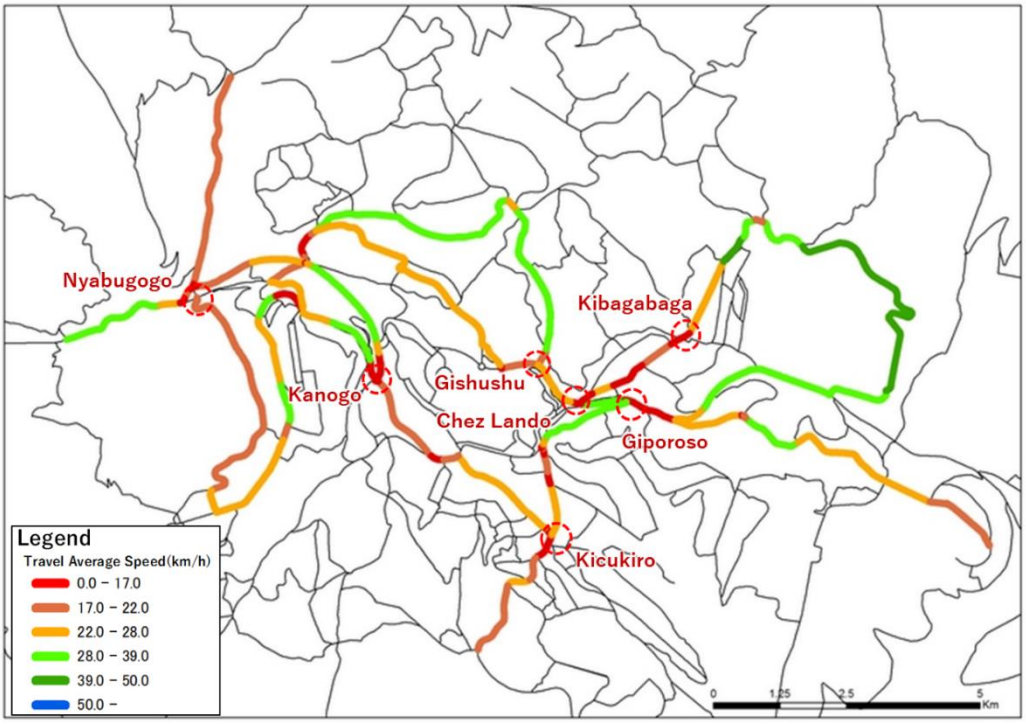
(4) Travel Speed Survey

The result of travel speed survey is shown in Figure 5.4.25. Slow travel speed means traffic congestion occurs in that route. In the morning peak hour (6:00-9:00), travel speed was noted to become lower in Nyabugogo, Kanogo, Gishushu, Chez Lando, Kibagabaga, Kicukiro, and Giporoso. Travel speed around these intersections is less than 17.0 km/h. In the evening peak hour (16:00-19:00), travel speed became low at the same location as in the morning peak including in CBD and Kinamba. Evening peak hour has much lower speed than morning peak hour.



Source: JICA Survey Team

Figure 5.4.25: Travel Speed in the Morning Peak Hour (6:00 – 9:00)



Source: JICA Survey Team

Figure 5.4.26: Travel Speed in the Evening Peak Hour (16:00 – 19:00)

5.5 Challenges on Urban Transport in the City of Kigali

5.5.1 Improvement of Unpaved Road

The current road network of Kigali City has more than 80% unpaved road. These unpaved roads become water-logged during the wet season and dusty during the dry season. Therefore, unpaved roads are a cause of various traffic issues such as rough ride, cargo damage, and increase of travel time required, among others.

Therefore, it is necessary to improve unpaved road in Kigali City.

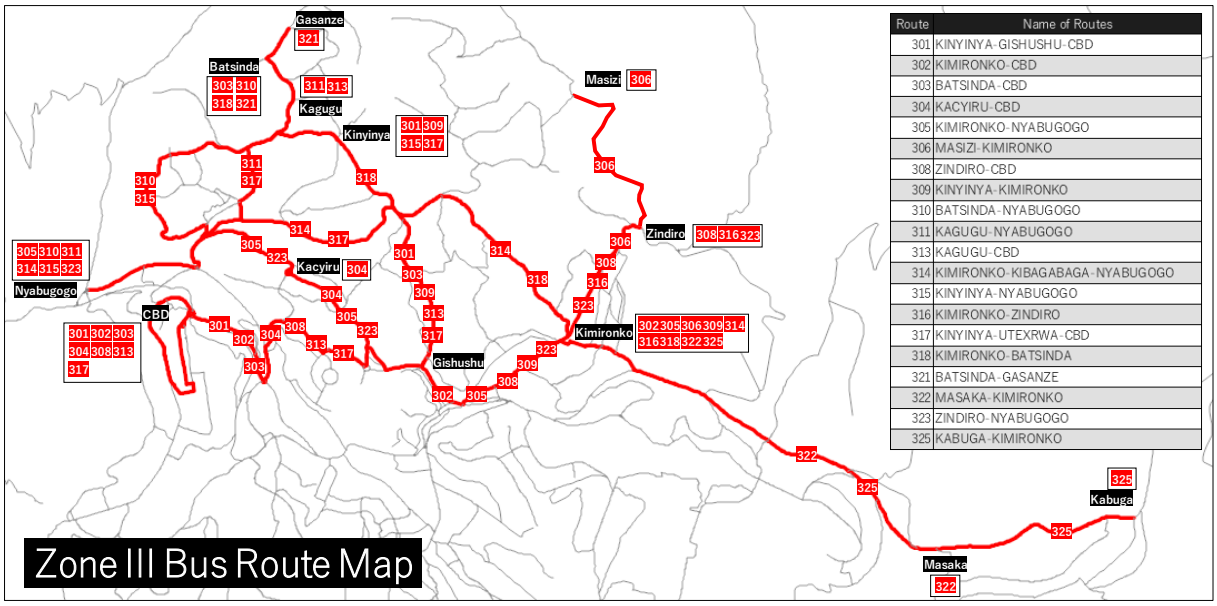
5.5.2 Improving the Convenience of Public Transport

Public transportation in Kigali City has the following issues. Therefore, the convenience is low.

- No one knows when bus will come because there is no timetable.
- No one knows when bus will leave at the bus terminal because bus does not leave until it is full.
- Bus users cannot get on the bus from the bus stop near the bus terminal because bus leaving the bus terminal is full.
- No one knows which route the bus will go through because there is no bus route map.
- It takes time to get on and off the minibus because minibus uses the collapsible spare seat.

These issues can be solved by making a timetable and bus route map, providing these information to bus users, and carrying out bus operations according to the timetable.

The bus route map shown in Figure 5.5.1 below was made by RFTC. They recognize that this bus route map is useful. Such efforts to improve convenience are necessary.



Source: JICA Survey Team

Figure 5.5.1: Zone III Bus Route Map

5.5.3 Development of Signalized Intersection

Signalized intersection in Kigali City operates on fixed timing and it has become a cause of traffic congestion. In addition, traffic capacity is insufficient during peak hours in some roundabouts.

Traffic volume will increase in the future in Kigali City, so the above intersection improvement is necessary.

For existing signals, signal control system is installed and signal cycles shall be applied according to traffic demands to reduce traffic congestion. For existing roundabout, it shall be improved to a signalized intersection and traffic congestion shall be reduced by incorporating it into the signal control system.

5.5.4 Countermeasure for Traffic Accident

There are many traffic accidents caused by motorcycles in Kigali City. First of all, it is necessary to find out the cause of motorcycle accidents. It is assumed that excessive lane changing, passing and overtaking, and excessive speed on a steep downhill slope are causes of motorcycle accidents.

As a measure against motorcycle accidents, dedicated lane for motorcycles can be considered.

5.5.5 Comments from the Working Group

In order to i) share the survey progress, ii) develop common understanding of transport challenges in Kigali City, and iii) discuss on the measures, the Working Group (WG) has been organized among key related authorities such as MININFRA, RTDA, CoK, RURA, and RNP. The member of the WG was selected properly depending on the theme to be discussed in the meeting. The outline of the WG meetings is summarized in Table 5.5.1 below.

Table 5.5.1: Outline of the Working Group Meetings

Working Group	Date	Participant	Contents	Major Output
1st WG	24th May 2018	● RTDA (Chair) ● MINIFRA ● City of Kigali ● JICA ● JICA Survey Team	● Outline of the survey ● Questionnaire from the JICA Survey Team ● Discussion on current status of urban transport development in Kigali City	● Data collection on ongoing/planned transport related projects in Kigali City ● Current traffic issues in Kigali City
2nd WG	28th May 2018	● RTDA (Chair) ● MINIFRA ● RURA ● City of Kigali ● RNP ● JICA ● JICA Survey Team	● Review of 1st WG ● ITS trend in Japan ● Discussion of possible adoption of ITS technology to Kigali City	● Suitable ITS contents for Kigali City ● Suitable smart city control contents in Kigali City
3rd WG	12th July 2018	● MININFRA (Chair) ● RTDA ● City of Kigali ● JICA Survey Team	● Progress of survey ● Proposed interventions by the JICA Survey Team	● Confirmation of the progress ● Discussions on the list of the proposed interventions

Source: JICA Survey Team

(1) Major Challenges Presented through the First Working Group Meeting

Current status and the challenges of transport in Kigali were discussed among transport stakeholders to develop common understanding. The major challenges identified in the WG are listed as follows:

a) Road Safety

- Lack of non-motorized transport (NMT) facilities
- Open roadside ditches
- Lack of road safety features (sign, marking)
- Need for the management of motorcycles

b) Traffic Management

- Uncoordinated traffic signals
- Lack of basic traffic data
- Lack of directional signs
- Outdated (analog) traffic signals
- No priority at junction for public transport
- Lack of real time information for public transport service

c) Public Transport

- Insufficient bus stops and shelters
- Extensive road network which needs to be paved; limited coverage of bus service due to poor condition of the road network
- No timetable for bus service
- No priority at junction for public transport system (bus)
- No dedicated bus lanes on major corridors
- Lack of real time information for public transport service

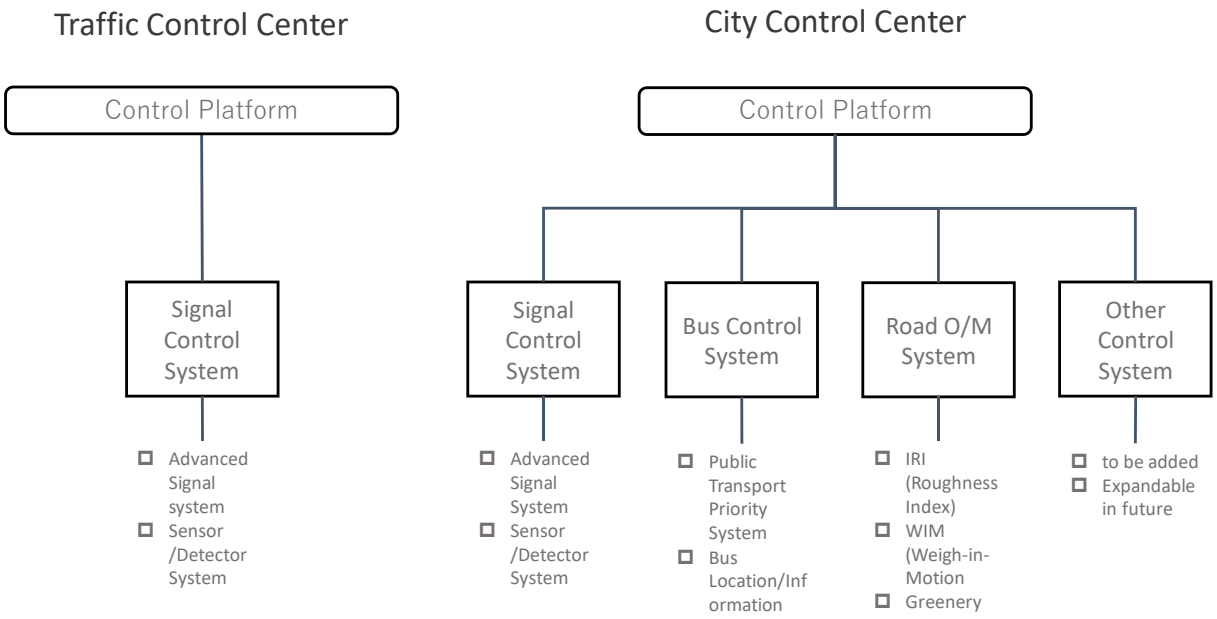
d) Road Network

- Extensive road network which needs to be paved
- Lack of NMT facilities
- Limited coverage of bus service due to poor condition of the road network
- Open roadside ditches
- Lack of road safety features (sign, marking)

(2) Introduction of Smart City Control Center for Kigali City (Discussed through the Second Working Group Meeting)

Through the first meeting, the JICA Survey Team noted that the ongoing/under planning projects were not focusing on the improvement of traffic management.

In the second meeting, the JICA Survey Team introduced ITS trend and examples which would be efficient for attaining the improvement of traffic management. Additionally, not only the Traffic Control Center (TCC) but also the City Control Center (CCC), which includes the TCC and other monitoring/control facilities for city management, was proposed by the JICA Survey Team taking into account the national vision anticipated for IT/Smart City.



Source: JICA Survey Team

Figure 5.5.2: Conceptual Overall Structure of CCC

The WG members have recognized the concept of CCC as an efficient new intervention which complement the current ongoing/under planning projects and synergy effects will be expected from the intervention for tackling the current issues. WG members proposed the following functions for the development of CCC:

a) General Transport

- Traffic signal control (synchronizing the signals by utilizing ITS)
- Big data sharing among all stakeholders
- Operator contracts management by tracking systems
- Axle load control systems
- Institutional arrangement advisory
- Speed limit monitoring system

b) Public Transport

- Punctuality of public transport system through ITS

- Real-time traffic information system
- Traffic control at the timing of special events (includes Umuganda)
- Data collection (i.e., traffic volume, traffic accident)
- Real-time navigation system for the users (drivers)
- Cashless system
- Bus parking management
- Dedicated lane management

c) Other Smart City Contents

- Waste collection by utilizing ITS
- Watering of the roadside green
- Disaster risk management (i.e., fire, earthquake)
- Energy management
- Street light management
- Weather forecast service to users
- Monitoring system for the waterway

(3) Proposed Intervention (Discussed though the Third Working Group Meeting)

The purposes of the third WG meeting are: to explain the interim progress of the survey and to present the proposed interventions as candidate future possible projects to be supported by JICA. The content of the meeting is described in Chapter 7 in this report as the way forward to the following process of the survey.

Chapter 6: Traffic Demand Forecast and Evaluation of Proposed Road Traffic Project

The future traffic demands in 2025, 2030, and 2040 were forecasted based on the results of the traffic survey and socio-economic framework. In conducting the traffic demand forecast, existing road development plan was reflected into the road network data, and forecasting the "with" intervention case, which was proposed by the JICA Survey Team, was also conducted. The effectiveness of road traffic interventions was evaluated by comparing the "with" and "without" intervention case.

6.1 Traffic Demand Forecast

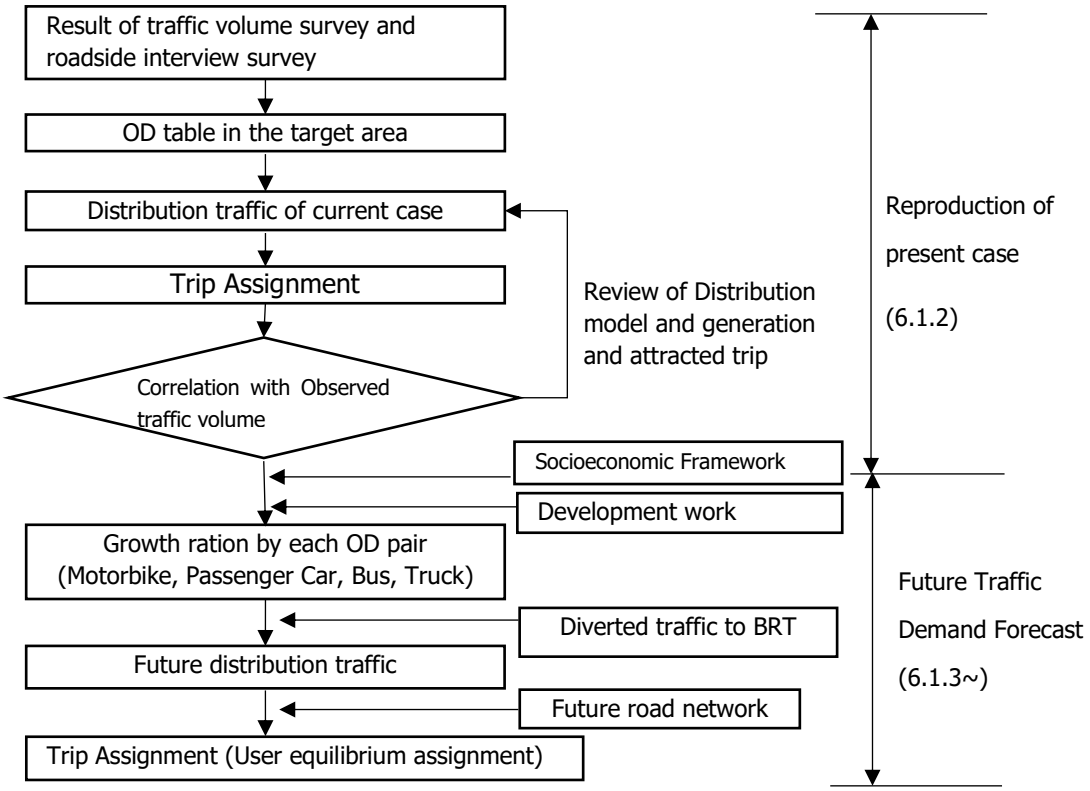
6.1.1 Methodology

(1) Objective

The traffic demand forecast has been conducted to understand the current traffic situation in Kigali City and also to forecast future bottleneck and congestion situations. The traffic demand forecast was conducted through a four-step methodology.

(2) Methodology

The traffic demand forecast was conducted with a four-step methodology. The process is divided into two parts, reproduction of the present case (base case model) and the forecast of the future traffic demand. To analyze the base year model, the JICA survey team collected trip information through roadside interview surveys including origin and destination information and type of vehicle and trip purpose etc. From the roadside interview result, an origin demand (OD) table was formulated considering the socioeconomic status in Kigali City and its surrounding areas.



Source: JICA Survey Team

Figure 6.1.1: Traffic Demand Forecast Flow

The secondary data, which is necessary for traffic demand forecast, is listed in Table 6.1.1. The data was received from different authorities. Population by sector data and other detailed socioeconomic data is not opened to the public since 2012. The JICA Survey Team has estimated the socioeconomic data in 2018 from the base data of 2012.

Table 6.1.1: Source of Secondary Data

Data Category	Source	Organization
Information on registered vehicles in Rwanda	Statistic Year Book	NISR
Current and future land use	Kigali Transportation Master Plan (KTMP)	CoK
Distribution of the resident population by age group	Fourth Population and Housing Census, Rwanda, 2012	NISR
Distribution of the school-age population	Fourth Population and Housing Census, Rwanda, 2012	NISR
Labor-force participation rate (%) among the resident population	Fourth Population and Housing Census, Rwanda, 2012	NISR
Unemployment rate (%) among the active population aged 16 years and above	Fourth Population and Housing Census, Rwanda, 2012	NISR
Bus operation data	-	RURA
Road network data	Kigali Transportation Master Plan (KTMP)	CoK

Source: JICA Survey Team

A traffic zone was created based on the administrative boundary and population distribution. There are 35 zones in Kigali City, nine zones outside Kigali City, and six zones outside Rwanda. Trip generation and attraction were estimated for each traffic zone.

Source: JICA Survey Team

Figure 6.1.2: Traffic Zones in Kigali City

Source: JICA Survey Team

Figure 6.1.3: Traffic Zones in Rwanda

Table 6.1.2: List of Traffic Zones

Traffic Zone	Province	District	Sector
1	Kigali	Gasabo	Bumbogo
2			Gatsata
3			Gikomero
4			Gisozi
5			Jabana
6			Jali
7			Kacyiru
8			Kimihurura
9			Kimironko
10			Kinyinya
11			Ndera
12			Nduba
13			Remera
14			Rusororo
15		Kicukiro	Rutunga
16			Gahanga
17			Gatenga
18			Gikondo
19			Kagarama
20			Kanombe
21			Kicukiro
22			Kigarama
23			Masaka
24			Niboye
25		Nyarugenge	Nyarugunga
26			Gitega
27			Kanyinya
28			Kigali
29			Kimisagara
30			Mageregere
31			Muhima
32			Nyakabanda
33			Nyamirambo
34			Nyarugenge
35			Rwezamenyo
36	Amajyaruguru	Burera,Musanze, Gakenke	
37		Gicumbi	
38		Rulindo	
39	Amajyepfo	Gisagara, Muhanga, Ruhango, Nyanza, Huye, Nyamagabe, Nyaruguru	
40		Kamonyi	
41	Iburasirazuba	Kayonza,Ngoma, Kirehe,Nyagatare,Gatsibo	
42		Bugesera	
43		Rwamagana	
44	Iburengerazuba	Karongi, Nyabihu, Rubayu, Ngororero, Rutsiro, Nyamasheke, Rusizi	
45	Burundi		
46	Democratic Republic of Congo		
47	Kenya		
48	Tanzania		
49	Uganda		
50	Zambia		

Source: JICA Survey Team

The Rwanda Feeder Road Standards state the passenger car unit for each type of vehicle. The JICA Survey Team referred to the standards and decided the Passenger Car Unit (PCU) for each vehicle type. The average number of passengers by vehicle type was estimated from the roadside interview result. As for the bus passenger capacity, Kigali City has several sizes of buses. The JICA Survey Team first collected the bus operational information from the

Rwanda Utility Regulatory Authority (RURA) including the number of operating buses for each route, fare of the route, and total revenue data for each route. From the received data from RURA, the average number of passengers was decided.

Table 6.1.3: PCU Factor

	PCU Factor in Rwanda Feeder Road Standards Terrain: Level	PCU Factor by set the JICA Survey Team
Motorcycle	0.5	0.5
Passenger car, pickup, jeep	1.0	1.0
Small bus	2.0	2.0
Medium bus	2.0	
Large bus	2.0	
Light goods vehicle	1.0	1.7
Heavy goods vehicle	3.5	

Source: Rwanda Feeder Road Standards

Table 6.1.4: Average Number of Passengers by Vehicle Type

Type of Vehicle	Average Number of Passengers by Vehicle Type
Motorcycle	1.38
Passenger car, pickup, jeep	2.03
Small bus	3.47
Medium bus	22.05
Large bus	50.70
Light goods vehicle	2.26
Heavy goods vehicle	2.00
Others (tractors, bicycle etc)	2.80

Source: JICA Survey Team

The road network was created based on the road network data shown in the Kigali City Transportation Master Plan Report. In the report, the existing road network and future road network in 2040 are described. The JICA Survey Team referred to the road network.

In the Kigali City Transportation Master Plan, the road classification has four categories, i.e.; high capacity urban roads, major arterial roads, minor arterial road, and collector road. Additionally, the Road Act No. 55/2011 has its own classification; national road paved or unpaved, district road class one, and district road class two. The JICA Survey Team referred the above road classification and calculated the road capacity by the JICA Survey Team. Road classification was decided based on the site survey or existing road network data received from Kigali City.

Multiple-lane Road: $C_D = C_B \times F_{lw} \times F_{rs} \times F_{tr} \times F_{los} \times \frac{N}{2} \times \frac{100}{K} \times \frac{100}{D}$

Two-lane Road: $C_D = C_B \times F_{lw} \times F_{rs} \times F_{tr} \times F_{pv} \times F_{los} \times \frac{100}{K}$

C_D: Daily Road Capacity PCU/day

C_B: Basic Road Capacity PCU/day

F_{lw}: Adjustment Factor for Lane Width

F_{rs}: Adjustment Factor for Right-Shoulder Lateral Clearance

F_{tr}: Adjustment Factor for Terrain

F_{los}: Adjustment Factor for Level of Service

N: Number of Lanes

K: K factor, Factor of Peak Hour Ratio

D: D factor, Factor of Directional Distribution

Table 6.1.5: Basic Road Capacity

Road Classification	Road Capacity	
Multi-lane or one-way road	2,200	pcu/h/lane
Two-way two-lane road	2,500	pcu/h/two-lane
Two-way one-lane road	500	pcu/h/lane

Source: Highway Capacity Manual 1984

Table 6.1.6: Adjustment Factor for Lane Width

Lane Width (m)	flw
W≧3.25	1.0
3.25＞W≧3.00	0.94
3.00＞W≧2.75	0.88
2.75＞W≧2.50	0.82

Source: Highway Capacity Manual 1984

Table 6.1.7: Adjustment Factor for Right-Shoulder Lateral Clearance

Lateral Margin	1.75	1.5	1.25	1	0.75	0.5	0
Two-lane	1	0.96	0.92	0.86	0.81	0.75	0.7
Multi-lane	1	0.99	0.98	0.97	0.94	0.9	0.81

Source: Highway Capacity Manual 1984

Table 6.1.8: Adjustment Factor for Terrain

Terrain	Two-lane	Multi-lane
Expressway	1	1
Mountainous	0.9	0.95
Flat	0.85	0.9
Urban	0.7	0.75

Source: Highway Capacity Manual 1984

Table 6.1.9: Adjustment Factor for Level of Service

Zone	One- or two- lane	Three-lane or more
Urban	0.80	0.80
Others	0.90	0.90

Source: Highway Capacity Manual 1984

Table 6.1.10: Adjustment Factor for Factor K and Factor D

Zone	K (%)	D (%)
Urban	7	56

Source: Highway Capacity Manual 1984

Table 6.1.11: Adjustment Factor for Signalized Intersection

Road Classification	Factor
Two-lane	0.8
Multi-lane	0.6

[1]Source: Highway Capacity Manual 1984

Table 6.1.12: Road Capacity by Road Classification

Road Classification	Speed	Number of Lanes	Road Capacity
HCUR	60	2	19,327
Major Arterial (four-lane)	60	4	32,800
Major Arterial (two-lane)	60	2	26,910
Minor Arterial	60	2	19,327
Rural Collector	40	2	17,394
Community Road	40	2	6,958
Unpaved Road in Outer Area	50	2	10,808

Source: JICA Survey Team

[1] The JICA Survey Team referred to the Highway Capacity Manual which was translated in Japanese to decide the adjustment factors.

6.1.2 Base Year Model

(1) Social and Economic Condition

To analyze traffic movement in Kigali City, population data is essential. The National Institute of Statistics of Rwanda (NISR) summarized population data in Fourth Population and Housing Census, Rwanda, 2012. Population in 2018 was estimated from the figures written in the Kigali City Master Plan. Several indicators in 2012 are shown below.

Table 6.1.13: Socioeconomic Data for Kigali City and Rwanda (2012)

	Population	Number of Household	Population over 16 years old	Labor-force Participation Rate (%) among the Resident Population aged 16 years	School Age Population		
					Pre-school Age	Primary School Age (7-12 years)	Secondary School Age (7-12 years)
Rwanda	10,515,973	2,424,898	-	73.6	1,280,857	1,712,459	1,365,771
Kigali	1,132,686	286,664	729,124	68.6	114,995	134,487	131,585

Source: Rwanda 4th Population and Housing Census, 2012 (NISR)

(2) Four-Step Methodology

As written above, the base year model was estimated from the roadside interview result, socioeconomic data, and road network data.

The trip generation and attraction model was estimated by types of vehicles and trip purpose as following classification. The parameter used in the generation and attraction model is analyzed from the neighboring area of the survey location first since the roadside interview does not cover the entire trips in the city. After deciding the parameters, generation and attraction traffic were estimated for all traffic zones. Regarding bus trips, operation data from RURA was utilized to assume the OD table.

Table 6.1.14: Considered Factors in Trip Generation and Attraction Model

Variables	Classification
Location	Kigali City, outside Kigali City, outside Rwanda
Type of vehicle	Motorbike, passenger car, bus, truck
Trip purpose	To Work, to school, to home, others
Personal attributes	Labor force people, students, others

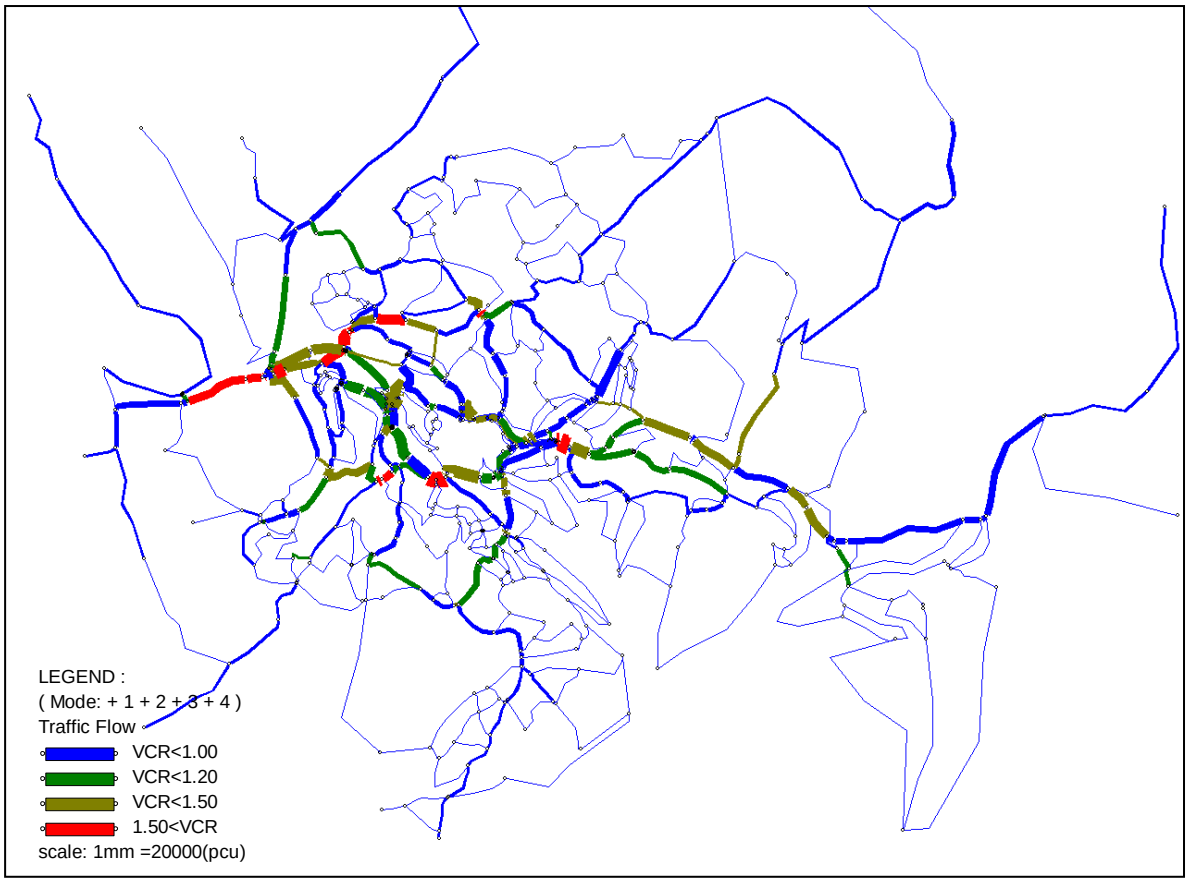
Source: JICA Survey Team

The distribution model was used in the gravity model and was estimated from the roadside interview result. The assignment trip was estimated by user equilibrium model. Assignment traffic was calibrated by comparing the traffic volume survey result and the collected OD data. Calibration was conducted by Frater Method.

(3) Base Year Model

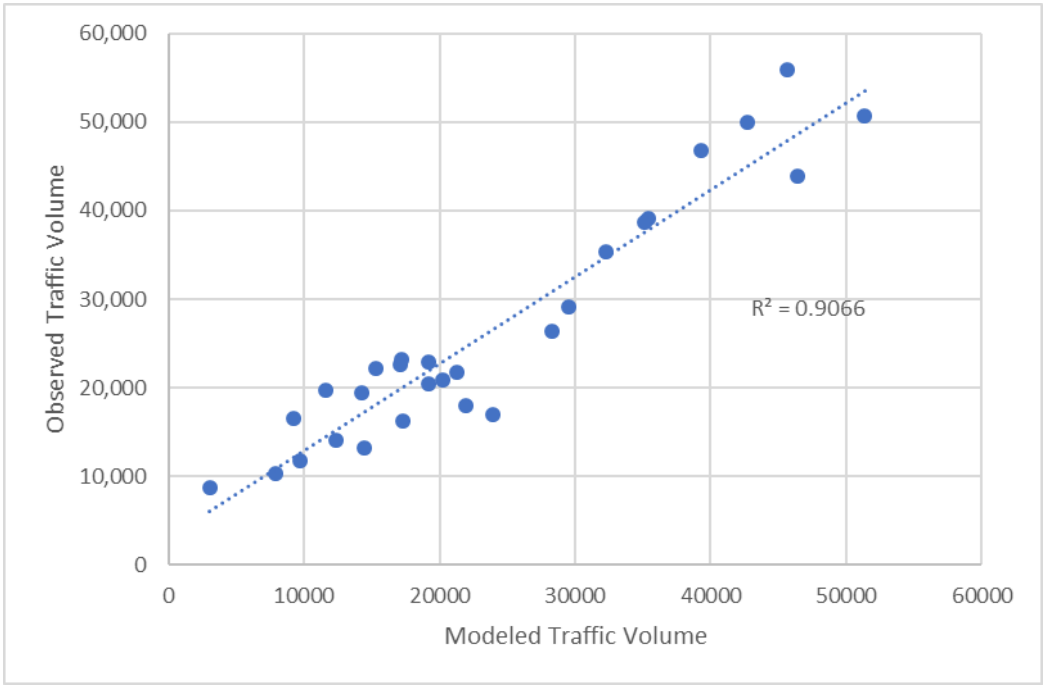
The reproduction result is shown in Figures 6.1.4 and 6.1.5. The correlation coefficient is 0.91 which compares the simulation result and the traffic volume survey result. It can be said that there is a correlation. It is found that major arterial roads such as RN3, RN15, KN5, and KN3 are congested due to the high traffic demand. The travel speed survey result also showed a similar tendency.

To cross the east–west direction in the city, vehicles need to pass the KN3 or RN3 usually. Therefore, traffic was concentrated on those two roads. A high VCR was observed in Gisozi, the road near the convention center, Giporoso, and Nyarugunga.



Source : JICA Survey Team

Figure 6.1.4: Result of the Base Year Model 2018



Source : JICA Survey Team

Figure 6.1.5: Correlation of Observed Traffic and Modeled Traffic

From the following part, methodology and result for future traffic demand were descripted.

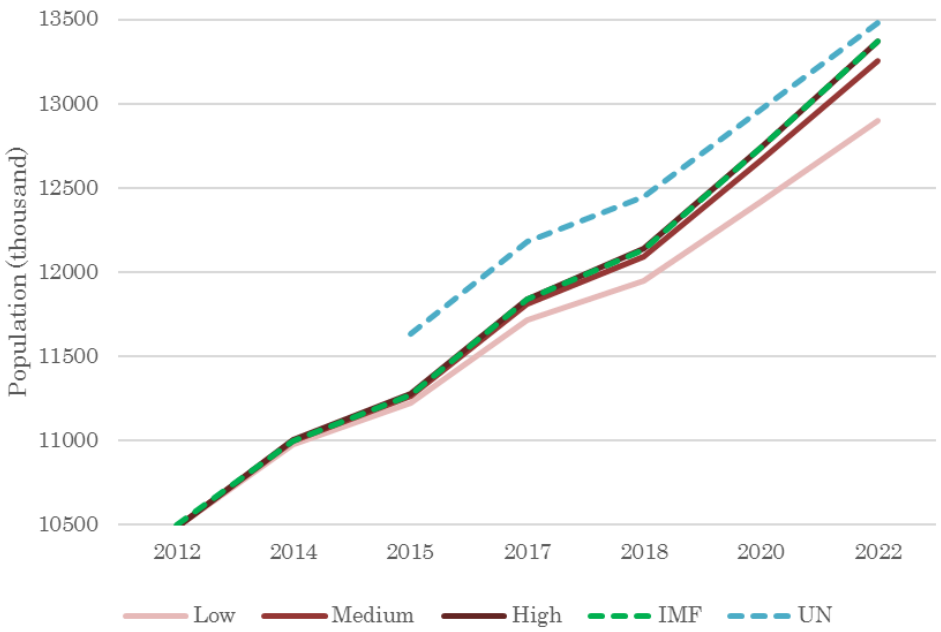
6.1.3 Future Socioeconomic Framework

(1) Population

Future population in Kigali was predicted based on the figure written in the Kigali City Master Plan. Future population was predicted for resident, nighttime population for worker, daytime population for worker, nighttime population for student, and daytime population for student.

On the other hand, the population outside of Kigali City was calculated by using the following methodology.

Step 1: The NISR predicted the future population for three scenarios by 2032 in the Fourth Population and Housing Census 2012. The JICA Survey Team compared the future population with the prediction done by the International Monetary Fund (IMF) and World Bank (WB). As a result, the population of high growth scenario is similar to the trend in the IMF and UN's prediction. The JICA Survey Team adopted the high growth scenario of NISR. The NISR did not predict the population after 2032. The population in 2040 was predicted based on the UN's data and by the JICA Survey Team's forecast.



Source: JICA survey team

Figure 6.1.6: Population of Rwanda in Three Scenarios

Step 2: After the construction of the Bugesera International Airport (BIA), the population in the Bugesera Province seems to be high. The population was then calibrated using the future population written in the "Bugesera Airport Belt Urban Development Plan".

Step 3: Considering the results of Step 2 and the population growth in Kigali, the population of other provinces were calibrated.

