REPUBLIC OF THE UNION OF MYANMAR
MINISTRY OF TRANSPORT AND COMMUNICATIONS (MOTC)
YANGON REGION GOVERNMENT (YRG)

COMPREHENSIVE STUDY OF THE URBAN TRANSPORT DEVELOPMENT PROGRAM IN GREATER YANGON (YUTRA UPDATE)

FINAL REPORT
MAIN TEXT

MARCH 2019

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ALMEC CORPORATION
NIPPON KOEI CO., LTD.
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LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
AEC	Asian Economic Corridor(s)
AFC	Automatic Fare Collection
AGT	Automated Guideway Transit
AH	Asian Highways
ARL	Airport Rail Line
ASEAN	Association of South East Asian Nations
BI	Business Intelligence
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BLC	Bus Line Committees
BMS	Bus Management System
BOT	Build–Operate–Transfer
BRT	Bus Rapid Transit
BSC	Bus Supervisory Committees
CBD	Central Business District
CNG	Compressed Natural Gas
DD	Detailed Design
DWT	Deadweight Tonnage
EDI	Electronic Data Interchange
ETC	Electronic Toll Collection
F/S	Feasibility Study
FTZ	Free Trade Zone
GMC	Private Company Name (General Motors Truck Company)
GMS	The Greater Mekong Sub-region
Gov't	Government
GPS	Global Positioning System
GRDP	Gross Regional Domestic Product
HCMC	Ho Chi Minh City
HIS	Household Interview Survey
HRD	Human Resource Development
HSR	High Speed Rail
ICD	Inland Container Depot
ICT	Information and Communication Technologies
I-RR	Inner Ring Road
ITS	Intelligent Transport Systems
IWT	Inland Water Transport
JICA	Japan International Cooperation Agency
KEC	Korea Expressway Corporation
KOICA	Korea International Cooperation Agency

LRT	Light Rail Transit
MC	Motorcycle
MLIT	Ministry of Land, Infrastructure, Transport and Tourism
MOC	Ministry of Construction
MORT	Ministry of Rail Transportation
MOTC	Ministry of Transport and Communications
MPA	Myanmar Port Autholity
MR	Myanmar Railways
MRT	Mass Rapid Transit
MYT-Plan	Myanmar National Transport Master Plan
O&M	Operation and Management
OD	Origin-Destination
ODA	Official Development Assistance
ORR	Outer Rind Road
Pax	Passenger
PCU	Passenger Car Unit
PJT	Project
PPP	Public–Private Partnership
PT	PT Infrastructure
RFID	Radio Frequency Identifier
RO-RO	Roll-on/Roll-off Ship
ROW	Right of Way
RTAD	Road Transportation Administration Department
SEZ	Special Economic Zones
SOE	State-Owned Enterprise
SUDP	The Project for the Strategic Urban Development Plan of Greater Yangon
TEU	Twenty-foot Equivalent Unit
TOD	Transit Oriented Development
TPD	Transport Planning Department
UG	Union Government
UMRT	Urban Mass Rapid Transit
USD	United States Dollar
V/C	Volume Capacity
VOC	Vehicle Operating Cost
W/O	without
YCDC	Yangon City Development Committee
YCR	Yangon Circular Railway
YGN	Yangon
YR	Yangon Region
YRG	Yangon Regional Government
YRTA	Yangon Region Transport Authority
YUEX	Yangon Urban Expressway
YUTRA	The Project for Comprehensive Urban Transport Plan of the Greater Yangon

CONVERSION RATE (AT OCTOBER 2016)

1 MMK	= 0.0815200 JPY,	1 JPY	= 12.2669 MMK
1 USD	= 100.606 JPY,	1 JPY	= 0.00993977 USD
1 USD = 1234.12 MMK, 1 MMK = 0.000810292 USD			

Source: JICA HP

1 INTRODUCTION

1.1 Study Framework

1) Background

1.1 Yangon, the former capital of Myanmar with a population of 5.2 million (as of the 2014 census), is the country's largest commercial hub. In the city, traffic and transport situation has quickly worsened, especially after the new administration took office, due to accelerated economic growth and motorization. The increase in traffic volume mainly accounted for by private cars and buses, has also resulted in air pollution and increasing severity of traffic accidents. By 2035, the population of Yangon is expected to reach 7.7 million, with the population concentrating in the urban area. The urban area is also expected to expand into the surrounding areas, transforming Yangon into a megacity with a population of 10 million in the future. Along with economic and population growth and the resulting increase in traffic demand and incomes, private vehicle ownership rate is expected to grow. The pressure for urban and transport development will only become bigger.

1.2 In 2013–2014, a study entitled "Comprehensive Study on Urban Transport Development Program in Greater Yangon" (YUTRA) was conducted with the technical assistance of the Japan International Cooperation Agency (JICA) to formulate an urban transport development plan for the Yangon metropolitan area focusing on road and urban rail intersections, traffic management and safety, public transportation, and transport sector institutions, among others. A comprehensive transport network and development plan was formulated based on the conduct of comprehensive traffic surveys which produced an important database. The YUTRA study was also conducted in coordination with a parallel JICA-assisted study entitled "Yangon Sustainable Urban Development Planning" (SUDP) which intended to formulate a comprehensive urban development plan for Yangon. Due to a rapidly changing urban transport situation, however, a need arose for a review and an update of YUTRA under the new administration's policy on urban transport development.

1.3 In response, JICA concluded an agreement with the Myanmar government in March 2016 to implement a study which would update and review YUTRA I study findings and recommendations, conduct a pre-feasibility study for the UMRT Line 1(north-south line) and UMRT Line 2 (east–west line), come up with policies and an action plan to ease traffic congestion in Yangon, prevent or minimize traffic accidents, and establish an organization to formulate these policies.

2) Objectives

1.4 This study has the following specific objectives:

(a) Review and update YUTRA study which has the target year of 2035;

(b) Update the roadmap on urban transport in Yangon;

(c) Implement a pilot project related to bus transport modernization and draw lessons from this pilot project; and

(d) Formulate a proposal for the Yangon Urban Railway Construction Programme and conduct a pre-feasibility study for selected lines.

1.5 Along with gathering the required data to review YUTRA, efforts have been made to draft a proposal and an action plan for developing the urban transport network and for strengthening the urban transport management system in Yangon.

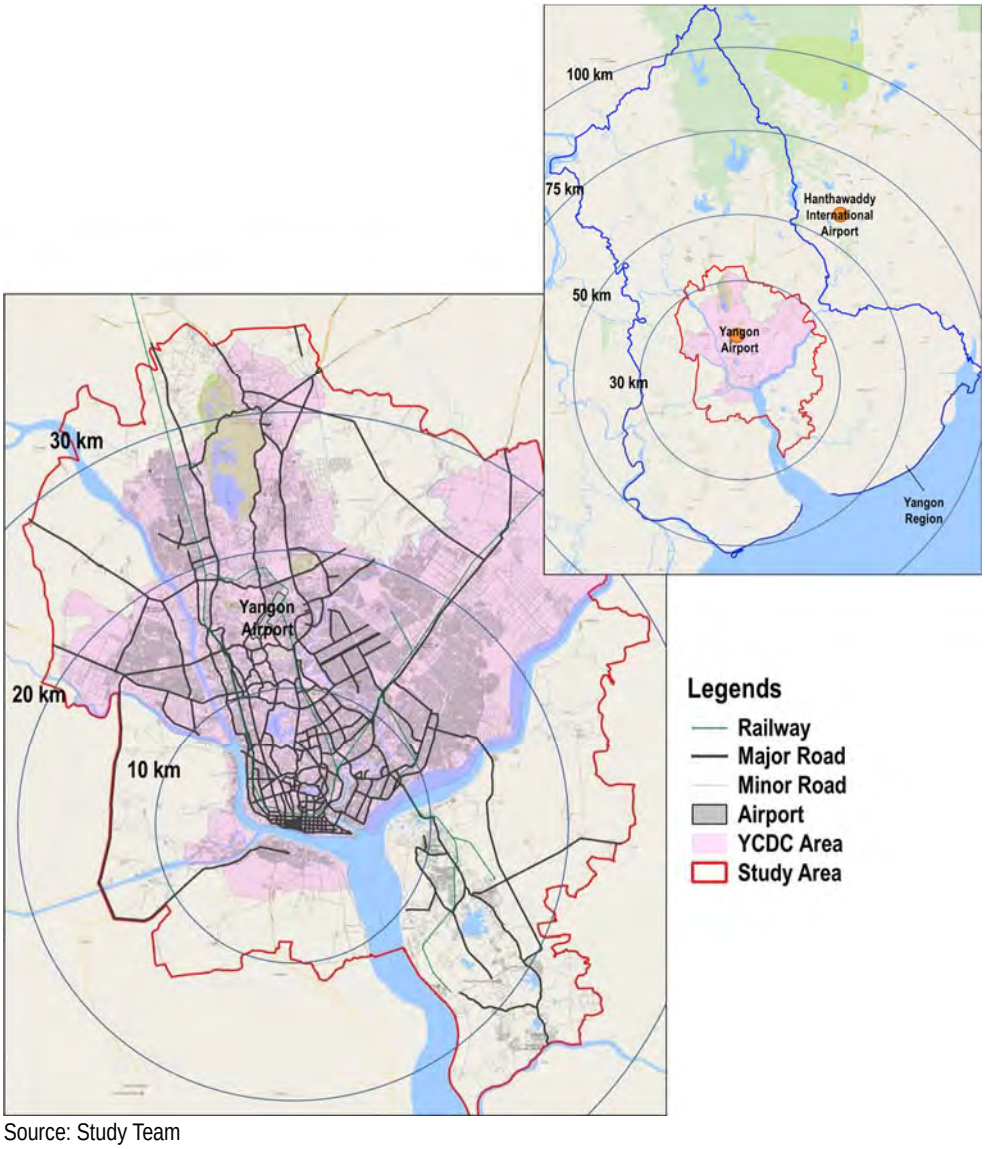
3) Approach

1.6 Updating the transport master plan for Yangon, including the development goals, basic strategies, overall transport network plan, list of projects/actions, and proposed roadmap, took account of the following points:

(i) Compliance with the overall urban and regional framework and structure by updating the Strategic Urban Development Plan (referred to as SUDP-II);
(ii) Incorporation of urban and regional transport policies and development directions of the new administration;
(iii) Review of the YUTRA (2014) plan and projects based on the results of supplemental traffic surveys carried out in this current study and on the updated database;
(iv) Consultation and coordination with Yangon Region Transport Authority (YRTA) to generate a shared understanding of the study and to build their capacity.

4) Study Area

1.7 The study area is the same as that of YUTRA, i.e., the metropolitan area of Yangon. It covers Yangon City, which is being administered by the Yangon City Development Committee (YCDC), and the urbanizing areas of Yangon Region, as shown in Figure 1.1.1. The study area is also called Greater Yangon and has an area of 1,500 km^2.



Source: Study Team

Figure 1.1.1 Study Area

1.2 Study Implementation

1.7 During the course of this study, the following meetings were held with relevant stakeholders in Myanmar along with the relevant Japanese agencies: Myanmar Union Government (UG), Ministry of Construction (MOC), Ministry of Transport and Communications (MOTC), Yangon Region Government (YRG), YRTA, Yangon City Development Committee (YCDC), JICA, and Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT).

Table 1.2.1 Meetings Held during the Study

Meeting			Date	Venue	Participant [1)]
Meeting with YRTA	Kick-off Meeting		3 August 2016	Yangon	YRTA, JICA, MLIT
	Periodic Meeting (1)		16 August 2016	Yangon	YRTA, JICA
	Periodic Meeting (2)		7 September 2016	Tokyo, Japan	YRTA, YCDC JICA, MLIT
	Periodic Meeting (3)		30 September 2016	Yangon	YRTA, YCDC, JICA
	Interim Report Meeting		10 October 2016	Yangon	YRTA, YCDC JICA, MLIT
	Periodic Meeting (4)		5 November 2016	Yangon	YRTA, YCDC, JICA
	Periodic Meeting (5)		5 December 2016	Yangon	YRTA, YCDC, JICA
	Periodic Meeting (6) – Investment and Funding Opportunity of MPs		23 January 2017	Yangon	YRTA, YCDC, JICA
	Periodic Meeting (7) – Review of YBS and Proposed Pilot Project		23 January 2017	Yangon	YRTA, JICA
	Summary of the Study for International Donors		20 February 2017	Yangon	YRTA, JICA and foreign donors
	Progress Report Meeting (& Announcement of Pilot Project)		10 April 2017	Yangon	YRTA, YCDC, JICA
	Interim Report on Urban Railway Pre-FS		9 July 2017	Yangon	YRTA, YCDC, JICA
	Discussion on Grade Separation Project of Yangon Circular Railway		17 August 2017	Yangon	YRTA, JICA
	Discussion on Taxi Policy		25 October 2017	Yangon	YRTA, JICA
	Discussion on Traffic Improvement at Level Crossing		1 November 2017	Yangon	YRTA, YCDC, JICA
	Discussion Paper on Pilot Project of Traffic Management		30 November 2017	Yangon	YRTA, YCDC, JICA
	Progress Report on Bottleneck Removal Program		10 February 2018	Yangon	YRTA, YCDC, JICA
Meeting with Myanmar Union Gov't	Kick-off Meeting	MOC	4 August 2016	Nay Pyi Taw	MOC, JICA, MLIT
		MOTC	4 August 2016	Nay Pyi Taw	MOTC, YCDC JICA, MLIT
	Interim Report Meeting	MOC	11 October 2016	Nay Pyi Taw	MOC, JICA,
		MOTC	12 October 2016	Nay Pyi Taw	MOTC, JICA
	Summary Report Meeting	MOC	19 December 2016	Nay Pyi Taw	MOC, JICA,
		MOTC	19 December 2016	Nay Pyi Taw	MOTC, JICA
	Interim Report on Urban Railway Pre-FS	MOTC	15 April 2017	Nay Pyi Taw	MOTC, JICA
Other Meetings	Kickoff Meeting of the Director Level Working Group by MLIT		6 September 2016	Tokyo, Japan	YRTA, YCDC, MLIT, JICA
	Working Group Meeting by MLIT (1)		10 October 2016	Yangon	YRTA, YCDC, MLIT, JICA
	Working Group Meeting by MLIT (2)		12 December 2016	Yangon	YRTA, YCDC, MLIT, JICA
	Summary of the Study for Japanese Companies		18 January 2017	Yangon	JICA, Japanese companies
	Summary of the Study for Japanese Agency		24 June, 2017	Tokyo, Japan	JICA, MLIT
	Report on Urban Railway Pre-FS		8 September 2017	Tokyo, Japan	JICA, MLIT

Source: JICA Study Team
1) Major stakeholder organizations.

2 OVERVIEW OF THE URBAN AND REGIONAL TRANSPORT SYSTEM

2.1 Strategic Location and Role of Yangon

1) Significance of Yangon

2.1 Yangon City is the most important hub for socio-economic activities in Myanmar and the gateway to the rest of the world. It is the capital of Yangon Region and had a population of 5.2 million in 2014 compared with Yangon Region's 7.4 million population (14% of the country). In the same year, Yangon accounted for MMK12,359 billion of the GRDP (19% of the country) (see Table 2.1.1).

Table 2.1.1 Yangon in Myanmar, 2014

Item		Myanmar	Yangon Region	Yangon
Population	(000)	51,486	7,361	5,191
	%	100	14	10
Area	km^2	669,794	9,804	971
	%	100	1.5	0.14
Population Density (1,000/km^2)		77	751	5,346
GRDP	MMK billion	65,262	12,359	n.a
	%	100	19	n.a
Per-capita GRDP (MMK000)		1,268	1,679	n.a

Source: Worked out by Study Team, based on Various sources.

2) Yangon in the Greater Mekong Subregion

2.2 Yangon is connected to the countries of the Greater Mekong Subregion (GMS) and the members of the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) through the Asian Highway network, as shown in Figure 2.1.1. Yangon Region is located on the Western Corridor which connects to the East-West Corridor passing though Thailand, Laos, and Vietnam. The Asian Highway network, however, is underdeveloped at present and Yangon is yet to be integrated with its neighboring countries.

Greater Mekong Subregion and Economic Corridors

National Spatial Development Framework

East–West Economic Corridor

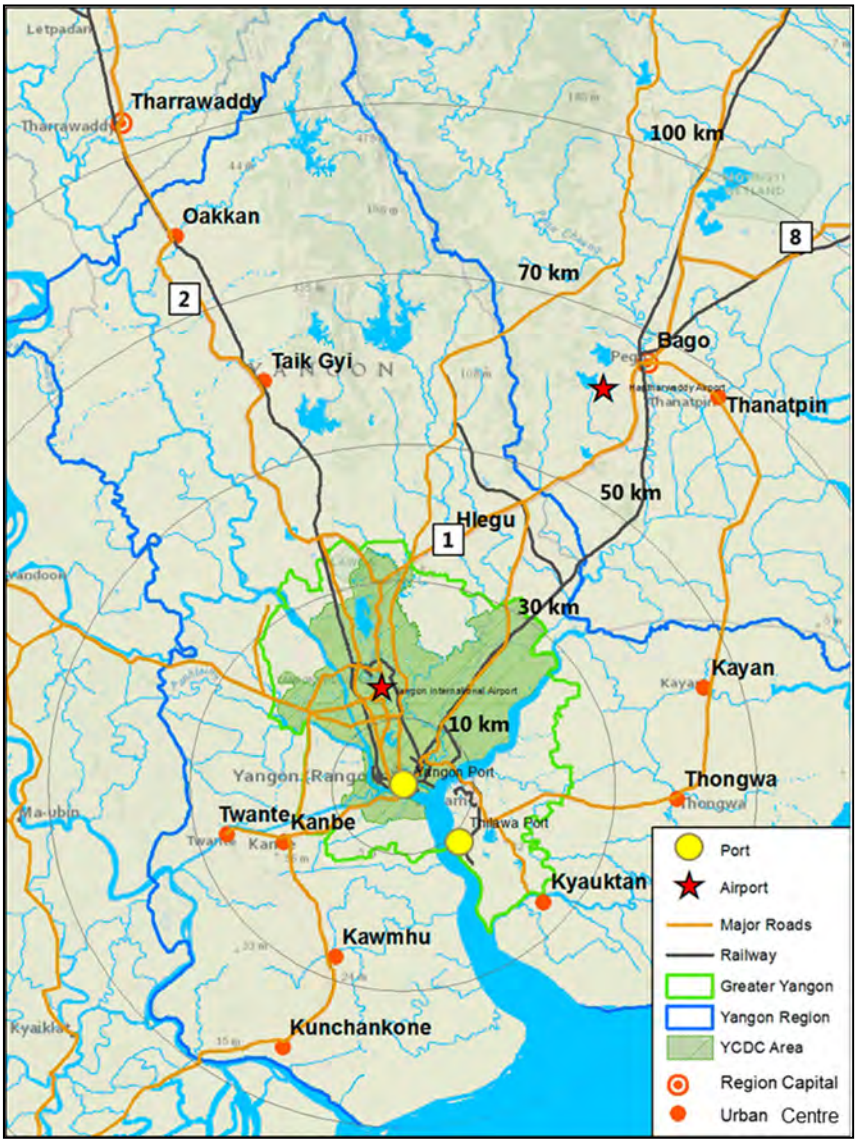
Source: Worked out by Study Team, based on Various sources.

Figure 2.1.1 Yangon Region in Myanmar and the Greater Mekong Subregion

3) Yangon in the National Transport Network

2.3 Yangon City, which is being administered by the Yangon City Development Committee (YCDC) has been growing rapidly. Its urban areas have expanded quickly as the population has increased, forming Greater Yangon[1].

2.4 Yangon Region is covered with a network of roads, waterways, rails, and provided with gateway ports and airports (see Figure 2.1.2). However, the current status of the transport infrastructure in the region is not satisfactory, requiring large investments to meet current and future needs. In 2014, more than 50% of the highways connecting to Yangon City were found to be in poor condition[2]. Although the road network around Yangon City accommodates a large share of national traffic, investments in maintenance, improvement, and new construction of roads are limited.



Source: Study Team

Figure 2.1.2 Transport Network in Yangon Region

[1] Greater Yangon is the study area of YUTRA study of 2013 and this study (YUTRA II).
[2] ADB Myanmar Transport Sector Policy Note: Urban Transport, 2016

2.2 Urban Transport System in Yangon

1) Overview

2.5 The urban transport system in Yangon City is composed of a network of roads, rails, waterways, ports, and airports (see Figure 2.2.2). Although the main urban areas are covered by major roads, railways, and waterways, they are not connected to each other nor provided with an adequate set of secondary network and feeder services.

2.6 During the last several years, the urban transport situation in Yangon has quickly worsened due to the constantly increasing urban population, increase in car ownership, slow progress in infrastructure development, and lack of traffic management to maximize the use of available transport capacities. The major transport problems identified include: (i) increasing traffic congestion; (ii) worsening traffic safety and undisciplined driving manner; (iii) low quality of public transport (bus, railway, taxi); (iv) worsening traffic pollution (air, noise); (v) illegal parking; (vi) widespread use of used/old vehicles; and (vii) worsening walkability. The problems are so much interrelated and present in many parts of the urban areas, making it difficult for the city to find and implement drastic solutions in a short time. The effectiveness of piecemeal measures is also limited.

2.7 Considering the national role of Yangon Region, urban transport issues should not be isolated from international/ regional transport because Yangon is the gateway for both passengers and cargos. As the country's economy grows and global integration makes progress, international traffic will increase and concentrate in gateways points, such as airports and border gates. The impact of international/ regional traffic will become increasingly significant. In view of this, two significant issues are currently being discussed in the Government. One is the development of a new airport in Hanthawaddy in Bago Region, and two is the relocation of port/ logistics facilities from the Yangon CBD.

2.8 Further development of roads and bridges, strengthening of existing railways, improvement and modernization of bus services, development of urban water transport is also ongoing.

Table 2.2.1 Vehicle Ownership in Yangon Region

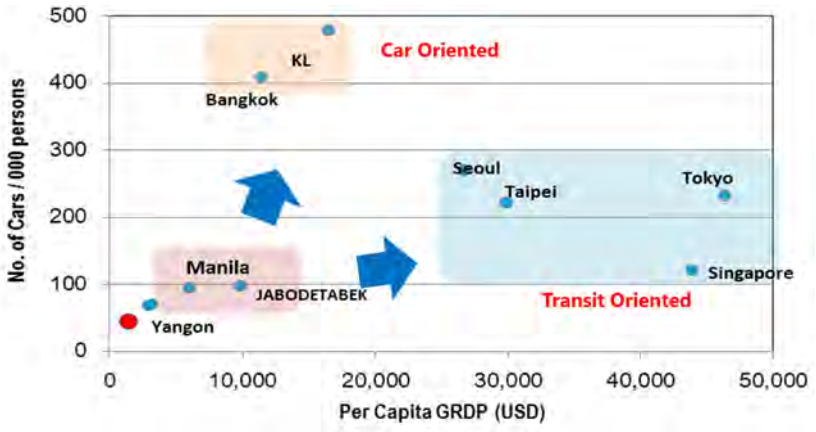
Classification		No. of Units (000)			Growth **Rate** (2016/2012)
		2012	2014	2016	
Private Car		160	270	330	2.1
Truck	Light	16	49	124	7.5
	Heavy	11	17	17	1.6
Bus		11	13	16	1.4
MC		56	143	253	4.5
Others		13	22	34	2.5
Total		269	514	773	2.9

Source: Statistical Yearbook in Myanmar, Road Transport Administration Department

Table 2.2.2 Vehicle Ownership among International Corporations by City

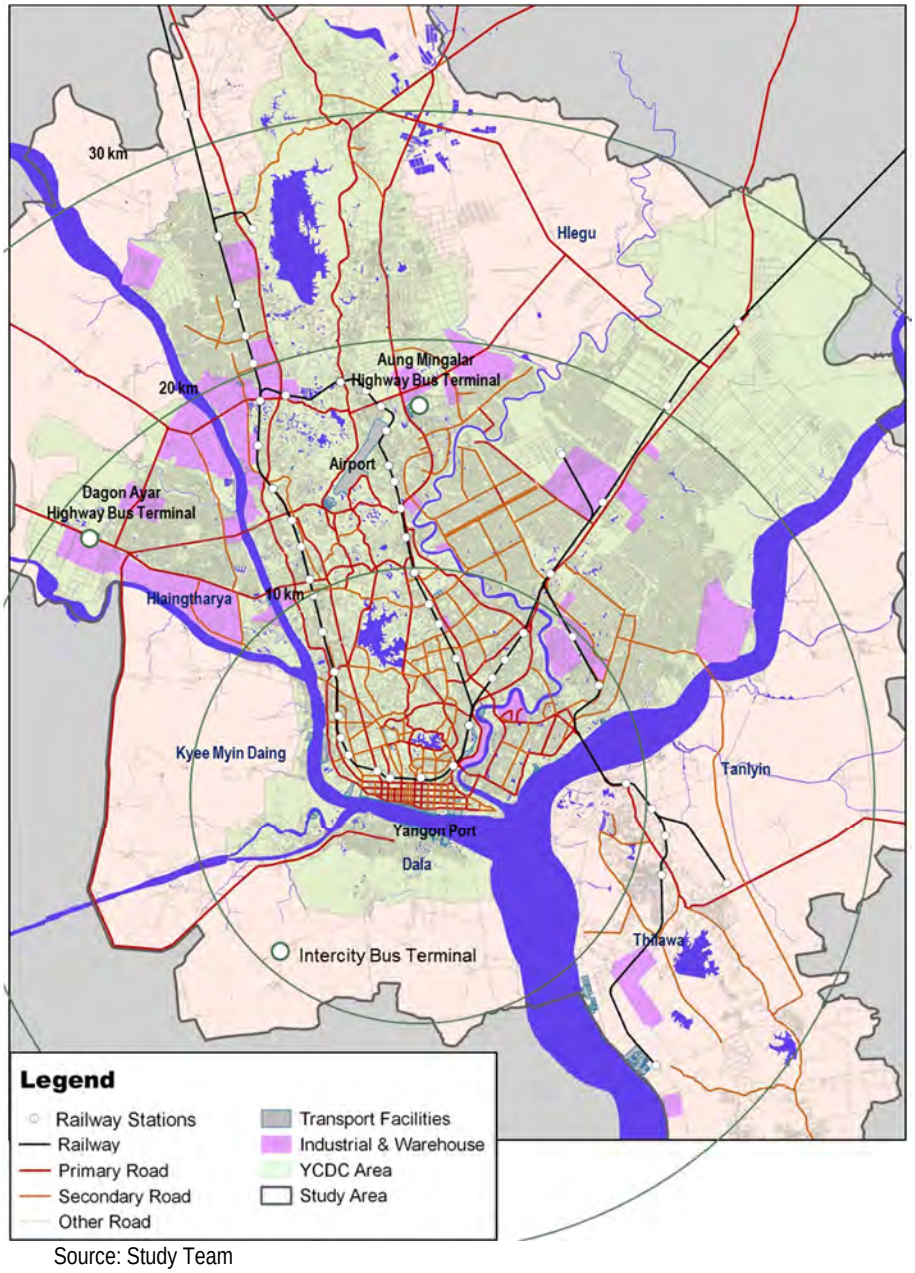
Capital City	No./ 000 Population	
	Car	M/C
Yangon	45	34
Hanoi	80	350
Bangkok	400	120
Manila	100	20
Kuala Lumpur	480	110
Taipei	220	150
Seoul	280	20
Singapore	230	15
Tokyo	120	10

Source: Worked out by Study Team, based on Various sources.



Source: Study Team

Figure 2.2.1 International Comparison of Car Ownership and Per Capita GRDP



Source: Study Team

Figure 2.2.2 Transport Network in Greater Yangon, 2016

2) Implications for Land Use and Urban Issues

2.9 Transport demand is derived from various socio-economic activities in urban areas. As transport and land use affect each other, traffic problems and issues should also be looked at in the context of urban development.

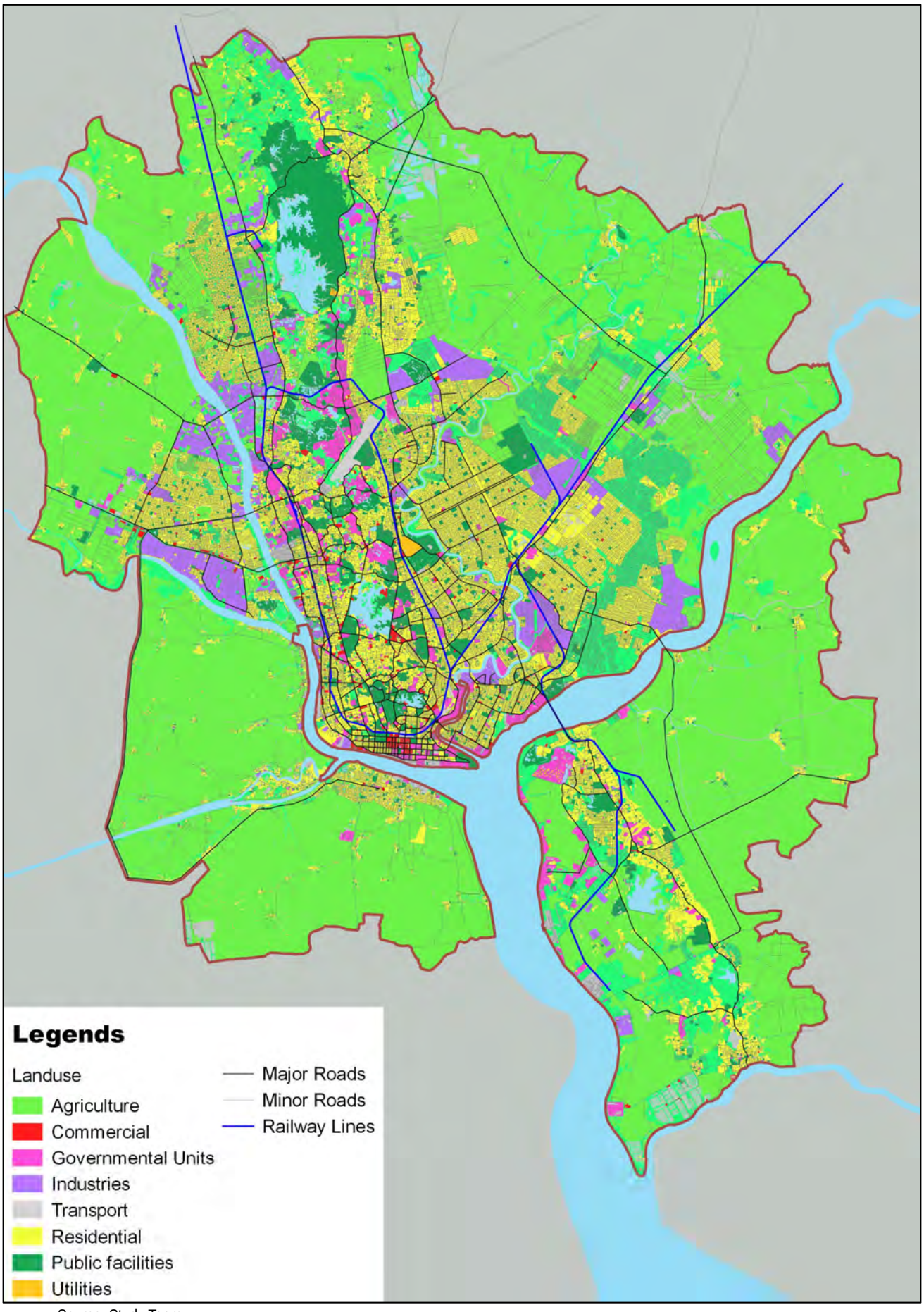
2.10 Urban areas in Yangon, i.e., the central business district (CBD) and the city center, are characterized by very high density and mixed uses, while areas along major roads have medium density and mixed uses. Between these areas and in suburban areas, there is low density. While population increase in central areas is slowing down, it is accelerating in outer areas in a sprawling manner. Yangon is rather monocentric in its urban spatial structure, though various scales of developments are taking place sporadically along major roads. Employment is significantly distributed in the CBD and city center, while higher-education enrolment is concentrated in a number of locations (see Figures 2.2.2– 2.2.6) The major urban needs facing Yangon include the following:

(i) Improvement of living conditions and environment provided with adequate utilities and protected against natural disasters such as flood;

(ii) Expansion of investment opportunities to make the city more competitive and create employment; and

(iii) Presentation of widely distributed heritage sites and rich natural resources (greeneries and water bodies) in urban areas which many cities have been losing in the urbanization process.

2.11 As transport is a key driver in influencing urban land use, it is necessary to look at various transport and traffic issues in relation to urban development and environmental management.



Source: Study Team

Figure 2.2.3 Land Use in Greater Yangon, 2012

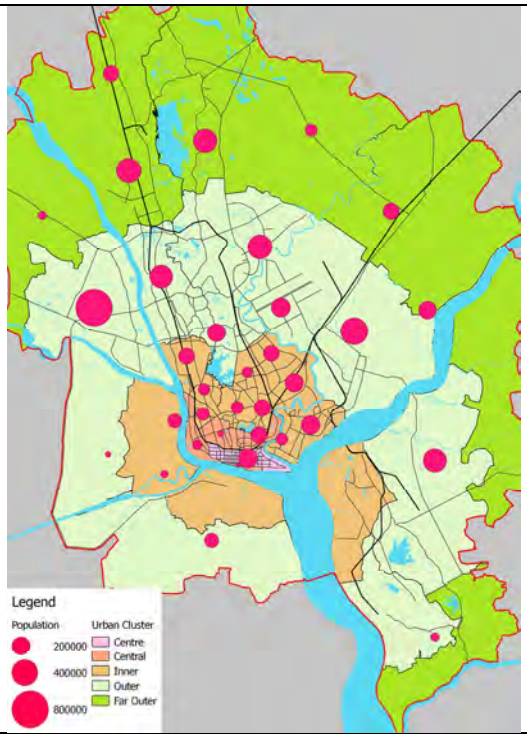


Figure 2.2.4 Distribution of Population by Township

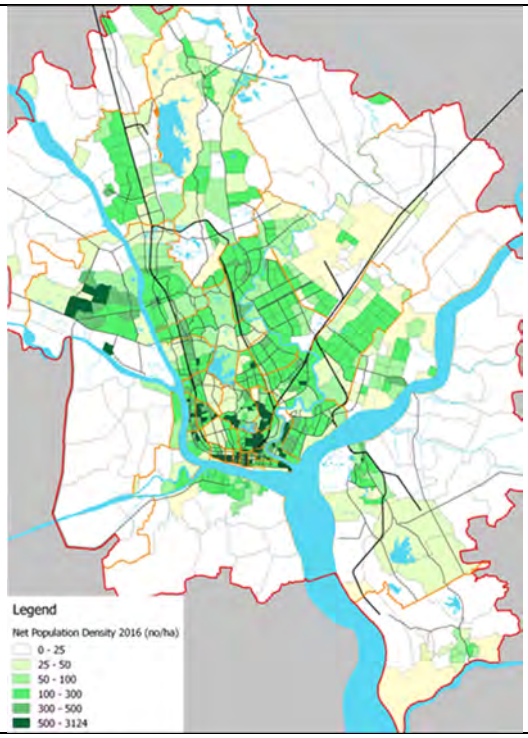


Figure 2.2.5 Population Density by Township

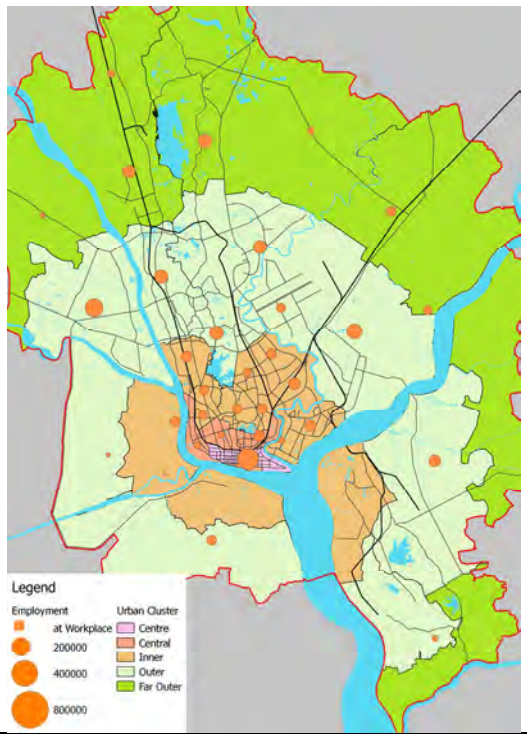


Figure 2.2.6 Workplace Employment by Township

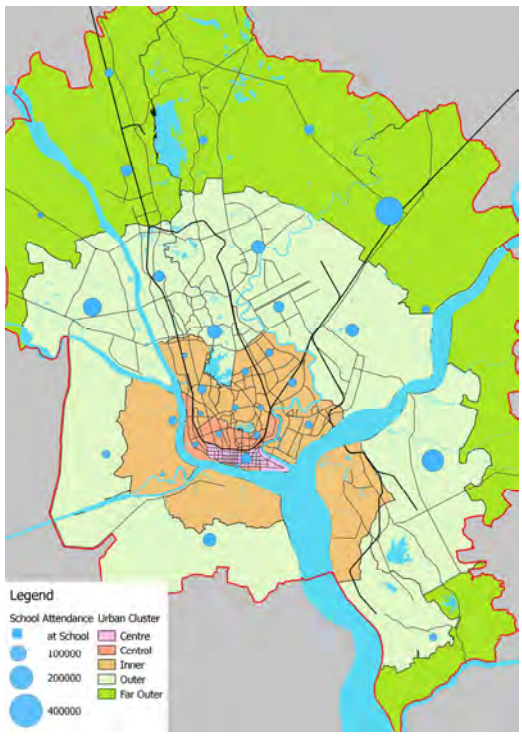


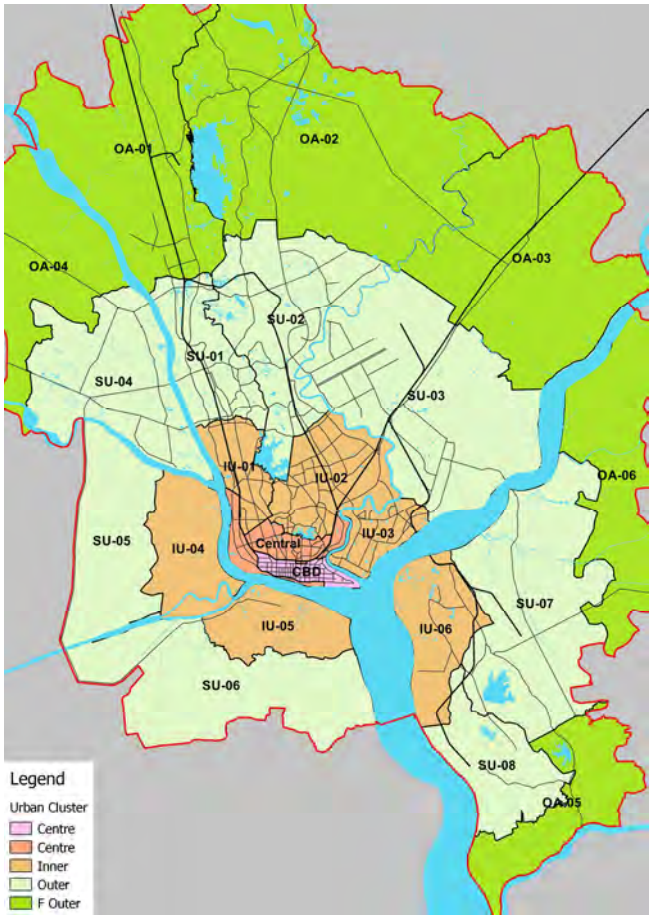
Figure 2.2.7 Higher-education Enrolment by Township

Source: Worked out by the Study Team based on the results of the HIS conducted in 2013.

2.12 The CBD, city center, and three clusters of inner urban areas (IU–01, IU–02, IU–03) have high population densities of 200 persons/ha or more (CBD has 341 persons/ha). Because of the high density, the population has not increased between 2011 and 2016, but has actually been decreasing, especially in the CBD and adjoining clusters.

2.13 Large populations are also distributed in some suburban clusters (SU–01, SU–02, SU–03, and SU–04) and outer area clusters (OA–01 and OA–02), though population density is relatively low. These clusters are located along major transport corridors, and their populations are expected to grow further as transport services improve.

2.14 As transport services affect the growth and distribution of population, spatial and land-use management must be coordinated and integrated with transport development.



CBD
Latha, Lanmadaw, Panbetan, Kyauktada, Botataung, Pazundaung

Central Cluster
Alone, (a part of) Kyeemyindaing, Dagon, Mingalar Taung Nyunt, Seikkan

Inner Cluster
IU-01 Inner North West: San Chaung, Kamayut, Hlaing
IU-02 Inner North: Bahan, Tarmwe, Yankin, Thingankyun, South Okkalapa
IU-03 Inner East: Dawpon, Tharkayta
IU-04 Inner South West: (a part of) Kyeemyindaing, Seikgyikanaungto, (a part of) Twantay
IU-05 Inner South: (a part of) Dala
IU-06 Inner East: Thanlyin

Outer Cluster
SU-01 Outer North West: (a part of) Mayangone, Insein
SU-02 Outer North: (a part of) Mayangone, (a part of) Mingalardon, North Okkalapa
SU-03 Outer North East: North Dagon, South Dagon, (a part of) East Dagon, (a part of) Dagon Seikkan
SU-04 Outer West: Hlaingtaryar
SU-05 Outer South West: (a part of) Twantay
SU-06 Outer South: (a part of) Dala, (a part of) Twantay
SU-07 Outer East: (a part of) Thanlyin
SU-08 Outer South East (Thilawa) : Kyauktan, (a part of) Tanlyin

Far Outer Cluster
OA-01 Far Outer North West: Shwepyitar, (a part of) Hmawbi
OA-02 Far Outer North: (a part of) Mingalardon, Hlegu, (a part of) Hmawbi
OA-03 Far Outer North East: (a part of) East Dagon, (a part of) Dagon Seikkan
OA-04 Far Outer West: Htantabin
OA-05 Far Outer South East: (a part of) Kyauktan
OA-06 Far Outer East: (a part of) Thanlyin

Source: Study Team

Figure 2.2.8 Urban Clusters in Greater Yangon

Table 2.2.3 Population Growth in Greater Yangon by Urban Cluster

Cluster			Population		AGR (%/yr)	Population Density (no/ha)
			2011	2016		
CBD			252,392	222,256	-2.5	341
Central			318,592	321,115	0.2	234
Inner Cluster	IU-01	Inner North West	344,103	346,743	0.2	200
	IU-02	Inner North	840,726	695,789	-3.7	205
	IU-03	Inner East	340,568	302,554	-2.3	208
	IU-04	Inner South West	89,376	86,786	-0.6	25
	IU-05	Inner South	111,954	112,592	0.1	38
	IU-06	Inner South East	93,526	169,023	12.6	47
	Subtotal		1,820,253	1,713,487	-1.2	103
Outer Cluster	SU-01	Outer North West	442,504	442,393	-0.0	135
	SU-02	Outer North	542,494	587,115	1.6	85
	SU-03	Outer North East	798,760	950,639	3.5	74
	SU-04	Outer West	488,768	803,127	10.4	112
	SU-05	Outer South West	11,297	9,894	-2.6	2
	SU-06	Outer South	17,768	16,976	-0.9	2
	SU-08	Outer South East (Thilawa)	13,974	16,466	3.3	4
	SU-07	Outer East	68,560	123,904	12.6	12
	Subtotal		2,384,125	2,950,514	4.4	50
Far Outer Cluster	OA-01	Far Outer North West	331,698	494,637	8.3	44
	OA-02	Far Outer North	191,473	301,391	9.5	18
	OA-03	Far Outer North East	61,199	73,710	3.8	6
	OA-04	Far Outer West	32,506	44,981	6.7	6
	OA-05	Far Outer South East	45,212	38,804	-3.0	9
	OA-06	Far Outer East	15,160	27,398	12.6	3
	Subtotal		677,248	980,920	7.7	16
Greater Yangon Total			5,452,610	6,188,292	2.6	44

Source: Study Team

2.15 In 2013, a household interview survey was conducted among a total of 10,068 households. Household heads were interviewed based on a comprehensive questionnaire consisting of 95 questions dealing with the household's socio-economic profile, such as the ages of the household head and its members, gender, occupations, incomes, ownership of vehicles and household goods, housing and housing conditions, availability of urban utilities (such as power, water, drainage, and garbage collection), access to various urban services, and public transport, among others. At the same time, people's assessment of the existing urban environment and public services, as well as their future needs and visions for the city were also asked. An analysis of the survey data is in Technical Report No. 4 entitled "Profile and Voices of Yangon People in 2013."

3) Urban Roads and Streets

2.16 Yangon lacks road infrastructure in terms of length, space, density, and quality as characterized in the following:

(a) **Small Network Size:** While the total road length is fairly long at 9,945 km, they are mostly one-lane roads. Those with more than 6 lanes or having 4 or 2 lanes are 126 km, 429 km, and 9,255 km in length, respectively. The share of the overall road area to the total urban area is only 4.5%, which is much lower than other large cities in the world (Table 2.2.5). On the other hand, roads in the old CBD are well provided both in terms of density and network (i.e., at a high 22%, although most of the space is blocked by parked vehicles and vendors).

Table 2.2.4 Profile of Roads in Greater Yangon

No. of Lanes	Length (km)	Average ROW (m)	Road Area (km^2)
≥ 6 lanes	126	32	4.0
≥ 4 lanes	429	24	10.3
≥ 2 lanes	2,906	8	23.2
< 2 lanes	6,349	4	25.4
Total	9,912	-	63.0

Source: Study Team from YCDC data

Table 2.2.5 International Comparison of Shares of Road Area to Urban Area

City / Urban Area	Share (%)
Tokyo (Japan)	18.4
Seoul (Korea)	13.2
Singapore	10.0
Hong Kong	6.3
Taipei City (Taiwan)	7.7
Bangkok (Thailand)	7.1
Jakarta (Indonesia)	7.3

Source: Worked out by Study Team, based on Various sources.

(b) I**nadequate Network Connectivity:** The urban area is covered with a limited number of major roads (i.e., four north–south roads) which lack east–west connectivity. Secondary roads, which articulate the primary road network, are also lacking.

(c) **Poor Road Standards:** Many roads are narrow, winding, and not properly maintained. Road surfaces are not smooth for cars and are also unsafe for pedestrians. Many sections tend to get flooded during the rainy season due to poor drainage.

(d) **Lack of Traffic Management:** Congestion takes place in many intersections, roundabouts, and road sections, especially around shopping centers and schools due to unregulated roadside parking and loading/unloading practices. Pedestrians are also not provided with adequate safety facilities and a comfortable walking environment.

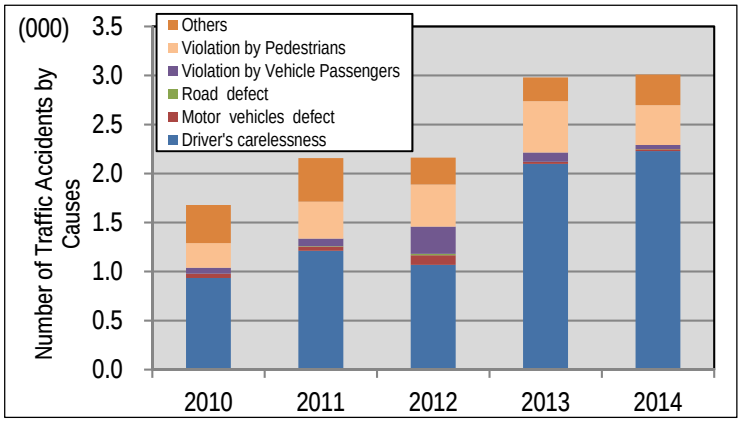
2.17 After the YUTRA study of 2013, the Bayint Naung Bridge was completed in 2014 and the new Thaketa Bridge is currently under construction using grant aid from JICA. The project on the construction of the Bago River Bridge is also underway using Japanese ODA Loan. The construction of Dala Bridge connecting Dala area with Pyay Road is expected to commence. Other donors are involved in road and bridge projects in the study area. In addition to roads and bridges, the number of flyovers has increased: From three (3) during the time of the YUTRA study in 2013, five more were finished by end-September 2016. Two (2) flyovers that were planned by the previous government were cancelled by the new administration in March 2016.

4) Traffic Congestion

2.18 Why has traffic congestion become the most critical concern of many cities, including those in developed countries? It is because the economic, social, and environmental costs of traffic congestion are significant. It affects many sectors of society not only transport but also socio-economy, environment, and urban land use. Traffic congestion reduces the mobility of people and accessibility to services, resulting in increased travel costs and discomfort. Traffic congestion also tends to increase air pollution and gasoline consumption. Traffic congestion negatively affects a city's competitiveness, livability, and environmental sustainability, as well as degrades its image. Traffic congestion hits the low-income groups more negatively.

Source: YUTRA Study (2013)

Figure 2.2.9 Congestion-prone Locations in Yangon City



Source: Myanmar Statistical Yearbook 2015

Figure 2.2.10 Number of Traffic Accidents in Yangon Region by Cause

Table 2.2.6 Understanding of Traffic Congestion

Area of Negative Impact	Main Issue/ Cause	Location
• Mobility of people • Smooth flow of goods • Accessibility to services • Safety and comfort • Transport cost (time, vehicle) • Energy cost • Environmental cost (air, noise) • Image of the city	• Road network: bottlenecks and missing links • Parking: facilities/ space, management (fee) • Public transport services: coverage, accessibility, quality, driving manner, boarding/ alighting practice, bus stops (location and facility), etc. • Roadside vendors, schools, commercial activities • Jay walking • Sidewalks/ pedestrian facilities and walkability • People's awareness	• Main corridors • Secondary roads • CBD • Area: clusters, urban block • Point: specific area (e.g. school, shopping center, industrial park, etc.)

Source: Study Team

2.19 Solving traffic congestion in large urban areas requires long-term and constant attention of the government and road users. There are four key areas that must be attended to in mitigating the negative impacts of traffic congestion.

(a) **Lack of Infrastructure Development:** Without adding transport capacities, demand cannot be met. Development infrastructure ranges from proper maintenance; minor improvement; rehabilitation; removal of bottlenecks/missing links; construction of new roads including bridges, elevated expressways, and exclusive transit lines (BRT, MRT), among others. Priorities must be given to basic, low-cost house-keeping measures.

(b) **Inadequate Provision and Use of Road Space:** Inefficient use of available road space is one of the most obvious reasons for traffic congestion in Yangon.

(c) **Sharp Increase in Private Vehicles and Lack of Competitive Public Transport Services:** Of the total current demand of 11 million trips/day, about 40% and 20% are shouldered by

buses and other modes of public transport (truck bus, taxi, rail, waterway), respectively. Bus ridership has gradually decreased, as passengers shifted to private cars and taxis. Although the number of buses has increased, the units are mostly old. The sharp increase in private vehicle numbers tends to worsen traffic congestion, affecting bus operation more negatively.

(d) **Need for Expansion and improvement of Bus Services:** In terms of passenger-km, bus meets 73% of total passenger demand although bus occupies only 21% of road space. Bus is so space-efficient that its services have to be expanded. At the same time, private vehicle traffic must be controlled to give priority to bus operation in view of the limited road space.