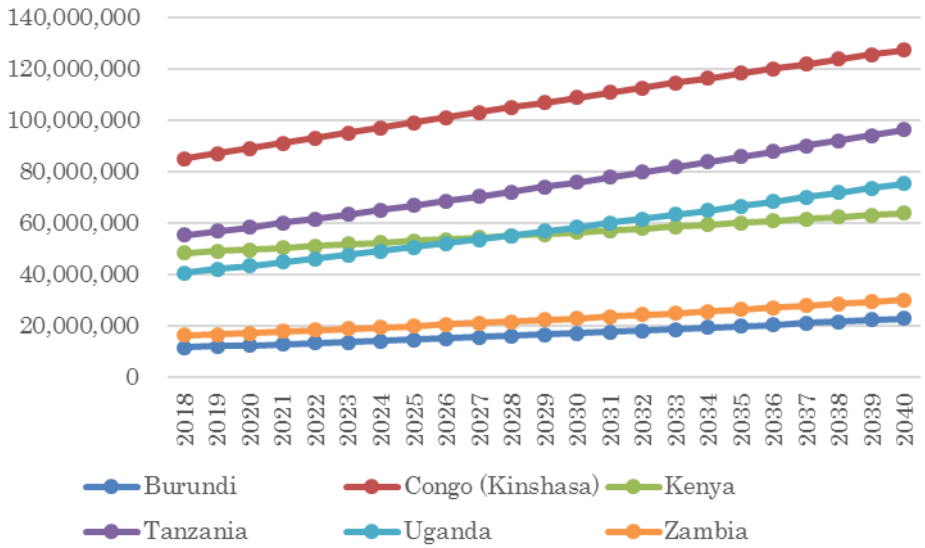
Table 6.1.15: Future Resident Population

Unit: People

Zone	Location			2018	2025	2030	2040
1			Bumbogo	48,401	98,134	118,089	153,393
2			Gatsata	50,055	47,923	51,885	58,895
3			Gikomero	22,719	29,670	35,937	47,025
4			Gisozi	59,912	85,948	99,880	124,528
5			Jabana	45,799	50,046	67,677	98,870
6			Jali	34,048	47,745	55,280	68,612
7			Kacyiru	49,441	65,002	74,273	90,676
8			Kimihurura	29,124	44,770	52,449	66,035
9			Kimironko	77,411	136,214	162,737	209,663
10			Kinyinya	70,662	184,747	228,715	306,503
11			Ndera	60,304	139,293	174,509	236,814
12			Nduba	34,596	65,323	78,593	102,070
13			Remera	58,121	76,235	88,834	111,123
14			Rusororo	47,499	110,598	158,317	242,742
15		Gasabo	Rutunga	20,513	42,258	42,662	43,376
16			Gahanga	37,859	126,735	180,812	276,486
17			Gatenga	77,324	91,715	117,459	163,004
18			Gikondo	28,988	32,470	37,560	46,564
19			Kagarama	12,976	80,662	102,675	141,621
20			Kanombe	71,417	94,762	139,375	218,304
21			Kicukiro	19,369	31,489	36,635	45,740
22			Kigarama	60,443	86,562	101,410	127,680
23			Masaka	53,221	121,843	217,265	386,087
24			Niboye	34,864	66,124	79,368	102,799
25		Kicukiro	Nyarugunga	51,509	98,568	119,071	155,346
26			Gitega	33,343	40,084	42,963	48,057
27			Kanyinya	29,476	53,985	64,426	82,899
28			Kigali	47,190	43,410	59,087	86,823
29			Kimisagara	63,298	59,903	64,299	72,077
30			Mageregere	32,014	32,161	53,815	92,127
31			Muhima	22,425	34,259	35,961	38,971
32			Nyakabanda	34,505	37,468	41,388	48,323
33			Nyamirambo	64,722	80,335	94,558	119,723
34			Nyarugenge	20,187	38,822	44,655	54,977
35	Kigali	Nyarugenge	Rwezamenyo	22,329	24,735	27,382	32,066
36	Amajyaruguru	Burera,Musanze, Gakenke		1,203,436	1,318,745	1,442,483	1,616,707
37	Amajyaruguru	Gicumbi		456,422	500,155	547,085	613,162
38	Amajyaruguru	Rulindo		331,906	363,708	397,835	445,886
39	Amajyepfo	Gisagara, Muhanga, Ruhango, Nyanza, Huye, Nyamagabe, Nyaruguru		2,595,285	2,843,957	3,110,806	3,486,530
40	Amajyepfo	Kamonyi		392,846	430,487	470,880	527,753
41	Iburasirazuba	Kayonza,Ngoma, Kirehe,Nyagatare,Gatsibo		2,215,540	2,427,825	2,655,628	2,976,376
42	Iburasirazuba	Bugesera		417,551	457,559	500,492	560,942
43	Iburasirazuba	Rwamagana		361,649	396,301	433,486	485,843
44	Iburengerazuba	Karongi, Nyabihu, Rubayu, Ngororero, Rutsiro, Nyamasheke, Rusizi		2,851,142	3,124,329	3,417,485	3,830,250

Source: JICA Survey Team

Population outside Rwanda was referred to the prediction by the United States Census Bureau.



Source: United States Census Bureau

Figure 6.1.7: Population of the Surrounding Countries of Rwanda

(2) Gross Domestic Product (GDP)

To conduct the traffic demand forecast, a change of economic situation needs to be considered, thus the GDP growth should be estimated. The "Project for Master Plan on Logistics in Northern Economic Corridor" shows the GDP value for some African countries. Furthermore, "The Study on Master Plan of Lusaka South Multi-facility Economic Zone in the Republic of Zambia" shows the GDP growth ratio in Zambia. The JICA Survey Team used the following values shown in Table 6.1.16 for the GDP values.

Table 6.1.16:Annual GDP Growth Ratio in Surrounding Countries of Rwanda

Country	2015	2020	2025	2030
Burundi	4.8%	4.5%	4.5%	4.2%
Rwanda	7.0%	6.0%	5.5%	5.0%
Tanzania	7.2%	7.0%	6.5%	6.0%
Kenya	6.0%	8.6%	7.9%	5.7%
Uganda	5.0%	9.5%	10.8%	5.7%
DRC	8.5%	5.4%	5.5%	5.5%
South Sudan	3.4%	5.5%	6.5%	6.0%

Source: The Study on Master Plan of Lusaka South Multi-Facility Economic Zone in the Republic of Zambia

6.1.4 Future Traffic Demand

(1) Future Road Network

The future road network was referred in the following development plan shown in Tables 6.1.17 and 6.1.18.

Table 6.1.17: Future Road Development Plan

Project Name	Speed	Capacity	Year	Note
Kigali Ring Road Project	90 km/h	80,988 pcu	2024	-
BRT	-	-	2025 2030 2040	Consider dedicated bus lanes
Kigali-Kayonza Road Rehabilitation Project	60 km/h	32,800 (4-lane)	2025	-
Rehabilitation and Upgrading of Kigali-Muhanga-Akanyaru Road	60 km/h	32,800 (4-lane)	2019	Focus on the Kigali-Muhanga section
Expressway Kigali Bugesera International Airport	60 km/h	32,800 (4-lane)	2020	-
Multi-lane Divided Highway Nyabugogo-Jabana and Nyachonga-Mukoto Upgrading Road Project	60 km/h	32,800 (4-lane)	2022	-
Upgrading and Rehabilitation of Urban Roads in city of Kigali	60 km/h	Depend on each road class	2025	
7 Intersection Improvement	This project was considered in the micro simulation			
Standard Gauge Railways	Development year and capacity are not studied, this project was not applied to the traffic demand forecast			
MRT	Development area and capacity are not studied, this project was not applied to the traffic demand forecast			
Kigali Transportation Master Plan (KTMP)	Depend on each road class	Depend on each road class	2025, 2040	-

Source: JICA Survey Team

Table 6.1.18: Future Development Plan

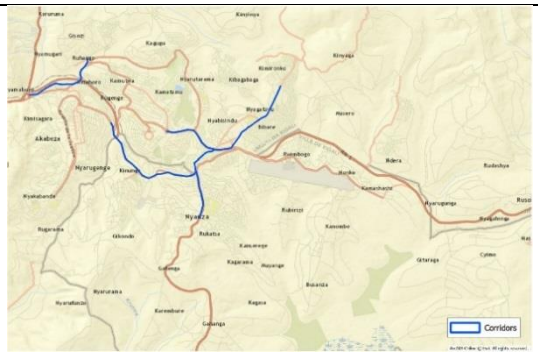
Project Name	Year	Traffic Demand
Kigali Logistic Platform (KLP)	2020	Referred to the Kigali Logistics Platform Project Brief
Development around Bugesera International Airport (BIA)	Year by year	Referred to the Bugesera Airport Belt Urban Development Plan and population growth was considered in the population forecast
Bugesera International Airport (BIA)	2020	Referred to the Bugesera Airport Master Plan

Source: JICA Survey Team

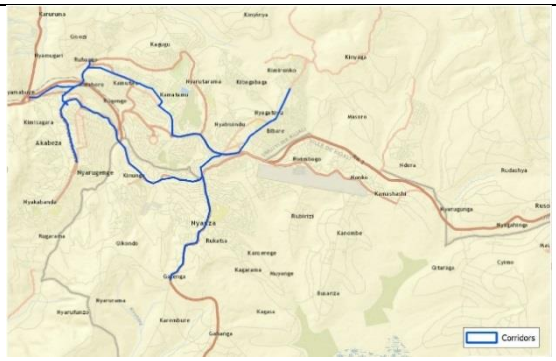
If the toll road will be constructed, pricing sensitivity needs to be considered. However, the existing report “Consultancy Services for Feasibility Study, Technical and Economic Studies, Detailed Engineering Design, and Preparation of Tender Documents for Kigali Ring Road (80 km) of Feasibility Study Report (Draft)” does not mention the specific toll price. Furthermore, during the interview with the Aviation Travel and Logistics Holding Ltd (ATL), the JICA Survey Team confirmed that toll collection is not considered in the Kigali-BIA expressway.

As for the BRT, the development plans for 2025, 2030 and 2040 are shown in the second interim report, development plan has a passenger volume for BRT and non-BRT services. Kigali City originally planned the dedicated bus lanes besides the current BRT plan, but Kigali City did not develop the dedicated bus lane plan since the feasibility study for the BRT is

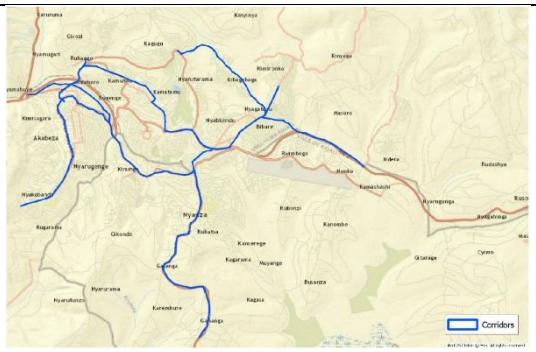
ongoing. Accordingly, the JICA Survey Team referred to the future dedicated BRT lanes from the second interim report of the BRT Feasibility Study. Figure 6.1.8 shows the plan of the dedicated bus lanes.



2025



2030



2040

2025: Dedicated bus lanes will be developed for 16.74 km
2030:13.6 km of sections will be developed
2040:17.3 km of sections will be developed

Source: Consultancy Services for Feasibility Study, Technical and Economic Studies, Detailed Engineering Design and Preparation of Tender Documents for Kigali Ring Road (80 km) of Feasibility Study Report (Draft)

Figure 6.1.8: Development Route of BRT

Regarding Kigali Transportation Master Plan (KTMP), future road plan is shown in the master plan. The JICA Survey Team referred to the future road network. In the Kigali Transportation Master Plan, “Major Arterial” is estimated as three-lane development, but some of them are already constructed as four- lane. Future road network should be set compared with the current situation and future plan.

(2) Generation and Attraction Trip

The future generated trip was calculated using the future population and working population by zone.

In general, the number of trips per person tends to increase as private car ownership rate rises with economic development. The number of trips per person excluding non-motorized traffic (NMT) was set to increase from 0.86 trips/inhabitant/day in 2018 to 1.17 trips/inhabitant/day in 2040 in accordance with the BRT Feasibility Study. Next, the cargo traffic volume was calculated based on the transition of GDP in the future.

(3) Distribution Trip

The distribution trip was estimated from average growth rate method using the base year model OD. The average growth rate method is a prediction of the future distribution trips by calculating the average growth of trips in both the generation zone and attraction zone.

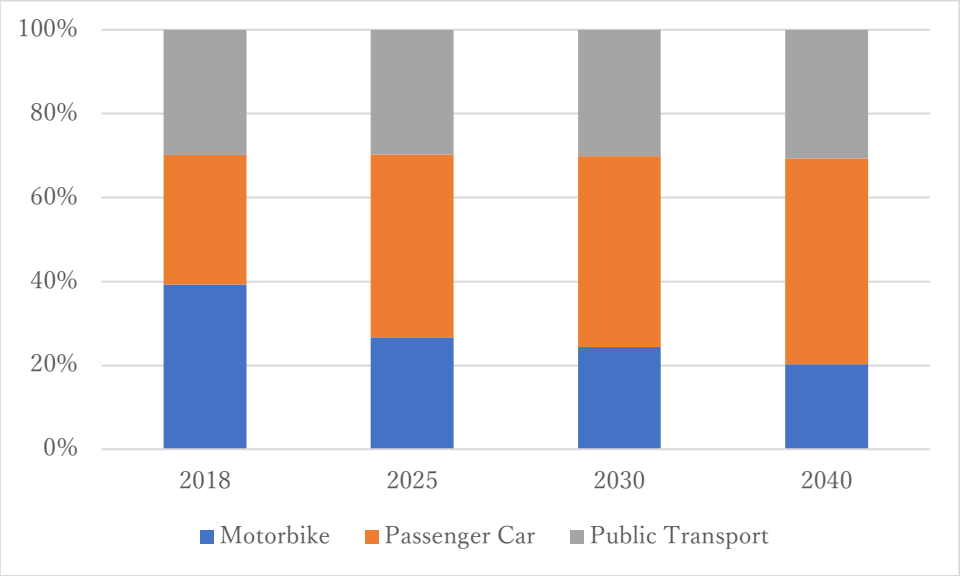
$$T_{ij} = t_{ij} * \frac{1}{2}\left(\frac{Gi}{g_i} + \frac{A_j}{a_j}\right)$$

T_{ij}: *Future Distribution Traffic* t_{ij}: *Distribution Traffic in* 2018
G_{ij}: *Future Generation Traffic* g_i: *Attraction Traffic in* 2018
A_{ij}: *Future Attraction Traffic* a_j: *Attraction Traffic in* 2018
T_{ij}: *Future Distribution Traffic*

(4) Modal Split

The modal split was decided and set based on the BRT Feasibility Study. In the BRT Feasibility Study, the "reference scenario" and "BRT scenario" were described, the JICA Survey Team decided the modal split ratio based on the BRT scenario. The modal split in the future is shown in the following figure. Public transport will be strengthened towards 2040, and the passenger car ratio will grow especially since car ownership will be higher.

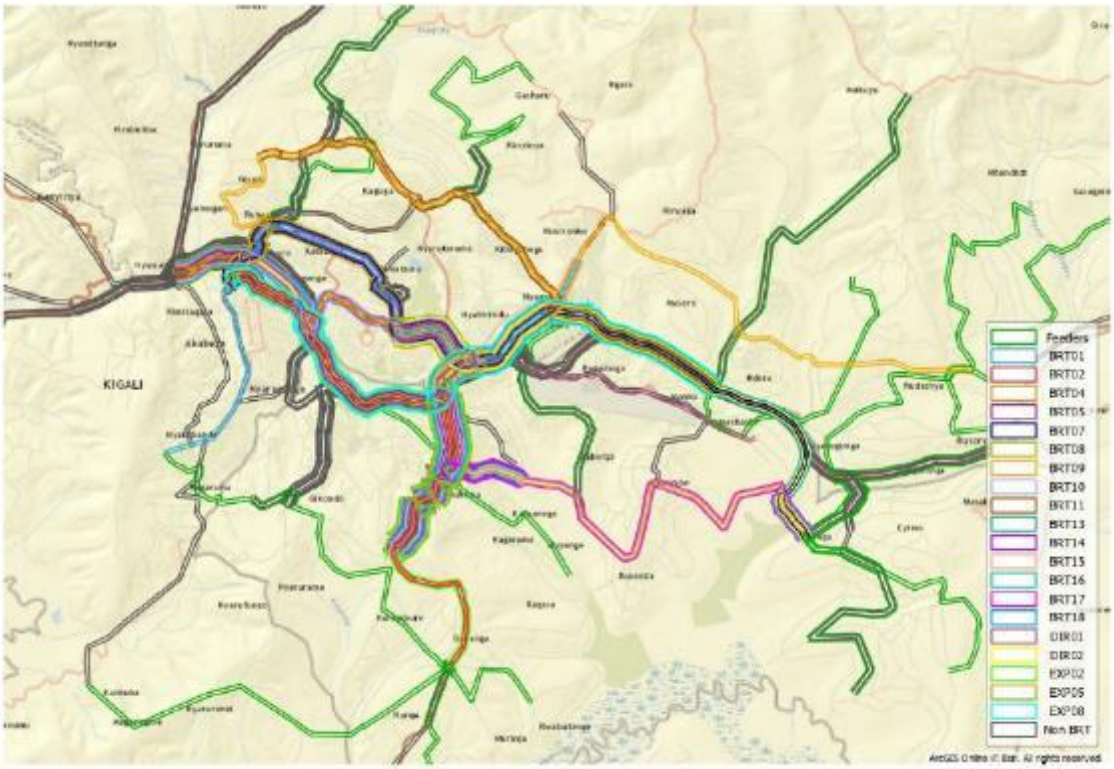
Figure 6.1.9 is estimated by the JICA Survey Team referring to the BRT feasibility survey result.



Source: JICA Survey Team

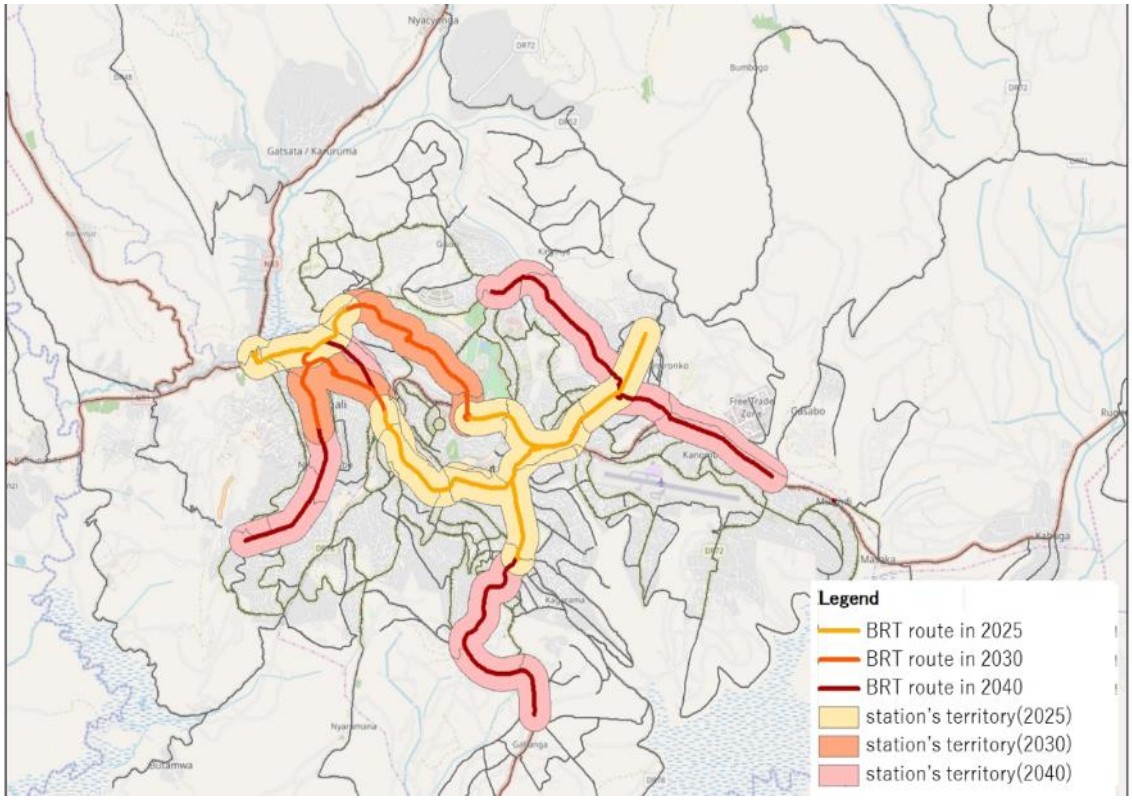
Figure 6.1.9: Modal Split Ratio except NMT and Freight Traffic

The total trip number of the BRT is written in the feasibility study report, but there is no description about the number of trips in the administrative zone. Therefore, it is necessary to estimate the number of BRT trips by traffic zones. Firstly, the BRT station's territories were set in a 400 m radius from the BRT route. Secondly, the number of BRT users is calculated from the coverage area of the BRT station's territories. Thirdly, the distribution trip was estimated by using the Frater Method and a number of generation and attraction trips. Walking area with a 400 m radius is the value adopted in the BRT Feasibility Study. The following figures show the future BRT route and urban bus and BRT station's territories.



Source: JICA Survey Team

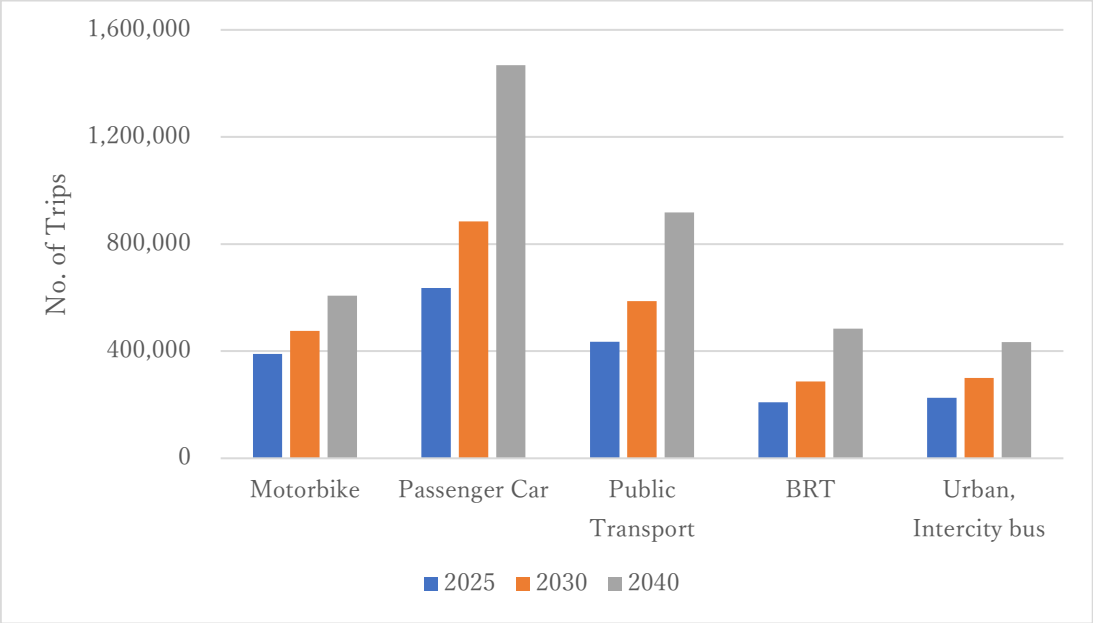
Figure 6.1.10: Development Plan of BRT and Urban Bus



Source: JICA Survey Team

Figure 6.1.11: BRT Station's Territories

In addition to the BRT, the current bus service is planned to be continued. The number of urban bus users was estimated considering the BRT development and distributed to each traffic zone.



Source: JICA Survey Team

Figure 6.1.12: Trip Growth Ratio by Mode of Transport

(5) Large-scale Development Plan

To conduct the traffic demand forecast, the development plan of the industrial zone and airport should be incorporated. Currently, the Kigali Logistic Platform (KLP) is being constructed at Masaka sector, west of Kigali City. Contracts have been concluded in 2016 for the 25-year concession period. The KLP will be completed in 2020. Table 6.1.19 shows the estimated traffic volume that the JICA Survey Team considered.

Table 6.1.19: Traffic Volume at KLP

Type of Vehicle	veh/year
Container trailer 1 TEU	51,000
Container trailer 2 TEU	26,000
Small cargo truck	130,000
Staff vehicle	36,500
Supply vehicle	36,500

Source: Kigali Logistics Platform Project Brief

With regard to the BIA, the airport aims to open by 2020, and the numbers of passengers and freight volumes were estimated as shown in Table 6.1.20 and Table 6.1.21. As a result of the interview with ATL, it was heard that the Kigali International Airport will not be used for passenger and cargo transportation after the BIA is in operation. Passenger and cargo transportation will be focused on BIA and the Kigali International Airport will be used for military purposes.

Therefore, the following estimate is taken as the traffic volume of BIA after 2020. However, for freight traffic volume, it is necessary to convert the traffic volume from weight-based data. In this data collection survey, the JICA Survey Team conducted the roadside interview survey, vehicle classification, and transport weight. From the results, the JICA Survey Team calculated the unit of truck transport weight, then converted to freight traffic volume.

The future passenger and cargo volume are only predicted until 2025. Therefore, it is necessary to estimate the number of passengers up to 2040. However, the number of passengers by region and the plan of flight schedule are not mentioned, the number of passengers will be calculated from the population growth in Kigali City and the freight traffic volume was estimated from the GDP growth.

Table 6.1.20: Number of Passengers at BIA

	2006	2010	2015	2020	2025
Base	290,000	386,000	542,000	752,000	1,008,000
High	290,000	406,000	613,000	914,000	1,314,000
Low	290,000	371,000	501,000	662,000	850,000

Source：Bugesera Airport Master Plan

Table 6.1.21: Freight Volumes at BIA

	2005	2010	2015	2020	2025
Base	5,830	7,400	9,500	12,100	15,500
High	5,830	7,700	10,200	13,500	17,800
Low	5,830	7,100	8,600	10,500	12,800

Source：Bugesera Airport Master Plan

Finally, the JICA Survey Team considered the progress of urban development around BIA. In the “Bugesera Airport Belt Urban Development Plan” issued by the Bugesera District, the future population is projected in Figure 6.1.13.

From the following table, the future development was considered in the increase of the traffic volume.

Sector	Population						
	2012	2022			2032		
		High	Medium	Low	High	Medium	Low
GASHORA	22,119	66357	55297.5	44238	132714	110595	88476
JURU	23,703	71109	59257.5	47406	142218	118515	94812
KAMABUYE	20,864	62592	52160	41728	125184	104320	83456
MAREBA	22,350	67050	55875	44700	134100	111750	89400
MAYANGE	28,297	84891	70742.5	56594	169782	141485	113188
MUSENYI	29,341	88023	73352.5	58682	176046	146705	117364
MWOGO	17,575	52725	43937.5	35150	105450	87875	70300
NGERUKA	30,661	91983	76652.5	61322	183966	153305	122644
NTARAMA	18,043	54129	45107.5	36086	108258	90215	72172
NYAMATA	34,939	104817	87347.5	69878	209634	174695	139756
NYARUGENGE	20,953	62859	52382.5	41906	125718	104765	83812
RILIMA	29,131	87393	72827.5	58262	174786	145655	116524
RUHUHA	23,022	69066	57555	46044	138132	115110	92088
RWERU	28,928	86784	72320	57856	173568	144640	115712
SHYARA	13,413	40239	33532.5	26826	80478	67065	53652
BUGESERA	**363,339**	**1090017**	**908347.5**	**726678**	**2180034**	**1816695**	**1453356**

Source：JICA Survey Team

Figure 6.1.13: Population Projection in Bugesera District

(6) Result of Traffic Demand Forecast

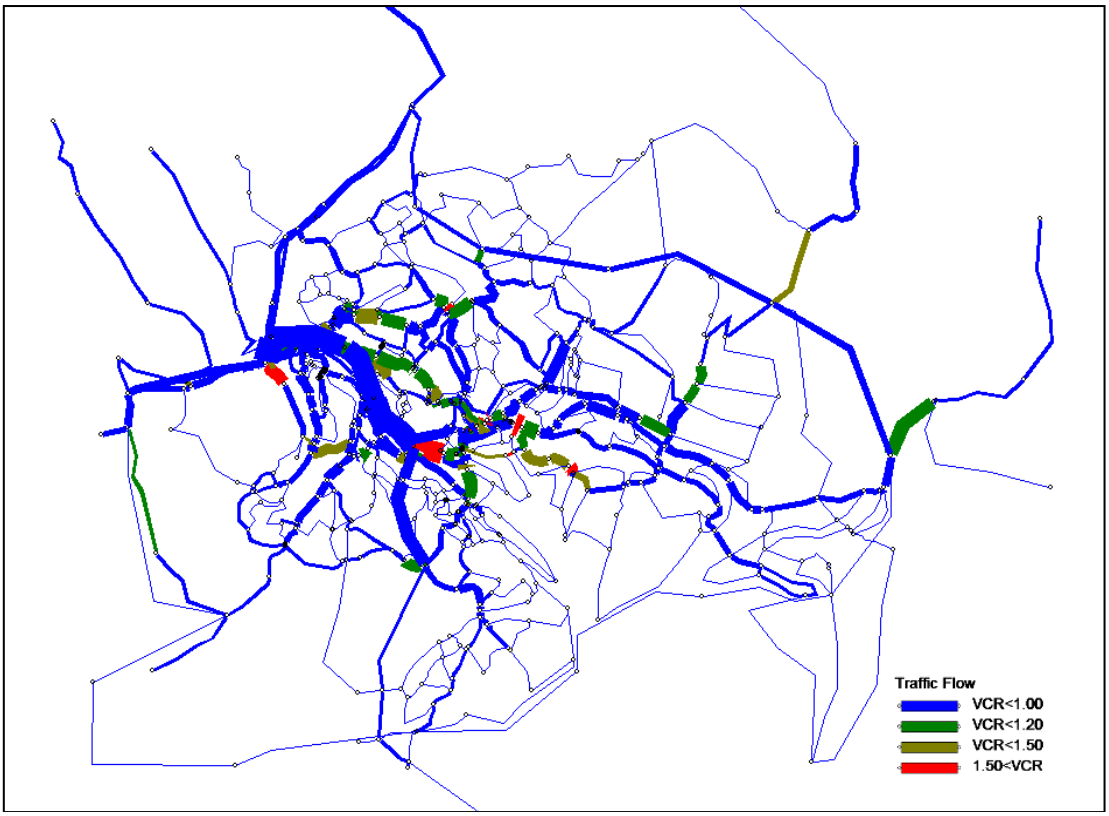
From the above results, the assignment trip was calculated through user equilibrium allocation. The results of the traffic demand forecast are shown in Table 6.1.22. As a result of the traffic demand forecast, road construction and BRT development will be progressed towards 2040, but the traffic volume increases due to the rapid population increase, which shows that the congestion situation will become worse over time.

The high capacity urban road (HCUR) passes from Nyabugogo to the southern part of Kigali, which is proposed in the Kigali Transportation Master Plan. The ring road was observed to have a large amount of traffic volume. It is expected that a ring road will surround Kigali City, but the traffic volume in the south is small.

Table 6.1.22: Result of Traffic Demand Forecast

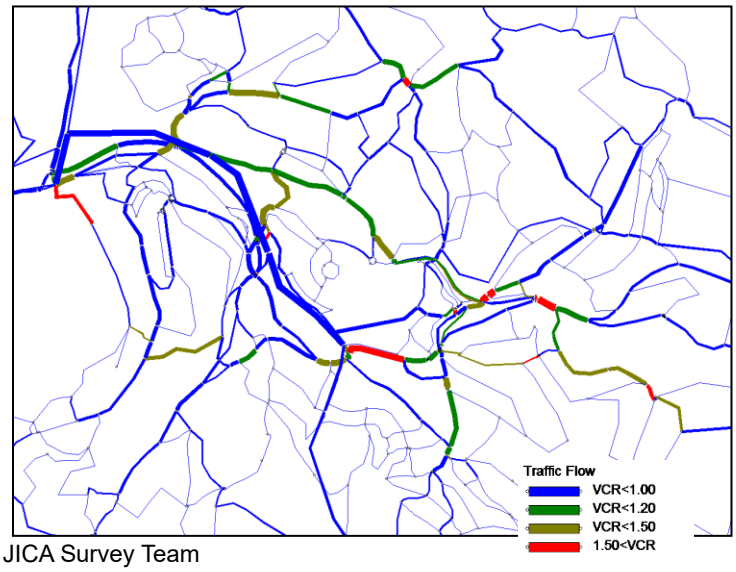
Year	V/C	Average Speed	Total Trip Length (km)	Total Trip Time (hour)
2025	0.27	59.9	6,373,968	106,474
2030	0.36	57.7	8,661,599	149,999
2040	0.53	52.9	14,001,251	264,710

Source: JICA Survey Team



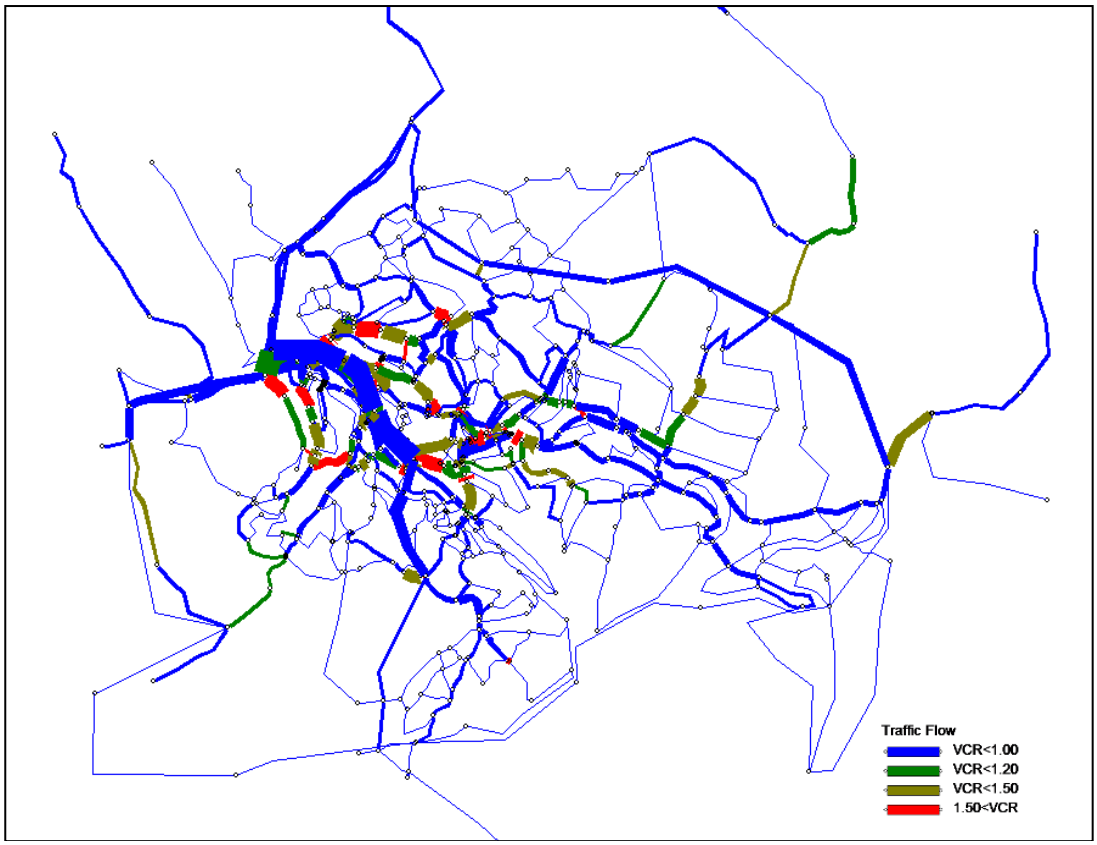
Source: JICA Survey Team

Figure 6.1.14: Result of the Traffic Demand Forecast- Entire Kigali (2025)



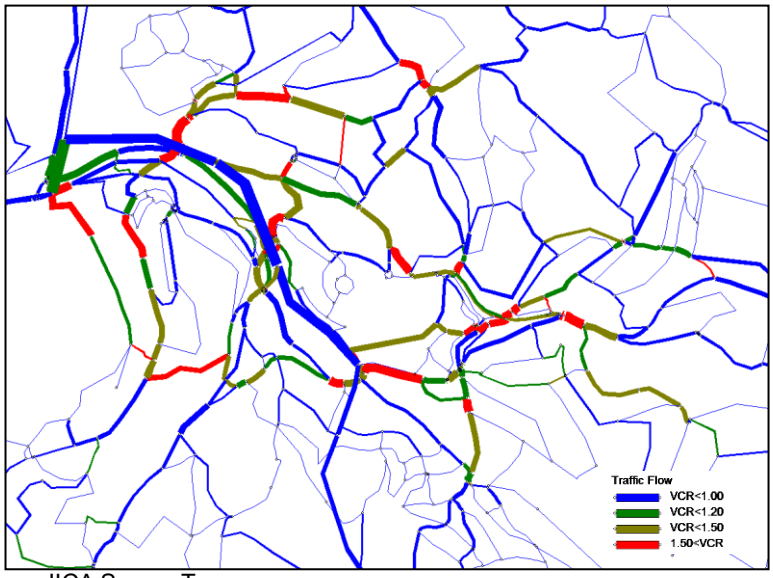
Source: JICA Survey Team

Figure 6.1.15: Result of the Traffic Demand Forecast- City Center (2025)