Table 2.2.7 Vehicle Registration in Yangon Region

Mode		No. of Units (000)			2016/2012
		2012	2014	2016	
Passenger Car[2)]		160,290	269,829	329,793	2.1
Truck	Light	16,426	48,948	123,700	7.5
	Heavy	10,916	16,917	17,257	1.6
Bus		11,393	13,036	15,524	1.4
M/C		56,379	142,830	253,440	4.5
Others		13,306	22,375	33,523	2.5
Total		268,710	513,935	773,237	2.9

1) From the website of the Department of Road Transport Administration, as of June 2016.
2) Taxis are included.
Source: Department of Road Transport Administration

5) Bus Transport

2.20 Public transport in Yangon heavily relies on buses, which share about 40% of the total motorized trips and carry about 2 million passengers a day. Considering the importance of bus services and in response to the needs of the people, the Government has committed to reform the system drastically. The reform program was initiated in January 2017 by restructuring bus routes from 333[3] to 70, which was later increased to 91 in August 2017. More than 100 companies and operators were amalgamated into 8 groups. New buses are being introduced to replace old ones. ICT in the form of GPS, and CCTV is being introduced gradually. Improvement of bus stops and terminals are also about to commence. Although the reform program still has many areas that need further improvement, it has been favorably accepted by bus users. Since February 2018, JICA TA Project names “The Project for Improving Public Bus Service in Yangon” has been launched.

[3] As of August 2016.

6) Railways

2.21 The current Myanmar Railway lines in the study area are operated poorly and have low transport capacity due to deteriorated infrastructure and a lack of maintenance although there is some demand from people who want to use the railway more. The maximum speed is approximately 25–30 km/h even on comparatively well-maintained sections (Yangon–Mandalay Main Line and Yangon–Pyay Main Line) in the study area. Branch lines are in poor condition and the speed is quite slow at about 5–10 km/h. The Yangon Circular Line is currently being upgraded. Toward railway modernization, Japan government supports both sides of hardware and software.

2.22 The daily peak hours are from 07:00–09:00 in the morning (peak ratio of 11%) and 17:00–18:00 in the evening (peak ratio of 17%). Four trains/hour (15 minutes interval) are operated in the peak hour. About 42% and 36% of railway passengers use the railway to go home and to go to work, respectively. The main means of access to the stations is by walking (72% of all railway users) due to poor feeder services. Continuous urban railway development, including the enhancement of feeder services, is required.

2.23 There are 25 at-grade crossings along the circular rail. Some level crossings with roads cause traffic congestion (e.g., Parami Road, Main Road No. 4, Bayint Naung Road, etc). However, an analysis conducted in one of the studies for the upgrading of the circular rail indicated that rail level crossings would not become traffic bottlenecks when railway signal and nearby road traffic signals were synchronized[4].

7) Taxi

2.24 The total number of registered taxis increases by over 3 times from 2011 to 2017. Since government changed the vehicle import policy in 2013, the number of taxis increased rapidly. Currently, the total number of taxi in Yangon reached over 70,000. YRTA is planning to half the number of taxis[5].

Table 2.2.8 Number of Taxi in Yangon Region

2011	2012	2013	2014	2015	2016	2017
24,288	31,931	46,460	55,000	60,522	68,731	over 70,000

Source: Worked out by Study Team, based on Various sources.

2.25 The fare of taxi is based on the negotiation. According to the drivers, taxi fares will vary depending on the congestion. The fare rate is assumed to be commodity charge which shorter trips have higher fare rate.

Table 2.2.9 Fare System of Taxi in Yangon (Kyat)

2 km	3 km	4 km	5 km	6-8 km	9-12 km	13-15 km
1,500	2,000	2500	3000	3500	4500	5500

Source: Interview with Taxi Drivers

2.26 Currently, mobile application based taxi services are being expanded in Yangon: Hello Cab and Oway Ride are the local service providers introduced in 2016. The foreign based services, Grab (Singapore based) and Uber (US based) expanded into Myanmar since 2017.

[4] Working Paper: Signal System for Level crossing, Basic Design Study on The Yangon Circular Railway Line Upgrading Project (Signalling, Rolling Stock) (YCR-RS/BD), 2016
[5] https://www.mmbiztoday.com/articles/yrta-halve-number-yangon-taxis-fight-against-traffic

8) Inland Water Transport

2.27 There are seven main inland waterway routes in the study area, namely Yangon River, Bago River, Hlaing River, Panhlaing River, Twante Canal, Pazundaung Creek, and Khanaungto Creek. Three routes are regularly operated by IW transport (IWT), i.e., Pansodan–Dala (Ferry service of 1 km, ferry, 0.8 million a month), Wadan–Dala (2 km, Ro-Ro, 8.5 thousands a month) and Land Thit–Kha Naung Toh (6 km, ferry, 65 thousands a month).

2.28 The new water transport service called Yangon Water Bus launched the first phase which operates between Insein and Boththaung area. As of March 2018, The second phase (Botahtaung to North Dagon) and third phases (Botahtaung to Thanlyin) are planned to be operated in July 2018.

2.29 Problems and Issues on Inland Water Transport are as follows:

(i) **Condition of Passenger and Cargo Vessels:** More than five thousands vessels have plied inland waterways, however about half of them are more than 40-year age. Ship conditions are generally inferior, and shortage of power, inadequate safety equipment and improper hull form are main issues. In consideration of these situations, Japan has supported to rehabilitate the ship docks to maintain vessels, or plans to provide vessels. As mentioned in previous phase, three ferry boats, which have an accommodating capacity of 1,000 is schedule to be procured by Japanese gratis fund, and will launch at the end of 2014.

(ii) **Condition of Navigation Channel:** Entrance into and Leave from Ports at night-time is not performed due to inadequate navigational facilities such as leading lights and navigation buoys. In order to maintain safety navigation and ship calling schedule, improvement and installation of navigation aids are required as well as maintenance dredging.

(iii) **Condition of Passenger Jetty:** Jetty is decrepit due to inadequate maintenance, and mooring facilities and equipment are damaged, for example, it is often observed that mooring rope is worn-out. Regular maintenance is fundamental to keep public facilities good condition. Establishment and introduction of maintenance system are required, and budget for implementation should be reserved.

9) Air Transport/Gateway Airports

2.30 The existing Yangon Airport is located in the north of the city, approximately 17 km from the city center. The airport has one runway (3,413 m) and separate terminals for international and domestic flights. The airport has direct flights to 16 international and 15 domestic destinations (see Table 2.2.10). The total number of daily flights is 105 for international and 129 for domestic trips. The number of annual incoming and outgoing international and domestic passengers is 3.83 million and 1.99 million, respectively. Peak hour time is 9:00–10:00 and 16:00–17:00.

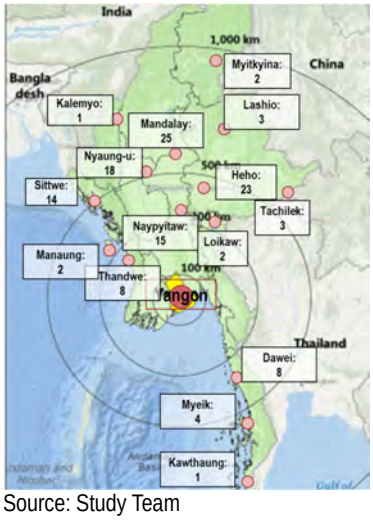
2.31 At present, the most popular access mode to the airport is private cars, followed by taxis. The access time to the airport from the CBD, for example, varies between 30 and 120 minutes at present. This large fluctuation is due to traffic congestion in the CBD and on major arterial roads.

2.32 Development of new international airport is planned and Hanthawady in Bago Region, which is 65 km away from the CBD of Yangon City is one of the candidates. The location of new international airport will change the pattern of access to air transport dramatically when it becomes operational.

Table 2.2.10 Total Number of Flights and Passengers

Destination		No. of Trips[1)]
Inter-national	Short-haul International (BKK, DMK, SIN, KUL, PEN, HAN, SGN, CNX)	79
	Mid-haul International (HKG, KMG, CAN, TPE)	20
	Long-haul International (NRT, DOH, DXB, ICN)	6
	Subtotal	105
Domestic		129
Total		234

1)Operating record as of May 25th, 2018
Source: Study Team



Source: Study Team

Figure 2.2.11 Origin/ Destinations of Domestic Freight to/ from Yangon Airport

10) Gateway Port

2.33 Yangon Port consists of Yangon Main Port and Thilawa Port. is located along the Yangon River, maintaining 8.5 m of draft during the dry season and 9.0 m during the rainy season, Yangon Main Port accommodate 15,000 DWT vessels and Yangon Port in Thilawa Area accommodate 2,000 DWT vessels. Port facilities occupy long stretches of waterfront areas, including the CBD, and disconnect the urban areas from the riverbank in many locations.

2.34 The Yangon Port system is composed of Yangon Main Port and Yangon Port in Thilawa Area. The former is located 32 km from the mouth of the Yangon River and extends to about 9 km on the left bank of the river including most of the waterfront area of the CBD. Yangon Port in Thilawa Area is located about 16 km downstream and also built on the left bank of the river.

2.35 Major cargoes at Yangon Port are handled in container terminals, while general cargo is handled in the general cargo terminal and coastal/inland waterway transport terminals. There are jetties and pontoons utilized for domestic/inland waterway transport. The wharves owned by the Myanmar Port Authority (MPA) under Ministry of Transportation and Communication, and private companies handle general cargoes and containers.

2.36 In 2011, the cargo handling volumes at Yangon Main Port and Yangon Port in Thilawa Area were 18.7 million tons and 3.1 million tons, respectively. Of these numbers, about 70% consisted of imported goods. Meanwhile, container cargo handling volume was 335,000 TEUs.

Table 2.2.11 Cargo and Container Throughput in Yangon Port, 2005–2015

Year	Container Cargo (000 TEU)									General Cargo (000 ton)		
	Yangon Inner Harbor			Thilawa Area Port			Yangon Port (Total)			Yangon Port (Total)		
	In	Ex	Total	In	Ex	Total	In	Ex	Total	In	Ex	Total
2005	86.1	85.8	171.9	17.0	18.8	35.8	103.1	104.6	207.7	n.a	n.a	n.a
2006	99.9	97.3	197.3	23.9	23.6	47.5	123.9	120.9	244.8	1,621	749	2,370
2007	111.3	111.2	226.5	19.5	23.3	42.8	130.8	134.5	265.3	1,727	885	2,612
2008	133.7	130.3	264.0	16.7	21.0	37.6	150.4	151.3	301.6	1,485	3,004	4,489
2009	152.1	151.3	303.4	9.3	14.0	23.3	161.4	165.3	326.7	2,595	1,333	3,927
2010	175.3	171.3	346.6	4.8	5.4	10.2	180.1	176.8	356.9	5,554	1,958	7,511
2011	207.5	200.5	408.0	1.4	1.0	2.5	209.0	201.5	410.5	3,132	1,877	5,009
2012	238.8	239.1	478.0	7.1	9.8	16.9	255.0	248.9	494.9	6,289	3,871	10,161
2013	310.8	306.3	617.2	5.6	7.8	13.4	316.4	314.1	630.6	7,202	5,048	12,250
2014	377.3	367.9	745.2	9.8	8.6	18.5	387.1	376.5	763.6	9,671	2,437	12,108
2015	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	11,526	775	12,301

Source: Myanmar Port Authority

2.3 Characteristics of Current Urban Transport Demand

1) Update of Urban Transport Demand Data

2.37 In the study, various supplemental traffic and transport surveys were conducted to update the OD tables prepared in YUTRA I and, at the same time, to analyze the current traffic situation and bus operation. Supplemental surveys conducted comprise the following:

(i) Screen line survey in 15 locations;

(ii) Cordon line survey in 5 locations;

(iii) Intersection traffic survey in 8 locations;

(iv) Travel speed survey on 6 roads;

(v) Bottleneck survey on seven corridors;

(vi) Interview survey on public transport access among 1,000 respondents;

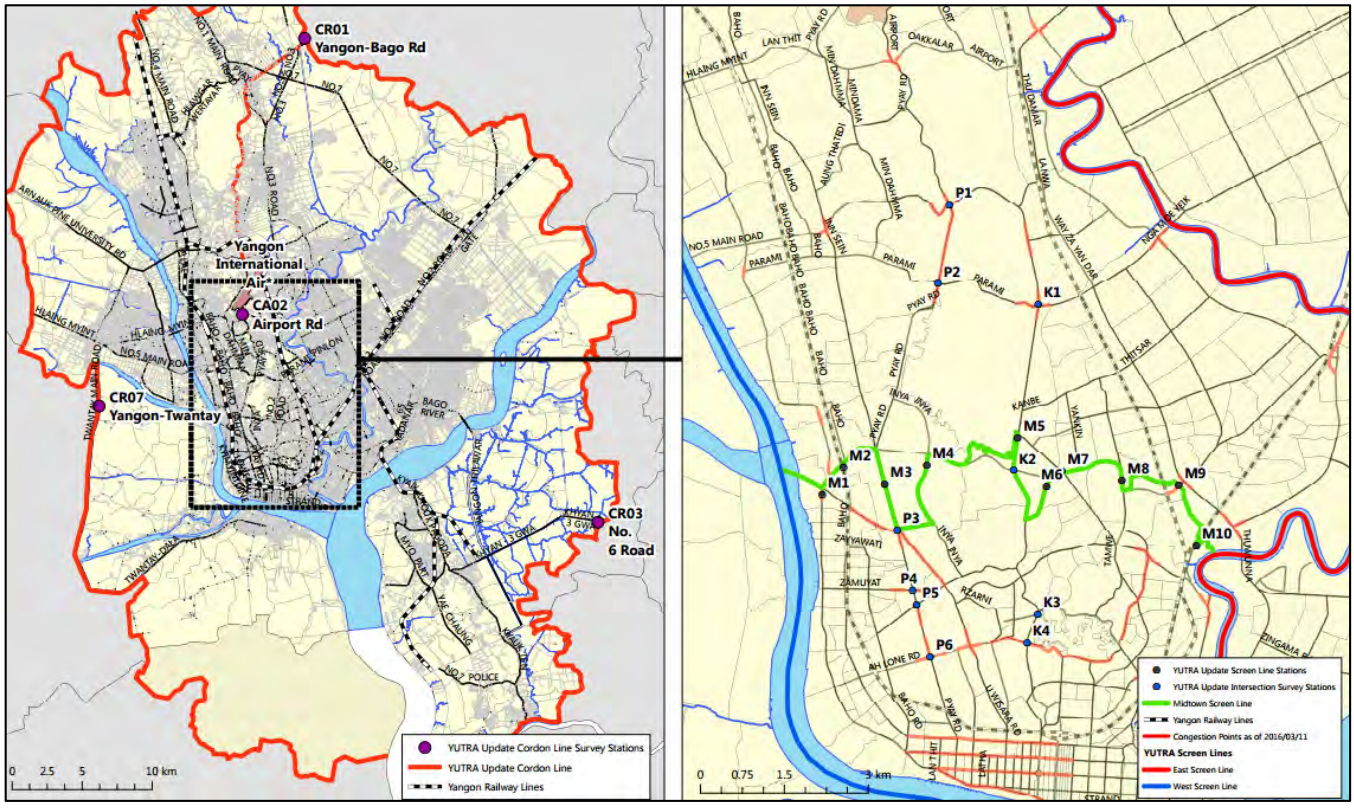
(vii) Willingness-to-pay survey among 1,000 respondents;

(viii) Bus passenger boarding/alighting survey on all 80 YBS routes;

(ix) YBS bus passenger interview survey among 2,400 respondents; and

(x) Bus departure / arrival survey for Tha Khin Mya Park and Sule.

2.38 Details and main outputs of the survey are included in Technical Report No.1.



Source: Study Team

Figure 2.3.1 Location of the Supplemental Traffic Surveys

2) Demand Characteristics

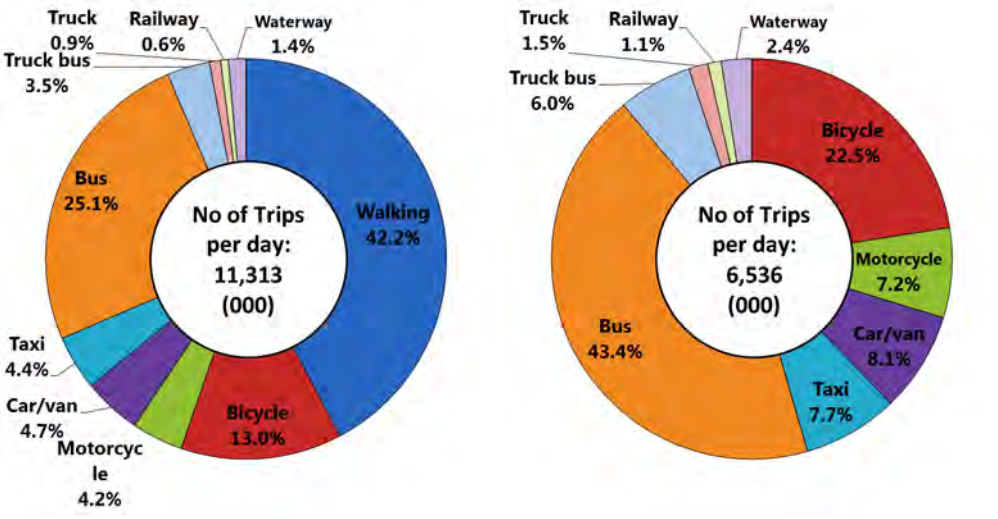
2.39 **Total Demand and Mode Share:** In the YUTRA study conducted in 2013, a comprehensive household interview survey was conducted. Results showed that in the study area, about 11.3 million trips were made on a normal weekday in 2013, as shown in Table 2.3.1. Of those 11.3 million

trips, about 4.8 million trips or 42% of the total trips were walk trips. The modal shares are presented in Figure 2.3.2.

Table 2.3.1 Urban Transport Demand by Mode Including Walking in 2013

Mode	Type	No. of Trips (1,000/day)	Mode Share (%)	
			Including Walking	Excluding Walking
Walking		4,778	42.2	-
Road	Bicycle	1,472	13.0	22.5
	Motorcycle	471	4.2	7.2
	Car/Van	530	4.7	8.1
	Taxi	502	4.4	7.7
	Bus	2,838	25.1	43.4
	Truck Bus[1)]	391	3.5	6.0
	Truck	101	0.9	1.5
	Subtotal	6,305	55.7	96.5
Railway		71	0.6	1.1
Inland Waterway		160	1.4	2.4
Total (Excluding Walking)		6,536	57.8	100.0
Total		11,313	100.0	-

1) Truck buses were banned by the government in 2014 and were replaced with minibuses (The Irrawaddy, retrieved on 24 April 2017 from https://www.irrawaddy.com/news/burma/rangoon-ban-passenger-travel-hilux-trucks.html)
Source: YUTRA Household Interview Survey (2013)



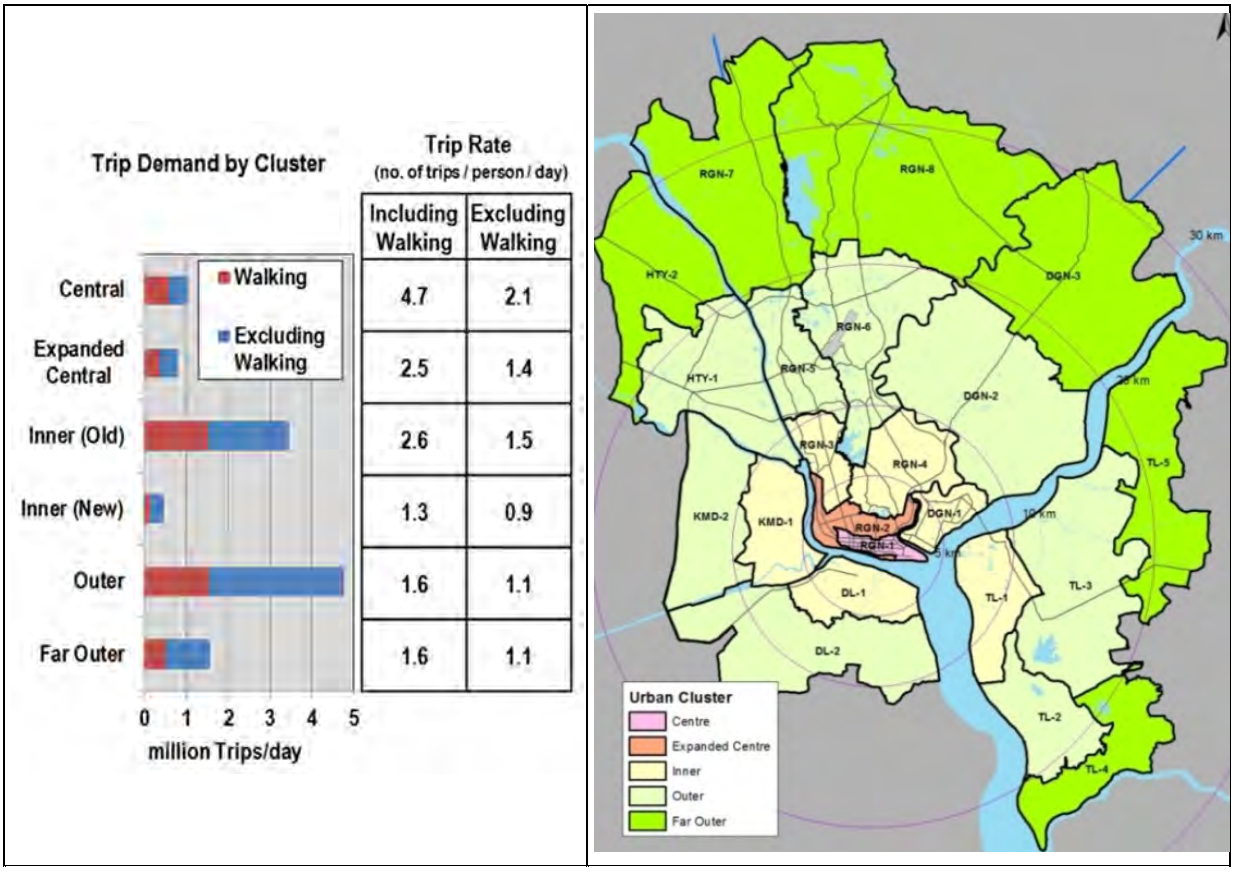
Source: YUTRA Person Trip Study (2013)

Figure 2.3.2 Urban Transport Demand by Mode in 2013

2.40 The modal share of public transport in 2013 was high at about 60% excluding walk trips. Among the public transport modes, buses made up 80% of the share, while railway only accounted for about 1%. The average commuting time was about 59 minutes and 87 minutes by bus and railway, respectively, and the average number of trips per day per person was about 2.0.

2.41 **Trip Generation and Attraction:** From the household survey results in 2013, the average trip rate was 2.0 trips/person/day, which is more or less comparable with other major cities in Asia (e.g., Bangkok: 2.3, Manila: 2.2, Hanoi: 2.7). When the share of walk trips, which accounted for 42% of the total demand in Yangon was excluded, the average trip rate became 1.1 trips/person/day which is

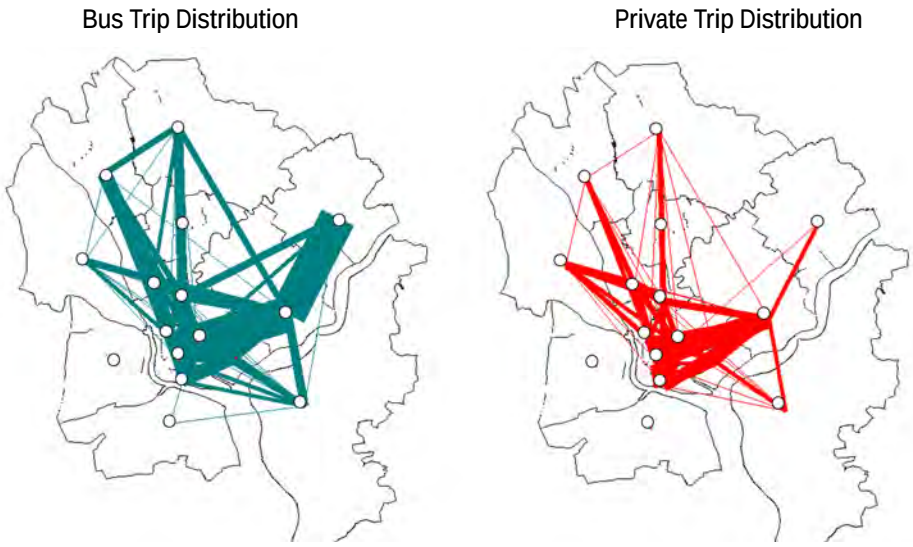
quite low compared to those of Manila and Hanoi, at 1.8 and 2.0, respectively. Trip rates in Yangon varied significantly by type of urban area. In the inner urban areas, trip rates were much higher than those in outer areas (see Figure 2.3.3).



Source: YUTRA Person Trip Study (2013)

Figure 2.3.3 Trip Rates in 2013 by Urban Cluster

2.42 **Distribution of Demand:** The distribution of public and private demand was quite different. Private transport demand was rather concentrated in the central part of urban areas, while public transport demand was spread more widely over urban areas.



Source: Study Team.

Figure 2.3.4 Trip Distribution in 2016

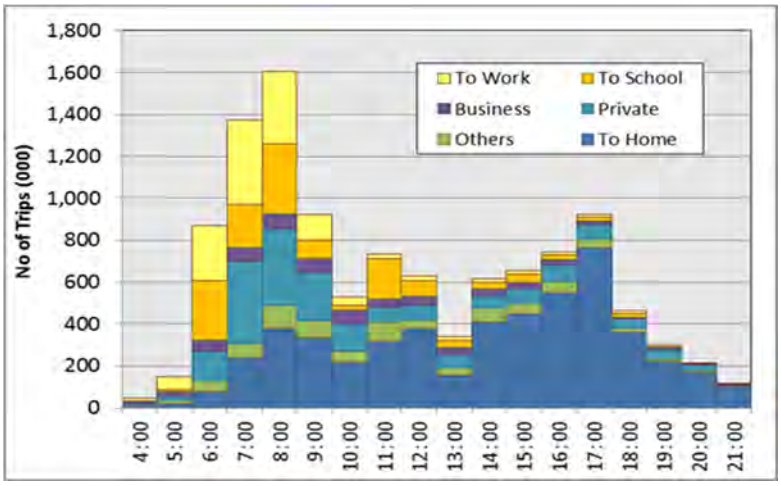
2.43 **Trip Lengths:** The average trip length in 2013 varied by mode. Bus users traveled the longest at 8.4 km, followed by truck bus users[6] (7.3 km), taxi users (6.9 km), and car/van users (5.7 km). Railway users traveled over 10.6 km, while IWT users cruised for 3.2 km. The average travel time for public transport users was about one hour, which can be compared to about 40 minutes for car/taxi users (see Table 2. 3. 3).

Table 2.3.2 Average Travel Length and Travel Time in 2013

Mode			Average Travel Length (km)	Average Travel Time (min)
Walking			0.5	14.1
Road	Private	Bicycle	1.6	17.1
		Motorcycle	3.8	17.2
		Car/Van	5.7	39.5
		Taxi	6.9	42.6
		Truck	7.4	52.5
	Public	Bus	8.4	61.2
		Truck Bus	7.3	52.9
	Subtotal		8.3	60.2
Railway			10.6	69.0
Waterway			3.2	61.1
Total (Excluding Walking)			5.9	44.4
Total			3.5	32.2

Source: YUTRA Person Trip Study (2013)

2.44 **Hourly Distribution of Demand:** In 2013 the peak hour time was from 7:00 to 9:00. Approximately 23% of the daily demand was concentrated during this two-hour period. “To work” and “to school” trips shared the substantial part of the demand (see Figure 2.3.5).



Source: YUTRA Person Trip Study (2013)

Figure 2.3.5 Urban Transport Demand by Hour in 2013

3) Road Traffic Demand

2.45 To capture the changes in traffic demand inside the study area since 2013 and to provide data for the calibration and verification of the traffic demand, a screen line survey was conducted comprising manual classified-traffic counts and vehicle occupancy surveys.

2.46 A summary of the results of the screen line surveys in YUTRA in 2013 and in this study is as follows:

[6] Truck buses were banned by the government in 2014 and replaced with minibuses

(a) **Changes in Road Traffic crossing Hlaing River:** Due to extensive developments of industrial estates and factories on the west side of Hlaing River, traffic across the entire screen line increased by 1.77 times between 2013 and 2016 with an annual average growth rate of 21.0% (numerical growth of 55,928 PCUs). In terms of vehicles, there were 128,470 PCUs in 2016 compared to 72,542 PCUs in 2013. This is shown in the following table.

Table 2.3.3 Traffic Growth across the Hlaing River Screen Line

Vehicle Type	Volume (PCU)		Growth Rate
	2013	2016	2016/2013
Car	11,306	24,358	2.15
Taxi	14,148	35,462	2.51
Small Bus	2,651	4,861	1.83
Large Bus	3,889	4,123	1.06
Light Goods Vehicle (LGV)	27,970	30,415	1.09
Heavy Goods Vehicle (HGV)	12,578	29,251	2.33
Total	72,542	128,470	1.77

Source: Screen Line Survey

(b) **Changes in Road Traffic Demand crossing Bago River:** Between 2013 and 2016, PCU traffic crossing Bago River increased by 1.68 times but in terms of numerical growth, traffic only increased by 16,379 PCUs compared to the increase in the number of vehicles crossing Hlaing River. This was because as of 2016, there were still relatively few developments on the eastern side of Bago River.

Table 2.3.4 Traffic Growth across the Bago River Screen Line

Vehicle Type	Volume (PCU)		Growth Rate
	2013	2016	2016/2013
Car	5,118	10,530	2.06
Taxi	5,059	8,471	1.67
Small Bus	1,179	3,890	3.30
Large Bus	2,734	2,814	1.03
Light Goods Vehicle (LGV)	6,919	8,543	1.23
Heavy Goods Vehicle (HGV)	3,061	6,201	2.03
Total	24,070	40,449	1.68

Source: Screen Line Survey

4) Traffic in Major Intersections

2.47 One of the biggest bottlenecks in Yangon City's road network is the design and operation of the intersections, many of which were already congested during the YUTRA study in 2013. A number of flyovers were being constructed then even without sufficient analysis of the affected intersections. The construction of a couple of the planned flyovers was eventually suspended because the issue of whether or not they could really contribute to network efficiency had not been resolved. The concern then was that traffic queues might just transfer to the at-grade intersection next/ nearest to the flyovers. The locations of constructed flyovers are shown in Table 2. 3. 6 and Figure 2. 3. 6.

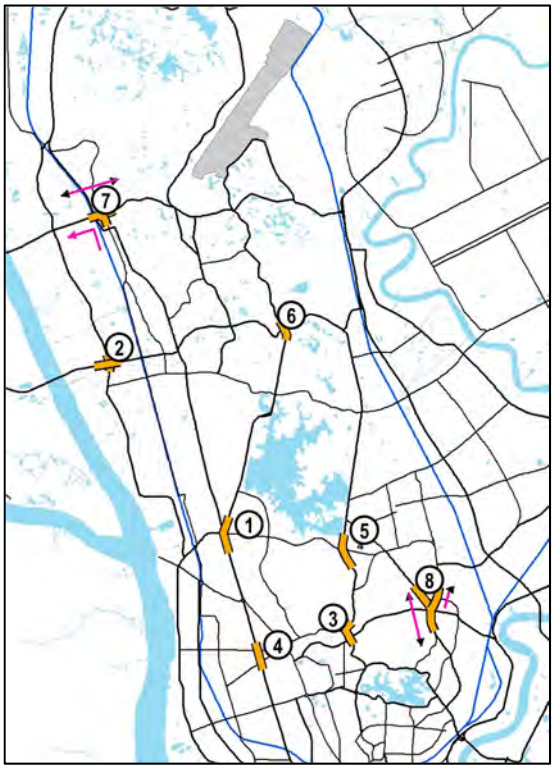
2.48 Based on the results of the survey conducted to assess the effectiveness of Kokkaing Flyover and 8 Mile Flyover, it was concluded that flyovers could increase the overall traffic capacity of intersections and help reduce congestion on the corridor. This implies that flyovers are effective in

some locations, especially where there are major traffic flows, and that flyovers must be provided along the major corridors.

Table 2.3.5 Flyovers in Yangon City

	Flyover	Opening Date
1	Hledan Flyover	April 2013
2	Bayintnaung Flyover	December 2013
3	Shwe Gon Daing Flyover	March 2014
4	Myaynigone Flyover	March 2015
5	Kokkaing Flyover	February 2016
6	8 Mile Flyover	March 2016
7	Insein Flyover	March 2016
8	Tarmwe Flyover	July 2017

Source: Study Team



Source: Study Team

Figure 2.3.6 Flyovers in Yangon City

5) Changes in Road Traffic in the Airport

2.49 The following tables show the growth in road traffic in the airport. Vehicles crossing the airport cordon line, i.e., vehicles entering or exiting the airport, increased by 1.80 times with an annual average growth rate of 21.7%.

(i) At Airport Road (West), the western entry point to Yangon International Airport, taxis showed the highest annual average growth rate, which was 21.7%. This is probably due to the growth in air traffic since 2013 and the increased demand to travel to/from the city by travelers.

(ii) At Airport Road (East), cars and large buses showed the largest annual average growth rates in vehicle traffic. This entry point is primarily used by airport workers and the growth in trips by these vehicle types suggests that an increase in employment at the airport occurred along with the growth in air traffic to Yangon.

Table 2.3.6 Traffic Growth on the Airport Road Cordon Line

Vehicle Type	Volume (PCU)		Growth Rate
	2013	2016	2016/2013
Car	9,775	19,004	1.94
Taxi	10,791	20,451	1.90
Small Bus	336	571	1.70
Large Bus	147	163	1.11
Light Goods Vehicle (LGV)	5,522	7,898	1.43
Heavy Goods Vehicle (HGV)	1,106	1,749	1.58
Total	27,677	49,836	1.80

Source: Cordon Line Survey

6) Volume of External Road Traffic

2.50 In order to gauge the changes in intercity traffic demand between the study area and outer areas since 2013, a cordon line survey was conducted which involved a 24-hour manual classified count for vehicles and a 24-hour roadside origin-destination (OD) interview survey. OD survey results were used to make 2016 OD trip tables.

2.51 Between 2013 and 2016, the total traffic demand on the cordon line increased by 1.2 times.

Table 2.3.7 Road Traffic Growth on the Cordon Line, 2013–2016

Location	Vehicle Type	Volume (PCU)		Growth Rate
		2013	2016	2016/2013
Entire Cordon	Car	7,558	19,996	2.65
	Taxi	2,683	14,427	5.38
	Small Bus	1,240	6,177	4.98
	Large Bus	5,757	7,053	1.23
	Light Goods Vehicle (LGV)	14,284	26,030	1.82
	Heavy Goods Vehicle (HGV)	11,496	19,296	1.68
	Total	43,019	92,979	2.16

Source: 2016 Cordon Line Survey, YUTRA II.

3 TRAFFIC DEMAND FORECAST

3.1 Approach and Methodology

1) Overview of Approach

3.1 The traffic demand analysis approach has been kept simple, as the original YUTRA traffic model was already comprehensive. The approach was based on the use of a transport database which was updated based on the following:

(i) Results of the recent (2014) census to update the socio-economic database;

(ii) Updates on urban development information from recent studies conducted for Greater Yangon including the Strategic Urban Development Plan for Greater Yangon (SUDP) and others;

(iii) Results of supplemental traffic surveys conducted in this study; and

(iv) Update information about ongoing and planned transport projects.

3.2 Regarding the demand forecast methodology, five major tasks were carried out:

(i) Updating of the socio-economic framework for 2016 and forecast years;

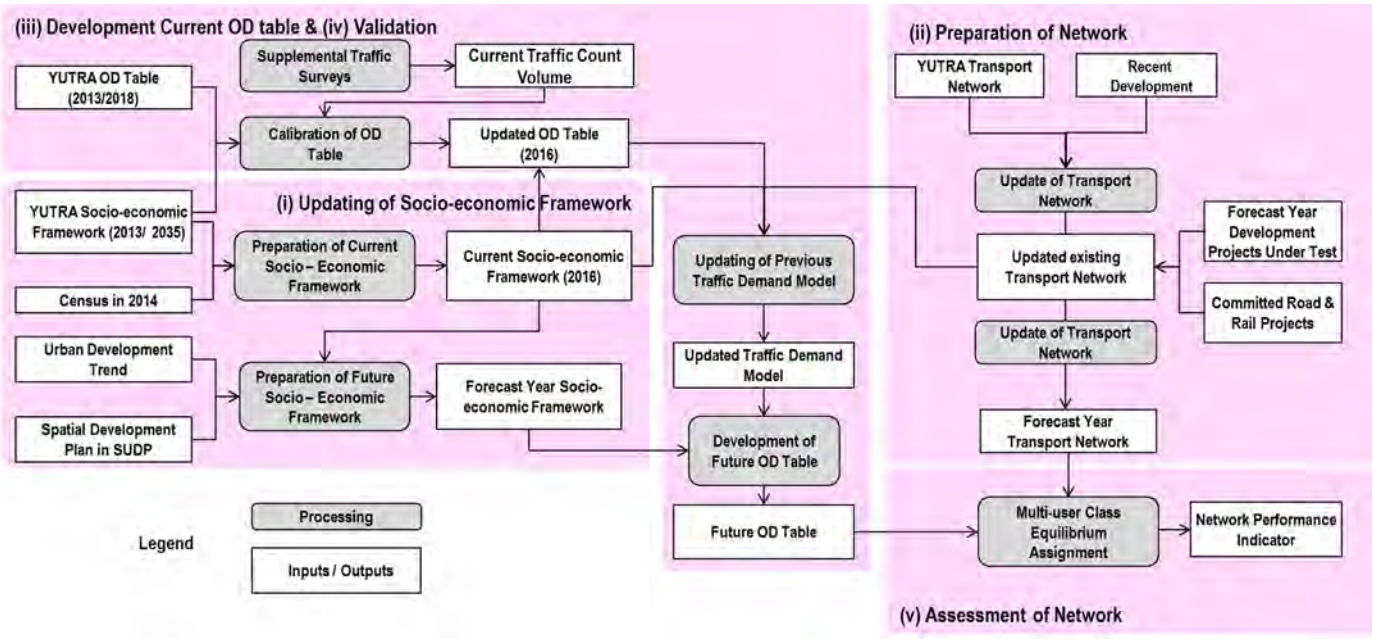
(ii) Preparation and updating of the transport model networks for 2016;

(iii) Development of the initial 2016 OD trip table by mode using the YUTRA 2013 & 2018 synthesized trip tables;

(iv) Analysis of recent traffic survey data and validation of models for the network and trip tables by mode to calibrate the 2016 situation; and

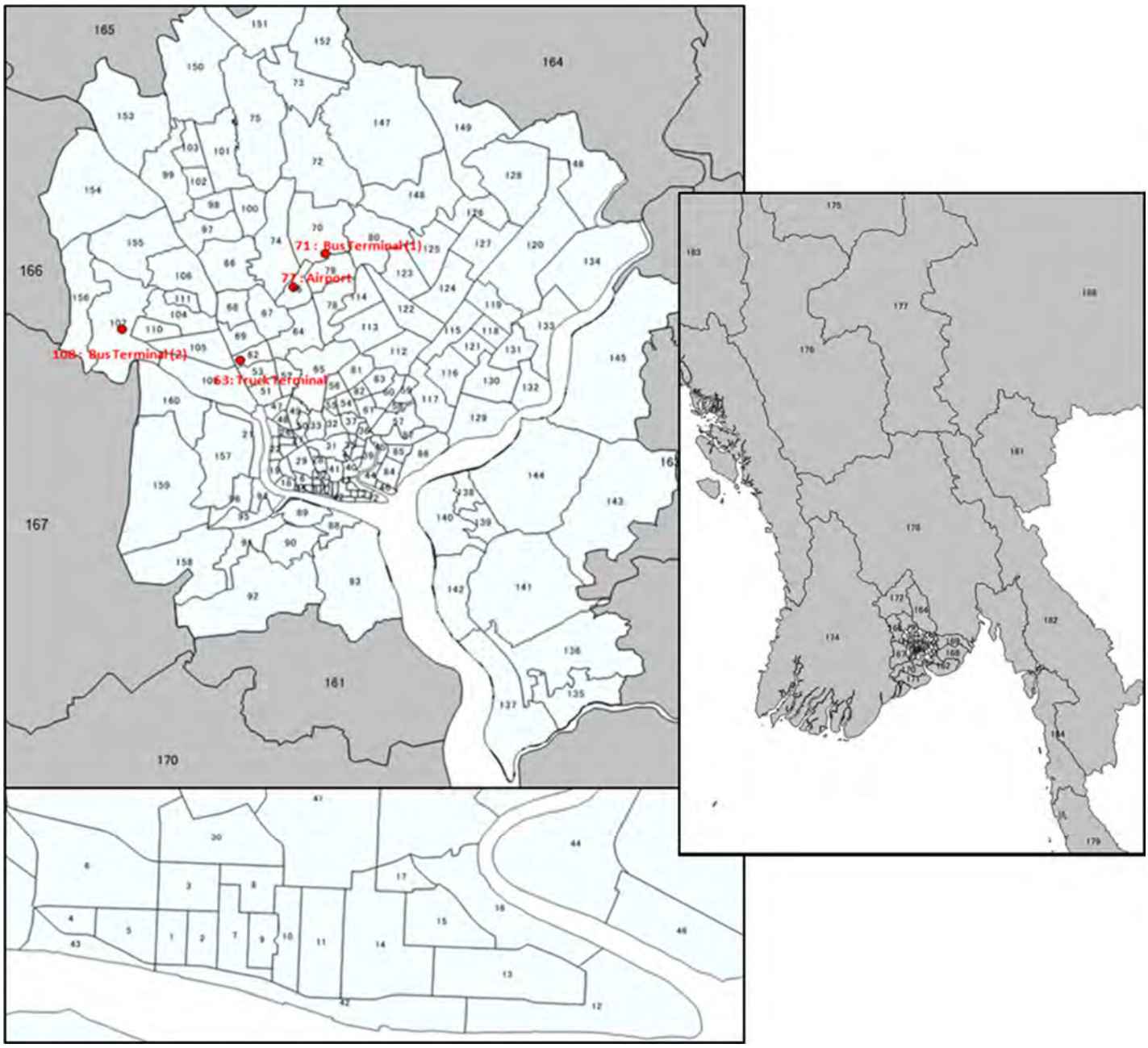
(v) Forecasting of demand and assessment of network to develop and evaluate the master plan.

3.3 The overall approach to update and forecast the demand is shown in Figure 3.1.1. The traffic zone system which was applied in the analysis was the same one used in the 2013 YUTRA.



Source: Study Team

Figure 3.1.1 Flowchart for Updating Demand Analysis

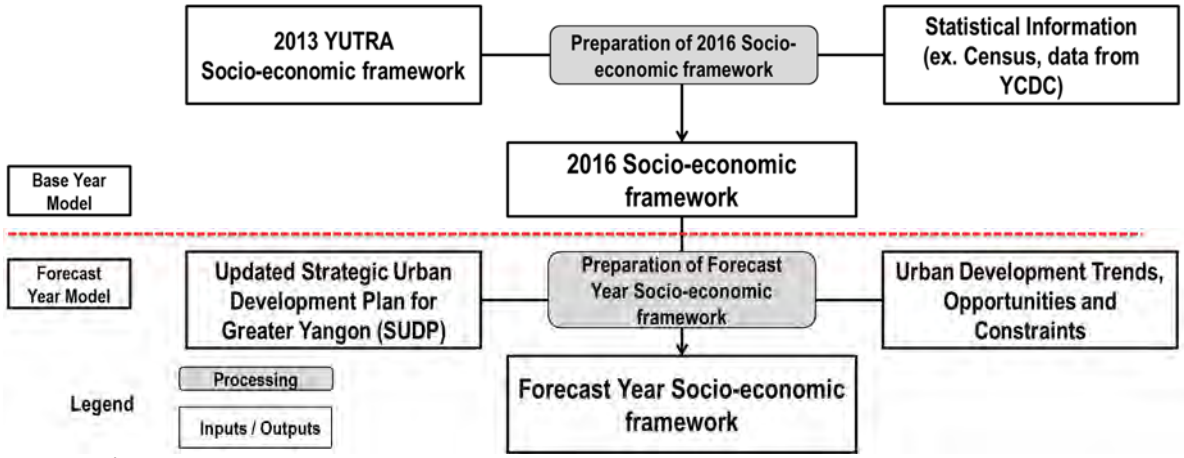


Source: Study Team

Figure 3.1.2 Traffic Zones in the Study Area

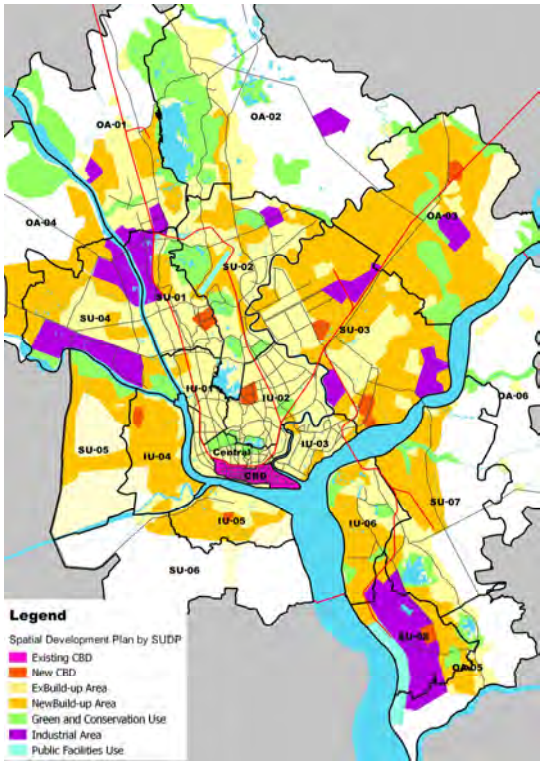
2) Update of Socio-economic Framework

3.4 The development of the future socio-economic framework comprised of two parts, as shown in Figure 3.1.3. The first part is developing the socio-economic baseline (2016) which was done by updating the 2013 YUTRA data using the 2014 census results, then projecting the results to 2016 using 1999 and other historical census data. The second part was forecasting the target-year socioeconomic framework based on the updated SUDP, reviewing ongoing and committed projects, and identifying urban development constraints.



Source: Study Team

Figure 3.1.3 Updating the Base-year (2016) and Forecasting the 2035 Socio-economic Framework



CBD
Latha, Lanmadaw, Panbetan, Kyauktada, Botataung, Pazundaung

Central Cluster
Alone, part of Kyeemyindaing, Dagon, Mingalar Taung Nyunt, Seikkan

Inner Cluster
IU-01 Inner North West: San Chaung, Kamayut, Hlaing
IU-02 Inner North: Bahan, Tarmwe, Yankin, Thingankyun, South Okkalapa
IU-03 Inner East: Dawpon, Tharkayta
IU-04 Inner South West: part of Kyeemyindaing, Seikgyikanaungto, part of Twantay
IU-05 Inner South: part of Dala
IU-06 Inner East: Thanlyin

Outer Cluster
SU-01 Outer North West: part of Mayangone, Insein
SU-02 Outer North: part of Mayangone, part of Mingalardon, North Okkalapa
SU-03 Outer North East: North Dagon, South Dagon, parts of East Dagon and Dagon Seikkan
SU-04 Outer West: Hlaingtaryar
SU-05 Outer South West: part of Twantay
SU-06 Outer South: parts of Dala and Twantay
SU-07 Outer East: part of Thanlyin
SU-08 Outer South East (Thilawa): Kyauktan, part of Tanlyin

Far Outer Cluster
OA-01 Far Outer North West: Shwepyitar, part of Hmawbi
OA-02 Far Outer North: part of Mingaladon, Hlegu, part of Hmawbi
OA-03 Far Outer North East: parts of East Dagon and Dagon Seikkan
OA-04 Far Outer West: Htantabin
OA-05 Far Outer South East: part of Kyauktan
OA-06 Far Outer East: part of Thanlyin

Source: Study Team

Figure 3.1.4 Proposed Land Use in SUDP (2035) and Locations of Urban Clusters

3.5 The key drivers of traffic demand on an existing or a proposed network are socio-economic factors such as: population, employment, vehicle ownership, GDP growth, changes in travel patterns, and the shift to/from other competing/ complementary modes. In addition, specific developments, such as a new port, special economic zones (SEZs), or the relocation of other similar special traffic generators, could impact traffic demand.

3.6 The socio-economic framework developed by the SUDP study was based on the likely future land use, distribution of population, employment, and development of new sub-centers and SEZs in Greater Yangon. The future land use is depicted in Figure 3.1.4, while the corresponding population distribution is summarized in Table 3.1.1. The population is expected to grow substantially over the next two decades to about 9.5 million inhabitants. The areas expected to post the highest growth would be the outer and new suburbs. Populations in the CBD and the city center are likely to decline as these areas are already fairly saturated.

Table 3.1.1 Current and Forecast Population

No.	Area Description	2016 Population ('000)	2035 Population ('000)	Growth (2035/2016)	Average Annual Growth Ratio (%)
1	CBD	222	196	0.9	-0.7
2	Central Cluster	321	342	1.1	0.3
3	Inner Urban Cluster	1,713	1,990	1.2	0.8
4	Outer Cluster	2,951	4,708	1.6	2.5
5	Far Outer Cluster	981	2,258	2.3	4.5
Total of Greater Yangon		6,188	9,495	1.5	2.3

Source: JICA SUDP study forecast.

3.7 The economic growth in Greater Yangon was forecast in the YUTRA study, and it shows a healthy growth. The economy will grow by more than 4.7 times from the 2016 level by 2035 (see Table 3.1. 2). Such economic growth would increase the GRDP/capita to over USD7,500 per annum. It has been proven that there is a direct correlation between increase in incomes and growth in car ownership in growing economies. Models derived from the 2013 Household Interview Survey (HIS) data predict that car ownership would increase from around 10–15 cars per one thousand population to about 35 cars.

Table 3.1.2 GRDP Growth Rates, 2016–2035

Year	Average Annual Growth Ratio (%)	Factor (Base=2016)
2016	-	1.00
2020	9.10	1.42
2025	8.40	2.12
2030	8.30	3.16
2035	8.30	4.71

Source: YUTRA Forecast

3.8 Other changes in the socio-economic characteristics of the study area population which would impact the growth in travel demand are summarized in Table 3.1.3.

Table 3.1.3 Key Traffic Growth Variables in 2016 and 2035

Description	2016	2035	% AAGR
Population in Full-time Employment ('000)	2,595	5,796	4.3
Population in Full-time Student ('000)	1,566	2,498	2.5
Employment Participation Rate (Emp./Pop.)	0.42	0.61	2.0
Vehicle Ownership (% of Households.)	15	35	4.6

Note: Estimated by the JICA Study Team

3.9 The increase in population, GRDP, and the effect of other socio-economic indicators would lead to a growth in trip numbers as more available vehicles naturally lead to more trips per capita.

3.10 These factors were used in the travel demand 'Trip End' model to estimate the future number of trips by both private and public modes. Similarly, there would be an increase in goods vehicle trips. The trip ends estimated were distributed using the 'Furness' process to present the total demand in OD matrices by mode.