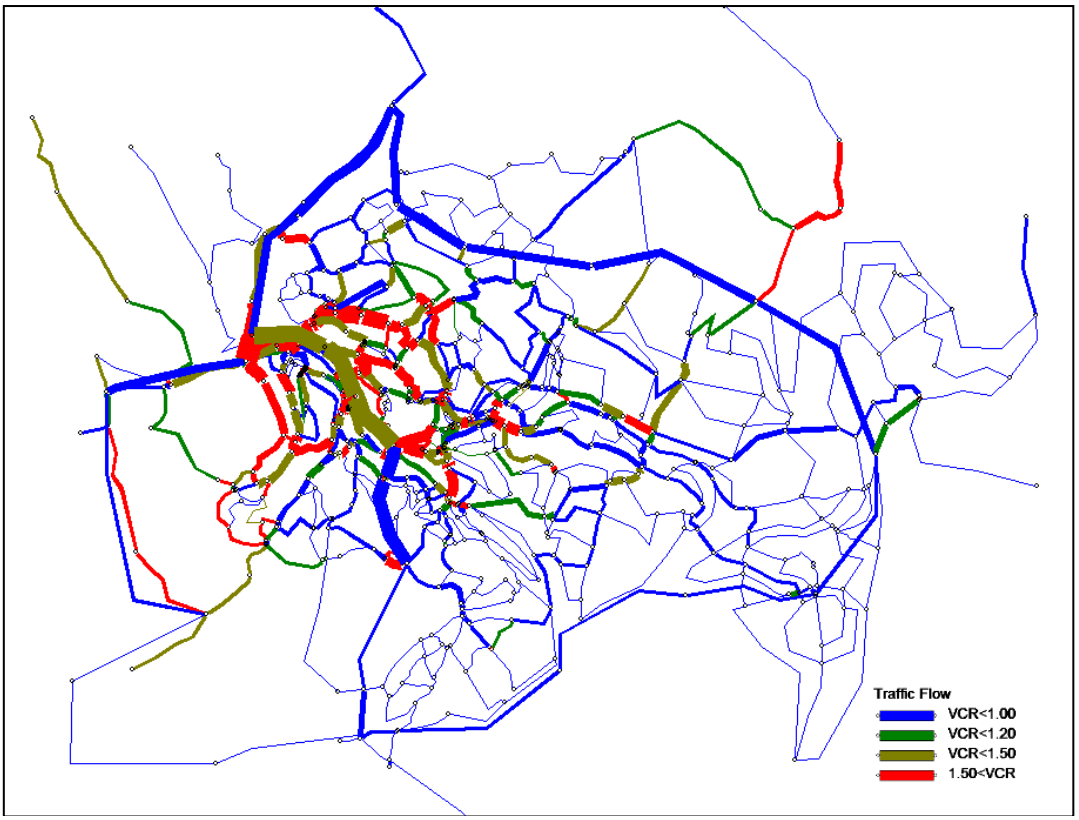
Source: JICA Survey Team

Figure 6.1.16: Result of the Traffic Demand Forecast – Whole Kigali (2030)



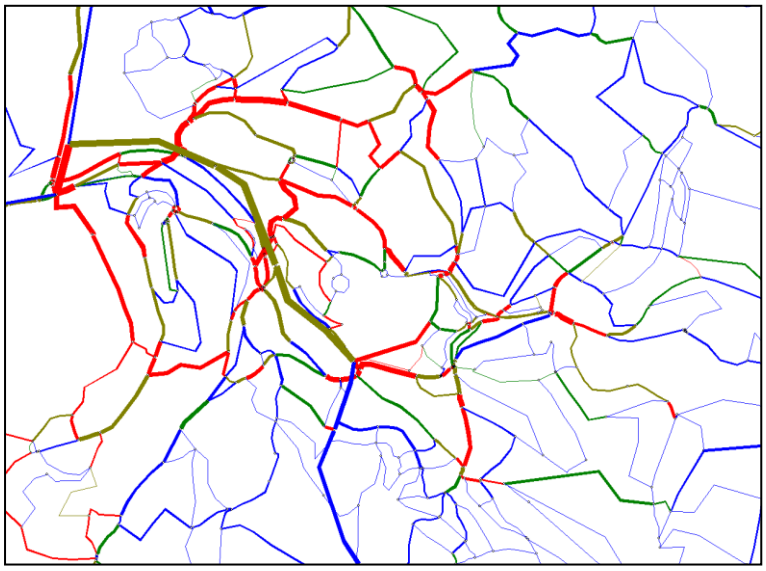
Source: JICA Survey Team

Figure 6.1.17: Result of Traffic Demand Forecast – City Center (2030)



Source: JICA Survey Team

Figure 6.1.18: Result of the Traffic Demand Forecast – Whole Kigali (2040)



Source: JICA Survey Team

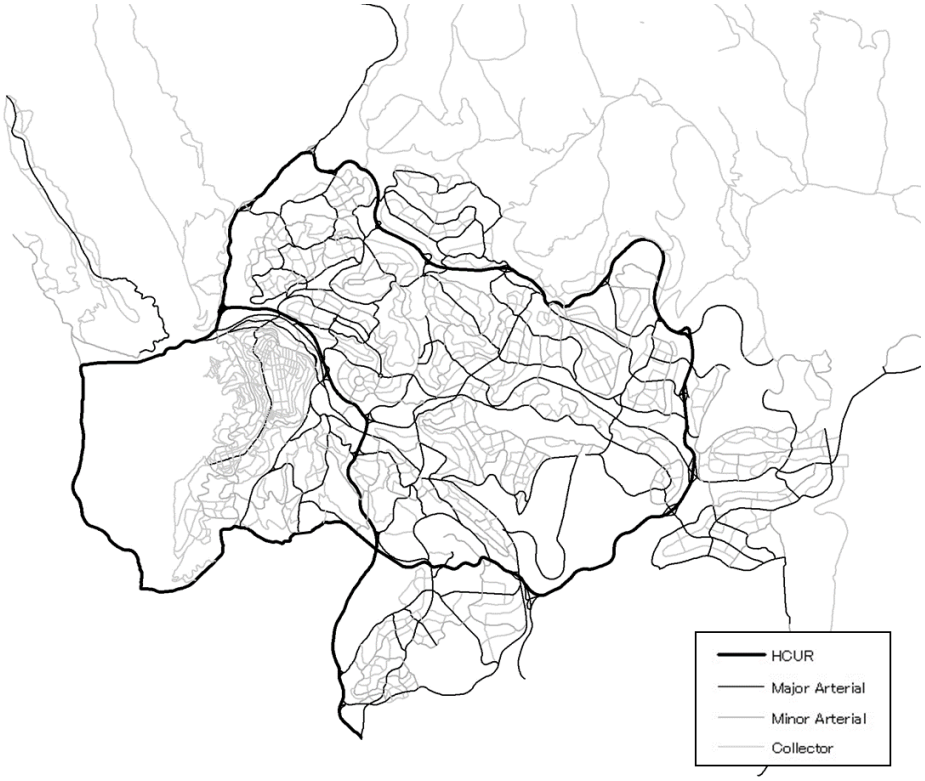
Figure 6.1.19: Result of the Traffic Demand Forecast – City Center (2040)

6.2 Evaluation on Validity of Rad/Transport Development Projects

In this section, the proposed projects in Kigali Transportation Master Plan or by the JICA Survey Team are evaluated based on the validity of the traffic demand forecast.

6.2.1 Projects Proposed in KMP 2013 (BRT, HCUR)

Many road projects are proposed by Kigali Transportation Master Plan. Major projects are BRT projects and HCUR construction such as ring road and north-south bypass road. These projects are evaluated and its validity is checked based on the traffic demand forecast.



Source: JICA Survey Team

Figure 6.2.1:Road Network Proposed in the Kigali Transportation Master Plan (2040)

(1) BRT

According to the BRT Feasibility Study, the BRT infrastructure will be developed until 2050 and ridership will be increased gradually. In 2040, 329 vehicles will be operated. In the BRT FS, the future ridership is forecasted based on the household interview survey and the traffic count survey.

Source: Consultancy Services for Feasibility Study, Technical and Economic Studies, Detailed Engineering Design and Preparation of Tender Documents for Kigali Ring Road (80 km) of Feasibility Study Report (Draft)

Figure 6.2.2:BRT Development Plan in 2050

The BRT development plan is planned until 2050, the project period is set until 2075 and the economic benefit was calculated. The economic benefit proved the project validity.

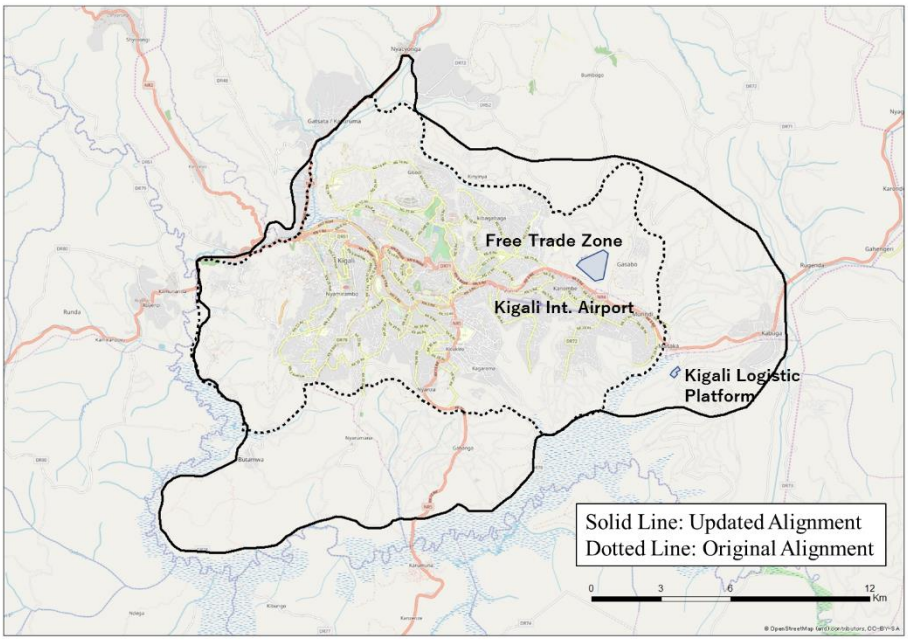
Table 6.2.1: Economic Analysis of the BRT

Indicator	Value
EIRR	19.39%
NPV cashflow (RWF Million)	354.522
NPV benefit (RWF Million)	571.037
NPV cost (RWF Million)	-216.485
B/C	2.64

Source：Consultancy Services for Feasibility Study, Technical and Economic Studies, Detailed Engineering Design and Preparation of Tender Documents for Kigali Ring Road (80 km) of Feasibility Study Report (Draft)

(2) Ring Road

In Table 6.1.22 and Figure 6.1.19, it is found that the development of the ring road will relieve the traffic congestion, but traffic volume is not high in the south according to the traffic demand forecast by the JICA Survey Team. Accordingly, the original alignment was also studied as well its future traffic volume. The original and updated alignment are shown in Figure 6.2.3.



Source: Data received from Kigali City

Figure 6.2.3:Route Alignment of the Ring Road

Table 6.2.3 shows the comparison of future traffic volume, it can be said that original alignment has more traffic volume than the updated alignment since the original one passes near the center of Kigali therefore, traffic volume has increased in the southern part. In terms of total travel time and total trip distanc, the original alignment is superior. In conclusion, considering the traffic situation in the whole of Kigali City and the benefit from toll payment, the original alignment is better than the updated alignment.

Table 6.2.2: Result of Traffic Demand Forecast including the Previous Ring Road Scenario

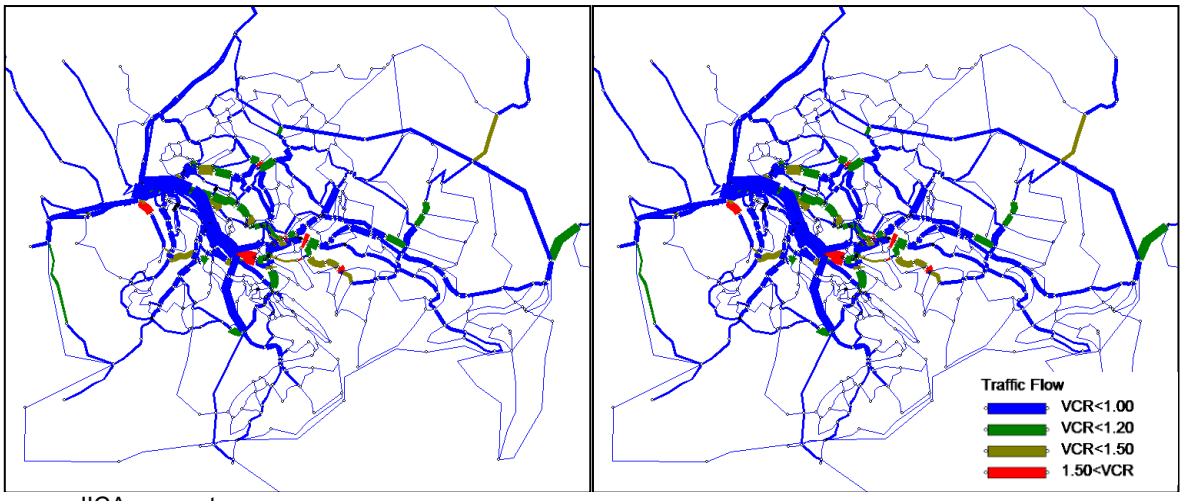
Year	Ring Road	V/C	Average Speed (km/h)	Total Trip Length (km)	Total Trip Time (hour)
2025	Latest Alignment	0.27	59.9	6,373,968	106,474
	Previous Alignment	0.35	59.1	6,536,643	110,672
2030	Latest Alignment	0.36	57.7	8,661,599	149,999
	Previous Alignment	0.46	57.3	8,762,784	153,023
2040	Latest Alignment	0.53	52.9	14,001,251	264,710
	Previous Alignment	0.56	53.8	13,893,314	258,222

Source: JICA Survey Team

Table 6.2.3:Comparison of the Ring Road Alignment

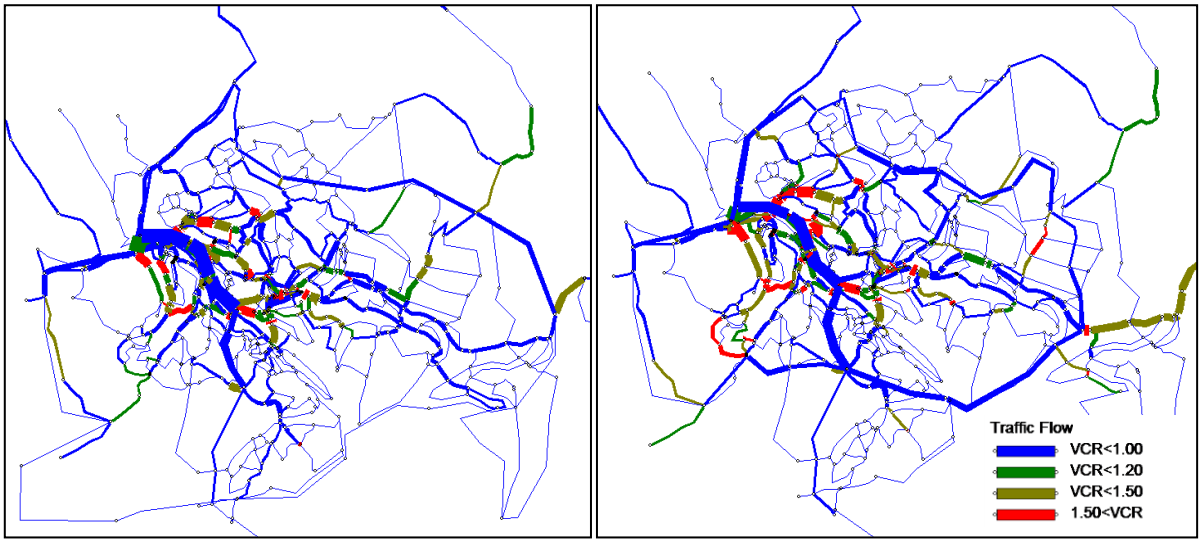
Year	Alignment	Traffic Volume (PCU)
2025	Updated	7,916
	Original	14,994
2030	Updated	10,896
	Original	21,981
2040	Updated	23,988
	Original	37,583

Source: JICA Survey Team



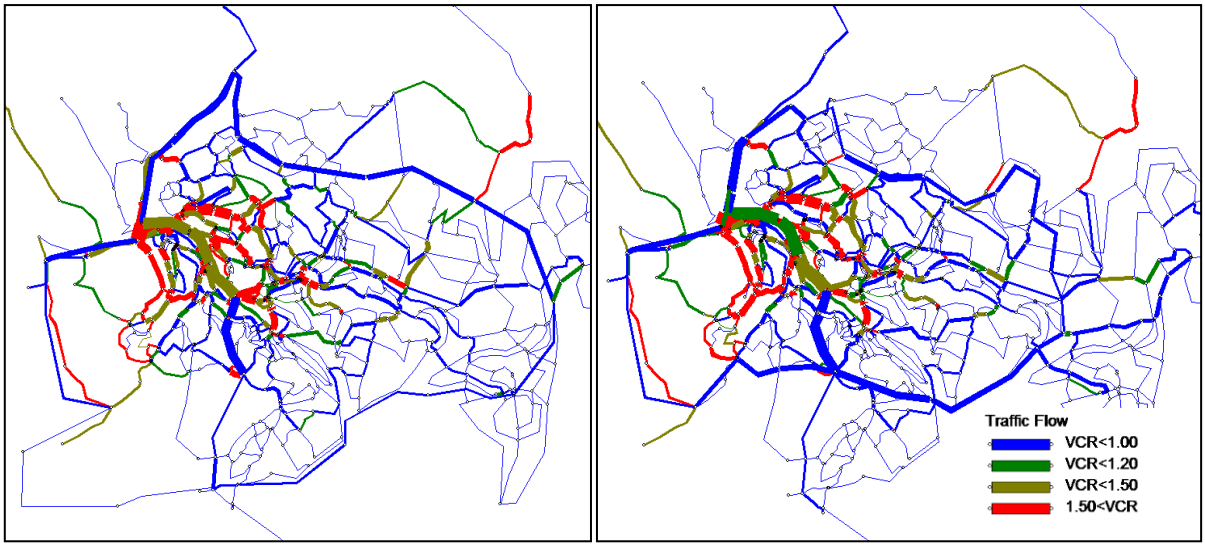
Source: JICA survey team

Figure 6.2.4: Comparison of the Ring Road Traffic Demand, 2025 (Left: Latest, Right: Previous)



Source: JICA survey team

Figure 6.2.5: Comparison of the Ring Road Traffic Demand, 2030 (Left: Latest, Right: Previous)



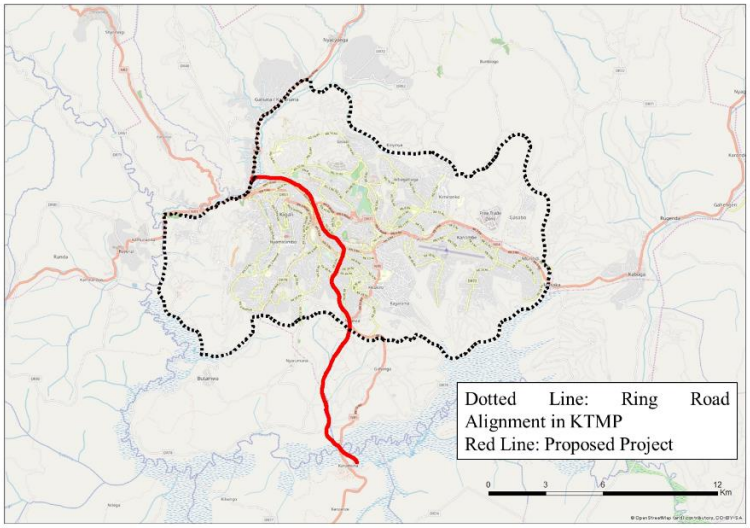
Source: JICA Survey Team

Figure 6.2.6: Comparison of the Ring Road Traffic Demand, 2040 (Left: Latest, Right: Previous)

As shown in Table 6.2.3, the free trade zone and logistic platform will be developed at the east part of Kigali City. The rind road alignment should be considered on such logistic transport demand.

(3) North-South Bypass

The effects of the North-South Bypass improvement are shown below. The North-South Bypass is the route described in the Kigali Transportation Master Plan which connects to the ring road.

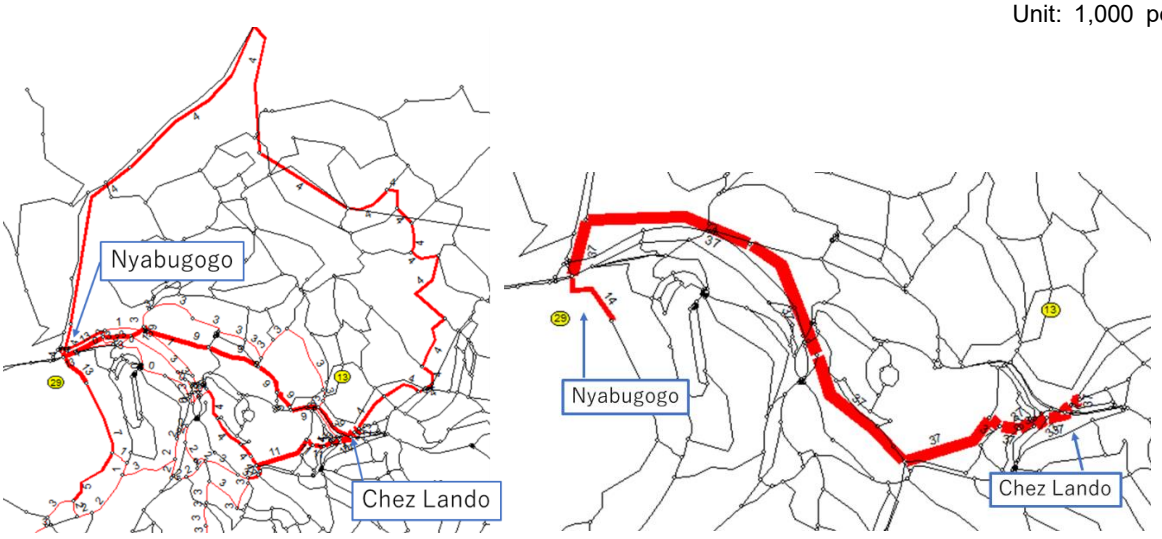


Source: Kigali Transportation Master Plan

Figure 6.2.7:Location of North-South Bypass

Regarding the trip between Nyabugogo and Chez Lando, many trips divert to the northern side via the ring road in the case of without North-South Bypass. On the other hand, if the North-South Bypass will be developed, all trips between Nyabugogo and Chez Lando will utilize the North-South Bypass.

Unit: 1,000 pcu



Source：Kigali Transportation Master Plan

Figure 6.2.8:Route Change in 2040 with the Development of North-South Bypass (Left: Without North-South Bypass, Right: With North-South Bypass)

Table 6.2.4: Traffic Demand Forecast Result of North South Bypass (2040)

	Average Speed (Km/h)	Congestion Ratio	Traffic Volume (PCU)
North-South Bypass (four-lane)	87.6	0.74	67,107

Source: JICA survey team

Also, as shown below, the North-South Bypass contributes largely to the relaxation of congestion degree (decreased from 0.57 to 0.53) on the entire Kigali City.

Table 6.2.5:Traffic Demand Forecast Result in terms of City Level Traffic (2040)

Indicator		Value
Total Vehicle-kilometer	Without	14,410,679
	With	14,001,251
Total Vehicle-hour	Without	277,284
	With	264,710
Total Vehicle-kilometer	Without	25,170,566
	With	26,665,767
Volume Capacity Rate (VCR)	Without	0.57
	With	0.53
Average Speed (km/h)	Without	52
	With	52.9

Source: JICA Survey Team

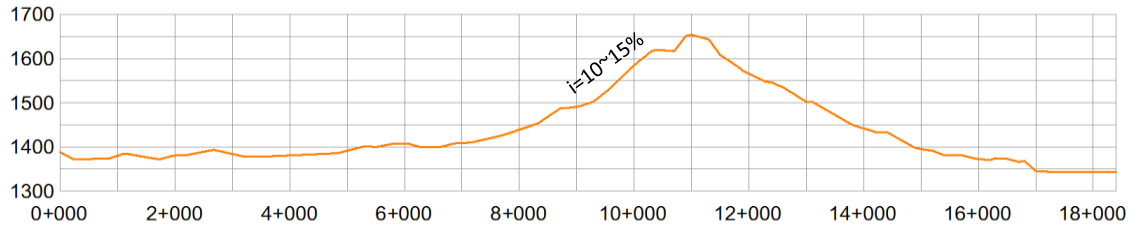
Validity was confirmed since the impact on traffic congestion was evaluated.

Table 6.2.6:Project Evaluation Result

Contribution to Congestion in Kigali City	Contribution to Congestion at Alternative Route	Alternativity in the Disaster and Event	Shortening the Travel Time
○	○	○	○

Source: JICA Survey Team

The road alignment of the North-South Bypass indicated in the Kigali Transportation Master Plan is passing through a steep mountainous road which has a vertical gradient of approximately 10% to 15%. Figure 6.2.9 shows the overall profile of the planned North-South Bypass.



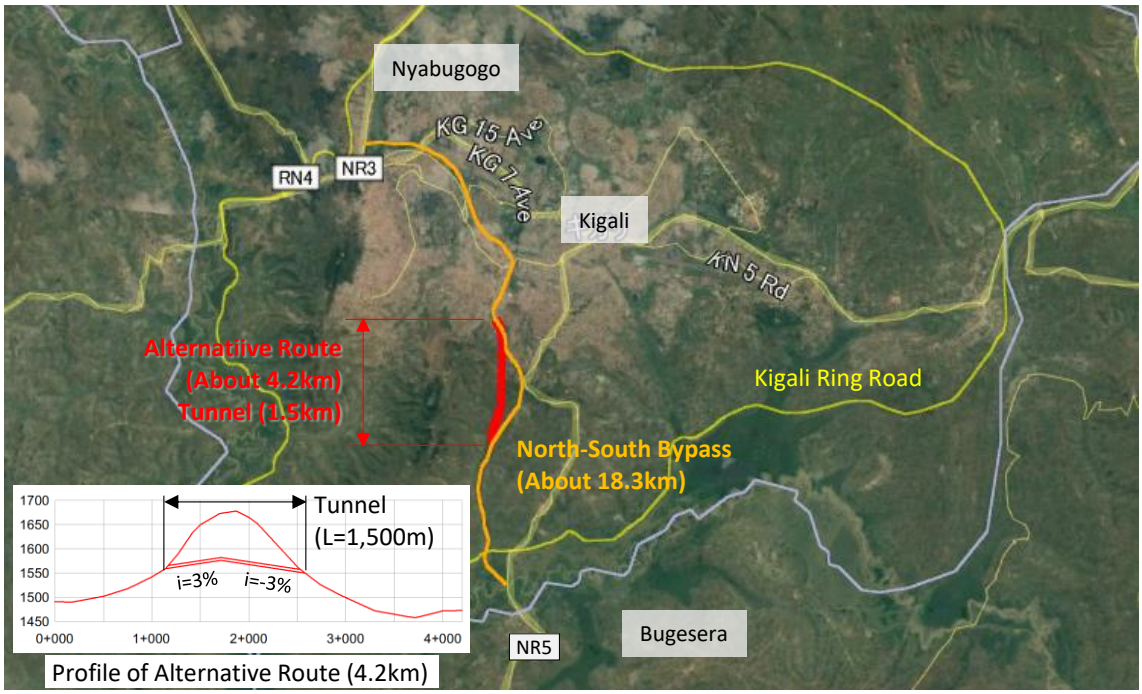
Source: JICA Survey Team

Figure 6.2.9: Overall Profile of the Planned North-South Bypass

The vertical gradient of Road Class 1 (paved dual carriageway) is limited to 10% (6~7% is desirable) in the Rwanda Road Geometric Design Manual drafted by the RTDA. It will be very difficult for heavy vehicles to pass through such a steep mountainous section. The North-South Bypass will be connected with the proposed Kigali Ring Road and the bypass is expected to serve as a logistics corridor for accessing the central business district (CBD) area to/from the ring road.

Accordingly, the JICA Survey Team has proposed the construction of a tunnel (approximately 1.5 km long) instead of the current planned alignment in the steep mountainous section (See Source: JICA Survey Team

Figure 6.2.10). The alternative route with the tunnel will enable the flow of smooth traffic of heavy vehicles as logistics network in Kigali City.



Source: JICA Survey Team

Figure 6.2.10: Alternative Tunnel Route for the North-South Bypass

6.2.2 Interventions Proposed by the JICA Survey Team

Although several road transport projects have been proposed in the Kigali Transportation Master Plan, traffic congestion will worsen as shown in Section 6.2.4. Even if the future road network includes all proposed projects. Therefore, the JICA Survey Team also proposes several projects in addition to the Kigali Transportation Master Plan. Several projects were proposed to solve the traffic congestion in Kigali and Bugesera districts, which is expected to be developed in the future.

(1) Intersection Improvement

It is difficult to evaluate the effects of intersection improvement by using macro level analysis such as traffic demand forecast. Therefore, the JICA Survey Team conducted a microsimulation analysis for evaluating seven busy intersections in Kigali City. Simulated traffic conditions in short, medium, and long term were grasped, and necessary intersection improvement measures were considered and proposed based on the analysis.

1) Microsimulation

(i) Pre-condition

For conducting the microsimulation analysis, the JICA Survey Team set seven busy intersections (Giporoso, Chez Lando, Gishushu, Nyabugogo, Gisozi, Kibagabaga, Kicukiro) as the analysis targets, and analyzed their future traffic condition based on traffic volume and network data which were estimated from the traffic demand forecast. The software for micro simulation is called AIMSUN. The detailed preconditions are shown in Table 6.2.7 below.

Table 6.2.7: Precondition of Microsimulation Analysis

Items	Preconditions
Analysis Year	2025 (Short term), 2030 (Medium term), 2040 (Long term)
Target Intersection	Seven intersections: Giporoso, Chez Lando, Gishushu, Nyabugogo, Gisozi, Kibagabaga, Kicukiro
Traffic Volume	Peak-hour Traffic Volume: This value was calculated by multiplying daily traffic volume which was estimated in the traffic demand forecast and peak ratio, which was acquired in the traffic survey.
Road Network, Intersection Structure	Confirm and reproduce the number of lanes, lane composition, etc., based on the road network data, site situation, and aerial photographs.
Traffic Signal Cycle and Phasing	Set 120 seconds as one traffic signal cycle. Each phase and cycle were set by the JICA Survey Team.
Software for Micro Simulation	AIMSUN (https://www.aimsun.com/)

Source: JICA Survey Team

(ii) Reproduced Road Network and Intersection Structure

The intersection structure of each intersection was reproduced for conducting the microsimulation. If there are neighboring intersections, which were expected to affect the target intersection, analysis will be conducted including these neighboring intersections. There is a study about the intersection improvement of six intersections excluding Nyabugogo Intersection (Consultancy Services for The Study of Multi-lane Divided Highway Nyabugogo-Jabana and Nyacyonga-Mukoto (RTDA, 2016)). However, interventions of this study are based on the existing traffic condition, and it was not considered in the future road plan and future traffic demand. In addition, the intervention measures of this survey are proposed mainly by constructing a roundabout junction, but the capacity of roundabout is lower than a cross intersection. This measure might not be appropriate because the future traffic demand in the city will be increased furthermore. Therefore, the JICA Survey Team proposes countermeasures for each intersection improvement based on the future road plan and future traffic demand, which were collected this JICA study.

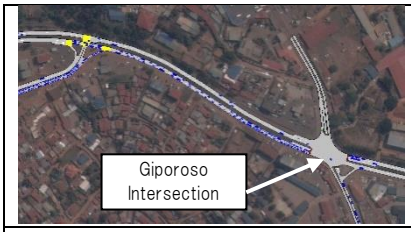
2) Result of the Microsimulation

The analysis results of each target intersection are shown as follows:

(i) Giporoso Intersection

Even in the year 2025 when the ring roads are constructed, traffic congestion at the west side and south side of intersection will still occur. Even if the road construction planned for the medium to long term is carried out, the situation will not change and congestion at the west and south side of intersection will worsen. However, it is necessary to implement traffic signal optimization measures in the short term because traffic congestion will not occur in all directions, however, it is required to implement the increase of road capacity up to 2025. There are also a lot of inflow traffic from the intersection at the west side of the Giporoso Intersection,

thus it is necessary to conduct integrated measures to the Giporoso Intersection and the west side intersection for considering measures.




Traffic Condition in Year 2025	Traffic Condition in Year 2030	Traffic Condition in Year 2040

Source: JICA Survey Team

Figure 6.2.11: Result of Microsimulation (Giporoso)

(ii) Chez Lando Roundabout

In year 2025, the capacity of the roundabout exceeds the concentration of traffic, and serious congestion will occur at the inflow part of the west side of the roundabout. This roundabout lies on RN 3, the main road in the city, which will have a lot of traffic. The capacity of the roundabout is lower than a cross-intersection. The roundabout is designed to withstand the future traffic condition because it has insufficient capacity. In 2030 and 2040, the situation will deteriorate through the increase of traffic demand.



Traffic Condition in Year 2025	Traffic Condition in Year 2030	Traffic Condition in Year 2040

Source: JICA Survey Team

Figure 6.2.12: Result of Microsimulation (Chez Lando)

(iii) Gishushu Intersection

As of 2025, although it is possible to deal with the traffic flow in the main direction (east-west direction), the traffic flow in the subordinate direction (north-south direction) cannot be controlled due to the excess of the intersection capacity. In 2030, the traffic volume will exceed the traffic capacity inflows in the main direction, and serious congestion will occur. As of 2025, serious congestion will also occur at the neighboring intersection on the north side of this intersection. The reason is that it is impossible to inflow from the neighboring intersection due to traffic congestion of the northern section of the Gishushu Intersection, and as a result, the traffic congestion of the neighboring intersection becomes serious because waiting vehicles accumulate.



Traffic Condition in Year 2025	Traffic Condition in Year 2030	Traffic Condition in Year 2040

Source: JICA Survey Team

Figure 6.2.13: Result of Microsimulation (Gishushu)

(iv) Nyabugogo Intersection

Due to the decentration of traffic by the construction of the ring road, improvement of the intersection (implemented through China financing), improvement and expansion of neighboring roads, traffic in this intersection can deal with the traffic flow up to 2030. Together with the increase of traffic demand in the future, traffic congestion will occur at this intersection because the inflow of traffic which is over the capacity of this intersection will be generated in 2040.

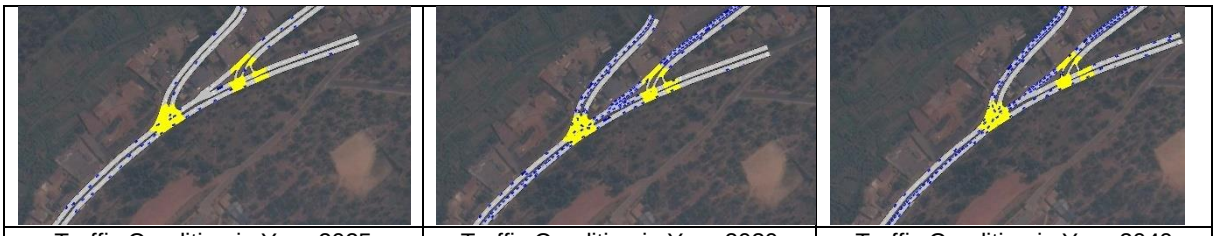
Traffic Condition in Year 2025	Traffic Condition in Year 2030	Traffic Condition in Year 2040

Source: JICA Survey Team

Figure 6.2.14: Result of Microsimulation (Nyabugogo)

(v) Gisozi Intersection

Traffic congestion will occur due to the increasing traffic volume from the north and northeast direction. As of 2025, however, it can be thought that it is only a temporary traffic concentration at peak time, and it is necessary to manage traffic demand with the controlling traffic signal as the short-term measure. Serious congestion will occur in this intersection because traffic flow from the same direction will also increase after 2030. Since traffic is complicated especially at these intersections, it is desirable to make traffic rectification by signal installation.



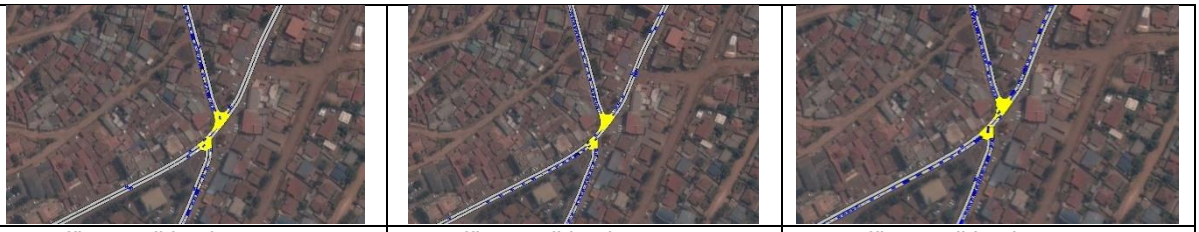
Traffic Condition in Year 2025	Traffic Condition in Year 2030	Traffic Condition in Year 2040

Source: JICA Survey Team

Figure 6.2.15: Result of Microsimulation (Gisozi)

(vi) Kibagabaga Intersection

As of 2025, traffic congestion will occur in this intersection due to the traffic inflow exceeding the intersection capacity. Due to the speed reduction by traffic complication at the intersection, traffic congestion will occur mainly from the traffic from the north-south direction. Traffic congestion will also occur in the east-west direction due to traffic concentration. Traffic congestion will be worsened further due to the increasing traffic volume in 2030 and 2040.



Traffic Condition in Year 2025	Traffic Condition in Year 2030	Traffic Condition in Year 2040

Source: JICA Survey Team

Figure 6.2.16: Result of Microsimulation (Kibagabaga)

(vii) Kicukiro Intersection

This intersection lies on the route where the road widening is carried out by China funding, and the lanes of the main road are converted from two to four, as of 2020. The traffic can be controlled in the future due to the increasing road capacity through road widening. However, there is traffic complication at the intersection because there is no traffic light. It is also difficult for the vehicles to turn right or left from the west side of this intersection to the main road. Traffic congestion will occur on the west side of the intersection in 2030, and this situation will worsen further in 2040.

Traffic Condition in Year 2025	Traffic Condition in Year 2030	Traffic Condition in Year 2040

Source: JICA Survey Team

Figure 6.2.17: Result of Microsimulation (Kicukiro)

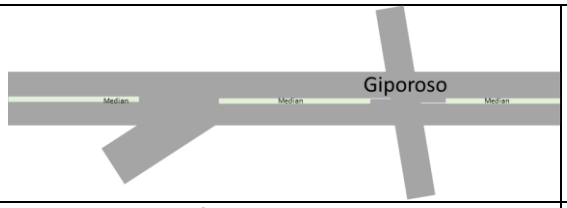
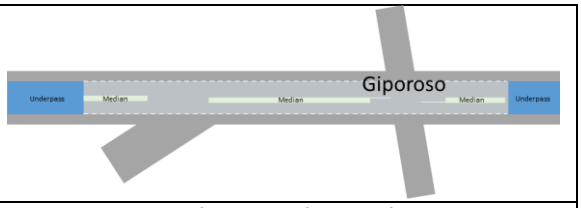
3) Proposed Interventions to Intersection Improvement

Based on the above, he JICA Survey Team considered improvement measures at each intersection. The proposed interventions are listed as follows:

(i) Giporoso Intersection

Even if the signal cycle is optimized at this intersection, it is not possible to deal with the west and south traffic volume in 2025. Therefore, it is necessary to improve the intersection by year 2025. It is necessary to manage traffic of the east-west direction by constructing a grade separated intersection. There is a lot of traffic inflow from the intersection on the west side of the Giporoso Intersection until 2030, but this traffic inflow will decrease in 2040 due to the decentration of traffic by another road improvement. Therefore, the JICA Survey Team proposes that it is necessary to construct a grade separation against the main traffic direction. At the same time, the road capacity is maximized by optimizing traffic from the south side of the intersection. In addition, it is preferable to adopt an underpass structure in consideration that BRT route (elevated) will pass through the intersection.