Table 3.1.4 Day-time Population in 2035

Area			Day-time Population (000)	No. of Employees in Workplaces				No. of Students in School				
				Primary	Secondary	Tertiary	Total	Primary	Secondary	Highschool	Higher	Total
CBD			511	0	38	398	436	10	10	18	25	63
Central			523	0	30	358	388	17	19	22	35	92
Inner Cluster	IU-01	Inner North West	447	0	32	295	328	17	19	23	25	85
	IU-02	Inner North	804	0	57	486	542	34	38	54	47	173
	IU-03	Inner East	325	0	36	180	216	14	16	19	9	59
	IU-04	Inner South West	226	2	6	118	126	12	13	16	24	65
	IU-05	Inner South	283	1	15	131	146	12	12	25	33	82
	IU-06	Inner South East	153	0	5	43	48	12	13	10	10	45
	Total		2,238	4	151	1,253	1,407	100	111	149	148	508
Outer Cluster	SU-01	Outer North West	481	3	94	197	295	24	27	23	41	116
	SU-02	Outer North	774	8	115	306	429	41	46	55	87	228
	SU-03	Outer North East	1,440	0	81	671	752	77	86	105	195	463
	SU-04	Outer West	772	0	167	268	435	54	60	54	71	239
	SU-05	Outer South West	103	7	13	47	67	6	6	6	4	22
	SU-06	Outer South	88	0	5	47	52	4	5	6	3	19
	SU-08	Outer South East (Thilawa)	253	1	79	51	132	10	11	19	48	89
	SU-07	Outer East	409	7	94	135	236	18	20	32	68	138
	Total		4,322	27	648	1,724	2,399	234	261	301	518	1,314
Far Outer Cluster	OA-01	Far Outer North West	746	28	233	146	407	44	49	45	34	172
	OA-02	Far Outer North	560	34	157	175	366	34	38	30	26	127
	OA-03	Far Outer North East	447	31	77	133	240	20	22	17	108	167
	OA-04	Far Outer West	121	21	25	30	76	7	8	6	5	27
	OA-05	Far Outer South East	60	4	14	25	43	3	4	4	3	13
	OA-06	Far Outer East	60	11	11	12	35	4	5	3	2	15
	Total		1,995	129	517	520	1,166	112	125	106	177	521
Greater Yangon Total			9,589	159	1,384	4,253	5,796	474	526	595	902	2,498

Source: the Study Team

Table 3.1.5 Night-time Population in 2035

Area			Night-time Population (000)	No. of Employees in Workplaces				No. of Students in Schools				
				Primary	Secondary	Tertiary	Total	Primary	Secondary	Highschool	Higher	Total
CBD			196	0	13	114	126	10	10	12	25	57
Central			342	0	20	179	199	17	19	22	43	101
Inner Cluster	IU-01	Inner North West	347	0	27	197	224	17	19	23	29	89
	IU-02	Inner North	678	0	47	347	394	34	37	45	78	195
	IU-03	Inner East	290	0	30	138	169	15	16	19	21	71
	IU-04	Inner South West	209	2	12	107	122	10	11	11	20	53
	IU-05	Inner South	234	2	10	109	121	12	12	12	22	58
	IU-06	Inner South East	232	0	12	108	120	12	13	13	15	52
	Inner Cluster Total		1,990	5	138	1,006	1,149	100	109	124	185	518
Outer Cluster	SU-01	Outer North West	492	3	86	197	286	25	27	33	52	136
	SU-02	Outer North	824	10	96	374	479	41	45	55	87	228
	SU-03	Outer North East	1,546	0	90	809	899	77	85	97	162	422
	SU-04	Outer West	1,077	0	209	487	696	54	59	68	102	283
	SU-05	Outer South West	114	4	22	47	74	6	6	7	7	26
	SU-06	Outer South	90	1	4	47	52	5	5	6	6	21
	SU-08	Outer South East (Thilawa)	205	2	66	51	119	10	11	13	19	54
	SU-07	Outer East	359	5	104	123	232	18	20	20	34	92
	Total		4,708	25	677	2,136	2,837	235	259	299	469	1,262
Far Outer Cluster	OA-01	Far Outer North West	890	41	233	243	518	45	49	56	56	206
	OA-02	Far Outer North	677	44	175	219	437	34	37	38	64	173
	OA-03	Far Outer North East	395	13	77	166	255	20	22	25	33	100
	OA-04	Far Outer West	144	14	42	37	93	7	8	8	9	32
	OA-05	Far Outer South East	67	2	14	31	47	3	4	4	4	15
	OA-06	Far Outer East	86	17	14	25	55	4	5	5	5	19
	Total		2,258	131	554	720	1,405	113	124	135	172	544
Greater Yangon Total			9,495	161	1,402	4,155	5,717	475	521	593	894	2,482

Source: the Study Team

Table 3.1.6 Day-Night Population Ratio in 2035

Area			Population	No. of Employees in Workplaces				No. of Students in Schools				
				Primary	Secondary	Tertiary	Total	Primary	Secondary	Highschool	Higher	Total
CBD			2.6	n/a	3.0	3.5	3.5	1.0	1.0	1.5	1.0	1.1
Central			1.5	n/a	1.5	2.0	2.0	1.0	1.0	1.0	0.8	0.9
Inner Cluster	IU-01	Inner North West	1.3	n/a	1.2	1.5	1.5	1.0	1.0	1.0	0.9	1.0
	IU-02	Inner North	1.2	n/a	1.2	1.4	1.4	1.0	1.0	1.2	0.6	0.9
	IU-03	Inner East	1.1	n/a	1.2	1.3	1.3	1.0	1.0	1.0	0.4	0.8
	IU-04	Inner South West	1.1	1.0	0.5	1.1	1.0	1.1	1.1	1.5	1.2	1.2
	IU-05	Inner South	1.2	0.5	1.5	1.2	1.2	1.0	1.0	2.0	1.5	1.4
	IU-06	Inner South East	0.7	n/a	0.4	0.4	0.4	1.0	1.0	0.8	0.7	0.9
	Total		1.1	0.8	1.1	1.2	1.2	1.0	1.0	1.2	0.8	1.0
Outer Cluster	SU-01	Outer North West	1.0	1.2	1.1	1.0	1.0	1.0	1.0	0.7	0.8	0.9
	SU-02	Outer North	0.9	0.8	1.2	0.8	0.9	1.0	1.0	1.0	1.0	1.0
	SU-03	Outer North East	0.9	n/a	0.9	0.8	0.8	1.0	1.0	1.1	1.2	1.1
	SU-04	Outer West	0.7	n/a	0.8	0.6	0.6	1.0	1.0	0.8	0.7	0.8
	SU-05	Outer South West	0.9	1.6	0.6	1.0	0.9	1.0	1.0	0.8	0.6	0.8
	SU-06	Outer South	1.0	0.0	1.2	1.0	1.0	1.0	1.0	1.0	0.6	0.9
	SU-08	Outer South East (Thilawa)	1.2	0.6	1.2	1.0	1.1	1.0	1.0	1.5	2.5	1.7
	SU-07	Outer East	1.1	1.5	0.9	1.1	1.0	1.0	1.0	1.6	2.0	1.5
	Total		0.9	1.1	1.0	0.8	0.8	1.0	1.0	1.0	1.1	1.0
Far Outer Cluster	OA-01	Far Outer North West	0.8	0.7	1.0	0.6	0.8	1.0	1.0	0.8	0.6	0.8
	OA-02	Far Outer North	0.8	0.8	0.9	0.8	0.8	1.0	1.0	0.8	0.4	0.7
	OA-03	Far Outer North East	1.1	2.4	1.0	0.8	0.9	1.0	1.0	0.7	3.3	1.7
	OA-04	Far Outer West	0.8	1.5	0.6	0.8	0.8	1.0	1.0	0.8	0.6	0.8
	OA-05	Far Outer South East	0.9	1.6	1.0	0.8	0.9	1.0	1.0	1.0	0.6	0.9
	OA-06	Far Outer East	0.7	0.7	0.8	0.5	0.6	1.0	1.0	0.7	0.4	0.8
	Total		0.9	1.0	0.9	0.7	0.8	1.0	1.0	0.8	1.0	1.0
Greater Yangon Total			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Source: the Study Team

3) Update of the Transport Network

3.11 The transport network for 2016 was developed by updating the 2013 YUTRA's highway network. The updates consisted of the following:

(i) Flyovers developed since 2013;

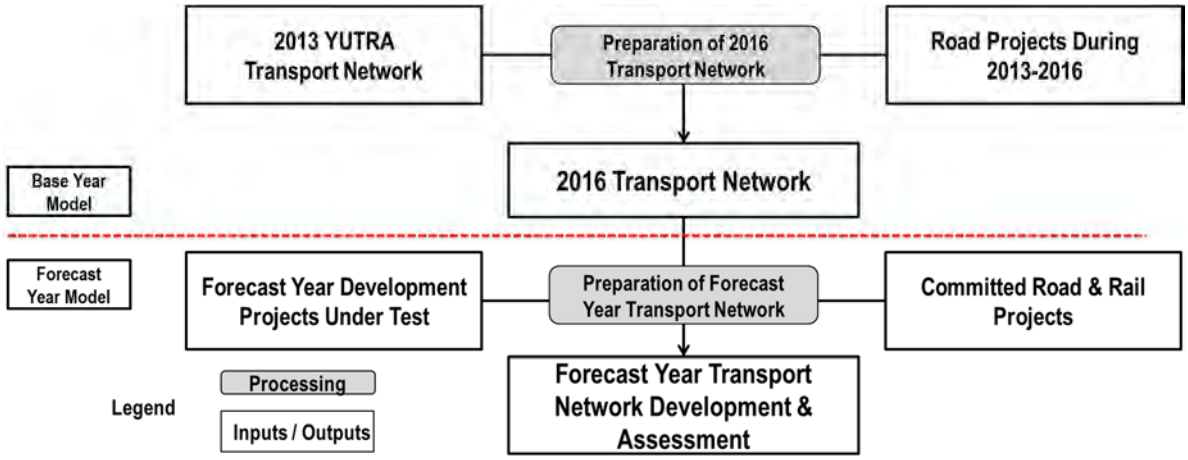
(ii) A new toll bridge across the Hlaing River;

(iii) Updated road network including all bridges and paved road crossings on the Yangon Circular Railway (YCR); and

(iv) Adjustments of road capacities and speeds where road widening has taken place.

3.12 In the case of the rail network, no modifications were made to the 2013 network because there had been no upgrading of any line to date.

3.13 The forecast 2035 transport network was based on the validated 2016 network, appropriate scenarios currently under consideration, and committed road and rail projects. The process is depicted in Figure 3.1.5.



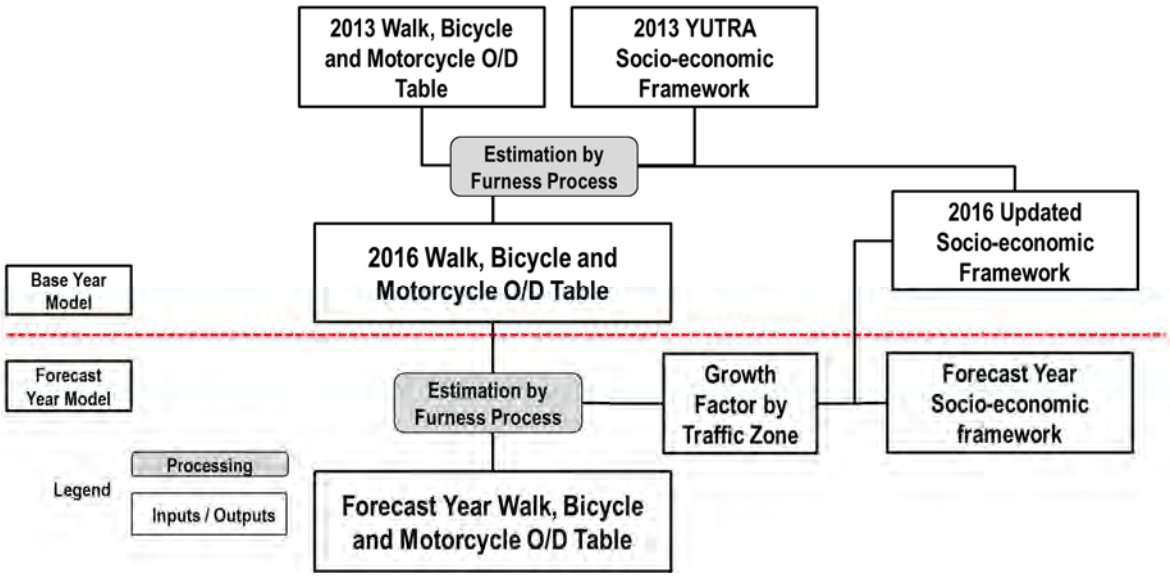
Source: Study Team

Figure 3.1.5 Updating the Base-year (2016) and Forecasting the 2035 Transport Network

4) Development of the Initial 2016 OD Trip Matrices

3.14 The initial 2016 OD tables were estimated by interpolating the YUTRA's 2013 and 2018 synthesized trip tables for the four main modes of travel: (i) car, (ii) taxi, (iii) bus and rail, and (iv) goods vehicles.

3.15 OD trip tables for 2016 for motorcycles (which are banned in most of the Yangon area) and the remaining non-motorized modes (walk and bicycle) were estimated using changes in the socio-economic framework between 2013 and 2016. This process is shown in Figure 3.1.6.



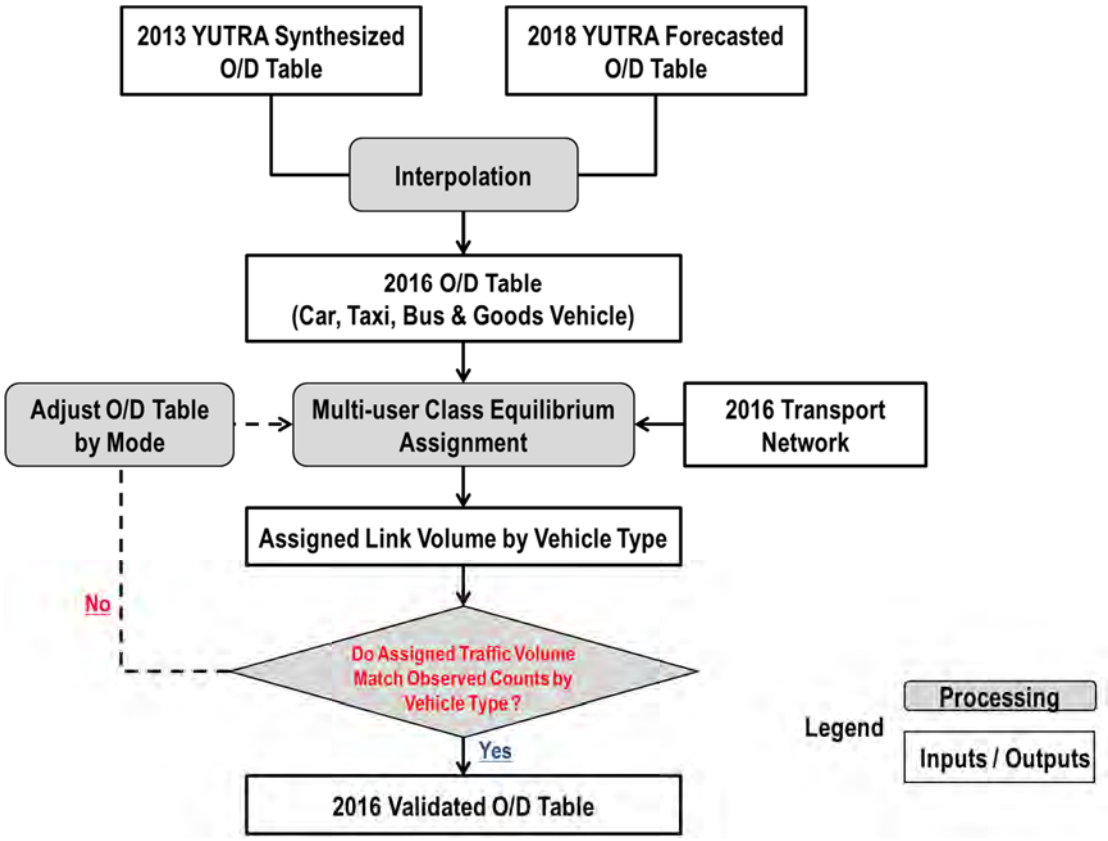
Source: Study Team

Figure 3.1.6 Updating the Base-year (2016) and Forecasting the 2035 Trip Matrices (Walk, Bicycle, and Motorcycle)

5) Methodology for Validating Base-year (2016) Model

3.16 The validation of the base-year model was carried out by comparing the assigned traffic volume against the observed traffic data. The initial OD trip tables for each mode were assigned to the updated network using the traffic assignment model. The results, i.e., the assigned traffic volumes, were then compared with the observed traffic counts across the study area's screen and cordon lines.

3.17 The OD trip tables for each mode were then adjusted for area-to-area movements across the screen or cordon line accordingly and traffic was assigned to the network. The OD table adjustment and traffic assignment were repeated until the assigned traffic volumes were within +/- 10% of the observed counts, at which stage the model was then considered valid. The final iteration of the OD trip matrices was deemed as the validated 2016 travel demand. This process is illustrated in Figure 3.1.7.



Source: Study Team

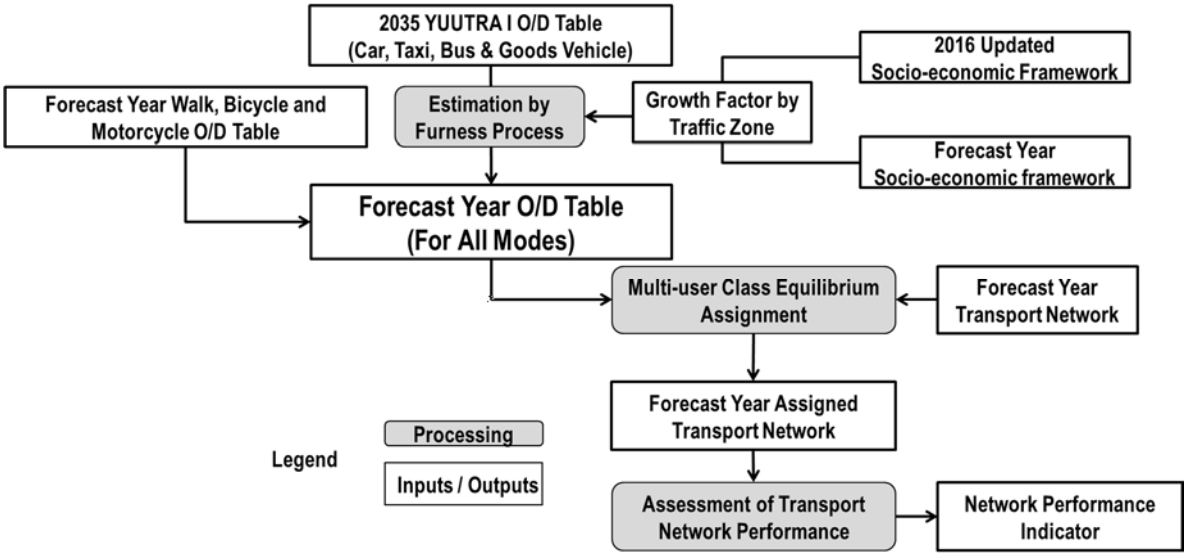
Figure 3.1.7 Validating the Base-year (2016) Model

6) Methodology for Estimating Forecast-year Model

3.18 The forecast-year demand was estimated using the YUTRA's 2035 synthesized OD tables and the ratio of the target-year to base-year socio-economic indicators. Using the Furness procedure, the base-year OD trip matrices were then used to yield the forecast-year OD trip tables.

3.19 The future network was developed to include target-year transport projects and development program(s). The future-year OD matrices were assigned to the network scenario. The assigned volumes were then analyzed in terms of network capacity, project viability, and project prioritization.

3.20 The above-mentioned analysis involves estimating the economic viability of a project or that of the whole network. The economic impacts are estimated in terms of time savings and savings in vehicle operating costs. In addition, network operational performance could be assessed by analyzing the link or area-based network speed and volume-capacity ratio (V/C Ratio). These indicators provide information on network capacity deficiencies and levels of service. This process is illustrated in Figure 3.1.8.



Source: Study Team

Figure 3.1.8 Forecast-year Demand Modelling

7) Travel Demand Characteristics

(1) Traffic Analysis Zones in the Study Area

3.21 The study area comprised of the entire area under the jurisdiction of the Yangon City Development Committee (YCDC) and parts of the adjoining townships which compose Greater Yangon. This area is referred to as the inner study area. For demand modelling, this area was divided into 154 traffic analysis zones. Meanwhile, special traffic generators, such as the Yangon International Airport, Yangon Port, two Yangon bus terminals, and the existing freight terminal, were represented by six zones.

3.22 The areas beyond the inner study area were represented by 25 zones, and three additional dummy zones were included to represent the future airport, port, and freight terminal. Table 3.1.7 summarizes the zones.

Table 3.1.7 Traffic Zones in the Study Area and Comparison with YUTRA

Area	No. of Townships	Number of Traffic Zones	
		Updated	YUTRA
YCDC Area	32	122	122
Special Generators in YCDC Area	-	6	6
Adjoining Townships (or parts of	7	32	32
Subtotal	39	160	160
Outer Areas (Rest of Myanmar)	-	25	25
Proposed Truck Terminal	-	1	1
Proposed Port @ Thilawa	-	1	1
Proposed Airport @ Hanthawaddy	-	1	-
Total	39	188	187

Source: Study Team

(2) Characteristics of the Base-year Transport Network

3.23 The base-year (2016) transport network was developed from the YUTRA study area network and included the recently built eight (8) flyovers in Yangon City. In addition, all roads, bridges, and paved level crossings which cross the YCR were included in the network. The key characteristics of the two networks are shown in Table 3.1.8.

3.24 The level of detail of the network was based on the area, i.e., in the inner areas the network includes all primary roads and most connecting secondary roads. In cases where the zone size is small (e.g., CBD and old inner areas), local roads were also included in the highway network but are treated as secondary roads.

3.25 Outside the CBD and within the study area, all major intercity national roads are included in the network. Secondary roads of strategic importance (i.e., those that link key conurbations to primary/national roads) and those which could become primary roads once the surrounding areas are developed, are likewise included.

3.26 The rail network included the four main railway lines in Myanmar. The main intercity lines like Yangon–Mandalay and Pyay lines were included up to the last station which lies inside the Greater Yangon boundary. The three spur lines to universities are included as part of the main lines.

3.27 The main ferry service between Yangon and Dala area was also included in the network.

Table 3.1.8 Characteristics of Road and Rail Network in the Study Area

Description	CBD Area (km)	Rest of YCDC (km)	Rest of Greater Yangon (km)	Total (km)
Primary Roads	22	329	104	455
Secondary / Local Roads	16	351	84	451
Total Road Length	38	680	188	906
Railway Network within Greater Yangon				
Line/ System	Length (km)		No. of Stations	
Yangon Circular Railway (YCR)	46.1		38	
Pyay Line	22.4		7	
Yangon Mandalay Line	42.4		8	
Thilawa Line	31.7		6	
Total Study Area Railway Network	142.6		59	

Source: Study Team

3.28 Table 3.1.9 summarizes the road network capacities and associated maximum (free flow) speeds. The road capacities were adopted from the YUTRA model and adjusted where appropriate. The quoted road capacity is daily, which is 10 times the hourly capacity for each road type. Future road capacities and free-flow speed will be based on the same table. Capacities and free flow speeds of planned expressways are also shown in the table.

Table 3.1.9 Road Network Capacities and Maximum Speeds by Location and Road Type

Location	Road Type	No. of Lanes	Daily Capacity (PCU)	Max. Speed (km/h)	Road Length (km)
1. CBD	Secondary	1	2,200	40	2.2
		2	7,600	40	13.8
	Primary	1	4,500	45	0.4
		2	10,000	45	13.9
		3	15,000	45	5.0
		4	20,000	45	11.9
2. Townships 7-13,15-21,24,25	Secondary	1	5,800	45	33.4
		2	13,600	45	70.7
	Primary	1	7,200	50	8.0
		2	16,800	50	91.6
		3	25,200	50	54.4
		4	25,200	50	1.8
3. Townships 22,23,26-39	Secondary	1	8,300	50	245.3
		2	17,600	50	82.8
	Primary	1	9,900	60	90.0
		2	21,000	60	136.7
		3	31,500	60	19.4
4. Bridge	Bridge	1	13,800	45	6.9
		2	30,000	60	5.1
		3	45,000	60	7.3
5. Flyovers	Flyovers	2	30,000	60	5.4
6. Urban/Intercity (Ramps)	Access	1	15,000	60	-
7. Urban/Intercity	Expressway	2	40,000	100	-
		3	60,000	100	-
		4	80,000	100	-
Total					905.9

Source: Study Team

(3) Traffic Assignment Model Parameters

3.29 All passenger OD trip tables were converted to vehicle trips by applying average weekday vehicle occupancy factors. These occupancy factors were derived from recent traffic surveys. These values are given below in Table 3.1.10. Vehicle trip matrices were then converted to a common unit for traffic assignment model. The assignment model assigns traffic in a common unit, i.e., equivalent PCU, or more commonly known as the PCU factor. The railway assignment parameters are detailed in Table 3.1.11.

Table 3.1.10 Assignment Model Parameters for Roads, 2016

Parameter	Bicycle	MC	Car	Taxi	Bus[1)]	Truck[1)]
Average 24-hour Occupancy (Person)	1.14	1.76	2.5	2.5	40.0*	n/a
PCU Factor	0.20	0.25	1.0	1.0	1.89*	1.64*
Fare (MMK/km)	n/a	n/a	n/a	260	18.5	n/a
Value of Time (MMK/min/person)	11.6	11.0	26.9	21.0	13.5	n/a

Source: Study Team
1) For bus and goods vehicles, weighted average occupancy and PCU factor for the study area are reported.