The figure below shows a proposed intervention. Traffic congestion is mitigated by this measure.

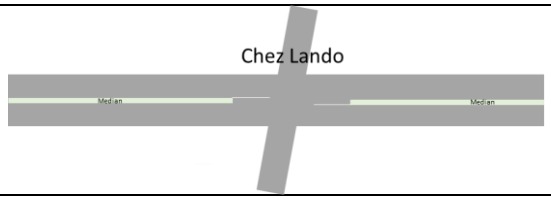
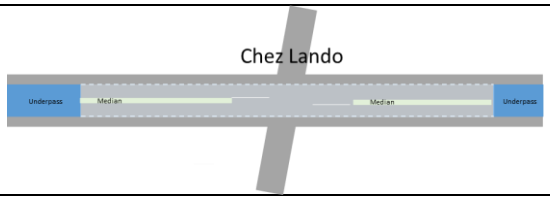
Structure		
	Before Improvement	Proposed Intervention: Underpass
Traffic Condition		
	Before Improvement	Proposed Intervention: Underpass

Source: JICA Survey Team

Figure 6.2.18: Structure and Traffic Condition Before and After Implementation of the Proposed Intervention (Giporoso)

(ii) Chez Lando Roundabout

The JICA Survey Team proposes to change the cross intersection from roundabout by intersection improvement and to optimize traffic control of this intersection by the installation of a traffic signal as countermeasure. In addition, the Giporoso Intersection and Gishushu Intersection will be improved by making a grade separation based on the future traffic concentration. Therefore, it is also necessary to improve this intersection by constructing a grade separation as of 2025 from the viewpoint of optimum traffic control.

Structure		
	Before Improvement	Proposed Intervention: Underpass
Traffic Condition		
	Proposed Intervention: Cross Intersection (Before 2020)	Proposed Intervention: Underpass

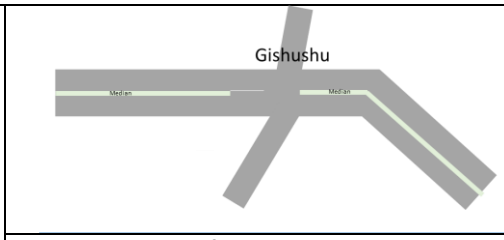
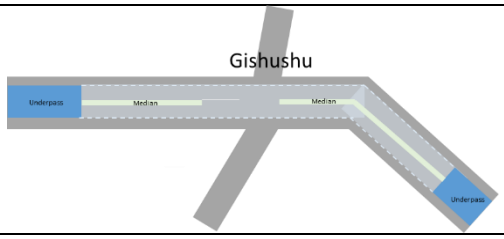
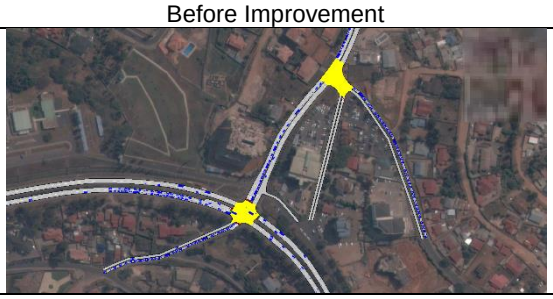
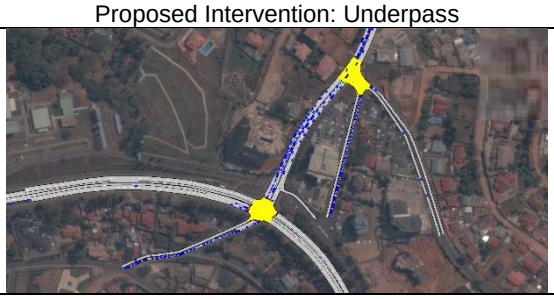
Source: JICA Survey Team

Figure 6.2.19: Structure and Traffic Condition After Implementation of Proposed Interventions (Chez Lando)

(iii) Gishushu Intersection

The JICA Survey Team proposed to manage the main traffic direction by constructing grade separation and to maximize intersection capacity by optimizing traffic signal cycle (increase green phase of north-south direction). In this way, it is necessary to control traffic inflow from the neighboring intersection and to mitigate traffic congestion at neighboring intersections. In

addition, this intersection and neighboring intersections have traffic inflow from the north-south direction. Therefore, it is also necessary to mitigate traffic concentration to this intersection and neighboring intersections by installing traffic signal for controlling traffic flow to the surrounding intersections.

Structure		
	Before Improvement	Proposed Intervention: Underpass
Traffic Condition		
	Before Improvement	Proposed Intervention: Underpass

Source: JICA Survey Team

Figure 6.2.20: Structure and Traffic Condition After Implementation of Proposed Interventions (Gishushu)

(iv) Nyabugogo Intersection

In order to deconcentrate traffic, the JICA Survey Team proposes to implement traffic demand management measures such as shifting to public transport. It is desirable to consider constructing a grade separation according to the traffic condition.

(v) Gisozi Intersection

This intersection has a peculiar shape and it is not preferable for traffic safety. According to the result of the traffic demand forecast, the traffic from the northeast direction will increase in the future. Therefore, the JICA Survey Team proposes to improve the traffic flow by intersection improvement which will change the main direction of traffic (from southwest and eastern direction to southwest and northeast direction). This measure will improve traffic safety and traffic concentration. However, it is expected that a large cost such as land acquisition cost, will be needed for the improvement of the intersection shape. Therefore, it is assumed that road widening should be conducted as a short-term measure and various adjustments should be taken for future intersection improvement.

(vi) Kibagabaga Intersection

Although some measures are needed up to 2040, it is difficult to conduct a large-scale intersection improvement because private houses are dense in the surrounding area. In the traffic demand forecast, it is estimated that there will be no serious traffic congestion, but temporary traffic congestion will occur. Considering this situation, the installation of traffic signals at the surrounding intersection to mitigate traffic concentration and conducting area traffic control through installed traffic signals is needed. Mobility management such as

promoting the shift to public transport is also needed for mitigating traffic congestion. In addition, it is necessary to decentralize traffic flow by improving the Ridge Link Bypass (to be described later) and to mitigate traffic congestion around this intersection.

(vii) Kicukiro Intersection

Although traffic signal is not installed in this intersection, it is preferable to install a traffic signal for appropriate traffic control as early as possible or up to 2020 at the latest. Since there are many right-turning and left-turning traffic from the main road to the connecting road, it is desirable to install additional lanes for right- and left-turning at the time of road widening. Because there are especially many left-turning traffic from the south direction, it is difficult to manage left-turning traffic volume on additional lane only. For this reason, it is desirable to change the lane composition of the south side of this intersection (additional lane for the left-turn, straight and left-turn lane, and straight lane).

Before Improvement

Proposed Intervention: Installation of additional lane for right- or left-turning

Source: JICA Survey Team

Figure 6.2.21: Proposed Intervention at Kicukiro Intersection

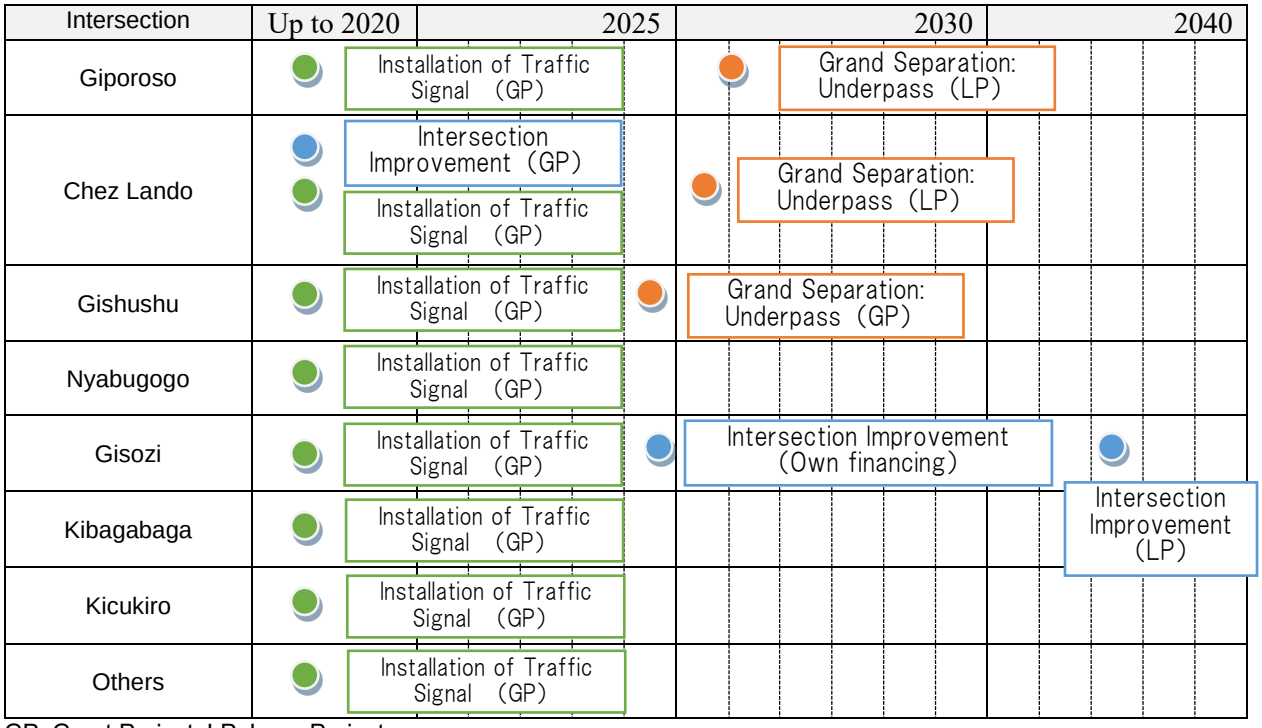
4) Implementation Schedule

For the implementation of the mitigating traffic congestion measures by intersection improvement, project implementation in the time series shown in Figure 6.2.22 below is assumed. The outline is described below.

- Until 2020, traffic control will be conducted by the intersection improvement of the Chez Lando Roundabout (change to cross intersection with four branches) and installing the traffic signals into several main intersections. To realize this as soon as possible, the JICA Survey Team proposes to implement the installation of the advanced signal control system (several intersections) and conducting a grant project for improvement of the Chez Lando Intersection.
- Grade separation measures for Gishushu, Chez Lando and Giporoso intersections will be implemented. In order to avoid overlapping with the elevated BRT route which is planned in the Kigali City Transport Master Plan, it is preferable to adopt the underpass structure. Firstly, to conduct this measure at Gishushu or Giporoso intersections where the traffic congestion become serious is required. However, since these intersections are close to each other, it is desirable to have a series of construction as much as possible. Grade separation projects at these intersections are assumed as candidates of grant and loan projects. These intersections are also candidates where signal system will be installed at the abovementioned grant project (installation of the advanced signal control system). However, although the traffic

signals need some relocation when the construction of grade separation is conducted, it is possible to use the signal after the construction.

- The implementation of traffic control by traffic signal and simple intersection improvement will be conducted up to 2025 for the Gisozi intersection. The shape of this intersection is peculiar, and it is also a cause of traffic congestion. However, it is necessary to modify the intersection shape and to prepare a large budget for land acquisition for the construction. For this reason, the JICA Survey Team proposes improvements at this intersection as loan project candidate, targeting from 2030 to 2040.
- For other intersections, some of them will be carried out through the intersection improvement measures. On the contrary, there is an intersection where it cannot be further improved by some restrictions despite exceeding the capacity. In the meantime, it is important to conduct a traffic demand control by performing an area traffic signal control and encouraging the shift to public transportation. It is assumed that installation project for expanding signal intersections as a follow-up project for grant project and technical cooperation project for strengthening public transportation operation are needed. It is also necessary to consider new countermeasures based on the improvement effect of other intersections.

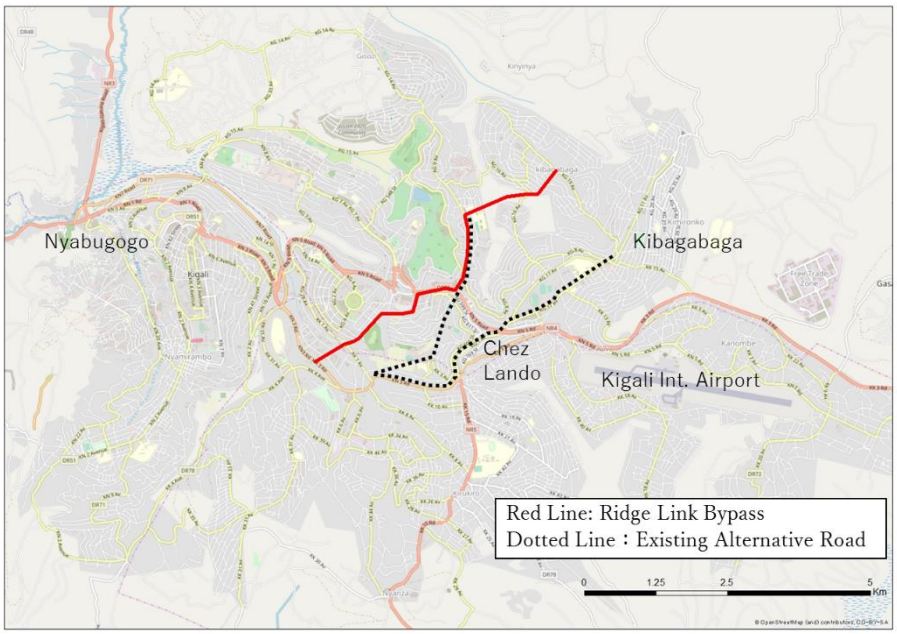


GP: Grant Project, LP: Loan Project
Source: JICA Survey Team

Figure 6.2.22: Implementation Schedule of Intersection Improvement Projects (Draft)

(2) Ridge Link Bypass

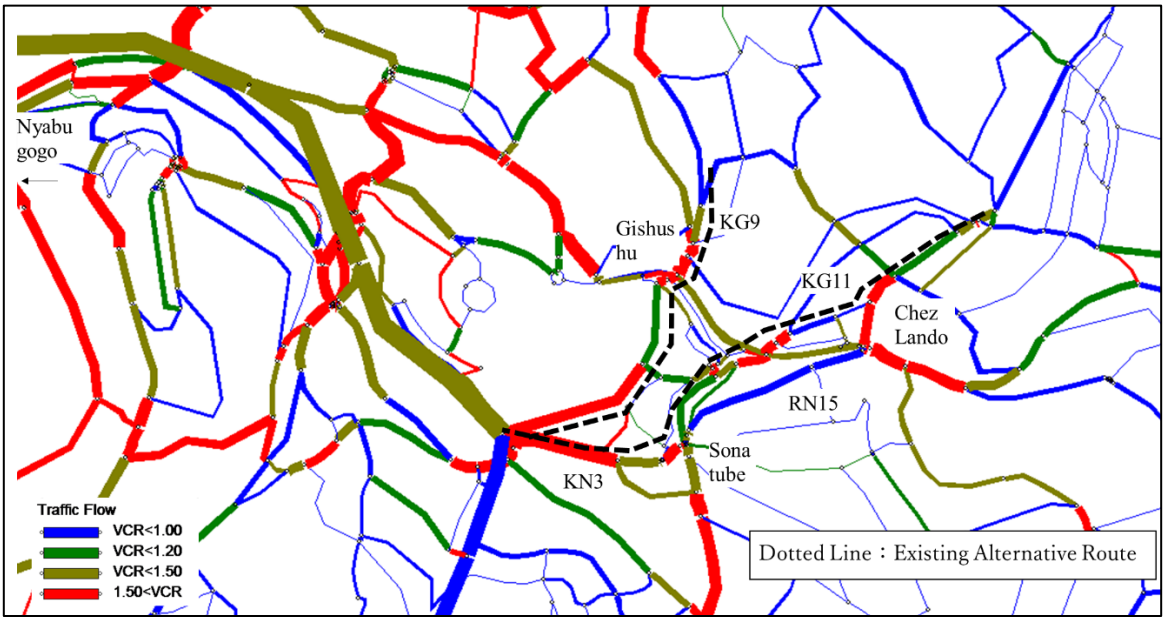
This proposed route connects Gikondo and Kimironko and passes through a ridge. It is named Ridge Link Bypass as its tentative name. An issue of the existing road planning, there is traffic congestion at the connecting road to the North-South Bypass, and at the Kibagabaga Intersection. In order to solve these problems, further North-South Road was proposed.



Source: JICA Survey Team

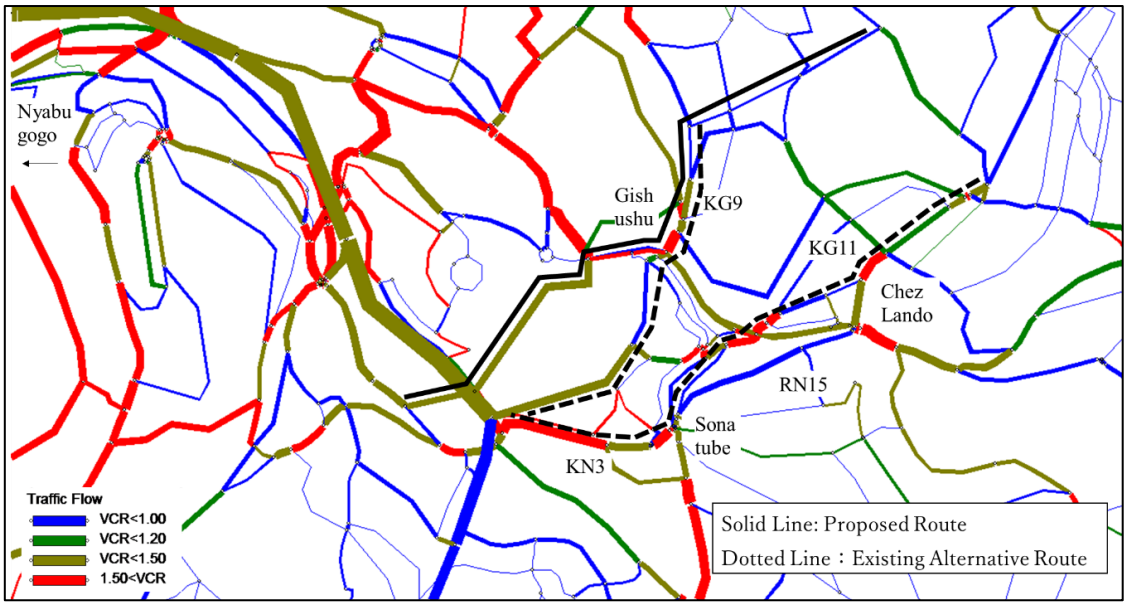
Figure 6.2.23:Location of Ridge Link Bypass

As a result of the traffic demand forecast (Figure 6.2.25 to Table 6.2.8), even in the case of the developed Ridge Link Bypass, all alternative routes have congestion degree of 1.0 or more. However, by improving the Ridge Link Bypass, the congestion degree of alternative routes will decrease and will alleviate congestion.



Source : JICA Survey Team

Figure 6.2.24: Result of the Traffic Demand Forecast of Ridge Link Bypass (Without, 2040)



Source：JICA Survey Team

Figure 6.2.25: Result of the Traffic Demand Forecast of Ridge Link Bypass (Without, 2040)

Table 6.2.8: Traffic Demand Forecast Result for the Proposed and Alternative Route (2040)

		Average Speed (km/h)	Congestion Ratio	Average Traffic Volume (PCU)
Ridge Link Bypass (4-lane)		57.2	0.79	29,771
Alternative route (KG9)	Without case	53.4	1.28	44,428
	With case	55.4	1.16	36,338
Alternative route (KN3, RN15, KG11)	Without case	55.4	1.61	42,821
	With case	54.0	1.29	39,834

Source: JICA Survey Team

From the viewpoint of improving traffic conditions throughout Kigali City, the improvements of the average congestion degree and average speed are limited as shown in Table 6.2.9.

Table 6.2.9: Traffic Demand Forecast Result in Terms of City Level Traffic (2040)

Indicator		Value
Total Vehicle-kilometer	Without	14,001,251
	With	13,867,382
Total Vehicle-hour	Without	264,710
	With	264,589
Total Vehicle-kilometer	Without	26,665,767
	With	26,787,003
Volume Capacity Rate (VCR)	Without	0.53
	With	0.52
Average speed (km/h)	Without	52.9
	With	52.4

Source: JICA Survey Team

Considering the above, this project can be evaluated from the viewpoint of its contribution to congestion relaxation at alternative routes and substitution during disaster. Travel time is also shortened along with congestion relaxation at the alternative routes.

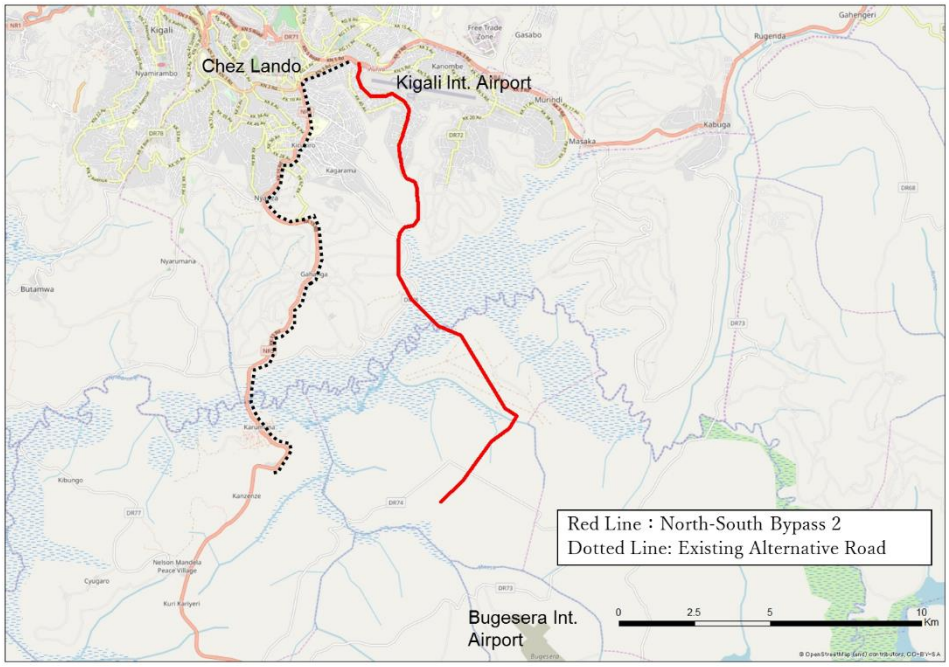
Table 6.2.10:Project Evaluation Result

Contribution to Congestion in Kigali City	Contribution to Congestion at Alternative Route	Alternativity in the case of Disaster	Shortening the Travel Time
△	○	○	○

Source: JICA Survey Team

(3) North-South Bypass 2

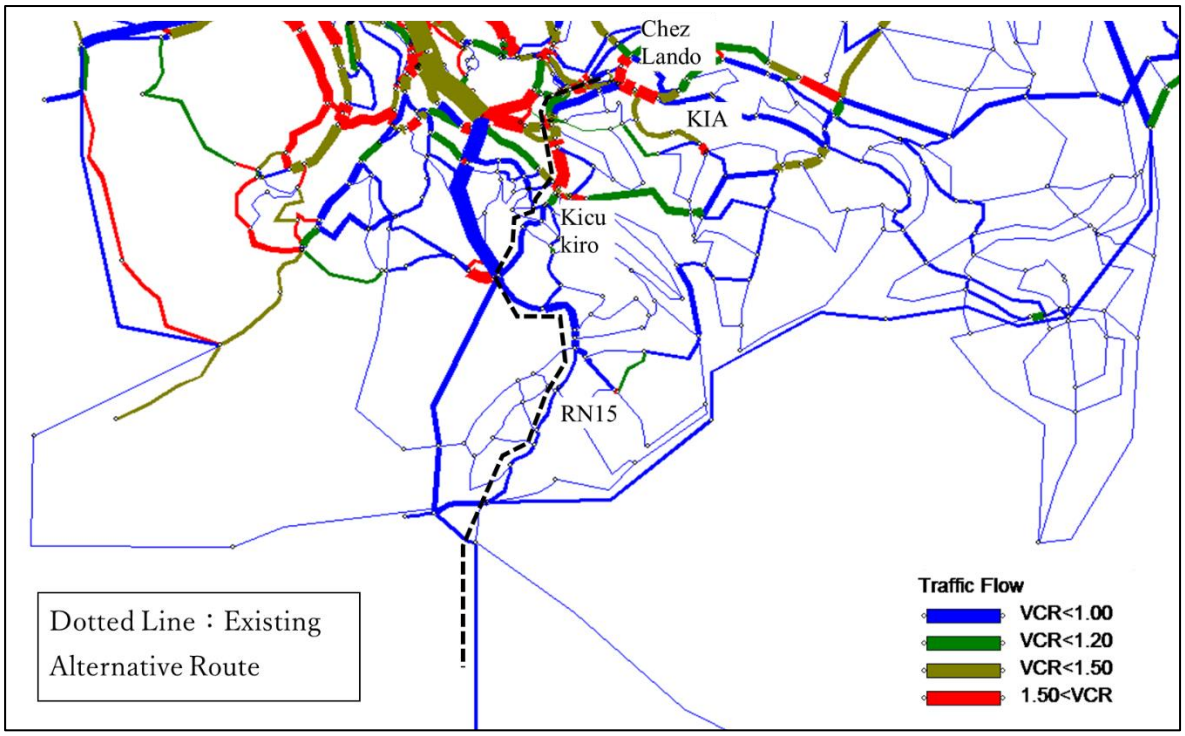
Currently, there is only one trunk road connecting Bugesera and Kigali. However, traffic congestion is expected to worsen when considering BIA. An expressway is planned between Kigali and Bugesera, but the population of Bugesera will drastically increase from 2012 to 2032 as shown in Figure 6.1.13. Thus alternative roads other than the expressway are necessary. The proposed route is shown in Figure 6.2.26.



Source: JICA Survey Team

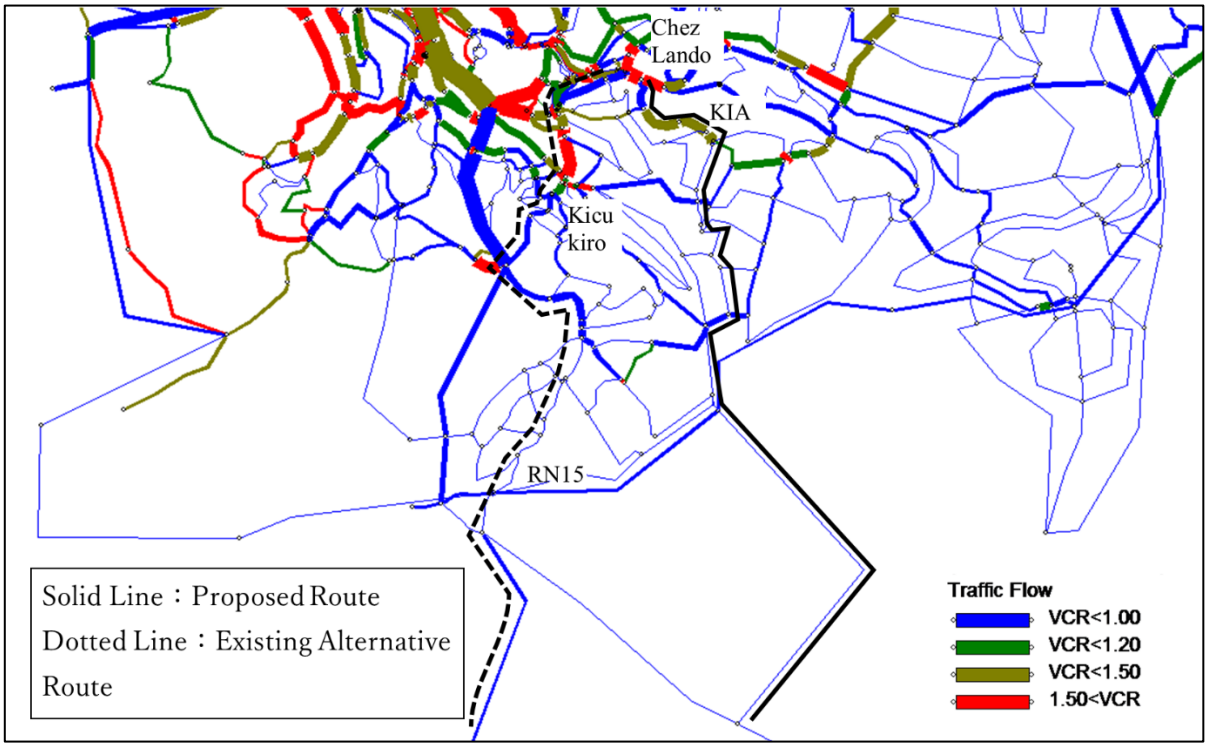
Figure 6.2.26: Location Map of North-South Bypass Road

As a result of the traffic demand forecast (Figure 6.2.27 and Table 6.2.11), it cannot be said that the traffic conditions of the alternative routes will be improved in terms of average speed and congestion level. However, the road connecting Bugesera and Kigali is only one route in the current situation, therefore it is important from the viewpoint of ensuring substitution.



Note: KIA stands for Kigali International Airport
Source: JICA Survey Team

Figure 6.2.27: Result of the Traffic Demand Forecast of the North-South Bypass (Without, 2040)



Note: KIA stands for Kigali International Airport
Source: JICA Survey Team

Figure 6.2.28:Result of the Traffic Demand Forecast of the Ridge Link Bypass (With, 2040)

Table 6.2.11:Traffic Demand Forecast Result for the Proposed Route and Alternative Route

Case		Average Speed (km/h)	Congestion Ratio	Average Traffic Volume (PCU)
North-South Bypass 2 (4-lane)		59.5	0.28	9,887
Alternative Routes (RN15)	Without case	58.9	0.45	13,325
	With case	58.9	0.43	13,027

Source: JICA Survey Team

Regarding travel time, it shows that North-South Bypass 2 has more advantages than using the expressway between Kigali-BIA when going towards the city center.

Table 6.2.12: Travel Time to City Center (2040)

Case	Travel Time from Bugesera to Chez Lando
Without Case (NR 5)	24.4 mins
With Case (North-South Bypass 2)	18.4 mins

Source: JICA survey team

From the above, the North-South Bypass can be evaluated in terms of alternativity and travel time.

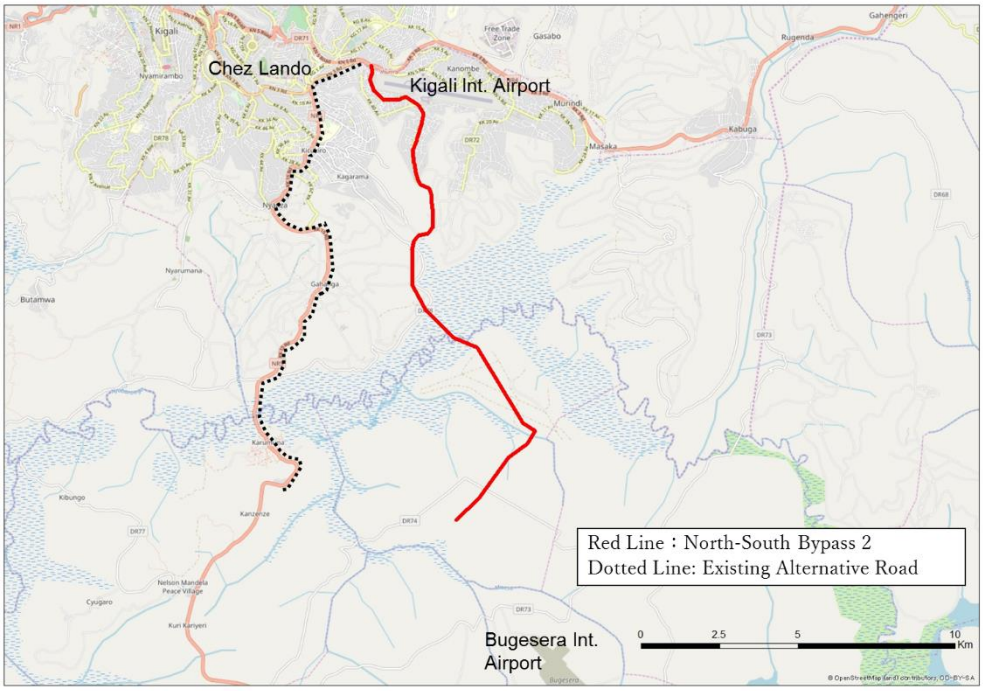
Table 6.2.13:Evaluation of Project Validity

Contribution to Congestion in Kigali City	Contribution to Congestion at Alternative Route	Alternativity in the Case of Disaster	Shortening the Travel Time
△	△	○	○

Source: JICA Survey Team

(4) Bicumbi Bypass Road

The Bicumbi Bypass Road includes the pavement of the existing road DR 53 and the replacement of the bridges for the through traffic from the south of Kigali. Traffic from Bugesera can use both the North-South bypasses 1 and 2.



Source: JICA Survey Team

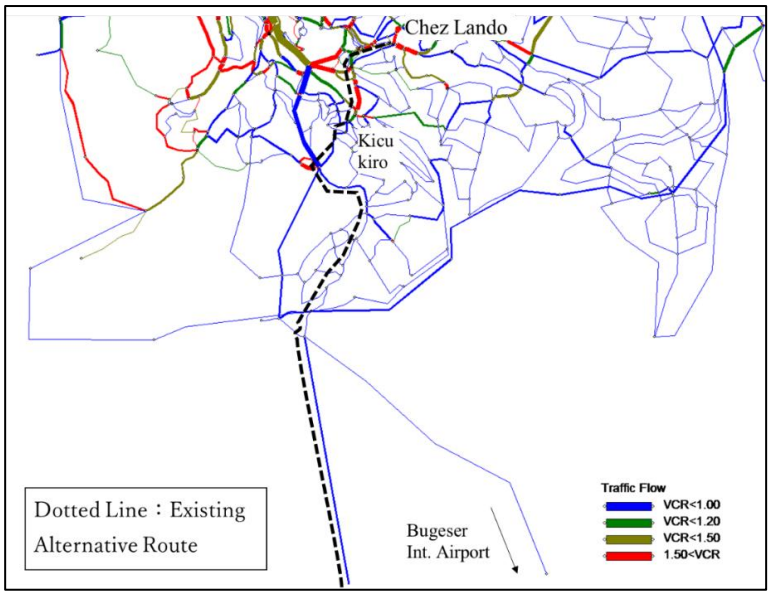
Figure 6.2.29:Project Location of the Bicumbi Bypass Road

As a result of the traffic demand forecast, it was found that the effect of the congestion alleviation at the alternative route does not have a big impact.

Table 6.2.14: Result of Traffic Demand Forecast for the Proposed Route and Alternative Route (2040)

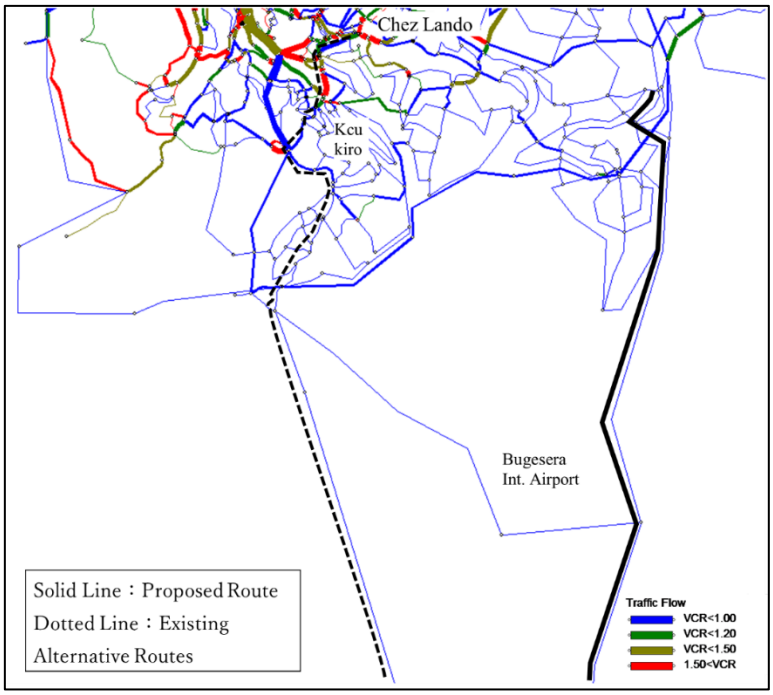
Case		Average Speed (km/h)	Congestion Ratio	Average Traffic Volume (PCU)
Bicumbi Bypass (2-lane)		60.0	0.04	1,230
Alternative Routes (RN15)	Without Case	58.91	0.60	19,893
	With Case	59.11	0.53	18,467

Source: JICA Survey Team



Source: JICA Survey Team

Figure 6.2.30: Result of the Traffic Demand Forecast of North-South Bypass 2



Source: JICA Survey Team

Figure 6.2.31: Result of the Traffic Demand Forecast of North-South Bypass 2 (Without case, 2040)

The effect is considered to be small for Kigali City, since the proposed route connects Kigali and outside Kigali. Since the congestion mitigation alternative route is small, the shortening of the travel time is also limited.