Table 3.1.11 Assignment Model Parameters for Railway, 2016

Parameter	YCR	Pyay	Mandalay	Thilawa
Average Hourly Headway of Each Line (min)	30	30	30	30
Average Speed (km/h)	16	20	25	16

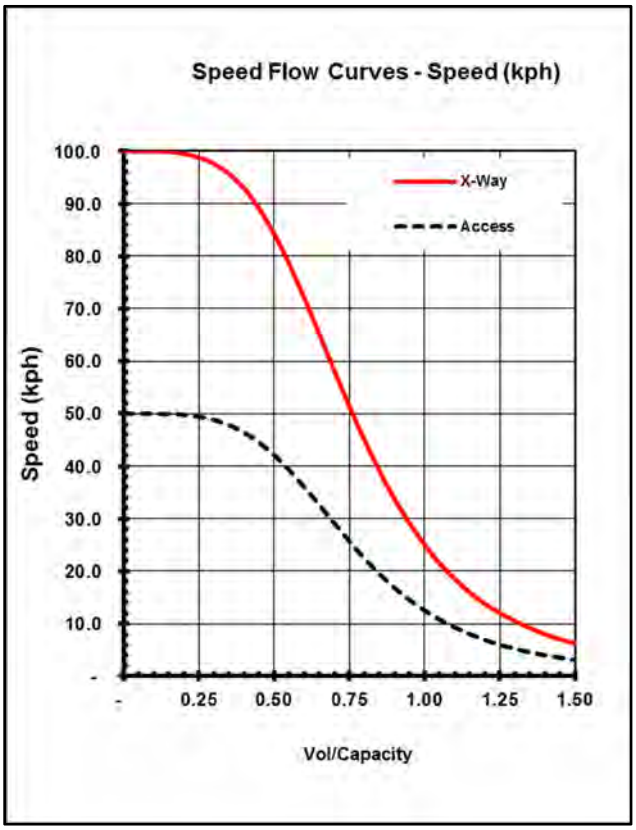
Source: Study Team

(4) Traffic Assignment Process

3.30 The combined road and rail network traffic model was used to assign the OD table. The assignment process used is based on a well-known 'multi-user class equilibrium' method, where the traffic from each OD pair is assigned iteratively to the network until no cheaper or quicker route could be found.

3.31 The shortest-path building was based on the generalized cost of travel for private mode, and public transport fares and wait & walk times were represented for the public modes according to the service on each line. The equilibrium method re-calculates the new travel time based on the road capacity and assigned traffic volume after each assignment iteration. As travel speed slows down with the addition of more traffic after each successive iteration, the assignment process calculates new routes and adds more traffic to the network.

3.32 The curve illustrates how speed decreases with an increase in traffic volume (see Figure 3.1.7). Two curves are shown as an example. In the assignment model, each road link is defined from the coded free-flow speed and its associated road capacity. In the assignment process, speed is computed for each road link after each iteration, depending on the total assigned traffic volume.



BPR function

Where,

$$t = t_0\left\{1 + \alpha\left(\frac{x}{c}\right)^{\beta}\right\}$$

$\alpha = 3.0, \beta = 4.0$

t	: Travel time
t_0	: Free flow time
X	: Traffic volume
C	: Road capacity
α, β	: Calibrated Parameter for Yangon

Source: Consultants' application of BPR formulation to Yangon traffic model highway network assignment

Figure 3.1.9 Speed–Flow Relationship (Highway Assignment)

3.2 Traffic Demand Forecast for 2035

1) Demand by Mode

3.33 The 2016 validated travel demand OD trip matrices were prepared during the traffic model validation. These OD tables reflect the current / recent situation when compared with the 2016 traffic counts. The forecasts for 2035 were estimated using the 2016 OD tables and 2035 trip ends derived using the socio-economic framework. All modes of travel, including walk, trips by bicycle and motorcycle, are forecast independently from other modes, i.e., car, taxi, bus and goods vehicles (GV). Of interest to this study were the trips by motorized modes excluding walk, bicycle, and motorcycle.

3.34 Trips by bicycle are usually short and localized. The share of bicycle trips is declining as the motorized modes become more popular and dominant. In 2016 bicycle trips accounted for less than 10% of the total trips and are likely to decline to about 6% of the travel demand by 2035. Trips by motorcycle, which are banned in major urbanized parts of the YCDC are a small proportion of total travel demand (less than 3%) and are expected to decline further to under 3% of the total trips by 2035. Therefore, a further analysis of bicycle and motorcycle trips is not provided anymore.

3.35 The growth in travel demand by dominant travel modes from 2016 to 2035 is compared in Table 3.2.1. It is demonstrably clear that car trips would increase at much higher rates than those of taxis, and mostly at the expense of public transport. However, public transport trips are likely to more than double by 2035. This shows that the need for travel would more than double (2.4 times) from 2016 to 2035, and the rate of increase is estimated to be over 4.6% per annum, which is almost double the growth in population.

Table 3.2.1 2016 and 2035 OD Person Trips by Mode

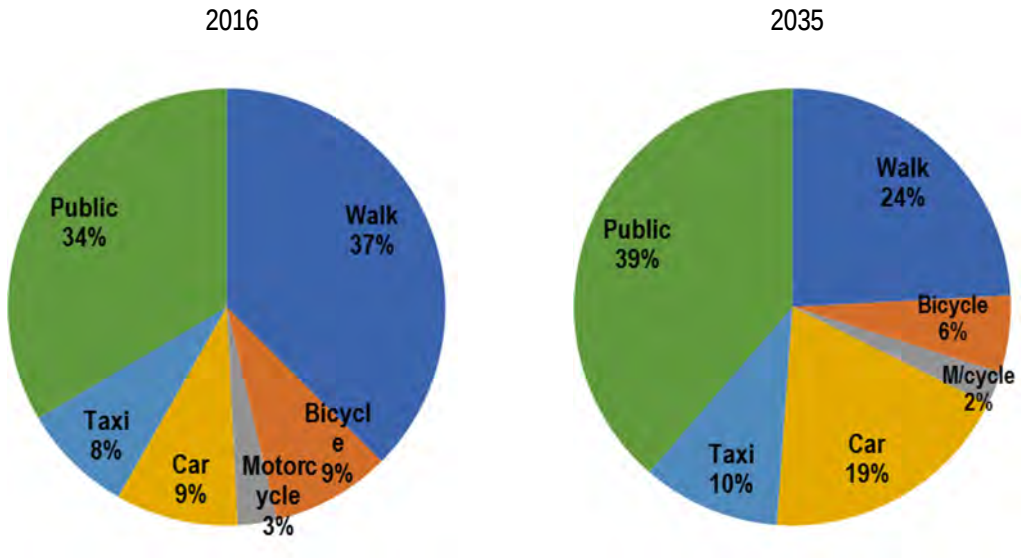
No.	Travel Mode	Validated 2016 OD Person Trips ('000)	2016 Mode Share (%)		Forecast 2035 OD Person Trips ('000)	2035 Mode Share (%)		Person Trip Growth (2035 / 2016)	AAGR in Person Trips (%)
			Total	4+ Wheel		Total	4+ Wheel		
1	Walk	4,624	37.5	-	5,375	24.2	-	1.16	0.8
2	Bicycle	1,091	8.8	-	1,268	5.7	-	1.16	0.8
3	Motorcycle	357	2.9	-	550	2.5	-	1.54	2.3
4	Car	1,118	9.1	17.8	4,186	18.8	27.8	3.75	7.2
5	Taxi	1,019	8.3	16.3	2,280	10.2	15.1	2.24	4.3
6	Public	4,132	33.5	65.9	8,591	38.6	57.1	2.08	3.7
4-6	4+ Wheel Modes	6,269	51	100	15,057	51	100	2.40	4.7
1-6	Total	12,339	100	-	22,250	100	-	1.80	3.2

Sources: Study Team

3.36 Changes in the share of all modes between the base year of 2016 and the forecast year of 2035 are illustrated in Figure 3.2.1. The share of walk, bicycle, and motorcycle trips would decline, with walk trips having the biggest decline. In Asia, as societies get richer, the tendency to walk declines. It is considered to be the mode of poor population, who tend to reside near workplaces for lack of resources to travel, even by bus. Car share would almost double, with a small increase in taxi trips.

3.37 Public transport is expected to increase, somewhat at the expense of walk trips. The expected increase in public transport share is also greater than the growth in population. This should be considered a blessing when compared with other Southeast Asian cities like Hanoi or HCMC where

motorcycles have swamped the cities and the share of public transport is very limited, despite massive investments in public transport.



Sources: Study Team

Figure 3.2.1 Mode Shares in the Base and Forecast Years

3.38 Trips by goods vehicles (GVs) are modelled as a separate category due to their nature, i.e., collection and delivery of goods, and the physical distribution of goods in the city. For a like-with-like comparison and for modelling road traffic, trips by all modes and by different sizes of goods vehicles were converted to PCU, where a 'standard' 4-wheel car is equivalent to 1.0 unit.

3.39 Table 3.2.2 below illustrates the 2016 and 2035 traffic in PCU trips for the four main modes (& Motorcycle) of road traffic in Yangon. Vehicle occupancies were observed during the recent traffic surveys and the PCU factors were sourced from the YUTRA study and compared with the factors used in similar cities in the southeast Asia region. Trips by all types/ sizes of goods vehicles were then added to form a single OD trip matrix in PCU.

3.40 The growth in car traffic in PCU terms is the highest, followed by the growth in GV trips. The significance of the growth in car trips is that the impact on road traffic would be more than 2.5 times that of the bus PCU. The taxi trip growth would be similar to that of the growth in bus passenger trips, reflecting the need for a strong and steady public transport at an average growth rate of about 4% per annum, in line with the growth in population and the impact of increased economic activities.

3.41 This is also due to the relative increase in the average trip rates (total trips / total population) by each mode of travel. This increase in trip rate is reflective of the increase in average incomes and the higher rate of vehicle availability. The distribution of population and economic activities over a wider area would lead to longer trips and hence an increase in road traffic.

3.42 The growth in GV trips over and above the rate of the GRDP growth was estimated based on an elasticity of 1.2, indicating that the increase in economic activities leads to more movement of goods in and around the city and in special traffic generators, such as ports, and the development of several SEZs in Greater Yangon.

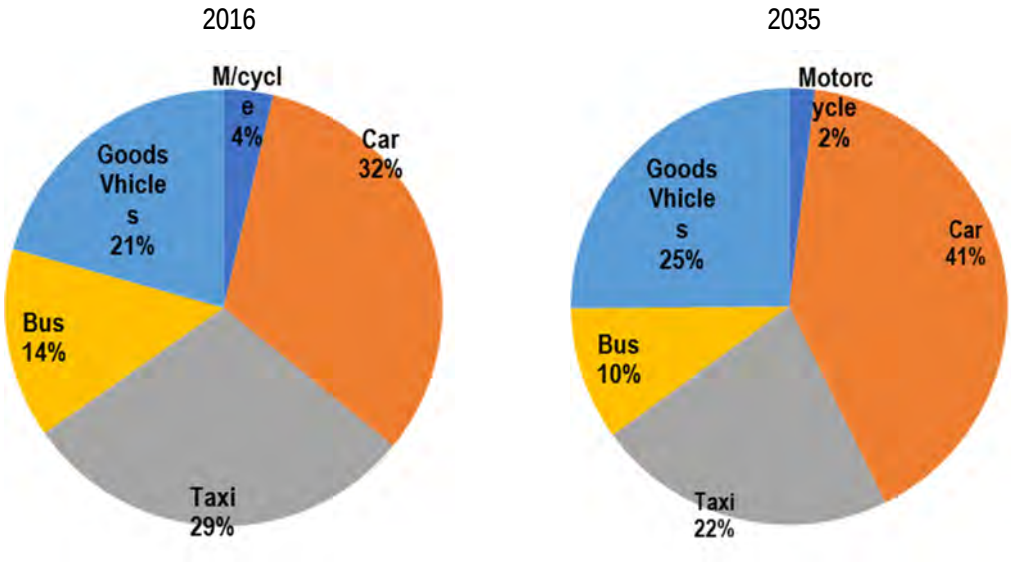
3.43 Traffic shares of motorized road modes in PCU terms are illustrated in Figure 3.2.2. It shows a marked increase in the share of car trips. GV trips would also increase as the proposed land use assumes that the port and other logistics activities would increase with the increase in

industrialization. Taxi trips would decline, so would the share of bus trips in PCU terms, as the car becomes the dominant mode with 41% of the PCU trips on the road.

Table 3.2.2 2016 and 2035 OD Trips in PCU Trips

Travel Mode	2016 Observed Vehicle Occupancy Person/ Vehicle	Average PCU Factor	2016 Validated OD Trips (PCU)	2016 Mode Share (%)	2035 Forecast OD Trips (PCU)	2035 Mode Share (%)	Growth in PCU Trips (2035/ 2016)	AAGR in PCU Trips (%)
Motorcycle	1.76	0.25	50,646	4	78,118	2		2.3
Car	2.50	1.00	447,036	32	1,674,577	41	3.75	7.2
Taxi	2.50	1.00	407,521	29	912,124	22	2.24	4.3
Bus	40.0	1.89	195,219	14	405,924	10	2.08	3.9
Goods Vehicle	n/a	1.64	286,447	21	1,029,712	25	3.60	7.0
All Modes	–	–	1,386,869	100	4,100,455	100	2.94	5.9

Note: Forecast by the JICA Study Team.



Source: Study Team

Figure 3.2.2 Mode Shares in the Base and Forecast Years in PCU Trips

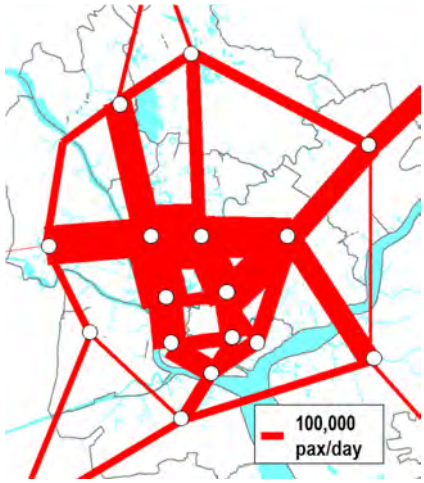
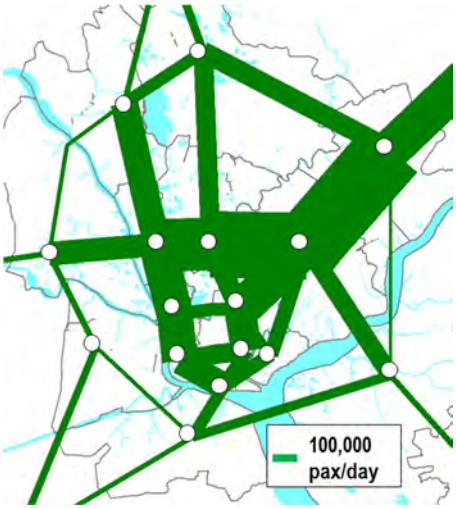
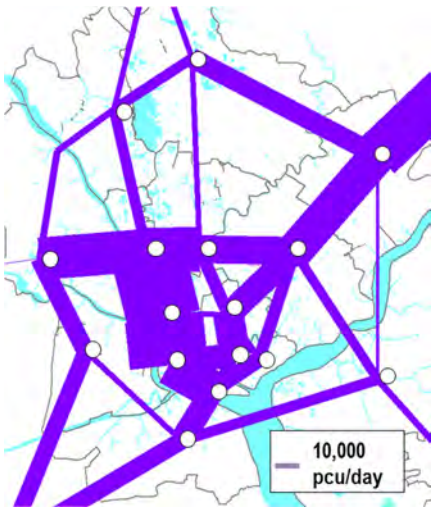
2) Trip Patterns

3.44 Main findings on the trip pattern are explained based on Figure 3.2.3, as follows:

(i) The 2016 distribution of public and private trips is quite different from each other. While private transport trips were rather concentrated in the central urban areas, public transport trips were widely spread over the urban areas. This is also verified from the supplemental survey which shows that the average travel distance of bus passengers was much longer than that of private car users. Meanwhile, freight traffic was concentrated in major traffic-generating centers mostly within the study area.

(ii) The future will be different from 2016 for all types of traffic demand. The common expectation is that the demand will increase significantly and will spread throughout much of the study

area. The increase will also be felt in the outer area, and this has implications for urban transport in Yangon; appropriate planning will thus be needed to address this concern.

Mode	2016	2035
Private (Including Taxi)		
Public		
Freight		

Source: Study Team

Figure 3.2.3 Trip Patterns in the Base and Forecast Years

4 APPROACH TO SUSTAINABLE TRANSPORT DEVELOPMENT IN YANGON

4.1 Impact of Future Growth on Urban Transport in Yangon

1) Socio-economic Growth

4.1 Yangon has been growing and is expected to grow further, bringing about significant impact on urban transport. Population will grow at 2.3%/year, resulting in a population of 9.5 million by 2035. Per capita GRDP will grow at 6.2%/year and 35% of households will own cars by 2035. There will be more employed people and more students who will enroll in higher education. Due to the socio-economic growth, trip rates will increase and total traffic demand will grow substantially. Because urban areas will expand, the average trip lengths of passengers will add to traffic demand.

Table 4.1.1 Assumed Socio-economic Framework for Greater Yangon by 2035

Indicator		2016	2035	Average Growth Rate 16-35 (%/y)	2035/2016
Population (000)		6,188	9,495	2.3	1.5
GRDP (Million USD)		14,148	60,990	8.6	4.3
Per capita GRDP (USD)		2,286	6,423	6.2	2.8
Employment	Total	2,339	5,717	4.7	2.4
	% (1/2/3) [1)]	4/ 21/ 75	3/ 25/ 72		
School Enrollment	Total	1,531	2,482	2.6	1.6
	(P/S/H/U) [2)]	98/ 44/ 67/18	100/ 100/ 90/ 45		
Vehicle Ownership (% to HH)		15	35	4.6	2.3
Trip Rate (%)	Including Walking	2.0	2.3	0.7	1.2
	Excluding Walking	1.1	1.4	1.3	1.3
Average Trip Length excluding Walking (km)		10.1	11.3	0.6	1.1

Source: Worked out by the Study Team based on various sources.
1) Economic sector: 1 = primary, 2 = secondary, 3 = tertiary.
2) Education level: P = primary school (6-10 years old), 2 = secondary (11-14), H = high school (15-17), U = university/ Higher (18-30).

4.2 Moreover, it is expected that the overall socio-economic growth of the country will bring about increasingly more significant impacts on the role of Yangon City as the country's growth hub and international gateway. As a result, the growth of intercity traffic demand to / from Yangon will accelerate.

2) Rapid Increase in Traffic Demand

4.3 Compounded by Yangon's socio-economic development, the future transport demand in the city will increase from 12.4 million in 2016 to 22.1 million trips a day (including walk) by 2035. Motorized trips (excluding walk and bicycle) will also increase from 6.7 million to 15.4 million.

Table 4.1.2 Estimated Transport Demand in Yangon by 2035

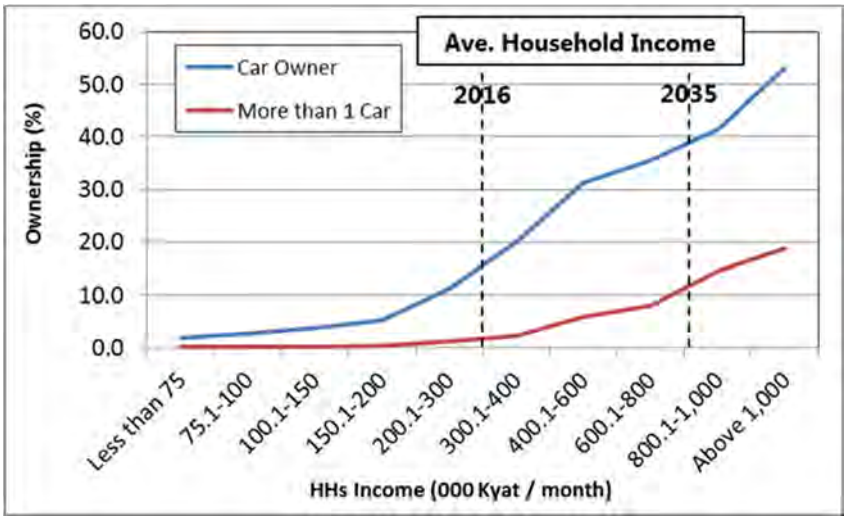
Mode		2016		2035		2035/ 2016	Annual Growth Rate (%/y)
		No. (000)	%	No. (000)	%		
Motorized	Motorcycle	357	2.9	547	2.5	1.5	2.3
	Car	1,136	9.1	4,137	18.7	3.6	7.0
	Taxi	1,125	9.0	2,509	11.3	2.2	4.3
	Bus	4,116	33.1	8,234	37.2	2.0	3.7
	Subtotal	6,734	54.1	15,427	69.7	2.3	4.5
Non-motorized	Walk	4,624	37.1	5,431	24.5	1.2	0.9
	Bicycle	1,091	8.8	1,281	5.8	1.2	0.9
	Subtotal	5,715	45.9	6,712	30.3	1.2	0.9
Total		12,448	100.0	22,139	100.0	1.8	3.1

Source: Study Team

Table 4.1.3 Estimated Intracity and Intercity Traffic Demand by 2035

Item		2016	2035	2035/2016
Person Trip (000/day)	Within Yangon City	10,522	16,560	1.6
	Intercity	1,925	5,579	2.9
PCU (000/day)	Within Yangon City	1,387	3,141	2.3
	Intercity	279	1,016	3.6
Freight PCU (000/day)	Within Yangon City	235	686	2.9
	Intercity	111	408	3.7

Source: Study Team



Note: Worked out by the Study Team based on the YUTRA Study's person trip survey done in 2013.

Figure 4.1.1 Car Ownership Patterns by Household Income

4.2 Transport Sector Goal and Basic Strategies

1) Vision

4.4 The transport sector, being an integral part of the overall urban development, aims to achieve the following goal:

Overall Goal of Yangon Transport

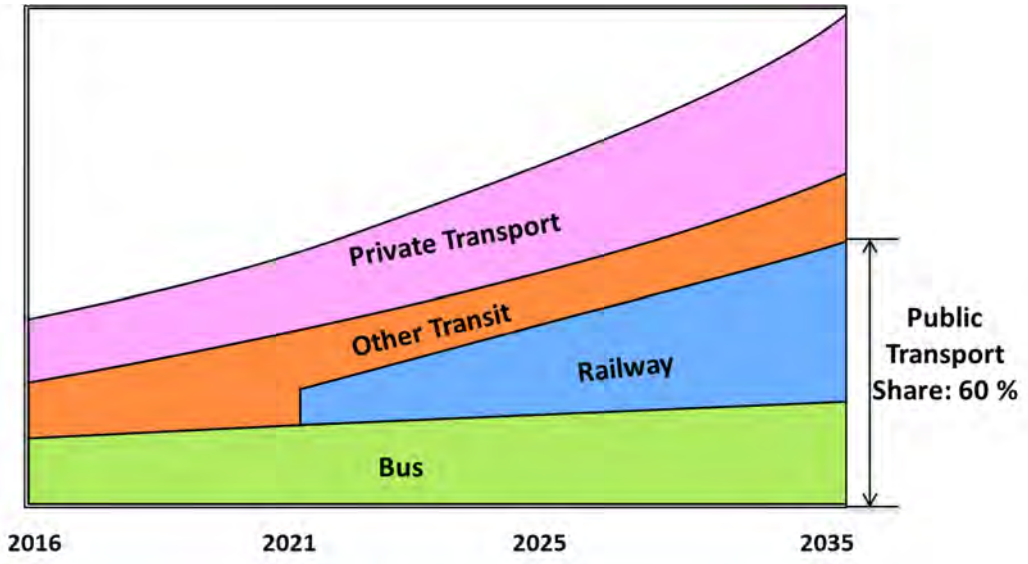
Sustainable transport development for the Yangon Region to enable it to function as a competitive international and national growth hub and provide needed mobility and accessibility for the people.

4.5 The goal is established through discussion in a series of the meetings held with relevant stakeholders, and based on the development vision of Yangon, “Attractive International Port and Logistics HUB - A City of Blue, Green, and Gold-”.

4.6 In this context, the intention is to rid Yangon Region from traffic congestion, traffic accidents, pollution, poorly accessible areas, and other barriers to ensure the smooth movement of people and goods. The urban transport network will also be comprehensible to both domestic and international visitors and accessible especially to the physically challenged.

2) Target Modal Share

4.7 At present, Yangon Region’s urban transport is supported by extensive bus services which, however, have been threatened by rapid motorization. But for the expected size of the future Yangon City, it will be difficult to sustain a public-transport-based city. In order to maintain the current high share of public transport demand, it is necessary to introduce a high-quality, mass transit system such as urban rail, BRT, improved bus system, and other transit services, as conceptually illustrated in Figure 4.2.1.



Source: Study Team

Figure 4.2.1 Indicative Target for Modal Share

4.8 Sustainable transport for Yangon City should have the following five characteristics:

(a) **Connected:** Transport must be connected at international, national, regional, and city levels.

(b) **Competitive:** Transport must be competitive, that is, it has high quality and high performance, must be comfortable and efficient, and offer various amenities.

(c) **Inclusive:** Transport must be inclusive, that is, people-oriented and accessible to vulnerable groups such as the elderly, people with disabilities, etc.

(d) **Ecological:** Transport must be ecological, that is, it is energy-efficient, less polluting, and disaster-resilient.

(e) **Coordinated:** Transport must be coordinated well among the vertical and horizontal government institutions and between public and private sectors.

4.9 With the above-mentioned goal and principles, Yangon's transport sector intends to minimize (i) traffic congestion, (ii) traffic accidents, (iii) pollution, (iv) poorly accessible areas, and (v) barriers to smooth movement of people and goods.

3) Basic Strategies

4.10 The basic strategies to achieve the above goal are summarized as follows:

(i) Development of high-quality public transport system comprising competitive urban rail, modern bus, and other public transport modes in integration with efficient land use and urban development. Because the development of urban rails requires lengthy time and large investments, a step-wise rail development, early improvement of bus services, and development of a BRT system must be considered;

(ii) Strengthening of the hierarchical urban road network comprising urban expressways, primary roads, secondary roads, and local roads, which are properly maintained. Priority must be given to road maintenance, minor improvements, and removal of bottlenecks/missing links. The development of elevated urban expressways on self-financing or PPP basis can also be considered;

(iii) Strengthening of traffic management to maximize available transport capacities through such measures as improved traffic control along major roads and intersections/roundabouts, provision of traffic safety facilities, improved enforcement of traffic rules, education of road users including drivers, and improved vehicle inspection, among others;

(iv) Improvement of walking conditions; and

(v) Introduction of alternative methods to address right-of-way (ROW) acquisition and resettlement issues more effectively, such as land readjustment which has been practiced widely in Japan.[1]

4.11 Key considerations in transport planning and development include the following:

(a) **Comprehensive Approach:** As many projects/actions in large urban areas are interrelated, sectoral approach and piecemeal solutions are not sustainable. Transport and urban development must be integrated. Transport modes need efficient intermodal connectivity, and infrastructure without proper management by IT and human resource may not function adequately.

[1] It was reported that about a third of urban areas in Japanese cities were developed based on the land readjustment scheme.

(b) **Continuity among Short-, Medium-, and Long-term Actions:** Short-term solutions must be continued over the midterm and the long term, while long-term solutions must be started during the short-term period. Integrated, coordinated, and phased actions are important for the effective use of limited resources.

(c) **Emphasis on Urban Transport Issues in National Transport Policy:** As the efficiency of Yangon's urban transport affects the country's economy and image, central government resources must be tapped adequately. This includes projects which strengthen the connectivity between Yangon and other regions, as well as access transport to international gateway ports and airports.

4.12 In addition to the aforementioned considerations, it must be emphasized that integration is key to formulating and implementing transport policy, plan, and projects, as briefly explained below.

(a) **Spatial Integration:** As Myanmar and Yangon are becoming globalized, spatial integration at international, national, regional, urban, township, and even ward/ community levels become more and more important to ensure seamless movement of people and goods. This is especially true for Yangon which must function as the most important socio-economic hub and gateway.

(b) **Sectoral Integration:** Transport, land use, and environment are highly interactive and must be planned and implemented in an integral manner.

(c) **Modal Integration:** Various public and private transport modes (such as air, water, rail, road) and services for goods and passengers must be properly integrated as well as efficiently and effectively provided.

(d) **Hierarchical Integration:** The transport network must be designed in a hierarchical manner, i.e., primary, secondary and tertiary, to enhance network orientation and cost effectiveness.

(e) **Institutional Integration:** As transport development involves various agencies and organizations at national and local levels, including the private sector and communities, coordination among these stakeholders is important and adequate institutions must be provided.

5 FUTURE TRANSPORT NETWORK FOR YANGON

5.1 Review of YUTRA Network

1) Viewpoints of Review

5.1 At the onset of this task, the future transport network proposed in YUTRA was reviewed from the following viewpoints:

(a) **Change in Future Land Use and Spatial Structure:** The land use and spatial structure updated in the SUDP study was incorporated.

(b) **Rapid Growth of Demand since YUTRA:** During the last 3–4 years, especially after the change in administration, road traffic has increased so rapidly that the future demand forecast made in YUTRA was revised based on the review and update of relevant policy and socio-economic framework.

(c) **Impact of New Airport, Relocation of Ports and South-Western Area of CBD:** Although this plan is not concrete plan but under consideration by the government of Myanmar, the possible impacts of developing a new airport in Hantharwaddy, the relocation of the existing port function to Thilawa area and urban development plan in South-Western Area of CBD were assessed because the traffic both will generate will significantly affect urban traffic.

5.2 The urban transport network proposed in YUTRA is composed of among others: (i) urban roads including primary and secondary roads; (ii) inner and outer ring roads; (iii) BRT (7 routes); (iv) urban rails including the circular rail, suburban lines, new north–south line, new east–west line, and others (see Figure 5.1.1 for roads and expressways and Figure 5.1.2 for urban rail).

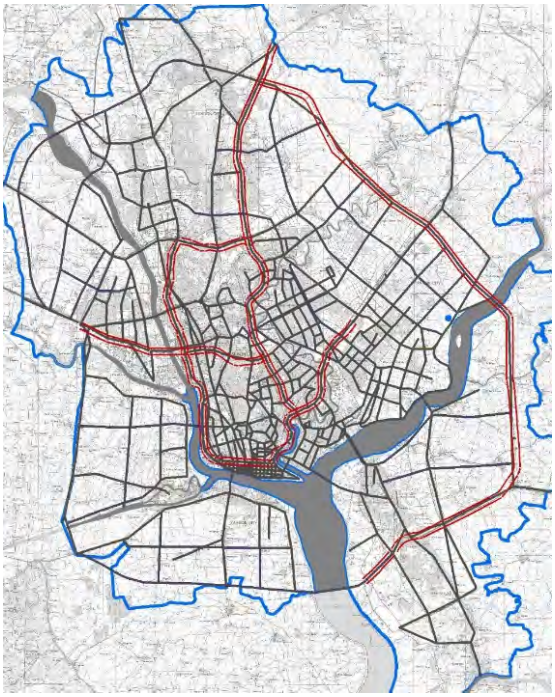
5.3 The YUTRA network was analyzed based on the updated traffic demand to identify demand–supply gaps and assess network and corridor performance. Performance indicators include volume–capacity ratio, average travel speed, ridership and traffic density of urban rails, overall transport costs including vehicle operating cost and passenger's time cost.

2) Assumed Spatial Framework for Traffic Analysis

5.4 Transport development must be planned in coordination with the policy on spatial development. This was discussed in the SUDP and is established both at city and regional levels, as shown in Figure 5. 1. 3 and Figure 5.1.4, respectively. Main characteristics are briefly as follows:

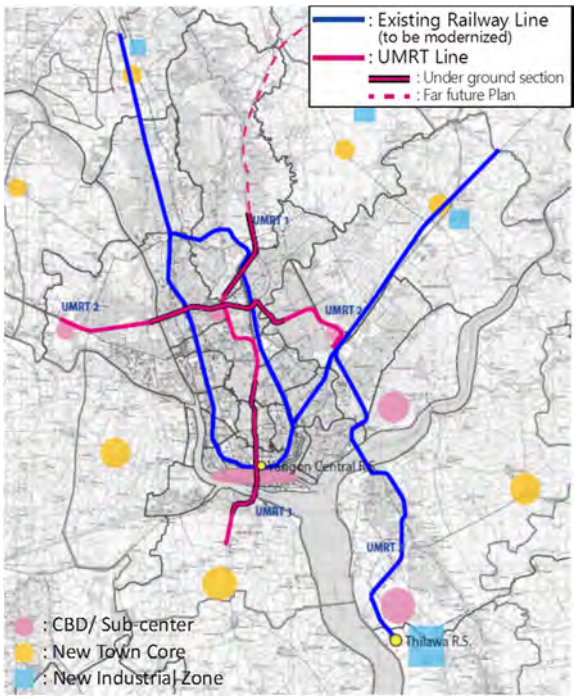
(a) **National Level:** At the national level, Yangon is assigned as the gateway of the north–south national corridor (Myitkyna–Mandalay–Yangon). At the regional level, the corridor splits into two in Bago, as shown in Figure 5.1.3. One corridor connects Hantharwaddy Airport, Dagon Seikkan, and Thilawa where new industries and ports are expected to concentrate. Along the corridor, universities are also located and expected to contribute to high-tech and R&D activities. Another corridor connects Bago with Kyee Myin Daing and the southern areas of Yangon Region where a new airport and a new deep-water sea port are being considered.

(b) **City Level:** At the city level, as shown in Figure 5.1.4, urban areas will expand along the existing transport corridors, especially the north and northeast. Transport development is also intended to guide new urban development in the west, (Kyee Myin Daing), south (Dala), and southeast (Thilawa). Most of the future urban areas will be more or less within or along the outer ring road (ORR). In order to distribute the urban function concentrated in the existing CBD and adjoining areas, three new towns in East Dagon, Kyee Myin Daing, and Dala, and five subcenters in Thilawa, Dagon Myothit, Dagon Seikkan, Yankin, and Mindama are proposed. As mass transit, especially urban rail, is expected to promote future urban areas, the extensive application of TOD is also considered.



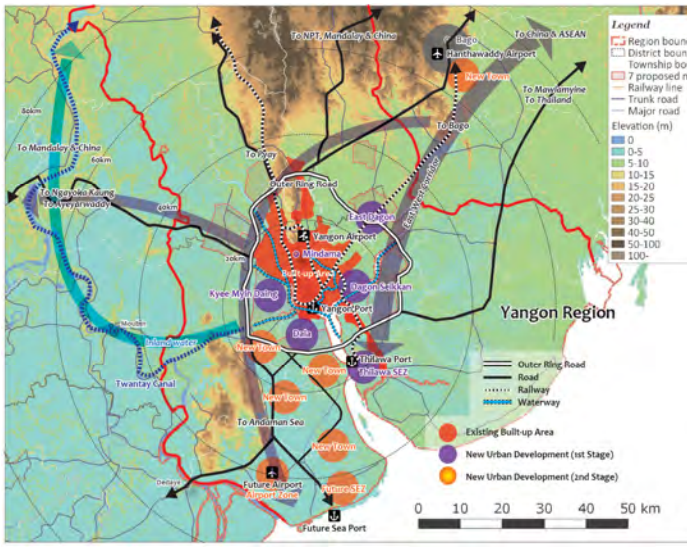
Source: YUTRA Study Team (2013)

Figure 5.1.1 Future Roads/Expressways Network Proposed in YUTRA Study (2013)



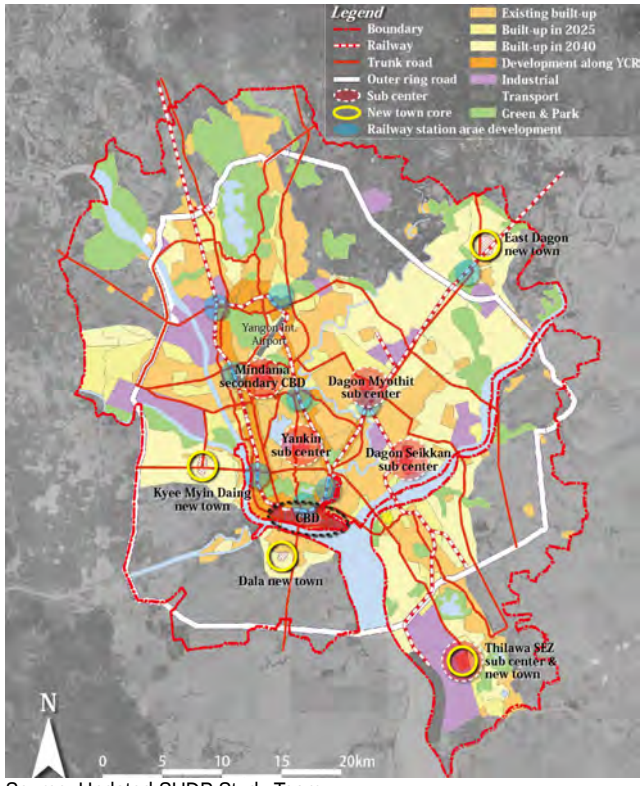
Source: YUTRA Study Team (2013)

Figure 5.1.2 Future Rail Network Proposed in YUTRA Study (2013)



Source: Updated SUDP Study Team

Figure 5.1.3 Regional Spatial Development Concept Proposed in Updated SUDP (2016)



Source: Updated SUDP Study Team

Figure 5.1.4 Urban Spatial Structure Proposed in Updated SUDP

5.2 Transport Network Analysis

1) Assessment of YUTRA Network

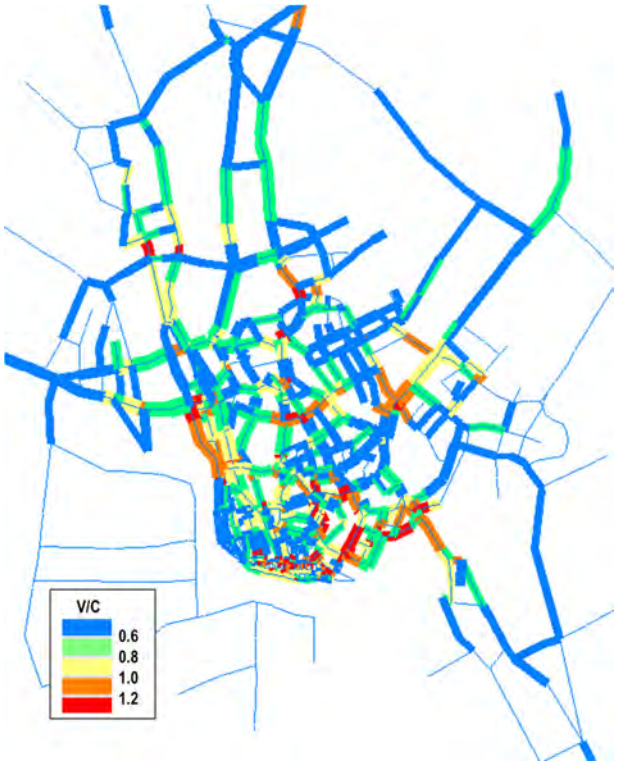
5.5 On the basis of the updated demand, the YUTRA network was assessed. Except for some sections where goods vehicles concentrate, and these are at ports and logistics areas, the assessment shows that the network is considered generally adequate. Therefore, the network proposed in the YUTRA is taken as the basis for further analysis in the study.

2) Do Nothing Scenario

5.6 This scenario aims to analyze the traffic situation in the future by assuming that no investments have been done. As shown in Figure 5.2.1, the entire transport network will be choked and bottlenecks will spread over the entire urban area. This greatly contrasts with the existing situation shown in Figure 5.2.2 where traffic congestion is already observed in many sections in the city. Under the Do Nothing Scenario, it is estimated that the total transport cost (sum of vehicle operating cost and time cost of passengers) will reach MMK 66.6 billion a day, which is a 6 times increase from 2016[1]. The result indicates that Yangon needs to expand and strengthen its transport system substantially to meet a very large demand.

Source: Study Team
1) Width of Line is 1 dot per 5,000 pcu/day

Figure 5.2.1 Traffic Situation in 2035 under Do Nothing Scenario



Source: Study Team
1) Width of Line is 1 dot per 5,000 pcu/day

Figure 5.2.2 Traffic Situation in 2016

[1] Vehicle Operating Cost and Unit Travel Time Cost are 2016 price

3) Do Maximum Scenarios

5.7 There are two Do Maximum scenarios, i.e., the one prepared in YUTRA Study and the other prepared in this study in response to the urban spatial structure updated in the SUDP study and new policy directions. The main differences between the two scenarios are the following:

(i) Expansion of the urban expressway to the outer ring road in the direction of Kyee Myin Daing / Twanty, Dala and the addition of an east–west link in the city center;

(ii) Reduction of 7 BRT routes to 2 due to lack of urban road space; and

5.8 This scenario aims to analyze the adequacy of the future transport network as of 2035. The results are shown in Table 5.2.1 and Figure 5.2.3. The main findings are as follows:

(i) The updated network shows overall improvement in traffic performance compared to the YUTRA plan, as shown in Table 5.2.1;

(ii) In 2035, overall traffic will improve and become better than the situation in 2016. Average VC ratio will also decrease from 0.56 to 0.45, while average travel speed will increase from 10.6 km/h to 15.1 km/h;

(iii) One of the most significant factors that will contribute to the improvement is the urban railway network which is expected to transport 4.4 million passengers a day in 2035;

(iv) Another important factor is the expressway network which will share about 15% of total road traffic demand. Without elevated expressways in urban areas, congestion on at-grade roads will worsen; and

(v) Average transport cost per person trip will decrease from MMK 1,733 in 2016 to MMK 1,539 in 2035, mainly because of reduced traffic congestion and improved connectivity between origins and destinations.

Table 5.2.1 Network Performance under Various Scenarios

Item		2016	2035		
			Do Nothing	Do Maximum (YUTRA)	Do Maximum (This Study)
Travel Demand	Person Trip (000)	6,268	15,058	15,058	15,058
	Person-km (000)	63,703	175,828	180,309	178,374
	Person-hours (000)	5,565	40,702	14,141	11,802
Road Traffic Demand	PCU-km (000)	13,708	42,034	40,017	35,233
	PCU-hours (000)	1,185	8,295	3,543	2,418
Network Performance	Ave. V/C Rate	0.55	1.67	0.62	0.45
	Ave. Travel Speed (km/h)	11.4	4.3	12.8	15.1
	Transport Cost (MMK billion) 1)	10.9	68.1	29.9	23.2
	Transport Cost/Pax Trip (Kyat)	1,733	4,524	1,987	1,539
Railway Performance 2)	No. of Pax (000)	77	499	4,637	4,450
	Pax-km (000)	1,846	5,934	37,796	37,584

1) Only Vehicle Operating Cost and Travel Time Cost. The value is modified as 2016 price.
2) Excluding BRT
Source: Study Team

5.9 The aforementioned analysis indicates that Yangon has a good chance at realizing a much improved urban transport provided the proposed projects are timely implemented.

Source: Study Team

1) Width of Line is 1 dot per 5,000 pcu/day

Figure 5.2.3 Traffic Situation in 2035 under the Do Maximum Scenario

4) Performance of Urban Rail

5.10 While the role of urban rail will be significant, the network is analyzed by line as shown in Table 5.2.2 and Figure 5.2.4. The main findings are as follows:

(i) With a total length of 192 km of urban rail lines and 34 km of BRT lines, a total of 4.3 million passengers will be transported every day;

(ii) All mass transit lines, i.e., urban rail and BRT, show high performance. The circular rail will carry 1.3 million passengers/day; three suburban commuter lines, 1.1 million/day; three UMRT lines, 1.5 million/day; and two BRT lines, 0.5 million/day;

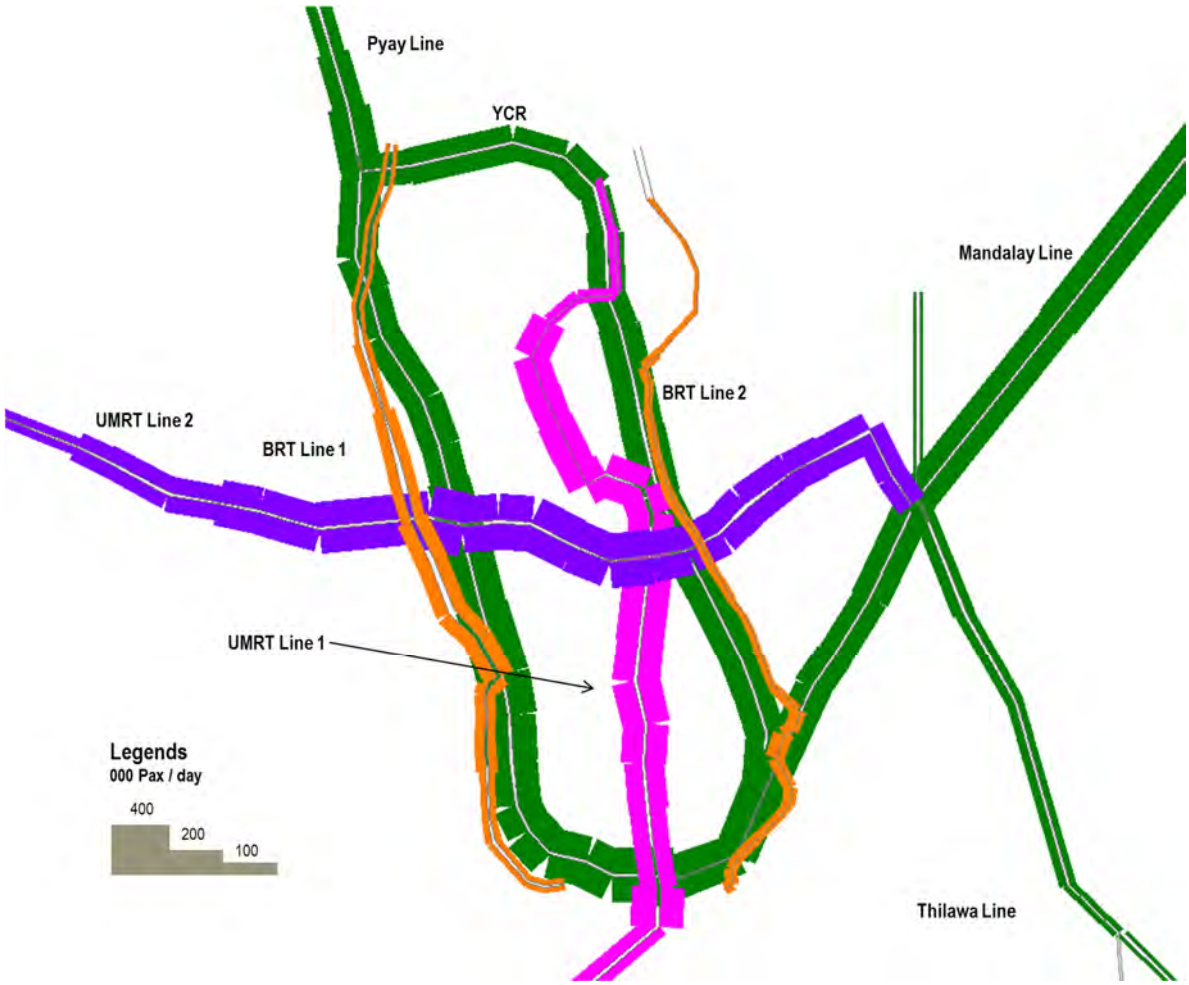
(iii) Group of high-density lines (passenger-km/route-km) include the circular line, UMRT Line 1 and 2 and Mandalay line, followed by the second group comprising Pyay Line and Thilawa Line; and

(iv) BRT lines also show good performance, though they are located on corridors parallel to the circular rail. While the BRT and the circular rail compete in some sections, they are complementary in others. They also meet different demands considering that their average trip lengths differ: 5.0 km for the BRT and 10.0 km for the circular rail.

Table 5.2.2 Railway Performance Indicators under the Do Maximum Scenario

Line Description		Line Length (km)	Ridership (000)	Pax*km ('000)	PPHPD (Maximum Pax/Ave. H)	Ave. Travel Distance (km)	Traffic Density (000)	
							Pax/km	Pax-km /km
Circle Line	YCR West (YNG-DNG)	20.1	744	6,290	32,000	8.5	37.1	313
	YCR East (DNG-YNG)	26.0	516	6,294	21,000	12.2	19.8	242
	Subtotal	46.1	1,260	12,584	32,000	10.0	27.3	273
MR Suburban Lines	Pyay Line	22.4	158	1,714	21,000	10.8	7.0	76
	Mandalay Line	42.4	775	11,479	21,000	14.8	18.3	271
	Thilawa Line	31.7	148	1,230	9,000	8.3	4.7	39
	Subtotal	96.5	1,081	14,423	21,000	13.3	11.2	149
UMRT Lines	UMRT Line 1 (N/S)	26.5	749	5,330	27,000	7.1	28.2	201
	UMRT Line 2 (E/W)	23.3	741	6,558	34,000	8.9	31.8	281
	Subtotal	49.8	1,489	11,888	34,000	8.0	29.9	239
BRT Lines 1 & 2	BRT Line-1 (IRR West)	17.4	299	1,424	9,000	4.8	17.2	82
	BRT Line-2 (IRR East)	17.5	182	968	6,200	5.3	10.4	55
	Subtotal	34.9	481	2,392	9,000	5.0	13.8	69
Total		227.4	4,311	41,287		-	9.6	19.0

Source: Study Team
1) Peak hour ratio: UMRT = 15%, BRT = 10 %



Source: Study Team

Figure 5.2.4 Railway Traffic Demand in 2035 under the Do Maximum Scenario

5) Performance of Urban Expressways

5.11 An extensive network of expressways with a total length of 288 km has been proposed and analyzed as shown in Table 5.2.3 and Figure 5.2.5. The main findings of the analysis are as follows:

(i) The performance of expressways is very different by route. The first group with VC ratios of 0.7 and above are the elevated expressways on the west and east sections of the inner ring road, the access to the Yangon–Mandalay Expressway, Yangon–Thilawa, and East–West smart tunnel (south route). The second group with VC ratios of 0.4–0.6 are Yangon–Pyay. Yangon–Pathein, Kyee Myin Daing Bridge, and east–west smart tunnel (north route);

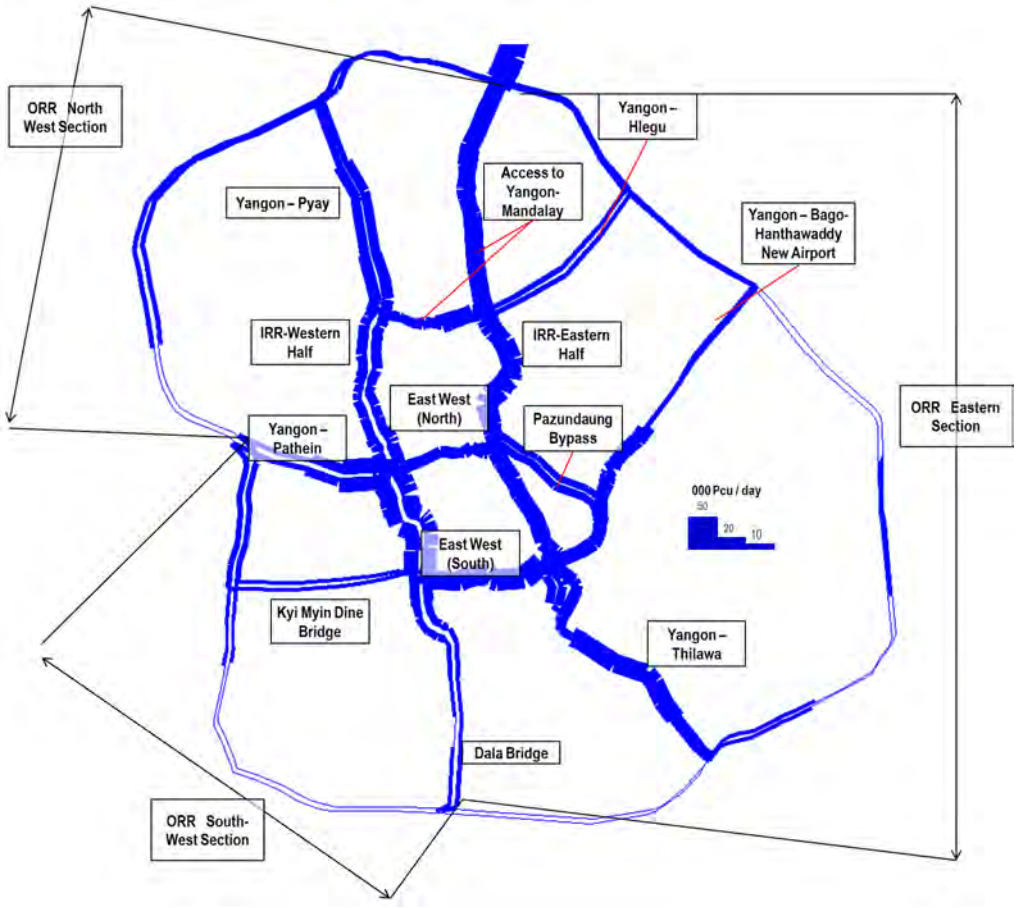
(ii) Although the VC ratio of Yangon–Bago–Hantharwaddy section is 0.3, it will become higher when the new airport is in full operation; and

(iii) The performance of the ORR varies by section, because its total length is very long. Its overall performance is low. The analysis indicates that the ORR must be developed in stages with adequate design standard.