Table 6.2.15: Evaluation of Project Validity

Contribution to Congestion in Kigali City	Contribution to Congestion at Alternative Route	Alternativity in the Case of Disaster	Shortening the Travel Time
△	△	○	△

Source: JICA Survey Team

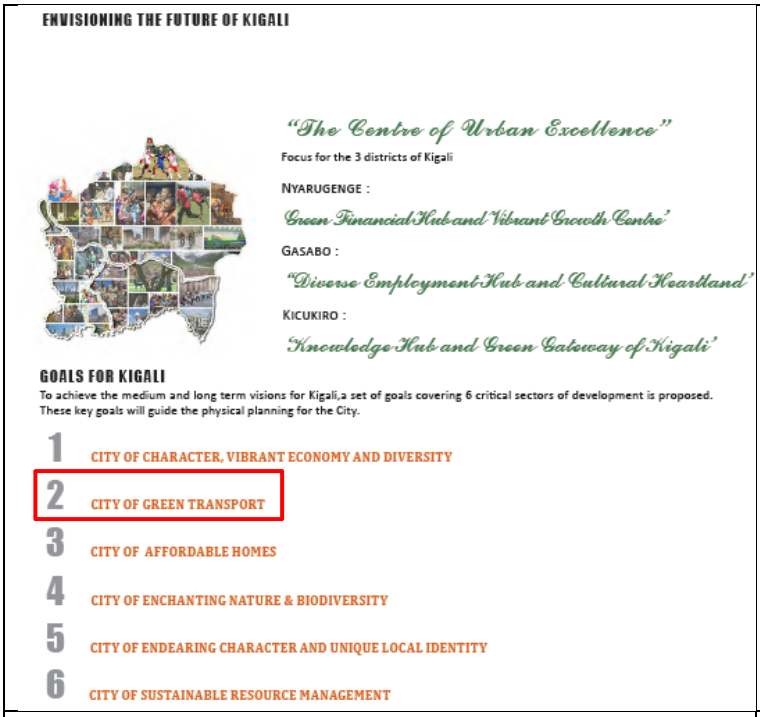
Chapter 7: Interventions to Kigali Transportation Master Plan

This survey involves data and information collected and examined by the JICA Survey Team for the urban transport sector of Kigali City. The results of the survey will be utilized by JICA to examine the Japanese Official Development Assistance (ODA) direction for the sector. The development of Rwanda, especially in the Kigali metropolitan area, has made remarkable and rapid progress. Hence, in this survey, it is expected to propose specific ODA candidate projects even at the earliest stage of the survey. In this chapter, based on the results of the survey progress as stipulated in the previous chapters, the JICA Survey Team will postulate the indicative direction for future ODA support by JICA. However, it is imperative to note that the proposed projects in this report have not been committed by the Japanese government. Both the Rwandan government and the Japanese government should continue further detailed discussions for realizing the project list.

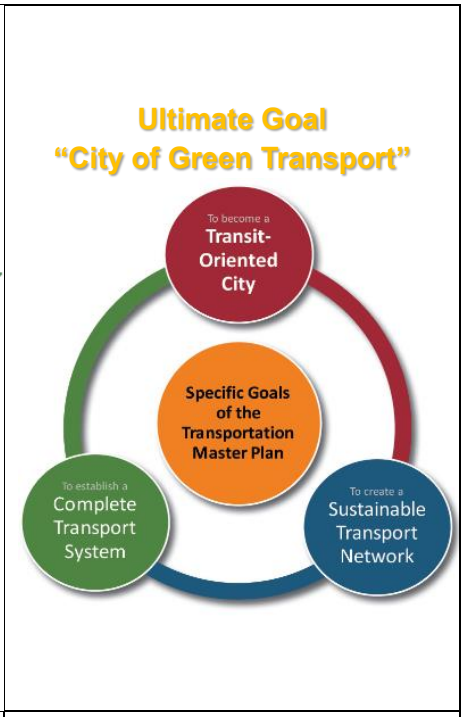
7.1 Basis and Correlation of Data Collection Survey by JICA

7.1.1 Kigali City Transportation Master Plan 2013

The Urban Transportation Master Plan (MP) in Kigali City was developed by the Rwandan government in 2013. Furthermore, currently the MP is being updated wherein the work for updating started in June 2018. The ultimate goal of Kigali Transportation Master Plan 2013 was set as “City of Green Transport” consisting of three specific development goals.



Goals for Kigali: Kigali City Master Plan



Specific Goals for Kigali City Transport Master Plan

Source: Kigali City Master Plan and Kigali City Transportation Master Plan Report, 2013

Figure 7.1.1: Vision and Development Goals of Kigali Master Plans

Figure 7.1.2 shows the development targets by hierarchy formulated by Kigali Transportation Master Plan 2013. Eight goals are set under the three development goals. A concrete project proposal to realize these eight goals was proposed. Representative projects include 1) public transportation improvement with Bus Rapid Transit (BRT) as the core mode, 2) urban road network construction to support public transport and private traffic, and 3) non-motorized traffic (NMT) supporting sustainable development. Among them, BRT is undergoing a feasibility study (FS) by the city of Kigali (CoK). Regarding the urban road network, the FS for the Ring Road was implemented by MININFRA, and it is currently in the stage of review by private companies. Each project is ongoing in line with these plans.

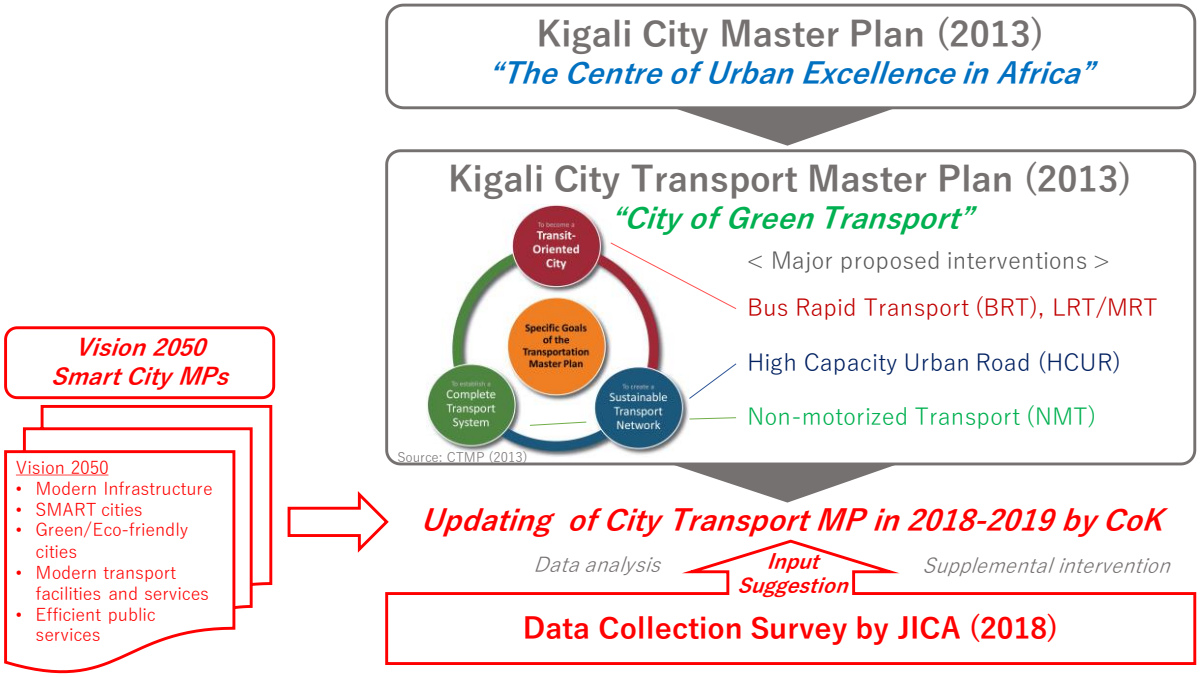
Ultimate Goal	City of Green Transport							
Specific Goals	To become a **Transit Oriented City**		To establish a **Comprehensive Strategic Road Network**			To create a **Sustainable Transport Network**		
Objectives	Public/Private transport modal split of 70:30	Average public transport commuting time of 60 minutes	Construction of urban roads to a minimum density of 6 km/km^2	Seamless intermodal transport connectivity	Construction of intercity freight routes and infrastructure	Integrated non-motorized transport infrastructure	100% of public amenities and facilities served by public transport	The establishment of green network and pedestrian-friendly streets

Source: Kigali City Master Plan and Kigali City Transportation Master Plan Report, 2013

Figure 7.1.2: Overall Structure of Kigali Transportation Master Plan 2013

7.1.2 Basis and Correlation of Data Collection Survey by JICA

The JICA survey was implemented in respect and honoring the existing MP. Accordingly, it is expected that the results of the survey will become a valuable input for the updating works of the existing MP. Figure 7.1.3 indicates the relationship between the JICA survey and related development plans by the Rwandan government.



Source: JICA Survey Team

Figure 7.1.3: Basis and Correlation of Data Collection Survey by JICA

When considering the development of the urban transportation sector in Kigali City, it is requisite to pay attention to the Vision 2050, which is the national development policy of Rwanda.

In addition to the basic human needs (BHN), the development plan shall be fully conscious of the following keywords in the vision to meet the advanced needs of the Government of Rwanda as well as the sustainable development goals (SDGs).

- Modern infrastructure
- SMART cities
- Green/eco-friendly cities
- Modern transport facilities and services
- Efficient public services

Also, it is noted that the following development plans were inaugurated regarding the development of “Smart City”.

- Smart Sustainable Cities: A Blueprint for Africa (Smart Africa, 2017)
- Smart City Rwanda Masterplan Version 2.0 (Ministry of ICT, 2017)

The Government of Rwanda assumes the role of the secretariat of the Smart Africa Society while the Hon. President Paul Kagame is the Chairman of the Smart Africa Board.

7.2 Major Issues to be Tackled

The issues to be addressed and challenged in the urban transport sector of Kigali City are summarized in Table 7.2.1 with reference to the contents of Chapter 4 and Chapter 5 (Current Situation) and Chapter 6 (Demand Analysis). These issues have been discussed during the series of the Working Group Meetings with the stakeholders.

These issues could be generally categorized into individual keywords of “ITS”, “TDM”, “Road Network”, “Safety”, “Capacity Development”, and “General”.

Table 7.2.1: Major Issues to be Tackled for the Urban Transport Sector in Kigali City

Key topics : Key indication to the direction and strategy

Road	Traffic	Public Transport	Others
Traffic jam at major junctions [ITS] [TOD]	Fixed signal phasing cycle [ITS]	Less bus network/route [Network] [TOD]	Massive increase of population [General]
No alternative route due to less road network [Network]	Manual operation by traffic police at peak hours [ITS]	Less frequency of bus service [TOD]	Urbanization axis toward east and south direction [Network]
Heavy vehicle inside the urban area [Network]	Less number of signalized junctions [Network]	No schedule/information of bus operation [ITS] [TOD]	Traffic flow/volume change by BIA development [Network]
Sole access bridge between Kigali and Bugesera [Network]	Less traffic information to the road users [Network] [ITS]	Old conventional style bus terminals [Network] [TOD]	Shortage of number of staff [Capa-Dev]
Unpaved surface behind the major arterial roads [Network] [Safety]	No accumulation of the traffic data [General] [Capa-Dev] [ITS]	No dedicated/priority bus lane [Network] [TOD]	Less cross sectional coordination [Capa-Dev]
Less pedestrian facility [Safety]	Less parking space [General]	Poor level of service for bus operation [TOD]	Response to the national ICT development policy [ITS]
No design guidelines for urban road [General] [Capa-Dev]	Traffic accidents/less pedestrian facility [Safety]	Excessive supply of 2-wheel taxi [General]	Increasing operational cost [General]
⋮	⋮	⋮	⋮

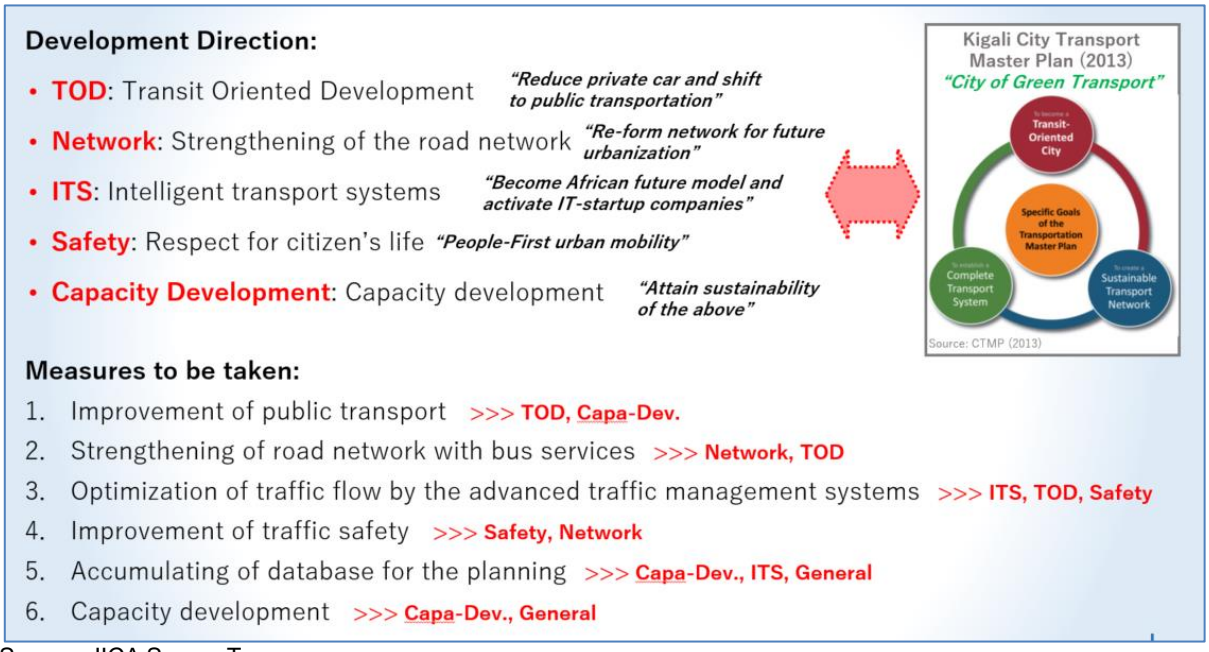
Source: JICA Survey Team

7.3 Directions and Strategies for Future Transport in Kigali

The five keywords extracted from the issues mentioned above are set out as the development directions in this survey, and the development strategies are also proposed in order to attain the recommended directions.

These recommendations have been prepared to become consistent with the development policy of the existing MP and the related transport development plans.

The JICA Survey Team has explained these recommendations to the Rwandan side and discussed in the Working Group Meeting of the survey to obtain basic consensus from the members of the Working Group.



Source: JICA Survey Team

Figure 7.3.1: Proposed Development Directions and Strategies

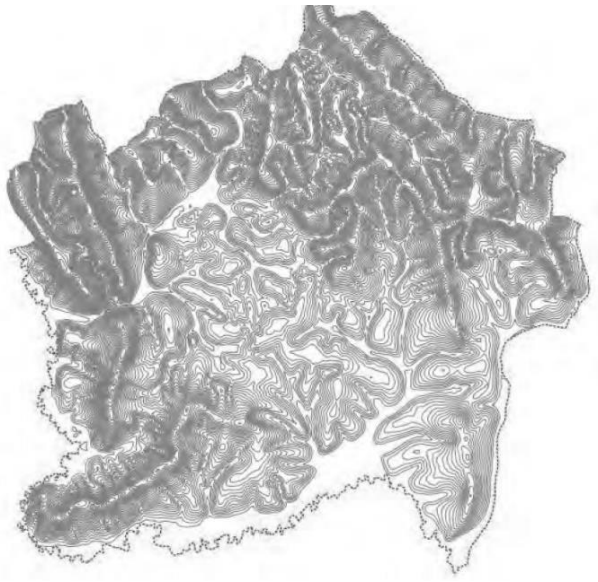
7.3.1 Realization of the Transit Oriented Direction (TOD)

As a topographical feature of Kigali City, it can be cited that multiple ridge topography is linked.

The low land area is called "wetland", and it plays a role of stagnation of rainwater during agricultural land and green spaces in peacetime and floods.

Urbanization has spread to the hillside slopes on ridges. However, due to constraints on topography and longitudinal gradient, the road network has a layout along the contour lines of the hilly terrain.

Therefore, there is a quantitative limit to newly construct road network.



Source: Kigali City Transport Master Plan Report, 2013
Figure 7.3.2: Undulating Topography in Kigali

It is necessary to promptly turn to the traffic policy (TOD) that emphasizes public transportation rather than a traffic policy dependent on the road network in order to realize the maximum transport capacity with a limited road capacity.

Promoting the shift of demand to public transportation, improvement of convenience of public transportation, and improvement of transportation capacity are essential. In the Kigali Transportation Master Plan 2013, BRT is proposed as a backbone public transportation mode, and the feasibility study is in progress. In this report, it is considered that the improvement of the current bus service is also important, and the improvement of the bus service is proposed.

It is necessary to introduce a signaling system to the congested intersections. Introducing a "Public Transportation Priority System (PTPS)" is also effective to promote TOD and Transportation Demand Management (TDM) measures.

According to the analysis of the JICA Survey Team (see Chapter 6: Demand Forecast), traffic congestion will become conspicuous after 2030 even if the full BRT planned route is realized. It will be necessary to consider another public transportation system with more transport capacity (i.e., automated guideway transit (AGT), monorail, etc.). Accordingly, the study for a mass transit system is proposed among the intervention projects.

7.3.2 Complete Road Network

There are no serious traffic jams on the road network except in the major intersections in the city. It was confirmed that similar results were obtained also in the simulated results of the current traffic flow described in Chapter 6. The major weaknesses on the road network are the following:

- Less road density
- Lack of detour/diversion route
- Less paved road

It is necessary to strategically and intensively prepare the backbone of the road network. The development of High Capacity Urban Road (HCUR) proposed by MP 2013 and the upgrading of the arterial roads will be effective from the demand forecast result by the JICA Survey Team.

In addition to the projects in MP 2013, the JICA Survey Team has newly proposed road projects as “interventions” to the MP 2013. It is expected that these interventions are referred and utilized in the updating process of MP 2013.

Table 7.3.1: Interventions to MP 2013

No.	Interventions
Strengthening of HCUR (High Capacity Urban Road)	
1	**North-South Bypass Tunnel** The North-South Bypass was proposed in MP 2013 as HCUR together with the Ring Road. The bypass will function as a high standard road network by connecting with the ring road. However, the vertical gradient in the hilly section will be more than 10%, meaning that the design speed can accept less than 20 km/h only and does not fulfil the RTDA Road Class I. Taking into consideration the high standard road function expected on this road and the logistics function to the city center, an alternative realignment with single tunnel section (L=1.5 km) to the hilly section. There is a potential nationwide demand for tunnel technology in Rwanda.
2	**Ridge Link Bypass** The existing road network has a layout along the contour line of a ridge terrain. Traffic across ridges is forced to detour along the contour line. From the demand forecast result, high traffic demand is forecasted on the inter-ridge origin destination (OD) and a shortcut road (ridge connection bypass) connecting the ridges is proposed. The project will need large-scale bridge piers (maximum height of about 50 m). In order to give consideration to the landscape and reduce regional division, the bridge span should be extended as much as possible. The technology of a viaduct can be adopted not only for Kigali but also for hilly terrains in Rwanda.
Improvement of Bottleneck Intersections	
	Intersections (at-graded) and Traffic Control Center (Implication to Smart City) At major intersections in the city of Kigali, traffic congestion during the peak hours has already become apparent and the urgent need for improvement is necessary as a short-term measure. Although traffic signals are installed partially at the intersections in the city, the current system is outdated (fixed cycle, stand-alone control). In the peak, the police officers are guiding the traffic flow manually. The upgrading of the signalized intersections shall be implemented immediately especially for the optimization of the shape of intersection without land acquisition, introduction of advanced signal system (variable cycle, synchronized control), and the establishment of traffic data collection facilities. Also, a traffic control center is required to control these systems. Consolidated and centralized traffic data can be utilized by road administrators to formulate a concrete traffic policy. Also, with awareness of the smart city concept aimed at Rwanda, the control center should be extensible to cover other urban control functions other than traffic signal. Along with the applicability to other cities in Rwanda, there is a possibility that Kigali City can become the premiere smart city model case of African countries.
3	**Intersections (grade separated)** As mentioned in Chapter 6 in this report, three at-graded intersections (Giporoso, Chez Lando, and Gishushu) shall be reformed to grade-separated in the medium term. Considering future implication of the elevated mass-transit system along these three intersections, an underpass structure is recommended. It is necessary to install a mechanical drainage pump for the underpass, but the ridge terrain of Kigali City can allow natural drainage flow instead of the pump. The technique of underground construction can be well applicable not only to Kigali but also to other similar cities in Rwanda which also have undulating terrain.

Elimination of Missing Link of the Road Network/secure Redundancy Network	
5	**New Two-lane Bridge on KG 774** This project is done to address a missing link on the KG774 Road especially in the rainy season. The construction of a bridge (span length of about 20 m) and an approach embankment road to make KG774 all-weather access is recommended. The road link can reduce the traffic volume at the Nyabugogo intersection through diversion of the traffic flow to KG774.
6	**Replacement of Bicumbi Bridge and Bugesera Bridges (2 bridges) on DR57** Development of Bugesera District will be accelerated by the new airport (BIA). Currently, there is only one access road connecting Kigali City and Bugesera. From the viewpoint of redundancy of urban functions, an alternative access route will be important. The existing road DR 57 can become the alternative route, but the existing three bridges on DR57 are damaged intensely. Therefore, the replacement of the bridges has been proposed.
Upgrading of the Existing Roads	
7	**Rehabilitation and Upgrading of Kigali-Kayonza Road** The Kigali-Kayonza Road is an important logistics lifeline between Kigali and Tanzania. Capacity expansion (to four lanes by widening) and introduction of an additional uphill lane for heavy vehicles will be necessary. Currently, high speed heavy vehicles are running on two-lane roads without proper sidewalks. There are schools and factories along the road, but pedestrians are walking on narrow road shoulders. The improvement of sidewalks is urgently required for reducing accidents.
8	**Sector project loan for the improvement of the urban road network** The urban community roads behind the main arterial road are mostly unpaved with a steep gradient. Such road conditions make it difficult for the public transportation system (bus) to be accessed, hindering the use of buses by citizens. In addition to paving, including improving road drainage, installing traffic safety facilities, and installing NMT facilities shall be implemented. The project is assumed to be a donor loan and the JICA Survey Team considers that it is important to give flexibility such as modification of the program even during the project period rather than fixing the program from the beginning. The construction work can be carried out by Rwandan contractors.

Source: JICA Survey Team

7.3.3 Promotion of Advanced Transportation System (ITS/Smart City)

In the survey, the JICA Survey Team has pointed out the traffic jams at bottleneck intersections and the vulnerability of existing traffic management systems (signals) since the initial stage of the survey. During the series of Working Group (WG) Meetings with counterparts, the members of the WG exchanged views on the effectiveness of transportation and the effectiveness of ITS.

The Kigali City Transportation Master Plan (KTMP) is currently being revised. In the interim document of the updating team, an additional “objective”, i.e., "To Implement Transport Policy Effectively", has been proposed as the ninth development target to the eight development targets proposed in the updating KTMP.

Ultimate Goal	City of Green Transport								
Specific Goals	To become a **Transit Oriented City**		To establish a **Comprehensive Strategic Road Network**			To create a **Sustainable Transport Network**			
Objectives	Public/private transport modal split of 70:30	Average public transport commuting time of 60 minutes	Construction of urban roads to a minimum density of 6 km/km^2	Seamless intermodal transport connectivity	Construction of intercity freight routes and infrastructure	Integrated Non-motorized transport infrastructure	100% of public amenities and facilities served by public transport	Public/private transport modal split of 70:30	To complement transport policy effectively

Source: Stakeholders Meeting #02, Master Plan Update in Sep. 2018

Figure 7.3.3: Overall Structure of Kigali Transportation Master Plan 2018

This additional "objective" focuses on the organizational and institutional aspect, and the following six items are cited as organizational system development strategies. It is noted that the implementation of "Intelligent Transport Systems (ITS)" which was not focused on MP 2013 is newly included.

Source: Stakeholders Meeting #02, Master Plan Update in Sep. 2018

Figure 7.3.4: ITS in the Draft Strategies of KTMP 2018

After the inauguration of the KTMP 2013, the following development plans regarding the development of "Smart City" are newly established:

- Smart Sustainable Cities: A Blueprint for Africa (Smart Africa, 2017)
- Smart City Rwanda Masterplan Version 2.0 (Ministry of ICT, 2017)

In the KTMP 2018, it will be anticipated that the direction will be taken with consciousness of smart city policy.

In addition, as a measure for Transportation Demand Management (TDM), it may be effective to introduce road pricing in the future. Collecting and analyzing traffic data is indispensable for concrete examination of such measures. The introduction of sophisticated signaling system, traffic volume collection system, and traffic control center will be effective in realizing TDM measures.

7.3.4 Attention to Traffic Safety

In general, human life loss and economic loss due to traffic accidents are enormous. Unfortunately, traffic accident data has not been provided from the police authorities. However, there are indications from the counterpart authorities (MININFRA, RTDA) that traffic accidents, especially motorcycle-related traffic accidents, are increasing rapidly. Improvement of traffic safety is urgent.

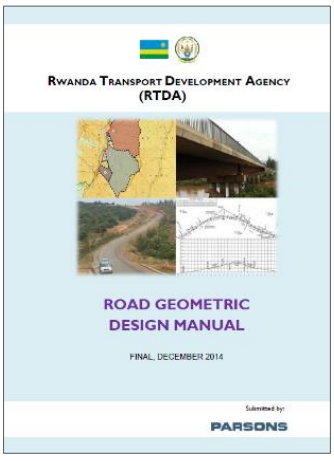
Table 7.3.2: Target and Issues on Traffic Safety

Target	Issues to be Improved
Drivers/owners	Statistically, it was found that most of the traffic accidents are caused by drivers/owners driving behavior. Lack of driving skills as well as manners gives strong influence to traffic safety.
Pedestrian/passenger	Lack or shortage of traffic safety awareness activities by schools and police
Mechanical	For public transport such as bus and bike, mechanical condition was the major cause related to traffic accidents.
Manual/guidelines	Most of the manual/guidelines including design standards were established long ago and have not yet been updated.
Institution/statistics	Utilization and reflection of analyzed past accident records to the planning and strategy are not only effective but also essential.
City infrastructure	Complicated road alignment with narrow roads, concentrated traffic flow, and inadequate traffic safety facilities make traffic accidents blackspots.

Source: JICA Survey Team

In general, measures to improve traffic safety consist of “hard infrastructures” such as safety devices and “soft components” such as safety awareness campaign. As mentioned above, in this survey, collection of accident data has not been realized and analysis of the causes of accidents has not been conducted. Therefore, this study does not mention measures on the soft component. As for the soft component measures, it is expected to be separately examined in cooperation with the police authorities and educational institutions such as schools.

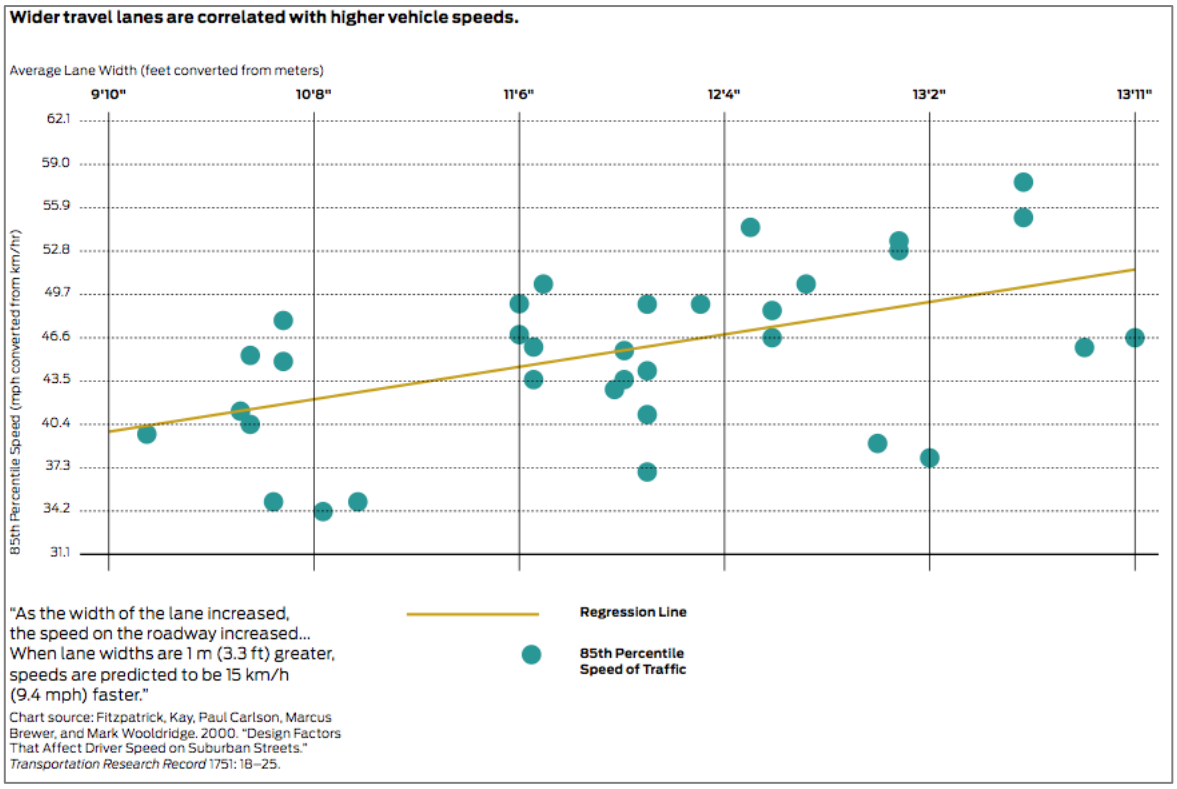
In the field survey conducted by the JICA Survey Team, it was also found that safety facilities for pedestrians even on major arterial roads are lacking. In order to implement traffic safety measures by the road administrator(s), it is essential to develop road design manuals that consider traffic safety. In Rwanda, the road design manual (see picture on the right) was drafted in 2014. However, it has not been authorized yet. In this manual, design guidelines such as geometric structures are shown. It seems to have been prepared with reference to the international standards such as AASHTO. The revision or update might be required based on the actual situation of Rwanda such as undulating terrain. As many developed countries are being developed, it is very effective to establish a manual/guideline specialized for “urban roads” from the viewpoint of improving traffic safety.



Source: RTDA

Figure 7.3.5: Road Geometric Design Manual

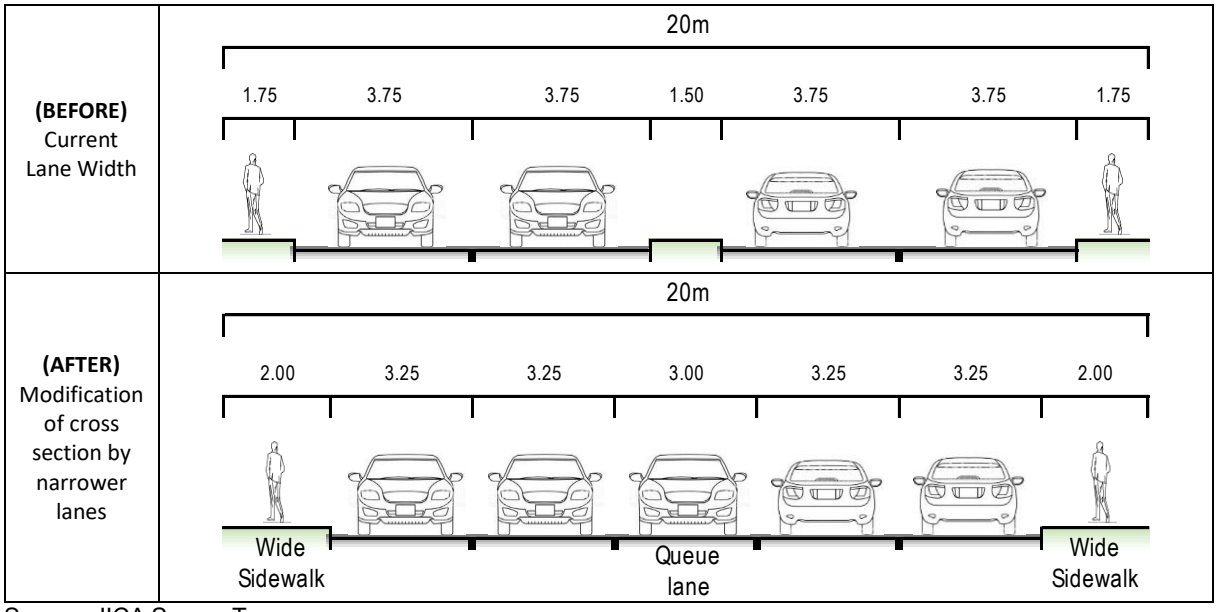
There are many pedestrians and roadside facilities (schools, etc.). High speed traveling (e.g., 80 km/h) is not necessarily required, rather it is necessary to suppress speed. Measures to deliberately narrow the lane width by the geometric structure for that purpose are actually introduced in developed countries. The figure below shows the relationship between lane width and actual travel speed.



Source: National Association of City Transportation Officials (NACTO), USA

Figure 7.3.6: Correlation between Lane Width and Travel Speed

By intentionally narrowing the lane, it is statistically shown that the driver voluntarily decreases the speed. For existing roads, by strategically reducing the lane width, it will be possible to provide right-turn lanes, left-turn queuing lanes and wide walkways, and to set bus priority lane. It will also be possible to secure space for introducing future elevated mass-transit systems.



Source: JICA Survey Team

Figure 7.3.7: Example of Lane Re-configuration Measures

As shown in Figure 7.3.3, the development of guidelines on transportation has been advocated in revising KTMP. The JICA Survey Team also agrees with the proposed direction of the revisions.

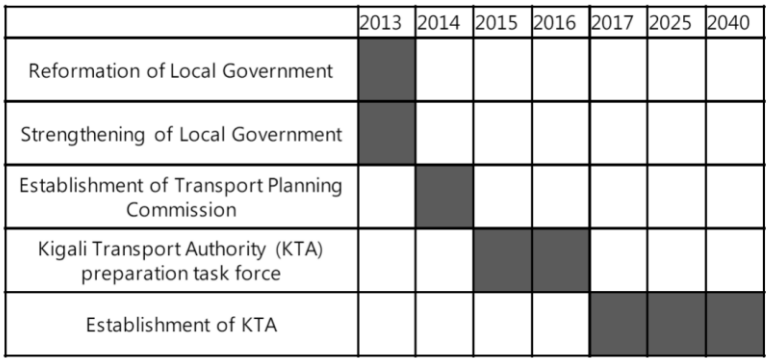
7.3.5 Capacity Development

The capacity development of stakeholders involved in the urban transport sector is essential as well. The target authorities should include not only the government sector but also the private sector such as bus operators as well. Since Rwanda takes into account the IT development policy, participation of IT entrepreneurs, start-up companies, etc., in the transport sector development should also be considered. In the smart city concept that Rwanda and Kigali are trying to seek ambitiously, mechanisms and project proposals are required in order to collaborate and cooperate with these IT stakeholders.

KTMP 2013 (in Chapter 5) also emphasizes the necessity of institutional improvement and capacity development and has proposed to establish the Kigali Transport Authority (KTA). The current issues of the stakeholders related to the urban transport sector of Kigali City are summarized as follows:

- Limitation in the number of staff and capacity;
- Lack of coordination among stakeholders; and
- Fragmented urban development policy, lack of statistics traffic data

Although the following schedule was proposed to establish the KTA in the KTMP 2013, it has not been realized as of 2018. Early establishment of KTA is desirable for responding to the existing traffic congestion at major intersections and also efficient implementation of BRT project which is under the feasibility study.



Source: Kigali City Transport Master Plan Report, 2013

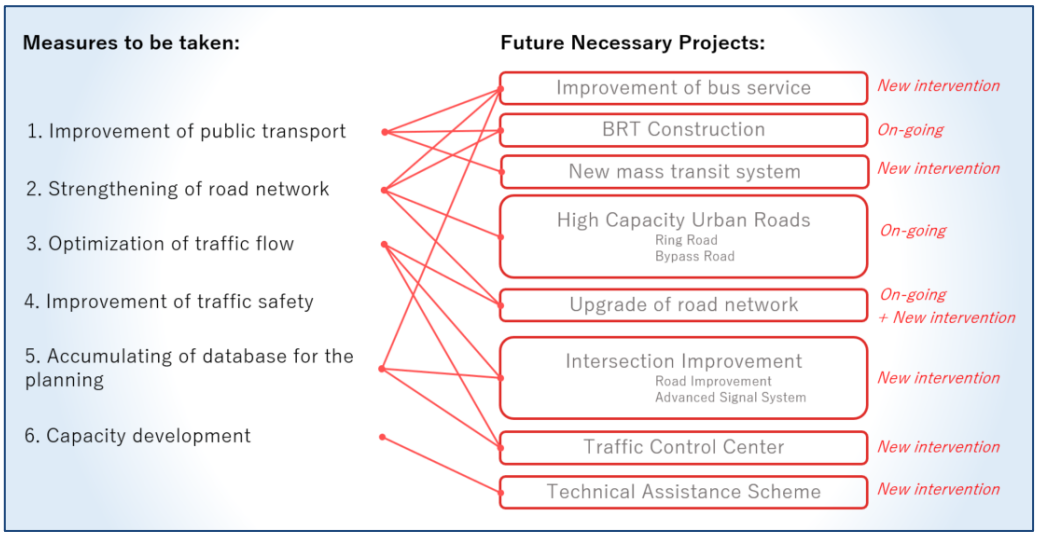
Figure 7.3.8: Timeline for the Establishment of KTA (Proposed in KTMP 2013)

Collecting and analyzing traffic data are essential for policy planning. Traffic data can be collected and accumulated in the Traffic Control Center (TCC) or City Control Center (CCC) proposed in this report. It is only when these data are properly analyzed that the reflection on traffic policy can be realized. In addition, it should be utilized by cross-sectoral stakeholders such as road/public transport administrators, private transport operators, etc. Ideally, the proposed KTA is expected to involve in the operation and management of the CCC.

The Government of Rwanda regards Information and Communications Technology (ICT) development as a national policy. Many IT startup companies have been established and are active. Traffic data collected by CCC should also be provided to these start-up companies, and it is expected that the functions of CCC could be further improved and expanded through the intervention and cooperation from start-up companies. The KTA with cross-sectoral function could be an organization that functions effectively for ICT development as well.

7.4 Proposed Interventions

The projects to attain the suggested directions and strategies above are proposed as interventions in updating KTMP.



Source: JICA Survey Team

Figure 7.4.1: Proposed Interventions

7.4.1 Ongoing and Planning Projects

The ongoing projects and the projects under the financing process are listed in Table 7.4.1. These projects are basically proposed in the existing MP.

Table 7.4.1: List of Ongoing and Planning Projects

Category	Project Title	Status	Funding
Public Transport TOD	Bus Rapid Transit (BRT)	FS ongoing (CoK)	n/a
	Dedicated Bus Lane (DBL)	Planning (CoK)	n/a
	Standard Gauge Railway (SGR)	Planning (GoR)	n/a
	Cable Car (Three lines from Nyabugogo)	EOI (CoK)	n/a
HCUR Network	Kigali Ring Road (modified alignment) and North-South Bypass	FS ongoing (Private: Mota Engil)	BOT
	BIA Expressway	DED ongoing (Private: Mota Engil)	BOT
Arterial Road Network	Widening of Sonatube-Akagera River Section to Four-lane	Contract process	Exim Bank
	Widening of Kigali-Muhanga-Akanyaru Road	Planning	未定
	Widening of Kigali-Kayonza Road	Planning	未定
	Urban Roads Upgrading Project (54.56 km Project) (Nyabugogo Intersection with Nyabugogo Bridge Construction is included)	Under construction （Exim Bank）	Exim Bank
	Urban Roads Upgrading Project (Rehabilitation of Asphalt Roads: 21.08 km, Construction of Asphalt Roads: 120 km, Widening of Paved Roads: 60 km)	Planning (CoK)	GoR/CoK
Institution O/M Capa-Dev	RAMS (Road Asset Management System)	Tendering (RTDA)	AfDB
Study General	Kigali Transport Master Plan (update of 2013 Version)	Ongoing (CoK)	GoR/CoK

Source: JICA Survey Team

7.4.2 Newly Proposed Projects (Interventions)

The JICA Survey Team proposes the long list of the Japanese ODA candidate projects as "interventions" to the existing and updating.

The long list projects are the newly proposed interventions, which are derived from the recommended development directions and strategies.

Table 7.4.2: Long List of Interventions

Category	Interventions	Brief Outline
Public Transport TOD	Technical Assistance in Public Transport (Improvement of Bus Service)	- Capacity enhancement of bus operators - Improvement of service level - Capacity enhancement of bus administrator (RURA)
HCUR Network	North-South Bypass Tunnel	- Shortcut of the proposed North-South Bypass - Logistics corridor for CBD via ring road - Future application of tunnel technology to mountainous terrain in Rwanda
	Ridge Link Bypass	- Shortcut of contour along road network - Alleviation of traffic jam in CBD - Future application of viaduct technology to mountainous terrain in Rwanda
Arterial Road Network Safety	Improvement of Major Congested Intersections (at-graded measures)	- Reconfiguration of intersection shape (small-scale road work without land acquisition) - Installation of advanced traffic signal control system
	Improvement of Major Congested Intersections (grade-separated measures)	- De-bottlenecking by grade-separated measure - Adequate structure type concerning future elevated mass-transit system and BRT
	New Two-lane Bridge on KG774	- Elimination of missing link - Alleviation of traffic jam at Nyabugogo Intersection
	Replacement of Bicumbi Bridge and Bugesera Bridges (two bridges) on DR57	- Replacement of damaged bridges - Improvement of traffic safety - Redundancy alternative access to Bugesera
	Rehabilitation and Upgrading of Kigali-Kayonza Road	- Adoption of EAC standard to DR57 Road - Alleviation of traffic jam on logistics lifeline of Kigali - Improvement of road safety
Other Roads Network Safety	Sector Project Loan for the Improvement of Urban Road Network	- Upgrading of urban road network (paving, drainage, safety facilities, etc.) - Extension of bus route network - Consideration for non-motorized transport (NMT) - Capacity enhancement of local small contractors
Safety ITS	SMART City Control Center Project (Smart C3 Project)	- Construction of traffic control center - Collection/accumulation of traffic data - Future implication for Smart City - Good practice for African countries
Capa-Dev	O/M Training for the SMART City Control Center	- O/M capacity for Smart C3 - Capacity building to analyse collected traffic data
Institution/ organization Capa-Dev	Technical Assistance to Establish Kigali Transportation Authority (KTA)	- Cross-cutting organization - Capacity enhancement of road administrators - Skill improvement for traffic planning
General Safety	Establishment of Urban Road Design Guideline	- Design standards specialized for urban roads - Consideration of Kigali and Rwanda's characteristics - Special attention to traffic safety
Study TOD	Pre-Feasibility Study for Mass Transit Transport System	- Confirmation of demand for mass-transit system - Appropriate mode selection of the system - Confirmation of project feasibility

Source: JICA Survey Team

7.4.3 Implementation Timeline of Interventions

The implementation schedule of the ongoing projects and the proposed interventions was examined.

(1) Short-term Measures

These are the measures to be realized in the next five years (2019 to 2023). As a measure to be developed in the short term, the following measures should be addressed in order to tackle the current traffic issues:

- Improvement of congested intersections (present traffic congestion at intersections)
- Upgrading of bus service (synergy for future BRT system)
- Elimination of missing links (more effectiveness for the road network)
- Replacement of old/damaged bridges (necessity of redundancy route for Bugesera)
- Improvement of urban community roads (quality of life improvement)
- Institutional capacity development (strengthening of capacity for urban traffic planning)

The interventions selected for short-term measure are conditions that there is no or less land acquisition to implement the projects. Furthermore, the preparation process (study and design) for the medium-term measures is included in the short-term intervention.

(2) Medium-term Measures

Medium-term measures include the construction of new roads in response to the future traffic demand. New road network is proposed by the JICA Survey Team based on the traffic demand forecast results carried out in this survey. These projects are large in scale and will require land acquisition. The adequate lead time (preparation period for planning, design, bidding, land acquisition period) shall be considered properly.

(3) Long-term Measures

The long-term measures will be affected by the progress of projects implemented in the short-term and medium-term. According to the demand forecast results conducted by the JICA Survey Team, it is necessary to introduce the mass-transit system by 2030-2040 in addition to BRT and HCUR implemented by mid-term.

(4) Proposed Timeline

The timeline of the interventions proposed by the JICA Survey Team is shown in Table 7.4.3.

Table 7.4.3: Implementation Schedule of Interventions

Interventions (Projects)	Short-term					Mid-term	Long-term	Project Profile ID
	Year 1	Year 2	Year 3	Year 4	Year 5	-2030	-2040	
SMART City Control Center Project (Smart C3 Project)	P	Con						KP-04
Improvement of Major Congested Intersections (At-graded measures)	P	Con			1 package			
O/M Training for the SMART City Control Center (Smart C3)			P	TA				
Establishment of Urban Road Design Guideline	P	T						KP-12
Technical Assistance in Public Transport (Improvement of Bus Service)		P	TA					KP-13
Technical Assistance to establish Kigali Transportation Authority (KTA)			P	T				KP-14
New 2-lane Bridge on KG774	P	Con						KP-08
Improvement of Major Congested Intersections (Grade-separated measures)			P	Con				KP-05-1 KP-05-2 KP-05-3
Replacement of Bicumbi Bridge and Bugesera Bridges (2 bridges) on DR57			P	Con				KP-09
Rehabilitation and Upgrading of Kigali-Kayonza Road				P	Con			KP-10
Sector project loan for the improvement of urban road network				P	Con			KP-11
North-South Bypass Tunnel				P	Con			KP-03 KP-03a
Ridge Link Bypass				P	Con			KP-06
Pre-Feasibility Study for Mass Transit Transport System						P	Con	KP-15
Note : Project Profile is attached at the end of this chapter (Chapter 7). Legend : P : Preparation Period Con : Construction Period TA : Technical Assisntance								

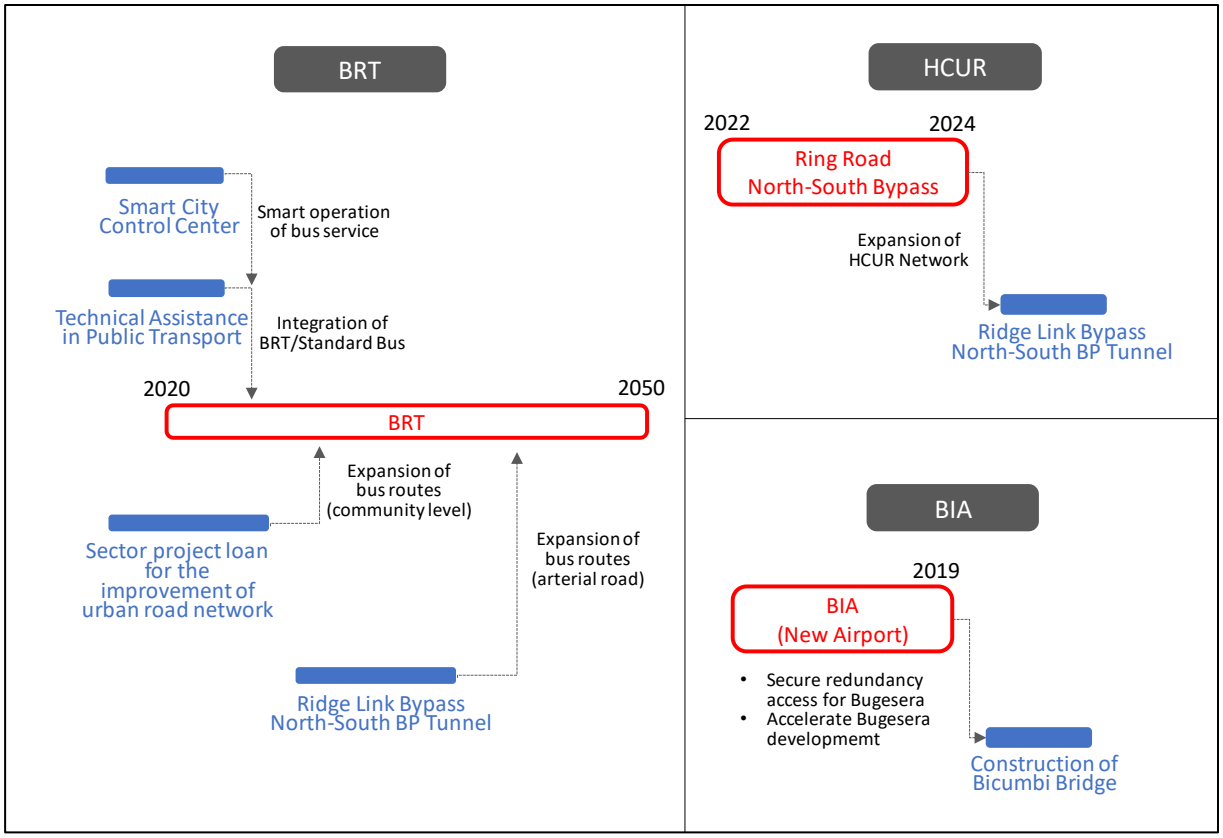
Source: JICA Survey Team

Figure 7.4.2 indicates a correlation and expected synergies between the interventions and the existing ongoing projects (BRT, HCUR, BIA).

The feasibility study of the BRT proposed in KTMP 2013 is currently ongoing. The interventions proposed by the JICA Survey Team are aimed at 1) improving the service level of the existing bus service, 2) upgrading the service level through the control system, 3) expanding the bus route by improving the urban road network, and 4) maximizing the function of the BRT.

The Kigali Ring Road and the North-South Bypass were proposed in KTMP 2013 and the feasibility study is ongoing. The interventions by JICA Survey Team will further expand the HCUR network after completion of the ongoing HCUR projects.

The new Bugesera International Airport (BIA) is under construction with the aim of opening it by 2020. The replacement of the damaged road will secure a redundancy access between Kigali City and Bugesera District (currently, there is sole access via the Akagera Bridge). The redundancy access will contribute to promote further economic development in Bugethera District.



Source: JICA Survey Team

Figure 7.4.2: Correlation and Expected Synergy between Interventions and Ongoing Projects

The tentative program for the implementation of the shortlisted interventions is proposed below.

7.4.4 Financing Plan

The financing plan for the ongoing projects and the proposed interventions by the JICA Survey Team is summarized below.

Table 7.4.4: Ballpark Cost of Ongoing Projects

Project Title	Ballpark Cost (USD million)	Financing Status
Bus Rapid Transit (BRT)	580	n/a
Kigali Ring Road (modified alignment)	n/a (Private)	Private (PPP)
North-South Bypass	100	n/a or BOT
Total	**680**	

Source: JICA Survey Team

Table 7.4.5: Ballpark Cost of Interventions

Intervention Title	Ballpark Cost (USD million)	
Improvement of Major Congested Intersections (at-graded measures)	25	
SMART City Control Center Project (Smart C3 Project)		
O/M Training for the SMART City Control Center (Smart C3)		
Establishment of Urban Road Design Guideline	1.0	
Technical Assistance in Public Transport (Improvement of bus service)	1.5	
Technical Assistance to Establish Kigali Transportation Authority (KTA)	1	
New 2-lane Bridges on KG774	4.2	
Improvement of Major Congested Intersections (grade-separated measures)		
1) Construction of Underpass at Giporoso Intersection	25.8	55.4
2) Construction of Underpass at Chez Lando Intersection	17.7	
3) Construction of Underpass at Gishushu Intersection	11.9	
Replacement of Bicumbi Bridge and Bugesera Bridges (two bridges) on DR57	5	
Rehabilitation and Upgrading of Kigali-Kayonza Road	86.5	
Sector Project Loan for the Improvement of Urban Road Network	77	
North-South Bypass Tunnel	45	
Ridge Link Bypass	260	
Pre-feasibility Study for Mass Transit Transport System	2	
Total	**563**	

Source: JICA Survey Team

(1) Government Budget

Large-scale projects are often implemented utilizing donor loans such as World Bank (WB), African Development Bank (AfDB), European Union (EU), JICA, or private fund (investor). Although the BRT project will require approximately USD 580 million, there are still no prospects for financing.

(2) Private Fund

Toll road projects could be suitable for utilization of private funds such as the PPP scheme. The Bugesera Expressway has already been included in the concession agreement for the new Bugesera International Airport, and the awarded private concessionaire is currently conducting the detailed design. The Feasibility Study of the Kigali Ring Road is also undertaken by the same private investor. Some of the interventions proposed in this report such as North-South Bypass Tunnel might be a possible candidate for the PPP scheme.

(3) Donor Fund

The international donor organizations such as WB, AfDB, EU, and JICA are providing technical cooperation, capital grants, and loans to the Government of Rwanda fundamentally as defined by the Development Assistance Committee (DAC) of the Organization for Economic Co-

operation and Development (OECD). The JICA Survey Team has visited some of the donor organizations for hearing their direction or policy of support for the urban transport sector in Kigali. The summary of the hearing is shown in Table 7.4.6.

The donor organizations are not focusing on the urban transport development in Kigali. Some rural road development projects are in progress. In general, the interest of the donors is not on the transport sector but other sectors such as energy sector which contribute not only for urban area but also rural and nation-wide area.

China is aggressively supporting the urban road development in Kigali. MININFRA does not have a future development plan of China. A Chinese enterprise is currently proposing the underpass project on Giporoso intersection but the concrete progress for the implementation has not been proceeded yet.

Table 7.4.6: Intentions to Support Urban Transport Sector by Donors

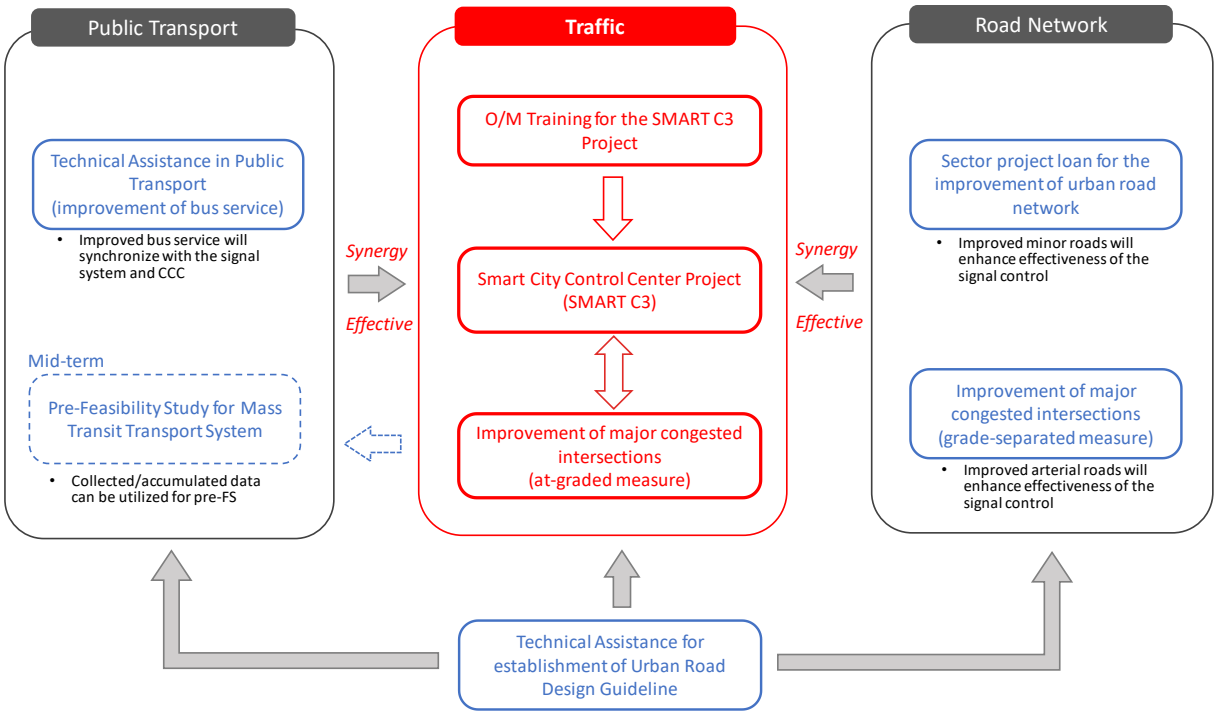
International Donor	Direction for the support of Urban Transport Sector in Kigali
World Bank	・ Target sector (under financing) is 1) feeder road, 2) regional road, 3) urban development, and 4) urban transport ・ USD 95 million is under funding by WB for the urban development of six cities in Rwanda. The urban road improvement in Kigali is also included in this project. ・ Bus upgrades were once considered, but the consideration has been suspended since the city of Kigali began planning the BRT. ・ Co-financing with JICA is considered. JICA is interested to support the urban transport sector.
African Development Bank	・ AfDB also agreed that traffic congestion at the intersection is a serious problem for Kigali City. The signal improvement will be effective in the short-term, but in the long-term grade-separated intersections such as flyovers will be necessary. AfDB is interested in supporting to finance the construction of flyovers. ・ Road Asset Management System (RAMS) is being undertaken with the AfDB fund.
Delegation of the European Union	・ EU is focusing on the energy sector. ・ The National Feeder Road Programme was the last project for the transport sector in Rwanda. (closed in 2018) ・ EU is providing only a grant program. There are joint financing with other donors but EU is in-charge of the grant portion only. ・ EU is interested in the public transport sector.

Source: JICA Survey Team

Regular meetings are held between the donor agencies and the Rwandan government. During the meetings support plans and progress reports are discussed. CRC is not the member of the regular meeting.

7.4.5 Priority Programs among Interventions

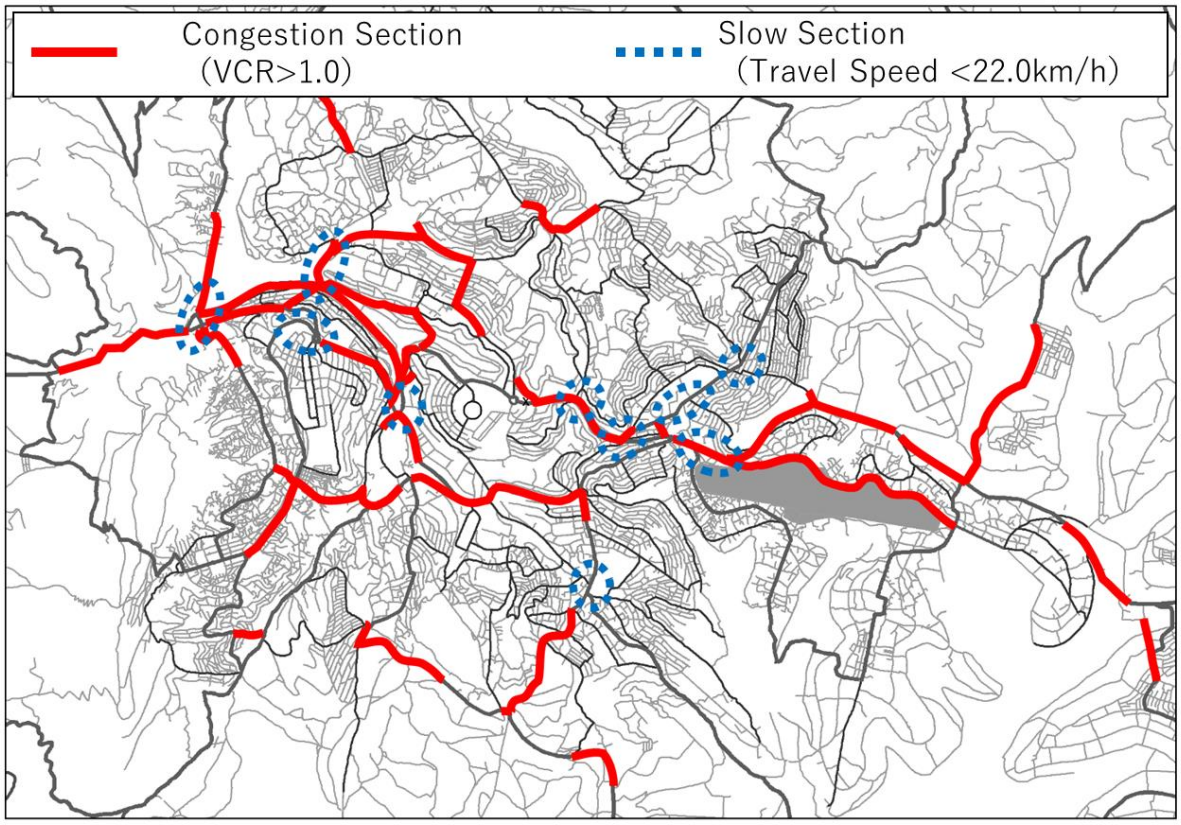
The priority programs have been selected from the proposed interventions. The selection criteria are 1) projects that can be implemented in a short term (within five years), 2) projects that need none or less land acquisition, and 3) projects to meet the development policy of the Government of Rwanda. Figure 7.4.3 indicates the correlation and synergistic relationship among the proposed short-term intervention projects as the priority programs.



Source: JICA Survey Team

Figure 7.4.3: Correlation and Expected Synergy Among Interventions

Although are few serious congestion points at present, according to the results of traffic survey and traffic demand forecast, there are many saturated road sections as shownin the figure below. Future traffic demand tends to increase towards 2040, and traffic congestion of road network in the Kigali city including these congested sections will be expected to become worse in the future. Furthermore, urban transport sector has various issues in the both hardware and software as shown in the Table 7.2.1. If these issues are not improved, it will accelerate the deterioration of the traffic situation in the future. On the other hand, newly construction of roads is inevitably difficult, because Kigali City has many undulations and many roads in Kigali City have alignment along with the ridge line of the hill. Since the development of the ring road and BRT, which are at the planning stage presently, need time for completion, it is necessary to make efficient use of the existing roads as much as possible in the short term. Traffic demand management using ICT such as ITS is suitable for this. Utilization of ICT is also consistent with the national policy of Rwanda, and further development and application in the future will be expected. The SWOT analysis based on the above situations is shown in Table 7.4.6.



Source: JICA Survey Team

Figure 7.4.4: Congestion and Slow Sections of the Current Road Network (2018)

Table 7.4.7: SWOT Analysis for Urban Transport Sector

Strengths	Weaknesses
Rwanda encourages the use of ICT. Utilization of ICT become a strong point to solve the traffic issues.	Kigali City is a hilly terrain, and this terrain arises constraints in urban infrastructure and transportation development.
Opportunities	**Threats**
ICT can be solve problems not only transportation fields, but also urban management field. It also matches Rwanda's policy toward smart city.	Traffic concentrates along the RN 3 (daily traffic volume is 5-60 thousand). In major routes and intersections, traffic concentration has caused speed down and congestion. This situation will be worse.

Source: JICA Survey Team

In light of the increase of future traffic demand, road construction is essential. However, it might be difficult to implement hardware measures in the short term by restraint of terrain. Therefore, it is important to maximize the use of the capacity of city road network by software measures. Traffic management situation in Kigali City are inefficient. There are few signal intersections in the city (6 intersections) in Kigali City, these signals are manually controlled by traffic police when the congestion occurred. Road users cannot get traffic information such as congestion area, detour routes, bus arrival time, etc. In addition, operation and maintenance for management of urban infrastructure including roads is also inefficient management at present. ICT should be utilized in the early stage for managing urban and traffic infrastructure effectively.

Based on the above, directions and procedures for solving urban transport issues are shown as follows;

- Utilize a combination of hardware and software measures from the viewpoint of efficient use of roads.
- Utilize a combination of hardware and software measures from the viewpoint of efficient use of roads.
- In light of the topographical constraints, in order to maximize effective use of roads, ICT utilization would be implemented as a top priority measure. As a countermeasure for traffic congestion, ITS measures are implemented to promote traffic optimization and information provision (roads, public transportation, assets). Since ITS has immediate effect, it should be implemented in the early stage to achieve its effect.
- Intersection Improvement in combination with ITS is carried out in the short term. At that time, civil work is carried out within ROW. Minor improvement to maximize the effect of signal control is conducted.
- Hardware measure should be implemented for managing future traffic demand. Main measures are the increasing capacity by construction of underpass along the main road (RN3) and new access route which can become alternative route. These measures will be implemented in mid- to long-term (Ring Road, HCUR, etc.).
- Utilization of ICT should be promoted for realizing future smart city. Builiding a platform to operate and manage the urban and transportation services collectively at the initial stage should be done. Additional system will be introduced systematically to this platform step by step based on the needs.

For the first step, traffic optimization by traffic management is positioned as a priority project. As described above, there are only six existing signal intersections in Kigali City. From the viewpoint of traffic optimization, it is desirable to improve intersection capacity and to rectify the traffic flow by implementing intersection improvement and installation of advanced traffic signal along with the introduction of the signal control system.

In traffic management using intelligent transport systems (ITS), the measures should be matched with the initiative of Rwanda encouraging ICT technology and Smart City (refer to Figure 7.4.6). The JICA Survey Team has proposed that a Smart City Control Center (hereinafter, Smart C3), “the facility which consolidates city management”, should be developed as a priority project. This priority project on traffic management and the project for improving public transport and road network development complement each other, and those project effects are maximized. Details of the priority project are shown below.

(1) Traffic Management Plan using ICT

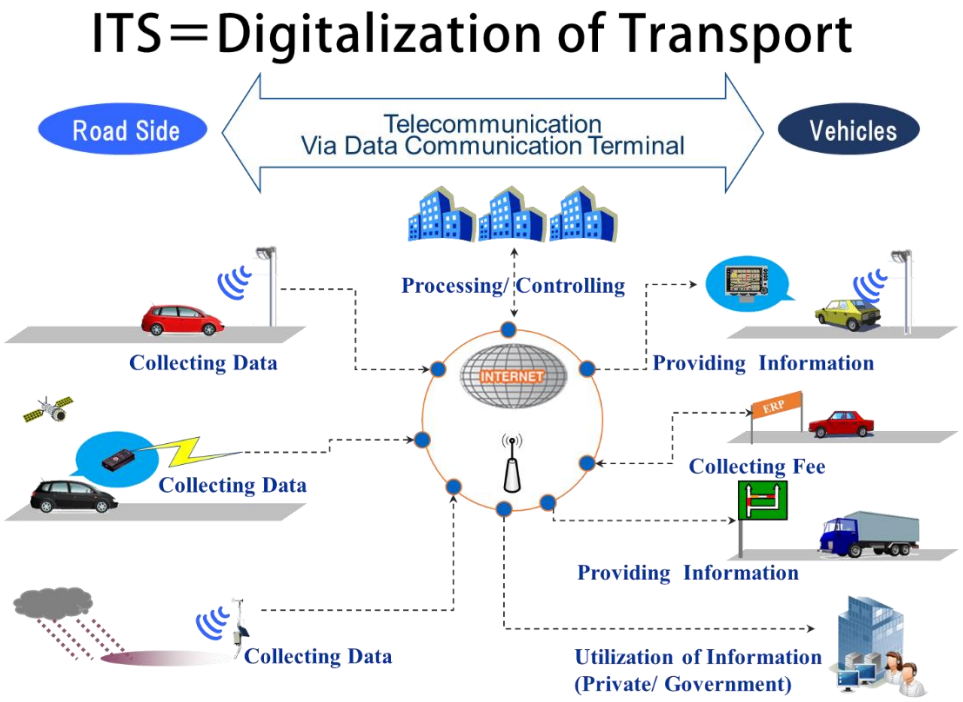
1) Traffic Management by Signal Control System and Information Provision System

As described above, the JICA Survey Team proposes to implement the installation of advanced traffic signal and intersection improvement as early as possible. The purpose of the sophistication of advanced traffic signal is to make traffic optimization by the installation of traffic-actuated signal and signal control system and the implementation of intersection improvement. There are some roundabouts in Kigali city, but it is necessary to improve from roundabout to cross intersection for main road such as RN 3. Roundabout is not controlled the volume of traffic inflow into roundabout, and the vehicle speed should be slow down inside roundabout. Therefore, its capacity is lower than cross intersection, and roundabout is not effective for congestion mitigation measures. If daily traffic volume is less than 10,000,

roundabout is effective for traffic control. According to the traffic survey which was conducted in this project, however, current daily traffic of main road in Kigali city has more than 10000. Roundabout is in-suited in these roads. In light of future traffic volume which are expected increase, intersection improvement to change the cross section from roundabout is needed in early stage. As described chapter 6, Chez Lando roundabout will be faced serious congestion in 2025.

In the ITS (Intelligent Transportation Systems) which utilized ICT in the transportation sector, it is utilized for information provision etc. utilizing traffic data collected, processed and analyzed, including signal control (see Figure 7.4.3), and ITS is utilized for traffic control and management in many countries. Advanced systems are included driving safety support and automated driving, etc. Although Rwanda encourages the utilization of ICT as described later, ITS is not introduced much in the transportation sector in Rwanda at the present, therefore, the stage of ITS in Rwanda is consideration or introduction stage. Operation of ITS is important for introducing ITS, and advanced systems are required experience and technical knowledges. In light of this, in Kigali city, it is desirable to introduce basic systems such as accumulation of traffic data and utilization of collected data on a preferential basis, and consider further development after accumulation of experience and the skill, etc. In Kigali city, the introduction of a signal control system using real time traffic count date, the collection and storage of traffic data, and the provision of traffic information should be introduced with priority. Traffic detector, CCTV camera, and sensors are installed in parallel with the installation of traffic signals. They can monitor and measure traffic volume, vehicle speed, etc. The installation of a CCTV surveillance system is also useful for the formulation of the city and transport plan for Kigali City, because it can grasp and accumulate traffic related data such as traffic volume, congestion road, etc. The information provision based on the analyses of the collected/accumulated data for road users and road administrators should also be implemented.

Japanese technology in ITS field is widely used and deployed. Japan has MODERATO which is traffic signal control system, and road traffic information is collected and provided at traffic control centers owned by each prefectural polices and expressway companies. State-of-the-art technologies such as automatic driving is being developed in the field of development of ITS field in Japan, and also the introduction of signal control systems and traffic information provision systems is proceeding in Uganda, Cambodia, India and Bangladesh by Japanese grant aid or capacity development projects. The introduction of the above technologies is possible to introduce without problems even in other countries. In terms of operation and maintenance, it is important to secure means of obtaining equipment for maintenance etc. However, some Japanese companies are working with local companies toward overseas deployment. The proposed ITS can fully utilize Japanese technology.



Source: JICA Survey Team

Figure 7.4.5: Concept of ITS

2) Utilization of ICT Encouraged by Rwanda

The Government of Rwanda formulated three ICT related plans" (i) "Smart Rwanda Master Plan 2015-2020", (ii) "Smart Sustainable Cities: A Blueprint for Africa, 2017", (iii) "Smart City Rwanda Master Plan, 2017", and they promote action for ICT and Smart City initiatives. The above documents are mentioned about development of road traffic infrastructure using ICT. The road traffic related actions/initiatives indicated in the above plan are shown in the following table.

1) Smart Rwanda Master Plan 2015-2020

13 projects to be implemented by 2020 are listed in this plan, and three of them are traffic related measures. (Red frame in the right figure):

- ✓ Real-time Traffic Information Collection System
- ✓ Public Transportation Information System
- ✓ Road Taxation System (Toll Collection System)

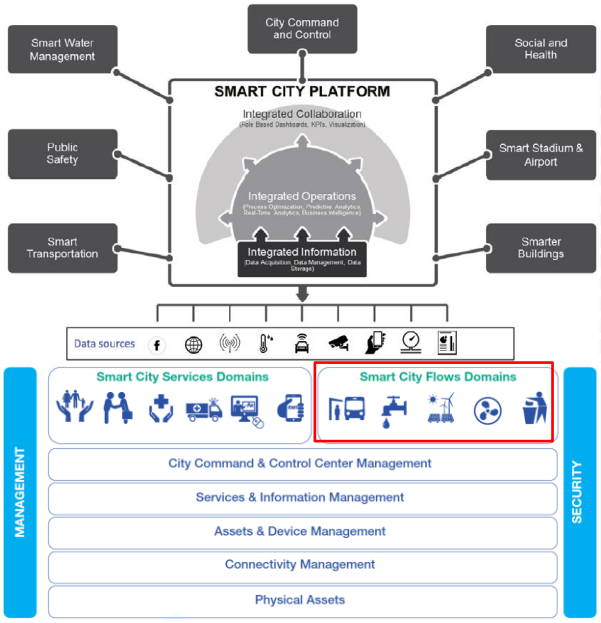
Project List		Description	Benefi-ciary	Responsible Department
1	Citizen Petition Analysis System	Automatic analysis system for public petition aggregated through citizen participation portal	G2G	Ministry of Local Government
2	e-Parliamentary System	Support the operation of Parliamentary from initiating bills, overseeing and sharing information with citizens Include parliamentary document management system, legislation enactment support system, parliamentary portal	G2G	RDB
3	e-Court Auction	Computerized management system for court auction : One-stop portal for citizen to query auction items and to participate in bidding backed up by settlement and payment system	G2C	Ministry of Justice
4	Real-Time Traffic Information System	Integrated Traffic Information System : Data collected from diverse sources, and the processed information provided to many sources of demand in real-time basis	G2C	Ministry of Infrastructure
5	e-Patent	Computerized registry and management system for intellectual property and electronic trial for patent infringement and dispute	G2B2C	Ministry of Justice
6	Smart Mobile Administration	Mobile devices with applications to enable public officials to work from outside home office	G2G	RDB/MYICT
7	U-Library	Building an integrated DB and management system of university libraries with education materials (books, journals, magazines, course materials, etc.) to be shared within the member network	G2B2C	Ministry of Education
8	Public Transportation Information System	Integrated Information System on Public Transportations : Provides the general public with arrival & departure time of bus transit at each bus stop	G2C	Ministry of Infrastructure
9	Road Taxation System (Toll Collection System)	Toll Collection System for Road Maintenance Financing : Both manned(conventional TCS) and Electronic Toll Collection System(ETCS) can be considered and implemented	G2G	Ministry of Infrastructure

②Smart Sustainable Cities: A Blueprint for Africa, 2017

This plan shows the basic concept of activities towards smart cities for African countries. This plan was formulated at the same time as "③ Smart City Rwanda Master Plan, 2017".

This plan proposes to build a smart city with two domains "Smart City Service" and "Smart City Flows". The transport sector is included in the "Smart City Flows" domain with water and environmental sectors. The following three items are stated as specific measures in this plan:

- ✓ Utilization of ICT in transportation fields to promote growth of the industrial field;
- ✓ Improvement of transportation system (improvement of logistics efficiency, cost reduction, etc.); and
- ✓ Improvement of public transport system.



2) Smart City Rwanda Master Plan, 2017

This plan proposes three pillars and 27 initiatives for the realization of a smart city. The descriptions related to the transport sector are as follows:

- ✓ Collection and provision of traffic information (accumulation of traffic related data, bus route/arrival time etc.), application development (Initiative 13)
- ✓ Utilization of meteorological sensors (collection and provision of information such as flood conditions, utilization for city planning) (Initiative 16)
- ✓ Implementation of TOD (Initiative 18)

PILLARS		BUILDING BLOCKS		INITIATIVES
1 Smart governance and planning	A	Data-led urban planning and management	1	Integrated, GIS-based urban management platforms
			2	Cross-ministry financial and project management platform
			3	Multi-stakeholder safer cities programme
	B	Smart policies and regulations	4	Dynamic data-supported urban master planning
			5	Enabling environments for urban technology testing
	C	Public engage-ment and open data	6	Data strategies including open data, privacy and cybersecurity
			7	Accessible internet zones in strategic and residential areas
			8	Digital citizen engagement tools accessible to all
			9	Urban Data accessible to all
2 Smart and efficient services and utilities	D	Shared local infrastructure	10	Digitally monitor and manage utility networks
			11	Explore smart micro grids based on the prosumer model
	E	Efficient, demand based services	12	Regulatory frameworks for virtual power plants and other de-mand-based management solutions
			13	Smart data-led 'door-to door' mobility solutions
			14	Digital service points for rural settlements
			15	Smart urban agriculture projects
	F	Sustainable and resilient resource management	16	Sensor-based environmental data
			17	Green and smart building labs
			18	Smart, sustainable and shared neighbourhood pilot projects
3 Localized innovation for social and economic development	G	Education, innovation and digital literacy	19	Innovation in education, from primary school to higher education
			20	ICT skills training in education, for local authorities and the general public
			21	National fund to encourage challenge-based innovation
			22	Innovation teams in ministries and local authorities
	H	Localized and challenge-based financial opportunities	23	Promote local digital business platforms
			24	Create collaborative community co-working and digital excellence centers
			25	Establish collaborative urban innovation acceleration labs with academy, community and industry
	I	Digital transformation of financial services	26	Introduce personalized e-finance platforms for all life-time services
			27	Electronic due-diligence and business loan systems for SMEs

Source: Smart Rwanda Master Plan 2015-2020, Smart Sustainable Cities: A Blueprint for Africa, 2017, Smart City Rwanda Master Plan, 2017

Figure 7.4.6: ICT Related Plans

Although these plans did not include project/activities for installation of traffic signals and traffic control center, the ITS projects added attraction and attention in this country, where it encourages ICT. In addition, a comprehensive city management can be realized by promoting the utilization of ICT in other urban infrastructure fields. Other transport related plans such as the national transport master plan, have also been mentioned about traffic management measure using ITS and ICT, so that it matches with national policy.

(2) Development of a Smart City Control Center (Smart C3)

Smart C3 project should be conducted for realizing smart city in the future. This center system should have expandability considering future expansion of the center. As the first system being installed in the Smart C3, installation of traffic control center and traffic actuated signal, intersection improvement, and development of traffic control center should be implemented. The specific system will be considered in the preparatory survey. Firstly, traffic optimization and accumulation related data should be conducted by introducing the signal control system including bus priority signal system as well as information collection and provision system at the initial stage. In addition to this, urban management system excluding traffic related, such as waste collection management system, irrigation system, etc., should be also introduced. In the final stage, Smart C3 will manage centrally all urban infrastructure. Figure 7.4.7 shows an image of the functions of Smart C3. In the traffic control of smart C3, it consists of a system for general traffic control such as a signal control system and traffic information provision system, a system for public transport such as a bus location system, etc. and a system for road maintenance such as road surface condition monitoring system. These systems and collected data are utilized for conducting traffic management and control, etc. Necessary or useful traffic information data for road administrators and road users are selected and shared for effective use.

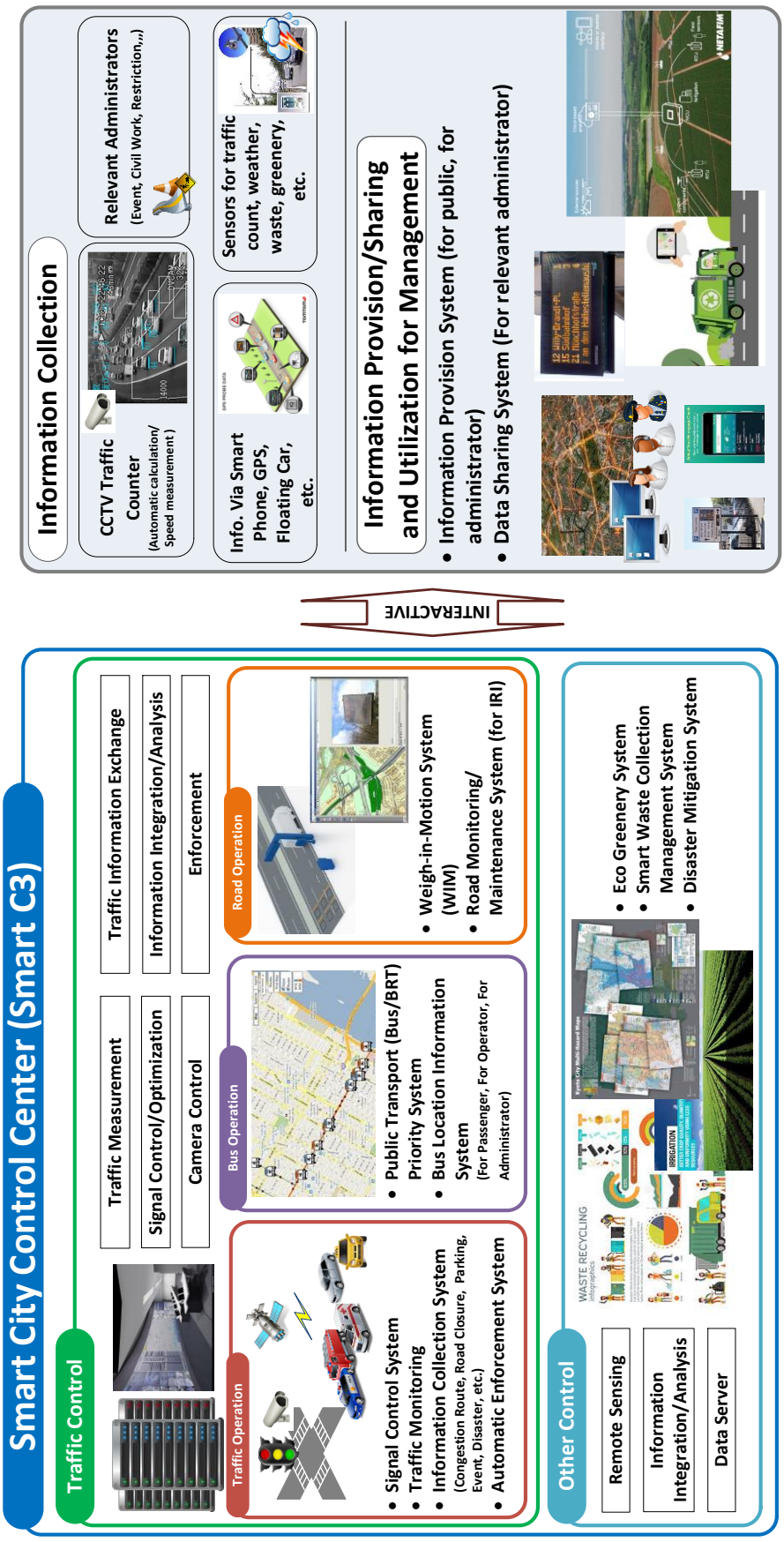
The draft outline for priority projects is also shown below.

1) Purpose of the Project

The purpose of this project is to improve the efficiency of maintenance and management of cities and transportation infrastructure by developing a central control center for sustainable urban infrastructure management in the future Rwanda and Kigali city. Taking into consideration the sustainable operation of Smart C3, expanding of facility will be conducted responding to the stage while human resources and technical resources related to operation and maintenance train and educate. Therefore, platform with expandability should be constructed at the initial stage of introduction.

2) Target Area

Within Kigali City

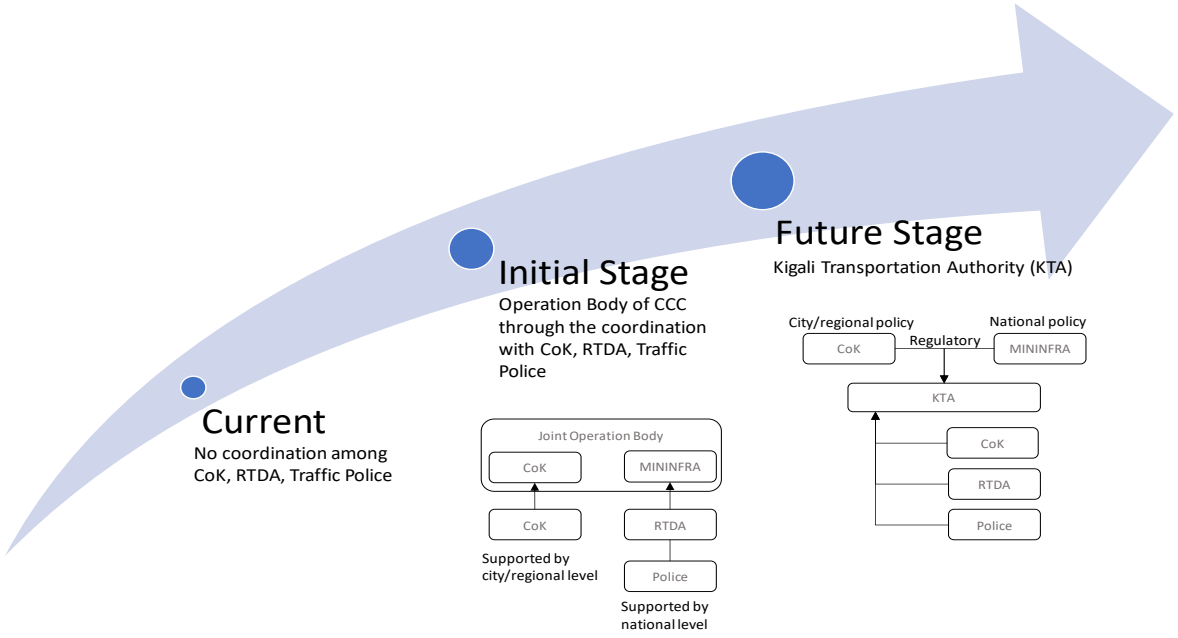


Source: JICA Survey Team

Figure 7.4.7: Concept of Smart City Control Center

3) Implementing Organization

The existing signal system is under jurisdiction of City of Kigali. The most appropriate implementing organization for the Smart C3 will be City of Kigali. Traffic management should be coordinated not only with the administrator of the traffic signal system such as CoK but also with governmental road administrators and also with traffic police. Therefore, the JICA Survey Team proposes an administrator of the proposed CCC system as a joint coordination organization by CoK and MININFRA. MININFRA is expected to coordinate especially the road administrator such as RTDA and the Traffic Police authority.
In the future, it is conceivable that the administrator of this system functions as the Kigali Transportation Agency which was proposed by Kigali Urban Transportation MP.



Source: JICA Survey Team

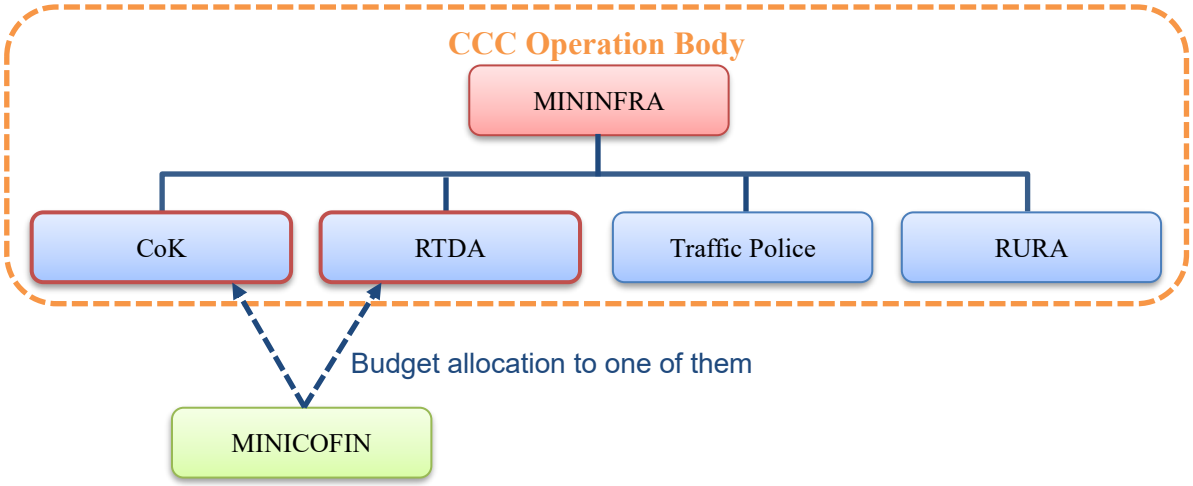
Figure 7.4.8: Proposed Implementing Organization of Smart C3

(I) Proposed Structure of CCC Operation Body

In order to operate Smart City Control Centre (CCC), not limited to installation of equipment, but also establishment of operational body is required. Since CCC has functions of i) operation and maintenance of the CCC, ii) traffic management and iii) any other municipal services management, the operational body should involve nodal agencies of the covered sectors.

Although Kigali Transport Authority (KTA) is expected to work as the operation body under the regulation which will be formed in long term, tangible operational scheme to manage CCC in the short term is required to accelerate the CCC project implementation.

In line with this understanding, structure of operational body in short term is drafted through discussions with MININFRA and other stakeholders as shown below;



Source: JICA Survey Team

Figure 7.4.9: Proposed Structure of CCC Operation Body

Since the organizations shown in the figure above is stakeholders in traffic management or municipal services, involvement of them is essential to work CCC smoothly.

Regarding budgeting, CoK or RTDA as main player of the CCC Operation Body receive required amount from MINICOFIN and allocate for the operation which includes, CCC system maintenance fee, personnel fee, office operation fee etc.

(II) Expected Roles of Each Stakeholders

Role of each player is proposed as below through discussions with stakeholders;

Table 7.4.8: Role of each Stakeholder in CCC Operation Body

Organization	Department in Charge	Role in CCC Operation Body
MININFRA	Transport Division	● Supervising and monitoring
COK	Transport Department	● Traffic management ● Transport planning
RTDA	Traffic Management Unit	● Traffic management ● Transport planning
Traffic Police	-	● Law enforcement ● Security and safety management
RURA	Transport Department and ICT Department	● Bus management

Source: JICA Survey Team

4) Activities

- Development of Smart C3: Development of city management center for urban management using ICT
- For the first step, ITS will be introduced, which can be expected to have immediate effect for mitigating traffic congestion. Detail is shown below;
  - ➢ Development of traffic control center (including signal control system, public transport priority system, road monitoring/maintenance system, etc.)
  - ➢ Introduction of data server for analyzing and accumulating traffic related data

- Introduction of road maintenance system (utilizing WIM (weigh-in-motion), RAMS)
- Installation of urban infrastructure management system (it would be selected based on the consultation with related personnel/organization)

・ Installation of traffic actuated signal and intersection improvement which can be conducted easily

5) Considerations

・ The JICA Survey Team confirmed in the consultations with related organizations that the location of a center can be established in Kigali City Hall, but it is essential to cooperate with MININFRA, Rwanda Transport Development Agency (RTDA), and the Traffic Police during operations.

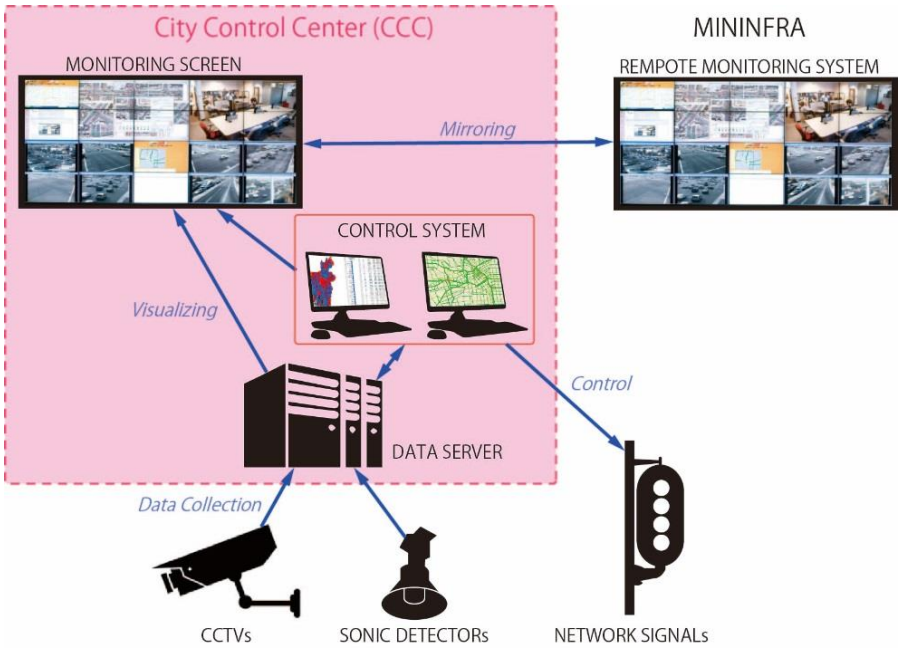
・ Intersection improvement should be conducted based on the progress of the BRT and DBL project.

・ In implementing priority projects, it is essential that the Rwanda side can properly operate the system on their own. Therefore, training for the related organization personnel is also required. In line with the introducing Smart C3, capacity development should be conducted so that the Rwanda side can operate and maintain the Smart C3 on their own. This also includes the establishment of the organization that operates and maintains Smart C3. In the initial stage, existing related organizations and agencies will operate Smart C3. In the future, KTA will manage Smart C3 on their own as a management organization.

・ The initial functions of the SMART C3 will be the traffic control system and the other additional functions which could synchronize with the traffic control system might be installed also in the initial stage. For instance, the traffic data provision to the waste collection works will be directly worked with the system, the automated greenery system can independently work with the cost reduction of the OM cost of the road administrator, and the over-loaded monitoring system should be introduced to address the present issue to tackle with the road damages by heavy vehicles. These additional functions could be managed by the road administrator.

・ The ITS is a part of the elements constituting the platform, and necessary functions for urban management in the future are added to Smart C3 based on needs etc. In the future, Smart C3 will fulfill the core function of Smart City in Kigali City and operate and manage related systems and services.

・ Since the collected data for CCC operation is highly confidential, raw data have to be accessed by other than CCC. However, since MININFRA requested to monitor the traffic situation for their supervising purpose, mirroring system to monitor the traffic lively will be installed in the MININFRA. The conceptual image of the remote monitoring system is shown as below;

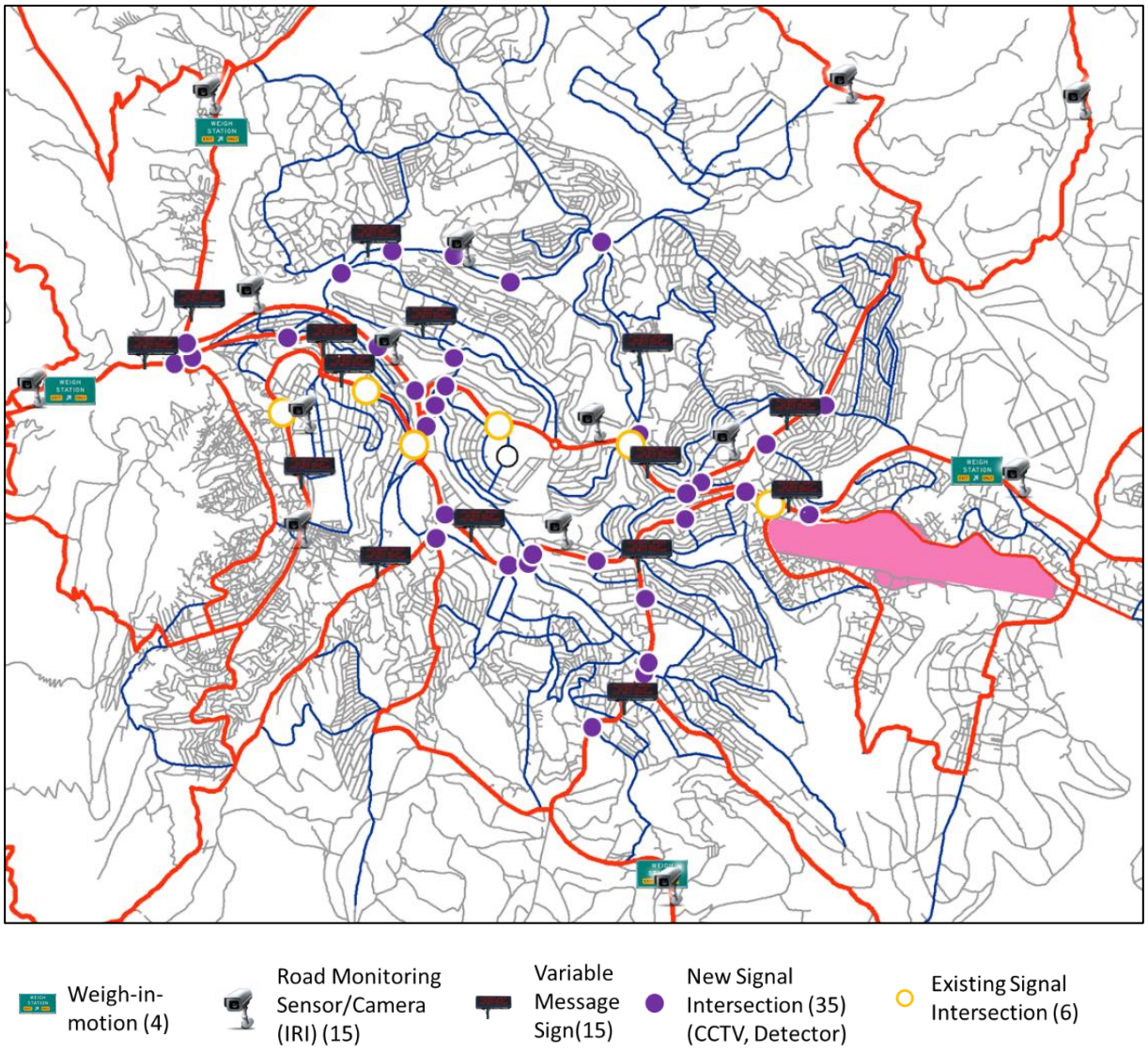


- Source: JICA Survey Team

Figure 7.4.10: Proposed Remote Monitoring System by MINIFRA

- As shown in the figure before, remote monitoring system in the MININFRA doesn't have remote traffic control function and accessibility to raw data.

In addition to the development of Smart C3, traffic signals, CCTV, VMS, and WIM are installed at intersections and roads in Kigali City. The deployment plan (draft) of traffic signals, CCTV, VMS in the short term is shown in Figure 7.4.7. This deployment plan was prepared based on the traffic demand forecast result which was carried out in this survey. The main congestion route and connection point of roads were selected as candidate location for the placement of equipment. In the medium and long term, the necessary location/intersection should be deployed based on the traffic conditions, progress of other road project, and progress of public transportation improvement.



Source: JICA Survey Team

Figure 7.4.11: Draft Layout Plan of ITS Equipment in the Short term

Table 7.4.9: Concept of Layout Plan of ITS Equipment in the Short-term

Equipment	Concept of Layout Plan
Traffic Signal	Based on current and future traffic conditions (refer SI.1), equipment is installed at major intersections of traffic congestion routes and public transport routes in the city. From the viewpoint of area control*, traffic signal is installed around the main signal intersection to maximize the effect of traffic control by harmonization of signal intersections. To maximize the effect of signal control at major intersections, Intersection improvements without land acquisition are implemented. *Area control: It iis to optimize traffic flow (maximize effect) in the vicinity by harmonizing the signal cycle based on the traffic volume of specific routes and area (not control at the point). It can be possible to maximize the amount of traffic passing the intersection and adjust the amount of traffic entering the signal intersection, and it is enable to efficient traffic control.
CCTV/Sensor	Install on major roads around the city boundary and on routes with high traffic demand. Camera monitor the traffic condition (congestion, accident, etc.). Observe the pavement situation (IRI) using sensors, applications, etc.

VMS	Install to main roads connected to the city, congestion route / around the signal intersection, near the city center, and along bus route. These are installed for provision of traffic information (congestion, detour route, travel time, arrival time for bus) to road users who enter the city in advance, road users whose vehicles passing through the city, and citizens.
WIM	Install in four major roads around the city border. It can be grasp the weight of vehicles which enter into the city. It has effect to reduce pavement damage due to overloading regulations and penalize overloaded vehicles.

Source: JICA Survey Team

Major ongoing projects and proposed interventions by JICA survey team are shown from next page.

Project Profile (Status: On-going)

Sector	Public Transport
Category	Public Transport
Reference No.	KP-01
Project Title	Bus Rapid Transit (BRT)
Executing Agency	City of Kigali (CoK), Bus Operation Company
Relevant Ministry	Ministry of Infrastructure (MININFRA), Rwanda Utility and Regulatory Authority (RURA)

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
1. The supply of bus fleet during peak hours is not sufficient to meet the demand for passengers. 2. A sustainable urban development is therefore necessary as the demand is projected to increase based on the rapid population growth that is expected in the future. 3. Under such conditions, BRT system is planned as a solution to attain the sustainable development of Kigali City. There are five main objectives of the BRT planning: (1) improvement of access to public transportation, (2) short travel time, (3) control of air pollution, (4) improvement of amenity and safety, (5) collection of the population.	**(Planning BRT Route)**  Source: Feasibility Study and Preliminary Design for a Bus Rapid Transit System for the City of Kigali (Second Interim Report)
Rationale	Project Plan (Outline)
- BRT for Kigali is a solution for sustainable mobility workshop	- BRT system - Road structure of BRT route - Fare collection system of BRT

Input	Tentative Cost (USD in Million)
- Pavement	80.9
- Stations	59.7
- Terminals	115.7
- Depots	130.6
- Demolition	18.0
- Containment	107.9
- Earthwork	5.4
- Special Structures	62.4
Total Estimated Cost	580.5

Schedule

Calendar Year	Start	End
1. Feasibility Study	2017	2020
2. Stepwise Development	2020	2050

Expected Output/Result	Action Plan
- Improvement capacity of public transport - Improvement of traffic congestion	

Necessity of Technical Assistance

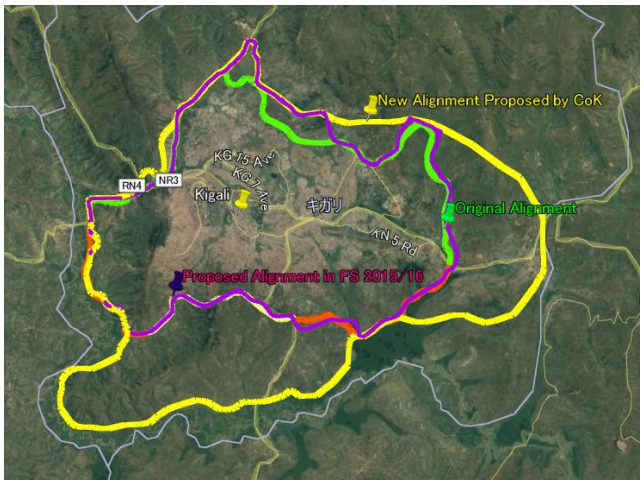
Remarks

- Workshop was conducted by the city of Kigali (consultants: LOGIT and SPEA) in February 2017 and May 2018.

Project Profile (Status: On-going)

Sector	Road (+ other sector/section(s))
Category	Highway Construction
Reference No.	KP-02
Project Title	Kigali-Ring Road
Executing Agency	City of Kigali (CoK)/Rwanda Transport Development Agency (RTDA)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
1. Mitigation of traffic congestion in the city of Kigali and smoother logistic flow as a bypass road for the city. 2. RTDA carried out the feasibility study (FS) in 2015/2016. 3. CoK modified the alignment to pass through outside of the SEZ. 4. Mota-Engil is updating the FS in 2018.	**(Location)**  Source: JICA Survey Team
Rationale	Project Plan (Outline)
- Priority Action Project in the National Strategies for Transformation (NST) 1 and Kigali City Development Strategy 2018-2024. - The economic internal rate of return (EIRR) is greater than the opportunity cost according to the detailed engineering design report (EIRR 22.2% > Discount factor 12%).	- Total length of the road is approximately 80 km. - Proposed lane width is 3.75 m (four lanes).

Input	Tentative Cost (USD in Million)	Schedule		
-	-	Calendar Year	Start	End
		1. Updated FS	2018	2018
		2. Detailed Design	2019	2020
		3. Tendering	2020	2021
		4. Execution	2022	2024
Total Estimated Cost	-			

Expected Output/Result	Action Plan
- Mitigation of traffic congestion in city of Kigali and smoother logistic flow as a bypass road for the city.	- .

Necessity of Technical Assistance
-
Remarks
- Mota-Engil is interested in funding.

Project Profile (Status: On-going)

Sector	Road (+ other sector/section(s))
Category	Highway Construction
Reference No.	KP-03
Project Title	North-South Bypass
Executing Agency	Rwanda Transport Development Agency (RTDA)/City of Kigali (CoK)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background

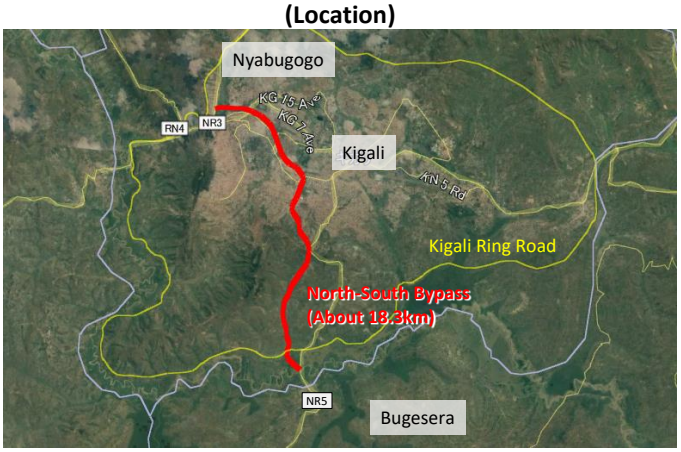
1. Providing an alternative access between the city of Kigali and Bugesera District.
2. Developing the shortcut route to the ring road.
3. There is a sole access (NR5: Kicukiro-Nemba) between the city of Kigali and Bugesera District.
4. Redundancy access will be necessary from the point of national security.
5. Mitigation of traffic congestion on NR5.

(Planned Viaduct at Nyabugogo Area)

Source: CoK

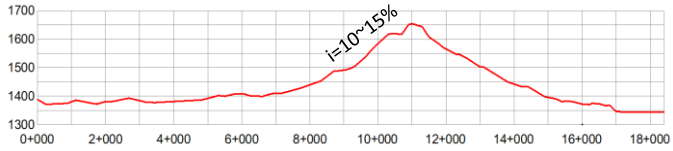
Location, Concept, Reference, etc.

(Location)



Source: JICA Survey Team

(Profile)



Source: JICA Survey Team

Rationale	Project Plan (Outline)
- Kigali Transportation Master Plan proposed the north-south bypass in short (2017) to middle (2025) term. - The road will alleviate the traffic congestion in the road network in Kigali City (V/C 0.57 to 0.53 in Kigali City).	- Total length of the road is approximately 20 km - Lane width is 3.75 m (four lanes for both direction)

Input	Tentative Cost (USD in Million)
- Civil works (estimated by the JICA Survey Team)	90
Total Estimated Cost	90

Schedule

Calendar Year	Start	End
1. Feasibility Study	2018	2018
2. Detailed Design	2019	2020
3. Tendering	2020	2021
4. Execution	2022	2024

Expected Output/Result	Action Plan
- Mitigation of traffic congestion on NR5. - Regional integration.	- Steep gradient in the mountainous section shall be re-considered.

Necessity of Technical Assistance

-

Remarks

-

Project Profile (Status: Newly proposed)

Sector	Road (+ other sector/section(s))
Category	Highway Construction
Reference No.	KP-03a
Project Title	North-South Bypass (Alternative Route with Tunnel)
Executing Agency	Ministry of Infrastructure (MININFRA)/Rwanda Transport Development Agency (RTDA)
Relevant Ministry	City of Kigali

Outline of the Project

Objectives/Background

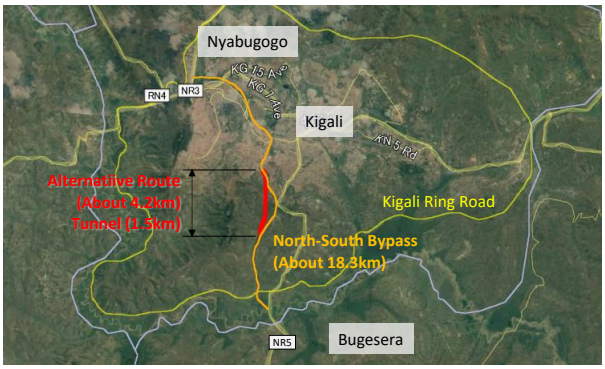
1. Providing an alternative route for North-South Bypass which is an access between the city of Kigali and Bugesera District.
2. Construction of tunnel (L=1.5 km) to avoid steep mountainous profile (i=10~15%).
3. Functional enhancement of North-South Bypass as a logistics network.

(Image of Tunnel)

Source: Electric Engineering Kawada

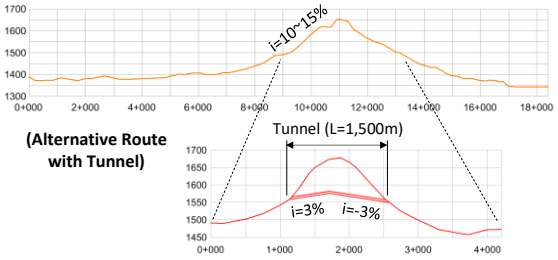
Location, Concept, Reference, etc.

(Location)



Source: JICA Survey Team

(Overall Profile of N-S Bypass)



Source: JICA Survey Team

Rationale

- Kigali Transportation Master Plan proposed the North-South Bypass in short (2017) to middle (2025) term.
- The road will alleviate the traffic congestion in the road network for the entire city (V/C 0.57 to 0.53 in Kigali City).

Project Plan (Outline)

- Total length of the alternative route is approximately 4.2 km.
- Length of tunnel section is approximately 1.5 km.
- Required number of lanes: two-lanes.

Input	Tentative Cost (USD in Million)
- Civil works (estimated by the JICA survey team)	45
Total Estimated Cost	45

Schedule (Tentatively proposed)

Calendar Year	Start	End
1. Feasibility Study	2022	2023
2. Detailed Design	2023	2024
3. Tendering	2024	2025
4. Execution	2026	2028

Expected Output/Result

- Mitigation of traffic congestion on NR5.
- Regional integration.

Action Plan

- Need to confirm the status of the bypass in the latest plan currently prepared by Mota-Engil under MININFRA/RTDA.

Necessity of Technical Assistance

- Technology transfer (TA) for tunneling technology.

Remarks

Project Profile (Status: Newly proposed)

Sector	Road + ICT
Category	Traffic Management
Reference No.	KP-04
Project Title	Kigali Smart City Control Center (KSC3)
Executing Agency	Ministry of Infrastructure (MININFRA)/City of Kigali (CoK)
Relevant Ministry	Rwanda National Police

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
1. Initiative to Smart City. 2. Collect and utilize social data such as traffic data, waste collection, water quality, air pollution, security monitoring, etc. 3. Utilize the data for future urban planning (not only for traffic issue). 4. Open to private sector for utilization of the data and encourage new Information and Communications Technology (ICT) business.  **(Image of control center)**	**(Data surrounding the City Control Center: C3)**  Source: NEC
Rationale	Project Plan (Outline)
- Conformity with the National ICT Policy. - Enhance citizen's convenience. - Reliable data to support future city planning.	- City control center (C3) - Advanced traffic signal system at intersections. - Intersection improvement at Chez Land (Roundabout to Cross-intersection). - Communication network to connect with C3. - Other monitoring devices and sensors.

Input	Tentative Cost (USD in Million)
- Installation of advanced traffic signal system - Civil works (Intersection improvement) - City control center (C3)	23.1
- Other monitoring devices and sensors	2.0
- TA (Technical Assistance) for the operation and maintenance (O/M)	
Total Estimated Cost	25.0

Schedule (Tentatively proposed)		
Calendar Year	Start	End
1. Preparation	2019	2019
2. Detailed Project Report	2019	2020
3. Tendering	2020	2020
4. Execution	2020	2022
5. Commissioning	2022	

Expected Output/Result	Action Plan
- Become a model of Smart City in Africa - New ICT business founded	- Detailed project report (basic design) shall be conducted soon

Necessity of Technical Assistance
O/M capacity building and utilization for city planning
Remarks
- Not only traffic section but also other sections such as waste collection, security control, water/sanitation, etc., shall be involved to define the function of C3 (city control center). - Close coordination with the Traffic Police Department is requisite.

Project Profile (Status: Newly proposed)

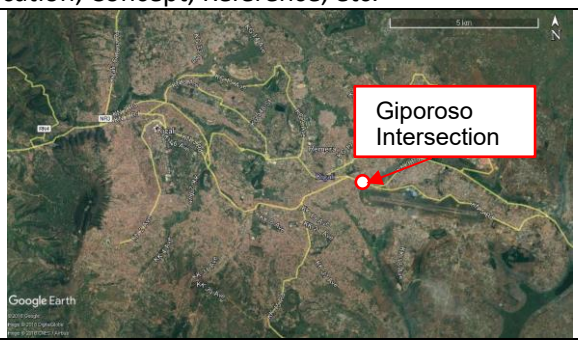
Sector	Road
Category	Traffic Management
Reference No.	KP-05-1
Project Title	Construction of Underpass at Giporoso Intersection
Executing Agency	Rwanda Transport Development Agency (RTDA) /City of Kigali (CoK)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background

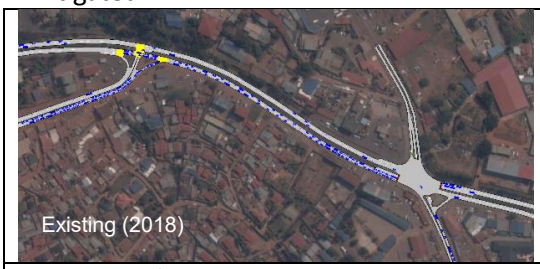
1. This intersection will have serious traffic congestion up to 2025.
2. Mitigate traffic congestion at Giporoso Intersection and neighbouring intersection (west side of Giporoso Intersection) by construction of grade separated intersection.
3. Natural gravity drainage by tunnel boring machine (TBM)

Location, Concept, Reference, etc.



Rationale

- Traffic congestion at Giporoso Intersection and neighbouring intersection will be mitigated.



↓ (after improvement)

Project Plan (Outline)

- Length: 970 m
- Road Width: 18 m (four lanes)

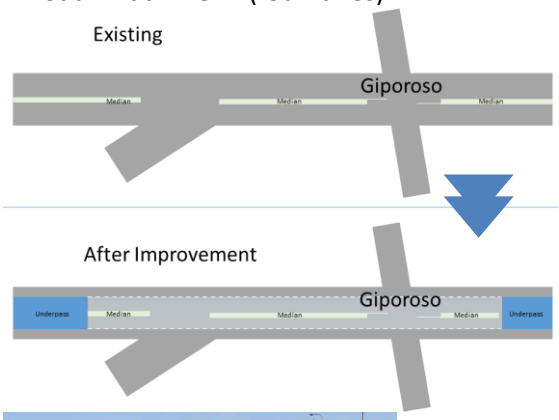


Image of Underpass

Input	Tentative Cost (USD in Million)
- Civil work	25.8
Total Estimated Cost	25.8

Schedule (Tentatively proposed)

Calendar Year	Start	End
1. Feasibility Study	2020	2020
2. Detailed Design	2021	2021
3. Tendering	2022	2022
4. Execution	2022	2024

Expected Output/Result	Action Plan
- Mitigation of traffic congestion at Giporoso area.	-

Remarks

- The structure of main traffic direction (east-west direction) will be an underpass in order to avoid overlap with the future metro rail transit (MRT) route (elevated).
- However, an alternative structure such as a viaduct could be re-examined in the design stage.

Project Profile (Status: Newly proposed)

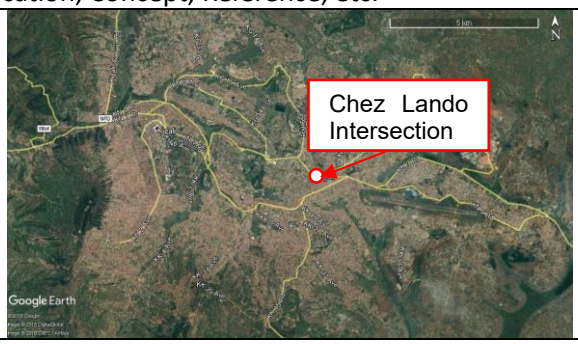
Sector	Road
Category	Traffic Management
Reference No.	KP-05-2
Project Title	Construction of Underpass at Chez Lando Intersection
Executing Agency	Rwanda Transport Development Agency (RTDA) /City of Kigali (CoK)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background

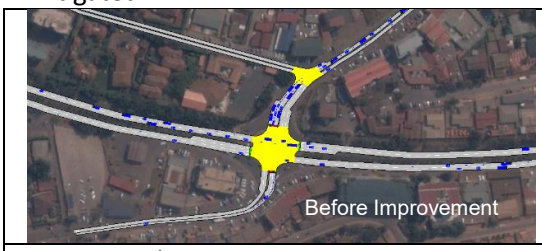
1. This intersection will have serious traffic congestion up to 2025.
2. Mitigate traffic congestion at Chez Lando Intersection by construction of grade separated intersection.
3. Natural gravity drainage by tunnel boring machine (TBM)

Location, Concept, Reference, etc.

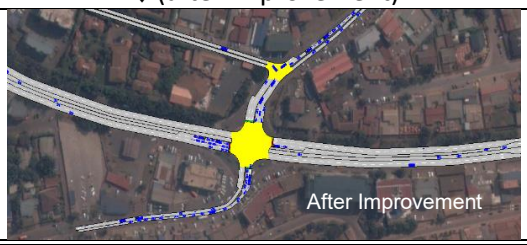


Rationale

- Traffic congestion at Chez Lando Intersection and neighbouring intersection will be mitigated.

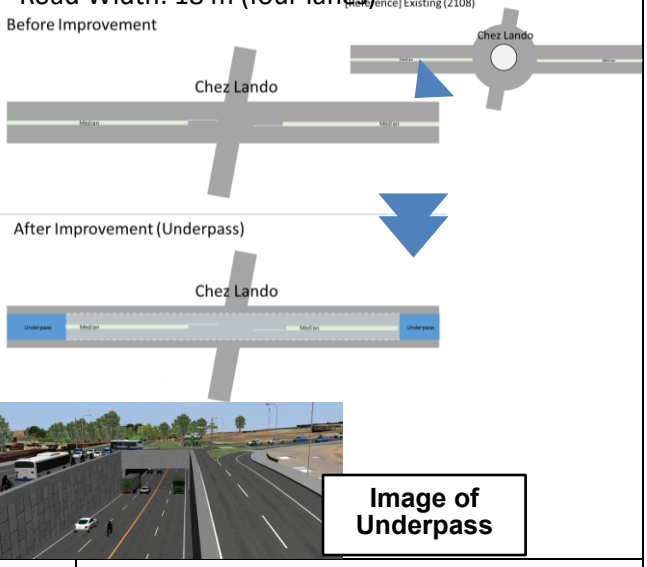


↓ (after improvement)



Project Plan (Outline)

- Length: 628 m
- Road Width: 18 m (four lanes)



Input	Tentative Cost (USD in Million)
- Civil work	17.7
Total Estimated Cost	17.7

Schedule (Tentatively proposed)

Calendar Year	Start	End
1. Feasibility Study	2020	2020
2. Detailed Design	2021	2021
3. Tendering	2022	2022
4. Execution	2022	2024

Expected Output/Result	Action Plan
- Mitigation of traffic congestion at Chez Lando area.	-

Remarks

- Chez Lando Intersection will be improved as cross intersection by C3 project firstly.
- The intersection structure of main traffic direction (east-west direction) will be an underpass in order to avoid overlap with the future metro rail transit (MRT) route (elevated).
- However, an alternative structure such as a viaduct could be re-examined in the design stage.

Project Profile (Status: Newly proposed)

Sector	Road
Category	Traffic Management
Reference No.	KP-05-3
Project Title	Construction of Underpass at Gishushu Intersection
Executing Agency	Rwanda Transport Development Agency (RTDA) /City of Kigali (CoK)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background

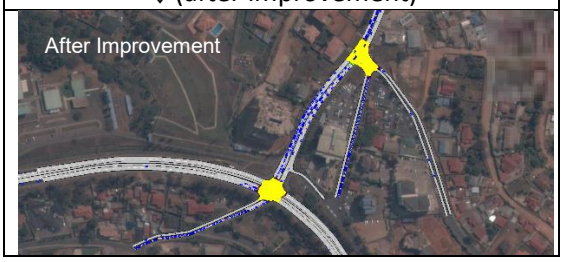
1. This intersection will have serious traffic congestion up to 2025.
2. Mitigate traffic congestion at Gishushu Intersection by the construction of grade separated intersection.
3. Natural gravity drainage by tunnel boring machine (TBM)

Location, Concept, Reference, etc.

Rationale

- Traffic congestion at Gishushu intersection and neighbouring intersection will be mitigated.

↓ (after improvement)



Project Plan (outline)

- Length: 450 m
- Road Width: 18 m (four lanes)

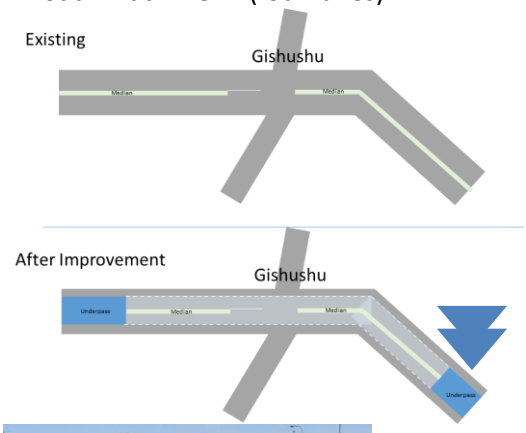


Image of Underpass

Input	Tentative Cost (USD in Million)
- Civil work	11.9
Total Estimated Cost	11.9

Schedule (Tentatively proposed)

Calendar Year	Start	End
1. Feasibility Study	2020	2020
2. Detailed Design	2021	2021
3. Tendering	2022	2022
4. Execution	2022	2024

Expected Output/Result	Action Plan
- Mitigation of traffic congestion at Gishushu area.	-

Remarks

- The structure of main traffic direction (east-west direction) will be an underpass in order to avoid overlap with the future metro rail transit (MRT) route (elevated).
- However, an alternative structure such as a viaduct could be re-examined in the design stage.

Project Profile (Status: Newly proposed)

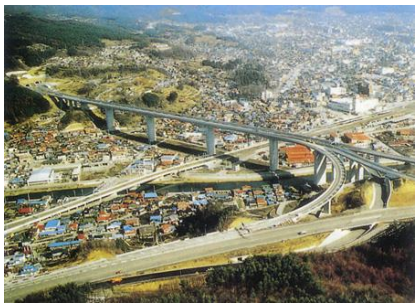
Sector	Road (+ other sector/section(s))
Category	Road and Bridge Construction
Reference No.	KP-06
Project Title	Ridge Link Bypass
Executing Agency	City of Kigali (CoK)/Rwanda Transport Development Agency (RTDA)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background

1. Providing a bypass route of Gikondo-Kimironko with new viaduct construction in Gikondo and Kimironko.

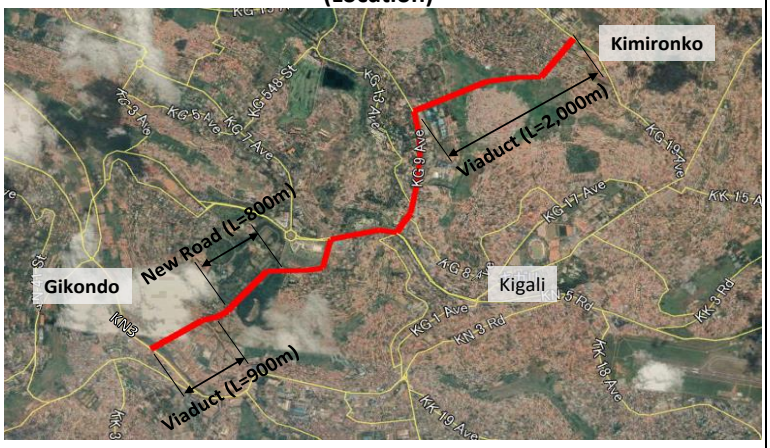
(Viaduct Image: Okae viaduct in Japan)



Source: Cantilever-method

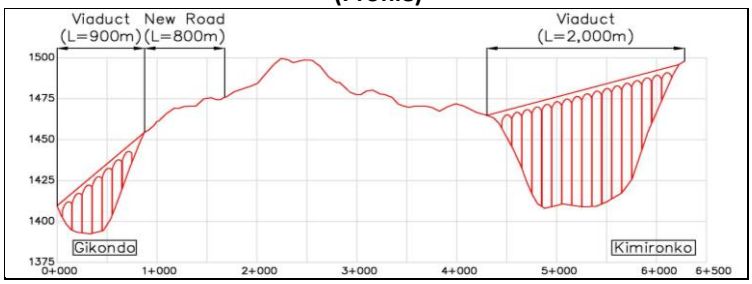
Location, Concept, Reference, etc.

(Location)



Source: JICA Survey Team

(Profile)



Source: JICA Survey Team

Rationale	Project Plan (Outline)
- Traffic congestion at KG9 and KG11, RN15, KN3 will be alleviated. KG9: V/C 1.28→1.16 (2040) KG11, RN15,KN3: V/C 1.61→1.29 (2040)	- Road Length: 6.3 km (including new road: 800 m) - Bridge Length: 900 m, 2,000 m - Bridge Width: 18.0 m (Carriageway: 4@3.5 m) - Bridge Type: PC Box Girder (Cantilever Erection)

Input	Tentative Cost (USD in Million)	Schedule (Tentatively proposed)		
- Civil works for bridge construction (estimated by the JICA Survey Team)	260	Calendar Year	Start	End
		1. Feasibility Study	2022	2023
		2. Detailed Design	2023	2024
		3. Tendering	2024	2025
		4. Execution	2026	2028
Total Estimated Cost	260			

Expected Output/Result	Action Plan
- Become a bypass route of Gikondo-Kimironko. - Mitigation of traffic congestion in the city of Kigali.	-

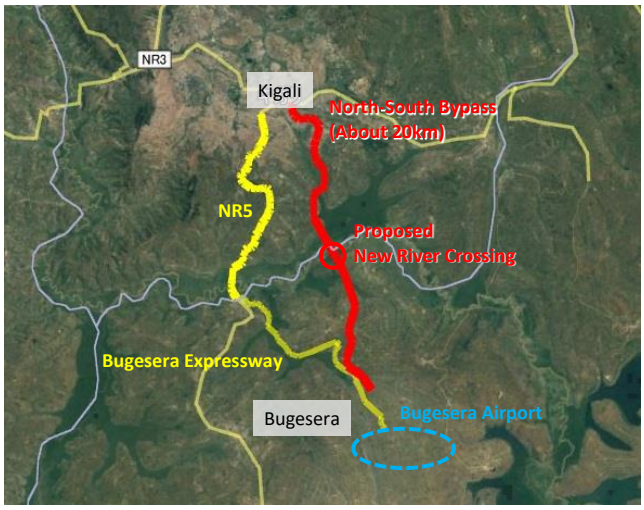
Necessity of Technical Assistance
-

Remarks
-

Project Profile (Status: Newly proposed)

Sector	Road (+ other sector/section(s))
Category	Highway Construction
Reference No.	KP-07
Project Title	North-South Bypass 2
Executing Agency	Rwanda Transport Development Agency (RTDA)/City of Kigali (CoK)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
1. Providing an alternative access between the city of Kigali and Bugesera District. 2. The Akagera River runs through between the city of Kigali and Bugesera District. 3. There is a sole access (NR5: Kicukiro-Nemba) between the city of Kigali and Bugesera District. 4. Redundancy access will be necessary from the point of national security. 5. Mitigation of traffic congestion on NR5.	**(Location)**  Source: JICA Survey Team
Rationale	Project Plan (Outline)
- Proposed route can shorten the travel time from Bugesera to the city center (travel time : 24.4 min to 18.4 min in 2040)	- Total length of the road is approximately 20 km - Lane width is 3.75 m (two lanes) - New bridge construction at the Akagera River Crossing - Bridge Length: 100 m

Input	Tentative Cost (USD in Million)	Schedule (Tentatively proposed)		
- Civil works (Estimated by the JICA Survey Team)	100	Calendar Year	Start	End
		1. Feasibility Study	2027	2027
		2. Detailed Design	2028	2028
		3. Tendering	2029	2029
		4. Execution	2030	2032
Total Estimated Cost	100			

Expected Output/Result	Action Plan
- Mitigation of traffic congestion on NR5 - Regional integration	- .

Necessity of Technical Assistance
-
Remarks
-

Project Profile (Status: On-going)

Sector	Road (+ other sector/section(s))
Category	Bridge Construction
Reference No.	KP-08
Project Title	New 2-lane Bridge on KG 774
Executing Agency	City of Kigali (CoK)/Rwanda Transport Development Agency (RTDA)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

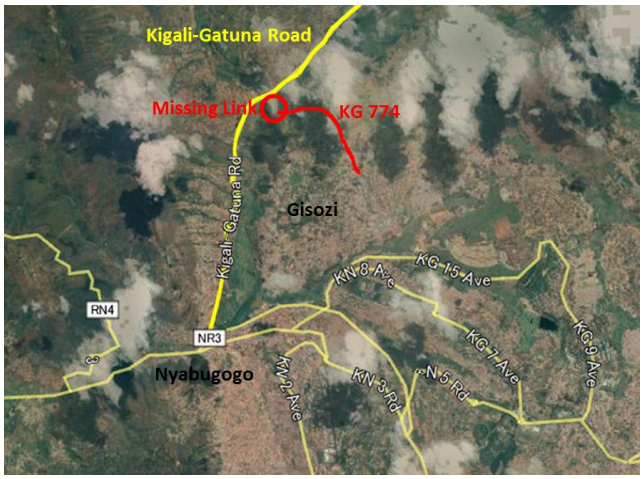
Objectives/Background

1. Providing a diversion route of Nyabugogo-Gisozi with a new bridge construction at the missing link on KG 774.
2. KG 774 (Gisozi-Karuruma: 2.5 km) is upgraded to asphalt road by CoK.

(Existing Condition)

Location, Concept, Reference, etc.

(Location)



Source: JICA Survey Team

Rationale

- Many trips will use the bridge from/to Gisozi, the bridge will alleviate the traffic congestion at KN8, KG15 according to the traffic demand forecast by the JICA Survey Team (45,273 pcu/day in 2040)

Project Plan (Outline)

- Bridge Length: 20 m
- Bridge Width: 9.0 m (Carriageway: 2@3.5 m)
- Bridge Type: Precast PC Girder

Input	Tentative Cost (USD in Million)
- Civil works (based on CoK, May 2018)	4.2
Total Estimated Cost	4.2

Schedule (Tentatively proposed)

Calendar Year	Start	End
1. Detailed Design	2019	2019
2. Tendering	2020	2020
3. Execution	2020	2022

Expected Output/Result	Action Plan
- Become a diversion route of Nyabugogo-Gisozi. - Mitigation of traffic congestion at Nyabugogo area.	-

Necessity of Technical Assistance

-

Remarks

- Fund is mobilizing.

Project Profile (Status: Newly proposed)

Sector	Road (+ other sector/section(s))
Category	Bridge Construction
Reference No.	KP-09
Project Title	Replacement of Bicumbi Bridge and Bugesera Bridges (2 Bridges) on DR 53
Executing Agency	Rwanda Transport Development Agency (RTDA)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

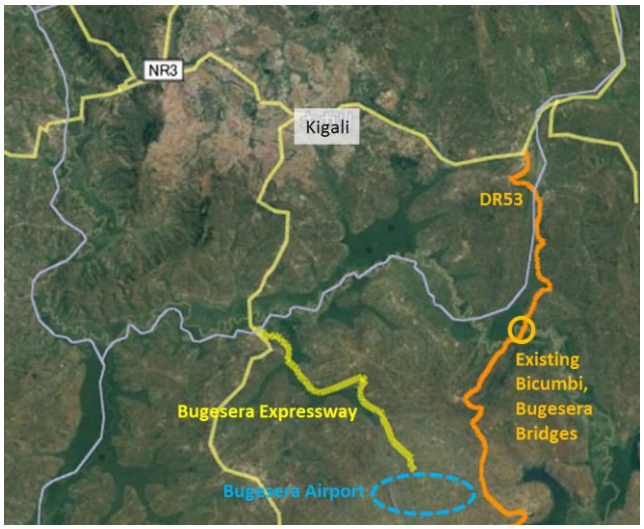
Objectives/Background

1. Urgent replacement of the existing damaged bridges and provide an alternative access to Bugesera District from city of Kigali.
2. No alternative access to Bugesera District from city of Kigali exists.
3. The existing Bicumbi Bridge (70 m) and Bugesera bridges (2 bridges 15 m) are old damaged bridges with loading restriction of 10 tons at a maximum.

(Existing Bicumbi Bridge)

Location, Concept, Reference, etc.

(Location)



Source: JICA Survey Team

Rationale

- Through traffic can pass the route and alleviate the congestion in Kigali City

Project Plan (Outline)

- Replace three bridges (70 m, 15 m, and 15 m)
- Bridge Width: 9.0 m (Carriageway: 2@3.5 m)
- Bridge Type: Precast PC Girder

Input	Tentative Cost (USD in Million)
- Civil works (Estimated by the JICA Survey Team)	5.0
Total Estimated Cost	5.0

Schedule (Tentatively proposed)

Calendar Year	Start	End
1. Feasibility Study	2021	2021
2. Detailed Design	2021	2022
3. Tendering	2022	2022
4. Execution	2022	2024

Expected Output/Result

- Alternative access to Bugesera District from the city of Kigali
- Regional integration.

Action Plan

-

Necessity of Technical Assistance

Remarks

-

Project Profile (Status: Newly proposed)

Sector	Road (+ other sector/section(s))
Category	Road Rehabilitation
Reference No.	KP-10
Project Title	Rehabilitation and Upgrading of Kigali-Kayonza Road
Executing Agency	Rwanda Transport Development Agency (RTDA)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background

1. Objectives are to smoothen the logistic flow and regional integration.
2. Main link conveying cargo from both Dar Es Salaam Port as central corridor and Mombassa Port as northern corridor to the city of Kigali.
3. Study is available.

(Existing Condition)

Location, Concept, Reference, etc.

(Location)

Source: JICA Survey Team

Rationale

- Priority action in NST1
- Connection between the city of Kigali and Rusumo-Kayonza Road which is funded by the Japan International Cooperation Agency (JICA) and African Development Bank (AfDB).
- In Kigali City, KN5 is now congested according to the base case year model by the JICA Survey Team. The proposed route can alleviate the congestion (V/C is around 1.02).

Project Plan (Outline)

- Road length is approximately 74 km.
- Road widening from 6 m single-carriageway (two-lanes) to dual-carriageway (four-lanes) for the section between Cyamuzing and Rugende.
- Remaining section is upgraded in accordance with EAC standard (two lanes)

Input	Tentative Cost (USD in Million)
- Construction cost (based on "List of projects to be implemented during the 2018-2035 period" by MININFRA)	86.5
Total Estimated Cost	86.5

Schedule (Tentatively proposed)

Calendar Year	Start	End
1. Detailed Design	2022	2022
2. Tendering	2023	2023
3. Execution	2023	2024

Expected Output/Result	Action Plan
- Smooth logistic flow - Regional integration	-

Necessity of Technical Assistance

-

Remarks

- Study is available.
- Fund is mobilizing.

Project Profile (Status: Newly proposed)

Sector	Road (+ other sector/section(s))
Category	Road Improvement
Reference No.	KP-11
Project Title	Sector Project Road for the Improvement of Urban Road Network
Executing Agency	Rwanda Transport Development Agency (RTDA)/City of Kigali (CoK)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background

1. Most of the roads including district roads and feeder roads behind the main arterial roads are unpaved.

2. The unpaved network cannot afford to become a diversion or alternative route.
3. Non-motorized traffic (NMT) facility especially for pedestrians is not sufficiently provided.

Location, Concept, Reference, etc.

(Location)

Road Name for 120 km Upgrading Project	Lendth (km)
Gakiriro-Kagugu	4.525
Kimironko-Zindiro	3.214
Bibare-Adventist Church	1.239
Kagarama	2.682
Quartier Niboye	4.386
Kumunyinya-Elcastro	1.283
Nyanza Landfill&Memorial Site	1.338
Unilak-Rwandex	1.509
Agatare-Rugarama	4.081
Around Grace Hotel	0.561
Road Behind Kimisagara Market	0.624
Gisozi	0.740
Gaculiro	6.238
Kimironko	7.641
Migina	3.125
Gikondo	2.180
Kagarama	4.574
Niboye	3.521
Muhima	1.528
Nyabisindu-Kibagabaga	0.9
Nyabisindu- Nyarutarama	0.6
Remera Sports View-Nyarutarama	1.33
Masaka-Rusheshe	9.75
⋮	⋮

Source: CoK

Rationale

- Priority Action Projects in Kigali City Development Strategy 2018-2024

Project Plan (Outline)

- Construction of asphalt roads: 120 km
- Construction of pedestrian bridges: 4

Input	Tentative Cost (USD in Million)
- Civil works: 120 km asphalt roads (based on CoK, May 2018)	75
- Civil Works: 4 pedestrian bridges (estimated by the JICA Survey Team)	2
Total Estimated Cost	77

Schedule (Tentatively proposed)		
Calendar Year	Start	End
1. Preparation	2022	2023
2. Execution	2023	2026

Expected Output/Result	Action Plan
- Mitigation of traffic congestion in the city of Kigali - Regional integration - Safety ensuring non-motorized traffic (NMT)	-

Necessity of Technical Assistance

-

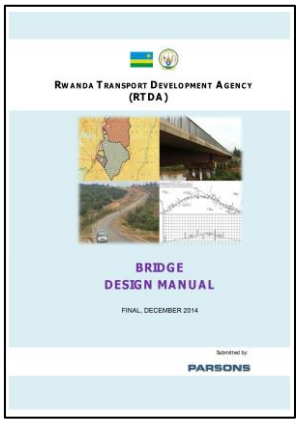
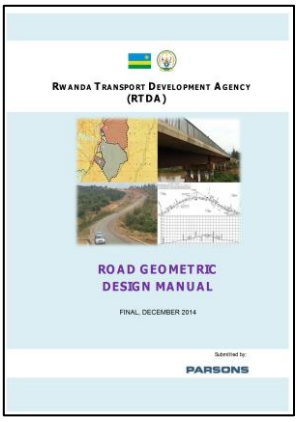
Remarks

-

Project Profile (Status: Newly proposed)

Sector	Road (+ other sector/section(s))
Category	Regulations
Reference No.	KP-12
Project Title	Establishment of Urban Road Design Guideline
Executing Agency	Rwanda Transport Development Agency (RTDA)
Relevant Ministry	Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
1. RTDA prepared the draft Bridge and Road Design Manuals in 2014. 2. Bridge Design Manual was drafted based on the American Association of State Highway and Transportation (AASHTO). 3. Road Geometric Design was drafted in consideration with the East African Community (EAC) recommendations. 4. In practice, AASHTO is referred for the structure design. 5. The draft has not yet been approved. 6. Need modification by retrofitting of the Rwandan condition particularly on steep terrain, etc.	**(Existing Draft Bridge and Road Design Manual)**   Source: RTDA
Rationale	Project Plan (Outline)
-	- Establishment of Urban Road Design Guideline

Input	Tentative Cost (USD in Million)	Schedule (Tentatively proposed)		
		Calendar Year	Start	End
Establishment of the Design Guidelines (Road)	0.5	1. Technical Assistance	2020	2020
Establishment of the Design Guidelines (Road)	0.5			
Total Estimated Cost	1.0			

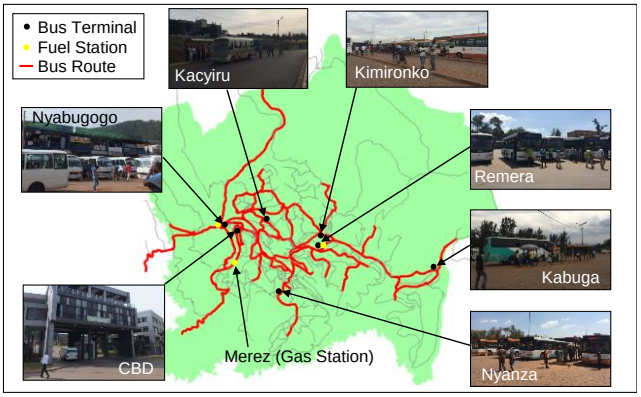
Expected Output/Result	Action Plan
-	- .

Necessity of Technical Assistance
-
Remarks
-

Project Profile (Status: Newly proposed)

Sector	Public Transportation
Category	Public Transport
Reference No.	KP-13
Project Title	Technical Assistance in Public Transport (Improvement of Bus Service)
Executing Agency	Rwanda Utility and Regulatory Authority (RURA), Bus Operation Company (Kigali Bus Service (KBS), Royal Express, Rwanda Federation of Transport Cooperatives (RFTC))
Relevant Ministry	City of Kigali, Ministry of Infrastructure (MININFRA)

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
Currently, a long waiting queue is regularly observed at the bus terminals in Kigali City, the supply of bus fleet in peak hours has not been sufficient to respond to the demand of passengers. Under such conditions, improvement of bus service is necessary as a solution to attain the sustainable development of Kigali City. 1. Establishment and enhanced organization structure of Rwanda Utility and Regulatory Authority (RURA). 2. Improvement of the service level of public bus. 3. Improvement of the bus operation level of bus company.	**(Main Bus Terminal)**  Source: JICA Study Team

Rationale	Project Plan (Outline)
-	- Improvement of public bus operation management of RURA. - Improvement of the service level of public bus. - Improvement of the operation management of bus company.

Input	Tentative Cost (USD in Million)	Schedule (Tentatively proposed)		
-		Calendar Year	Start	End
		1. Technical Assistance	2020	2022
Total Estimated Cost				

Expected Output/Result	Action Plan
- Public bus operation management capacity of RURA is improved. - The service level of public bus transport in Kigali is improved. - Bus operation level of bus companies is improved.	

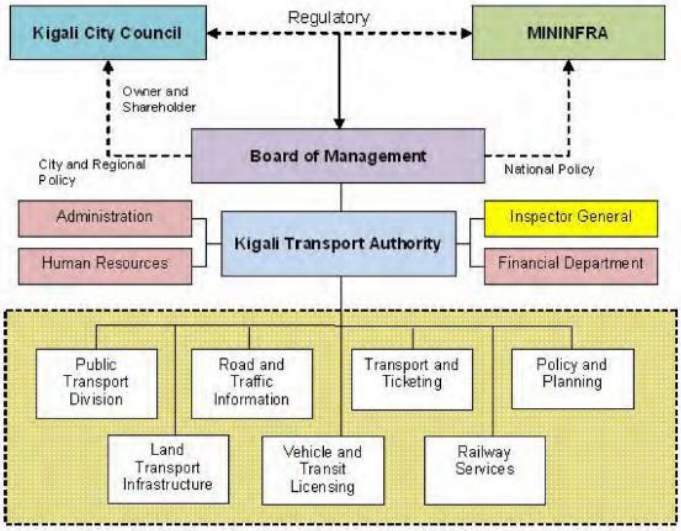
Necessity of Technical Assistance
- Capacity building: Public bus operation management, bus route management, labor management, bus user service, and safety management.

Remarks

Project Profile (Status: Newly proposed)

Sector	Road (+ other sector/section(s))
Category	Institutional/Capacity Development
Reference No.	KP-14
Project Title	Technical Assistance to Establish Kigali Transportation Authority (KTA)
Executing Agency	City of Kigali (CoK)
Relevant Ministry	Ministry of Infrastructure (MININFRA)/ Rwanda Transport Development Agency (RTDA)

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
The Kigali Transport Master Plan (MP) 2013 identified that the management of urban transport as a single function is almost nonexistent in the city of Kigali specifically due to: 1. Weak institutional capacity and lack of adequate qualitative and quantitative human resources. 2. Too many stakeholders involved across the spectrum of urban transport - between municipalities and also national authorities cross-cutting into local affairs, which has resulted in a fragmented planning process and lack of coordination, vertically and horizontally, between different levels of government and departments.	 Source: Kigali Transport MP 2013 **Structure for KTA Proposed in the MP 2013**
Rationale	Project Plan (Outline)
- Integrated transport planning and management. - Effective and proper utilization of the collected/accumulated traffic data by the city control center (CCC). - Best practice in the East African Community (EAC) and AU.	- Establishment of Kigali Transportation Authority (KTA). - Operation and maintenance of CCC under KTA by well-trained staff.

Input	Tentative Cost (USD in Million)	Schedule (Tentatively proposed)		
- Capacity building to support the newly established KTA.	1 million	Calendar Year	Start	End
		1) Construction of CCC	2020	2021
		2) Soft component of CCC	2021	2022
		3) TA for KTA	2021	2022
		4) Establishment of KTA		2023
Total Estimated Cost	1 million			

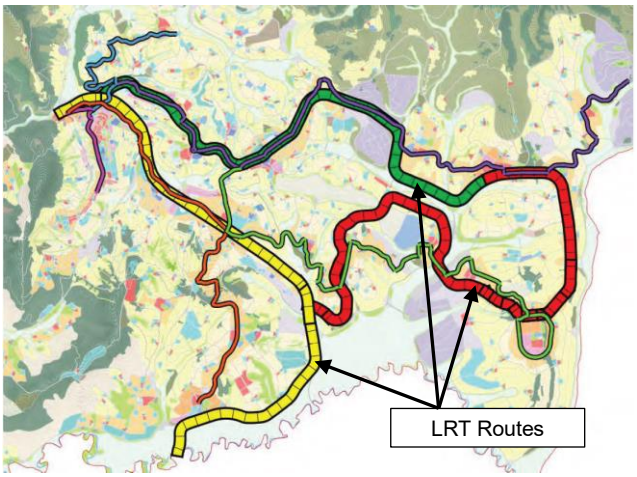
Expected Output/Result	Action Plan
- Establishment of KTA. - Necessary legal set-up.	The concept of KTA was once proposed in MP 2013. The target year of the establishment was 2017. The modification of the schedule will be proposed in the MP 2018.

Necessity of Technical Assistance
This project itself is a Technical Assistance (TA) scheme.
Remarks

Project Profile (Status: Newly proposed)

Sector	Public Transport
Category	Public Transport
Reference No.	KP-15
Project Title	Pre-Feasibility Study for Mass Transit Transport System
Executing Agency	Ministry of Infrastructure (MININFRA)
Relevant Ministry	Rwanda Utility and Regulatory Authority (RURA), City of Kigali (CoK)

Outline of the Project

Objectives/Background	Location, Concept, Reference, etc.
1. Kigali City Transportation Master Plan 2013 mentioned that introduction of mass transit system is one option for future transportation in Kigali City. 2. Bus rapid transit (BRT), one transportation mode of mass transit system, is planning to be introduced in Kigali City. 3. In the future, the metro rail transit (MRT) and light rail transit (LRT) are also candidates in the introduction of mass transit system in Kigali City. 4. However, feasibility study for selecting an appropriate transportation mode is needed before implementation.	**(Proposed Routes of LRT and BRT)**  Source: Kigali City Transportation Master Plan 2013
Rationale	Project Plan (Outline)
- LRT and MRT are proposed as options of the future transportation modes in Kigali City Master Plan 2013. - The criteria for selecting appropriate transportation mode is needed for the relevant organizations.	- Conducting pre-feasibility study.

Input	Tentative Cost (USD in Million)	Schedule (Tentatively proposed)		
- Conducting pre-feasibility study Study items (tentative); Collect issues for the implementation, economic and financial analysis, cost estimatation, assessment of mass transit system basic design	2.0	Calendar Year	Start	End
		1. Study	2024	2024
		(Refer for after study)		
		2. Detailed Design	2025	2027
		3. Tendering	2027	2028
		4. Execution	2029	2033
Total Estimated Cost	2.0			

Expected Output/Result	Action Plan
- Feasiblity of Mass Transit System in Kigali City.	- The progress of BRT project shall be confirmed before conducting the study.

Necessity of Technical Assistance
-

Remarks
- Capacity building on the operation and management for main organization (KTA) is needed before the introduction of mass transit system. - KTA stands for Kigali Transport Authority, which is a candidate for operating mass transit system.

Chapter 8: Conclusion and Recommendations

8.1 Conclusion

Currently, there are no serious traffic jams on the road network of Kigali City except for several major intersections. However, basing on the steady national economic growth and rapid population growth in the city of Kigali, the traffic congestion inevitably worsen.

Since the city of Kigali (CoK) has a unique undulating terrain, there are limitations on the development of new roads. Thus, the reliance on private traffic will not be an appropriate measure to accommodate future traffic demand. In the Kigali Transportation Master Plan (KTMP), which was prepared in 2013 and currently being revised, has stated that Transit-Oriented Development (TOD) as a primary goal of the development and the Bus Rapid Transit (BRT) was proposed.

The JICA survey team conducted the future traffic demand analysis with the target year of 2040. A macro demand forecasting model has considered the BRT and other ongoing and planned projects such as the Ring Road and the North-South Bypass. However, it was revealed that future traffic conditions will worsen even if these projects are realized. Therefore, the JICA survey team has additionally proposed several new projects for short- and mid-term measures as “interventions” to the KTMP. In addition, a long-term measure is also suggested in the form of introducing a mass-transit system which has a greater capacity than the BRT system in anticipation of the future excessive traffic demand after 2030.

A microsimulation model has been applied for area-specific traffic conditions of particular intersections that are difficult to be captured by the macrosimulation model. As a result of the microsimulation, an introduction of the advanced signal control has been proposed. The grade-separation of the intersections have also been also proposed as the mid-term measure.

It is expected that this report will be utilized in the formulation of future support policies of the Japan International Cooperation Agency (JICA) and that it will be beneficially used for the revision work for the KTMP.

8.2 Recommendations

The public transit-oriented development (TOD) advocated by the KTMP is assessed as a quite reasonable statement. Early implementation of the BRT is essential to complete the backbone of the TOD measures. Furthermore, it is confirmed from the demand forecast by the JICA survey team that the planned road projects are effective for strengthening the road network. It is urgent to see through the realization of these planned projects. Other recommendations from the study team are as follows:

1) Urgent measures should be taken against the current congested intersections. Improvement of the intersections by implementing an advanced signal control system and introduction of the centralized traffic control system have been proposed as a short-term measure.

2) The existing bus service has many issues and can be improved. In order to tackle these issues, the technical cooperation program aimed at improving the service level of the existing bus service should be implemented as a short-term measure. The improved bus service shall be well-connected and synchronized with the future BRT network and

the overall bus network can function more effectively.

3) Design standards that specialize on urban roads are not available in Rwanda. It might be difficult for the standard to simply refer to the international standards since CoK has unique conditions such as undulating terrain. The proposed design speed might be intentionally lower than the international standards. Rwanda's own design standards should be established such as allowing low speed and prioritizing traffic safety.

4) KTMP has proposed the establishment of high capacity urban roads. These projects should be realized as the mid-term measure to accommodate future traffic demand. However, further strengthening of the road network will be necessary according to the results of the traffic demand analysis in this report. It is expected that the proposed interventions in this survey will be referred to during the updating of KTMP. As mentioned above, newly development of the road network in the undulating terrain of CoK is subject to limitations. The introduction of techniques such as elevated viaduct, underpass and tunnel into CoK will be applicable not only for CoK but also for other cities in Rwanda. Technology transfer to Rwandan contractors should also be taken into consideration.

5) The paving rate of CoK is extremely low. The expansion of the bus service network becomes difficult and citizens suffer inconvenience during access of the public transport system. Projects to improve these unpaved urban roads (i.e. pavement, drainage facility improvement, etc.) should be implemented immediately. Since each component of the improvement works will be small-scale with lots of bidding packages, a flexible project scheme will be recommended to modify and adjust the contents of the project even during the implementation.

6) There are many stakeholders related to the urban transport sector and the management of the sector as a single-window function is non-existent. The single-window organization to bundle the stakeholders is essential. The KTMP proposed to establish the Kigali Transportation Authority (KTA). Such cross-sectoral organization will contribute to appropriate traffic planning and prompt implementation of projects.

7) Traffic data is essential for urban transportation planning and urban planning, but no data has been collected or accumulated in Kigali. Introducing the signal control system can facilitate data collection and accumulation in the centralized traffic control center. The control center proposed in this survey is a city control center oriented towards a future “Smart City”. Rwanda role is to be the secretariat of “Smart Africa” (chaired by the President of Rwanda), which is greatly meaningful; and its responsibility is to promote the smart city concept. The proposed center should work closely with the proposed KTA. In the future, the KTA might be responsible for the operation and maintenance of the center.

8) The JICA survey team visited the international donor agencies in Rwanda. There were no particular intentions to support the urban transport sector of Kigali. The World Bank is implementing a road improvement work as part of the urban quality of life improvement project. As mentioned in this report, the development of infrastructure will require a large amount of funding. It is necessary to gather the support of donor agencies for the urban transport sector.

9) The revision works of the KTMP will continue till March 2019. The revised master plan shall be appropriately shared with the donor agencies for the realization of the

implementation of the plan.

10) This survey report is expected to be a reference for the revision works of the KTMP. It will be appreciated if the report could be shared and distributed to relevant stakeholders.