Table 5.2.3 Urban Expressway Performance Indicators under the Do Maximum Scenario

Section		Length (km)	PCU-km (000)	V/C	PCU-km/km	Cross-section Traffic (max.) (000 pcu/day)
ORR	East Section	65.1	592	0.11	9,091	16.0
	South-West Section	31.3	266	0.11	8,498	11.9
	North-West Section	35.0	343	0.12	9,794	12.0
Radial	Yangon–Bago–Hanthawaddy	18.7	505	0.34	26,963	22.8
	Yangon–Pyay	10.2	493	0.61	48,567	34.4
	Yangon–Thilawa	14.9	879	0.74	58,828	37.6
	Yangon–Hlegu	8.8	154	0.22	17,558	11.2
	Yangon–Pathein	8.4	355	0.53	42,358	44.3
	Dala Bridge	8.6	73	0.11	8,421	6.0
	KMD Bridge	9.7	89	0.11	9,176	5.2
IRR	I-RR (Western Axis: Insein–CBD–Dala)	18.8	1,297	0.86	68,888	54.9
	I-RR (Eastern Axis: Mindamar–CBD)	17.6	1,164	0.83	66,000	42.0
Others	Access to Yangon–Mandalay Expressway	21.9	1,428	0.82	65,241	48.2
	Pazundaung Bypass	6.6	202	0.38	30,646	16.7
	East–West Tunnel (North)	6.0	239	0.50	39,874	32.9
	East–West Tunnel (South)	6.7	423	0.79	63,372	35.9

Source: Study Team



Source: Study Team

Figure 5.2.5 Expressway Traffic Demand in 2035 under the Do Maximum Scenario

5.12 The impact of urban expressways on traffic is significant, especially in Yangon where widening and the development of new roads are extremely difficult to do in urbanized areas. When grade-separated (either elevated or underground) expressways are provided, substantial volume of road traffic on at-grade roads will transfer to expressways to avoid traffic congestion on the surface roads, although the volume will be affected by toll fees on expressways. Truck and logistics traffic which are banned from main roads during the day are also a potential market for urban expressways. As is seen in other big cities, the financial viability of urban expressways is relatively high so that the development cost to the government can be reduced significantly.

6) Impact of Relocation of Port and Logistics Facilities

5.13 Port traffic is one of the factors which amplify traffic congestion on urban roads in different sections, but especially at and around ports, truck terminals, and other logistics facilities areas. An exercise was made on their possible impacts on urban traffic when they are relocated from existing urban areas to more appropriate locations such as Thilawa and ORR, among others.

5.14 In 2016, Yangon Port generated approximately 49,300 trucks or 80,800 pcu a day which is predicted to increase to 160,000 pcu in 2035. Meanwhile, truck terminals generated approximately 38,100 pcu in 2016 which is expected to increase to 118,700 pcu in 2035.

5.15 When the port is relocated to Thilawa and the truck terminals in areas along the ORR, traffic congestion in and around the facilities will greatly reduce.

Table 5.2.4 Estimated Goods Vehicle Demand Generated by Port and Truck Terminals

Traffic Generator		2016	2035
Port Area	No. of trucks (000/day)	49.3	97.6
	PCU (000/day)	80.8	160.0
Truck Terminals	No. of trucks (000/day)	23.2	72.4
	PCU (000/day)	38.1	118.7

Source: Study Team

7) Impact of New Airport

5.16 When Hanthawaddy Airport is opened, it will divert and attract a large number of airport traffic, as shown in Table 5.2.5. Despite the lack of reliable data, the Study Team has boldly estimated that approximately 198,000 passenger trips/ day would move to / from the airport.

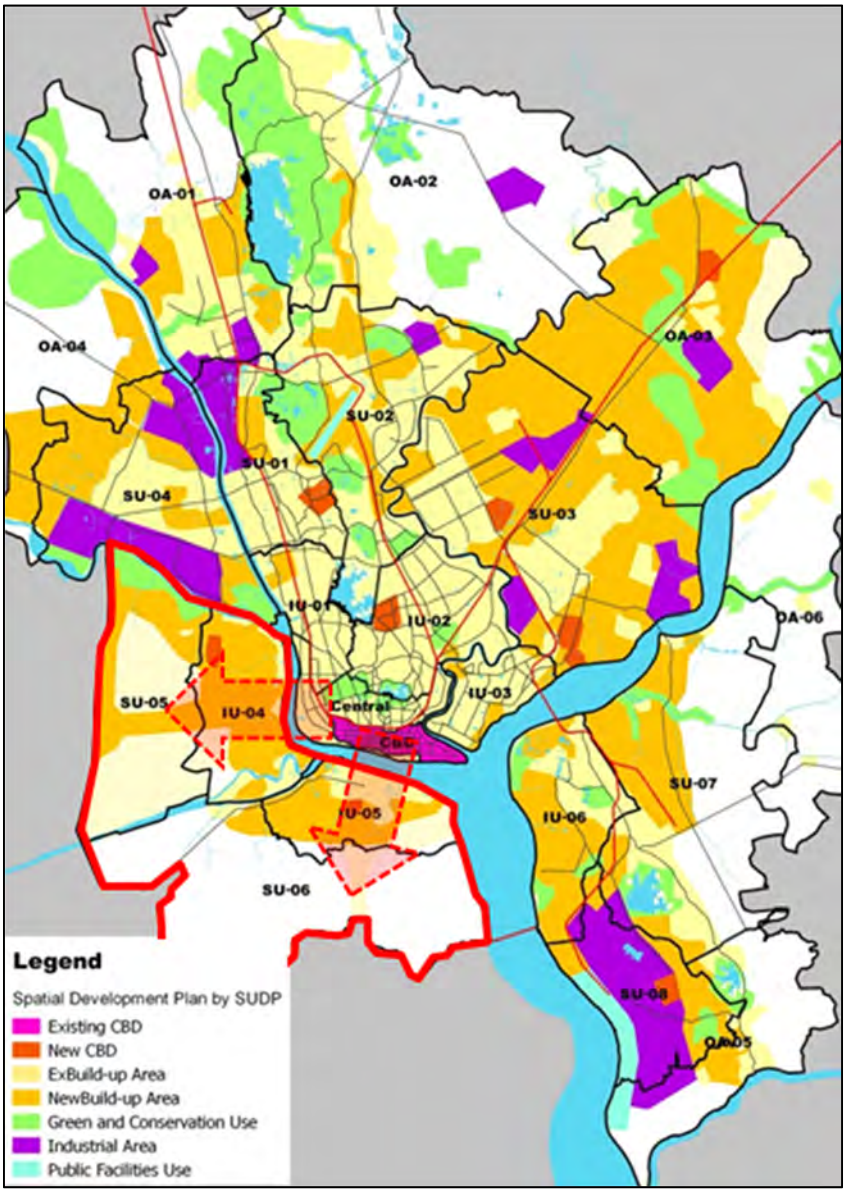
Table 5.2.5 Estimated Demand Generated by the Yangon International Airport in 2016 (000/day)

Item		2016	2035	
			Yangon Airport	Hanthawaddy Airport
Passengers	Domestic (000 / day)	5.2	20.7	2.8
	International (000 / day)	10.3	3.6	56.6
Well Wishers	Domestic (000 / day)	30.9	20.7	1.7
			0.5 per passengers * 2 trips	0.3 per passengers * 2 trips
	International (000 / day)	7.3	7.2	79.2
			1.0 per passenger * 2 trips	0.7 per passengers * 2 trips
Airport Workers (000 / day)		13.4	19.5	47.5
			0.4 per passenger * 2	
Total (000 / day)		67.1	71.8	187.8

Source: Estimated by Study Team, based on the PPP-F/S of Hanthawaddy International Airport Project by JICA (2015)

8) Impact of Urban Development Plan in the South-Western Area of CBD

5.17 Development of southern area across the River is planed which is expected to bring about significant impact both on transportation and spatial structure of Yangon when they are completed the area is composed of Dala and Kyee Myin Daing shown in as IU-04, IU-05, SU-05 and SU-06 in Figure 5.3.3. The area is populated approximately 647,000 persons with a population density of 31 persons/ha over the wide area of 20,000 ha. Advantage of the area is proximity to CBD. Most of the area is located within 15 Km radius from CBD. Disadvantage is poorly provided access and widely distributed flood prone area. At present direct access is only provided by ferry or the long detour by road.



Source: the Study Team

Figure 5.2.6 Development Direction of Alternative Socio-economic Framework

5.18 YRG has intention to accelerate the area. In "*A Development Master Plan for the Yangon-Hanthawaddy-Bago Corridor and Yangon's Southwest*" by KOICA (2016-2017), the large-scale development in Dala Area and Kyee Myin Daing Area is proposed. The projected population is 1.7 million in 2035 (excluding existing settlement) with 94 (no/ha) of gross population density. When new developments are taking place the access will be provided with following modes:

(i) Construction of Dala Bridge which is on-going

(ii) Extension of Line 1 to Dala

(iii) Extension of expressway at Kyee Myint Daing to the west

(iv) Consideration of Line 3 in the south connecting KMD, CBD and Thilawa

(v) And network of primary and secondary roads in integration with this above primary network.

Phase	Target Year	Area (ha)	Population (000)	Landuse
1	-2020	3,685	450	Commercial, Residential, Mixed Use, Business, Pagoda, Culture
2	-2025	3,809	450	Commercial, Residential, Mixed Use, Business, Public, Industrial, Distribution
3	2030	4,172	300	Commercial, Residential, Mixed Use, Business, R&D, Culture, University, Distribution
4	2035	6,333	500	Residential, Mixed-Use, Industrial, Distribution
5	2040	1,540	0	Sport-Park, Distribution

Source: A development master plan for the Yangon-Hanthawaddy-Bago corridor and Yangon's southwest

Figure 5.2.7 Proposed Land Use of Dala & Kyee Myin Daing Area in A development master plan for the Yangon-Hanthawaddy-Bago corridor and Yangon's southwest

5.3 Proposed Transport Network for Yangon

1) Proposed Network

5.19 In order to meet the expected large traffic demand in Yangon as a result of promoting the desired growth and expansion of urban areas, the future transport network is formulated with the following considerations (see Figure 5.3.1):

(a) **Road Network:** Improvement and development of hierarchical urban roads consisting of primary and secondary roads both in existing and emerging urban areas including new towns.

(b) **Expressway Network:** The development of a network of elevated or access-controlled toll expressways in integration with urban roads is a must to resolve traffic congestion on at-grade roads.

(c) **Public Transport Network:** The development of a high-quality, high-capacity public transport system is the most important challenge for Yangon, not only to improve the traffic situation but also to promote compact and desirable urban areas and land use. With the circular rail forming the backbone, it must be integrated with suburban commuter lines and new urban lines. BRT development under elevated urban expressways is also worth considering.

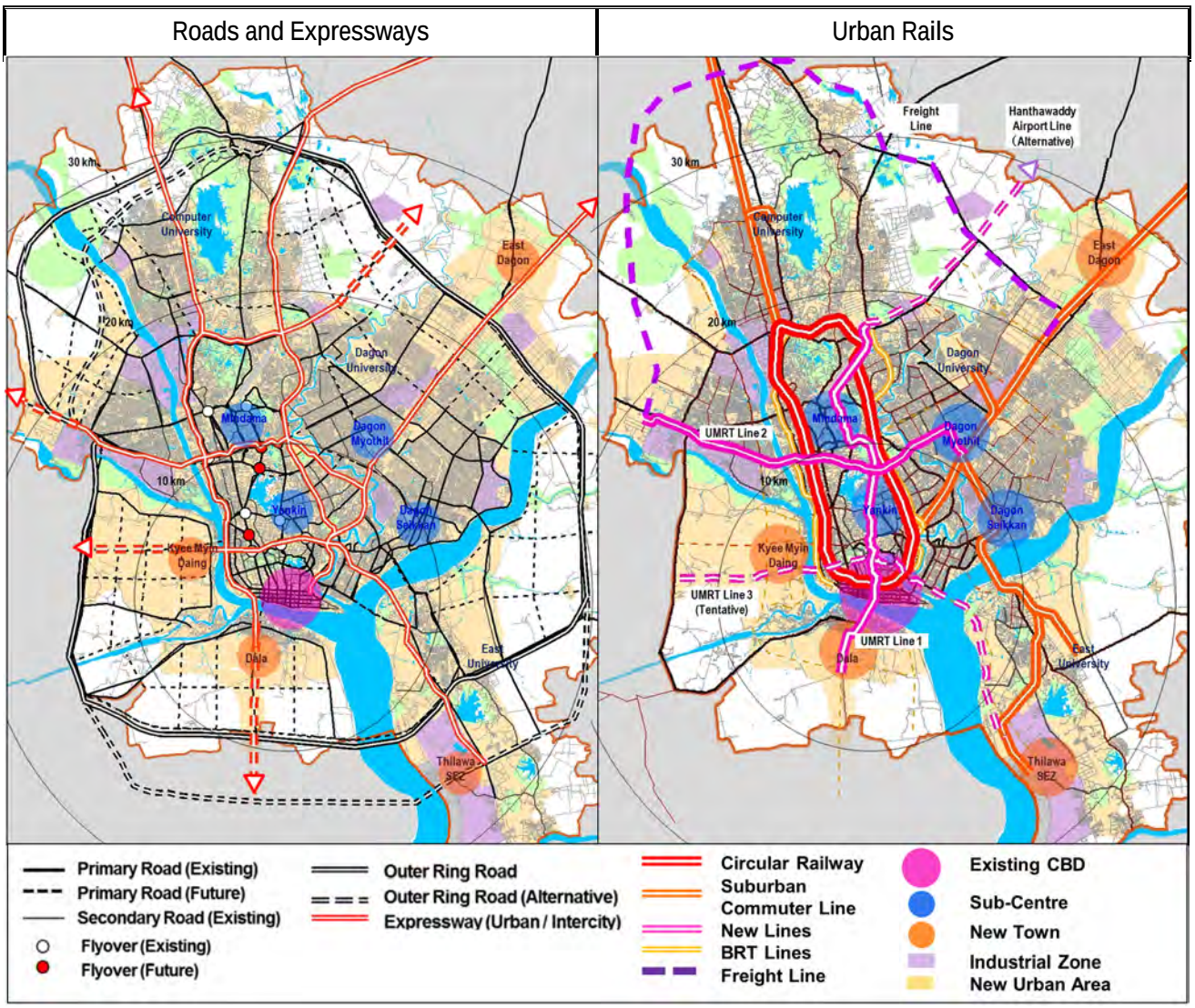
5.20 The overall urban transport network proposed in the YUTRA Study has been deemed appropriate to meet the future transport demand in Yangon. The main findings of the review which was based on the updated database and planning policy of the new administration include the following:

(a) **Development of At-grade Roads:** Further expansion and development of at-grade roads is the most fundamental undertaking of the government. In addition to the upgrading of existing roads, the development of missing links in existing urban areas and new roads in emerging suburban areas must be promoted in integration with land use development.

(b) **Expansion of Expressways:** The expansion of the urban expressway network is proposed because of substantial increases in the future transport demand compared to YUTRA's estimates, the anticipated difficulties in developing at-grade roads, and in response to the redefined spatial structure in the SUDP. The proposed expressway network will cover the future urban area which will cover areas within and along the outer ring roads. For this, new expressway routes connecting Dala, Kyee Minh Daing, Thilawa, and East Dagon, as well as an additional east-west link in the city center, are proposed. Urban expressways will be elevated or underground in the city center and at-grade in suburban areas.

(c) **Development of BRT Routes:** The seven BRT routes proposed in YUTRA should be reduced to two to spare road space for vehicular traffic, except inner ring road sections where elevated expressways are to be constructed and is at-grade sections of the roads are wide enough to accommodate two-lane dual carriageways even after BRT development.

(d) **Development of Urban Rails:** A high-quality mass transit network supplemented with BRT, bus, and other public transport modes is proposed for Yangon. The proposed urban rail network will also promote diversion from private cars through park & ride schemes, especially in suburban areas. The urban rail network will be composed of the Yangon Circular Rail, suburban commuter rails, and new metro lines. In view of the concentration of high demand in the city center and expected developments in the south, west, and east areas, an additional east–west line can be proposed to connect the city center with Kyee Minh Daing / Dala and Thilawa.



* Alignment of Outer Ring Road is still in discussion by relevant agencies.

Source: Study Team

Figure 5.3.1 Proposed Urban Transport Network for Yangon

2) Assessment of Proposed Urban Transport Network

5.21 Selected main corridors of the proposed network was assessed, and the results are shown in Table 5.3.1 and Table 5.3.2 for 2016 and 2035 situations, respectively. The main findings are as follows:

(i) While overall traffic demand on 10 selected corridors will increased, The average volume–capacity ratio and average travel speed improve.

(ii) While traffic situation will improve, it will not be so in CBD, implying that demand management measures should be introduced in the area; and

(iii) It is still necessary to strengthen traffic management for more effective and safe use of limited capacities.

Table 5.3.1 Performance Indicators for Main Corridors in 2016

Corridor	Length (km)	PCU-km	Ave. V/C Ratio	Average Speed (km/h)	Pax-km	% Public (Pax)	Transport Cost per PCU-km (MMK)
Kannar (Waterfront) Road	21.9	459	0.82	8.7	1,472	67.9	1,085.0
Pyay Road–Insein Road	19.2	657	0.85	11.7	2,610	62.5	943.7
Inya Road–Pyay Road	12.2	420	0.88	12.4	1,550	45.5	804.8
Kabar Aye Pagoda Roazd	19.6	776	0.94	10.5	2,455	47.5	929.1
Wizar–Yan–Tar	7.2	220	0.70	27.5	841	58.3	500.0
No.2 Main Road	15.7	528	0.81	11.5	2,391	60.3	912.9
East–West (Northern Corridor)	22.1	853	0.93	12.5	2,237	48.3	866.4
Ahlon Road–Shwe Gone Daing Road	11.1	380	0.91	9.5	1,429	52.6	1,028.9
Thanlin–Thilawa Link	14.7	341	0.86	10.7	1,320	58.5	947.2
All CBD Roads	37.8	362	0.92	4.8	1,234	64.3	1,770.7
All Corridors	182.0	4,996	0.87	10.3	17,539	56.1	973.4

Source: Study Team

Table 5.3.2 Performance Indicators for Main Corridors in 2035

Corridor	Length(km)	PCU-km	Ave.V/C Ratio	Average Speed (km/h)	Pax-km	%Public (Pax)	Transport Cost per PCU-km (MMK)
Kannar (Waterfront) Road	21.9	866	0.83	9.4	1,715	43.8	879.9
Pyay Road–Insein Road	19.2	756	0.80	13.0	2,524	46.4	760.6
Inya Road–Pyay Road	12.2	464	0.86	15.0	1,413	36.9	648.7
Kabar Aye Pagoda Road	19.6	971	0.82	15.9	3,258	51.7	674.6
Wizar–Yan–Tar	7.2	245	0.62	27.2	852	44.6	408.2
No.2 Main Road	15.7	585	0.75	13.9	2,719	56.7	717.9
East–West (Northern Corridor)	22.1	741	0.60	22.5	3,108	52.6	506.1
Ahlon Road–Shwe Gone Daing Road	11.1	300	0.63	15.0	1,418	63.8	743.3
Thanlin–Thilawa Link	14.7	535	0.91	9.9	2,099	44.3	942.1
All CBD Roads	37.8	711	1.24	5.1	1,988	56.1	1,607.6
All Corridors	182.0	6,174	0.80	11.4	21,094	50.4	819.2

Source: Study Team

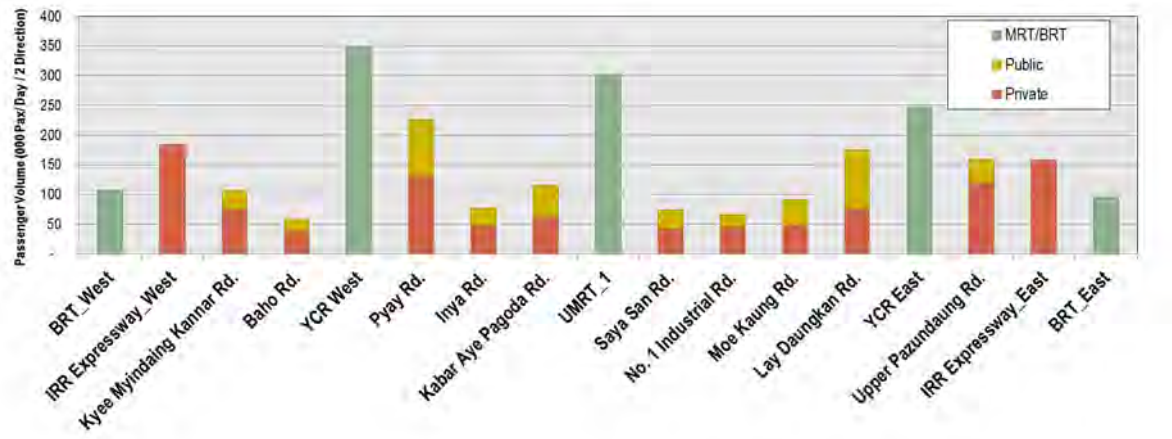
5.22 Figure 5.3.2 shows the traffic situation along the east–west cross-section of the city between the inner ring roads. The main findings are as follows:

(i) For the most important north–south traffic movement, the role of public transport by rail is significant, especially the Circular Rail and UMRT Line 1. The BRT on Kyee Myindaing Kannar Road also plays a critical role;

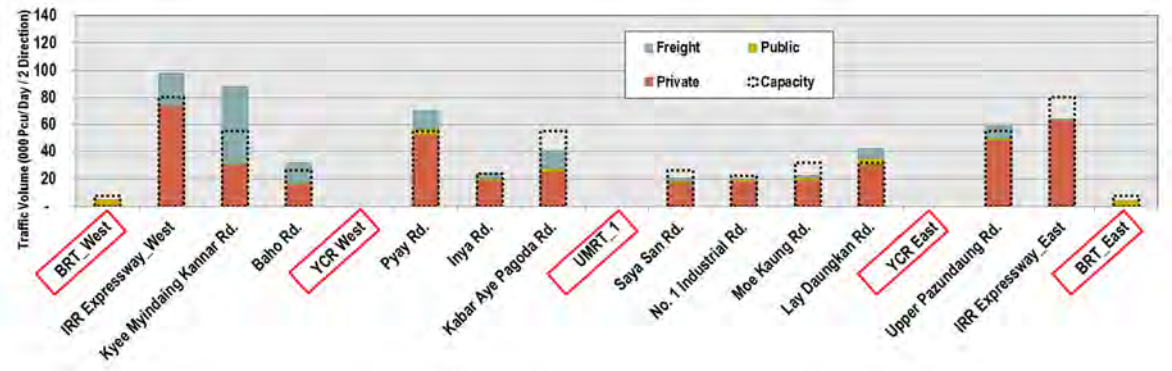
(ii) Elevated expressways to be constructed on inner ring roads will contribute remarkably to the reduction of at-grade road traffic; and

(iii) The impact of freight traffic on western corridors, including Kyee Myindaing Kannar Road, IRR expressway, and Baho Road, will be substantial.

Passenger



PCU



Source: Study Team

Figure 5.3.2 Traffic Situation on the North–South Cross-section

6 REGIONAL TRANSPORT AND URBAN LOGISTICS

6.1 Regional Transport Characteristics

1) National Spatial Development Structure and Transport Corridors

6.1 Myanmar's national spatial structure is built with different types of activity centers and corridors. The former includes regional/state capital cities such as Yangon, Mandalay, and Bago. Industrial zones and special economic zones (SEZs), agro-industrial centers are also included. The latter refers to strategic transportation networks, including ASEAN/transnational land, water, and air transport corridors. Connecting the aforementioned strategic activity hubs are 10 development corridors comprising the national network. These development corridors are listed below and shown in Figure 6.1.1.

(i) Central North–South Corridor (approximately 1,200 km);
(ii) East–West Corridor (approximately 600 km);
(iii) Northern Corridor (approximately 550 km);
(iv) Mandalay–Tamu Corridor (approximately 610 km);
(v) Second East–West Corridor (approximately 1,120 km);
(vi) Main River Corridor (part of the Western North–South Corridor);
(vii) East–West Bridging Corridor (approximately 710 km);
(viii) Delta Area Network (approximately 340 km);
(ix) Southern Area Development Corridor (approximately 690 km);
(x) Western North–South Corridor (approximately 690 km); and
(xi) Eastern North–South Corridor (approximately 760 km).

6.2 Four corridors, namely, Central North–South Corridor, East–West Corridor, Western North–South Corridor, and Delta Area Network, are located in Greater Yangon, the common and only international gateway. In this regard, interregional traffic in this area should be properly managed so as not to affect urban traffic negatively.

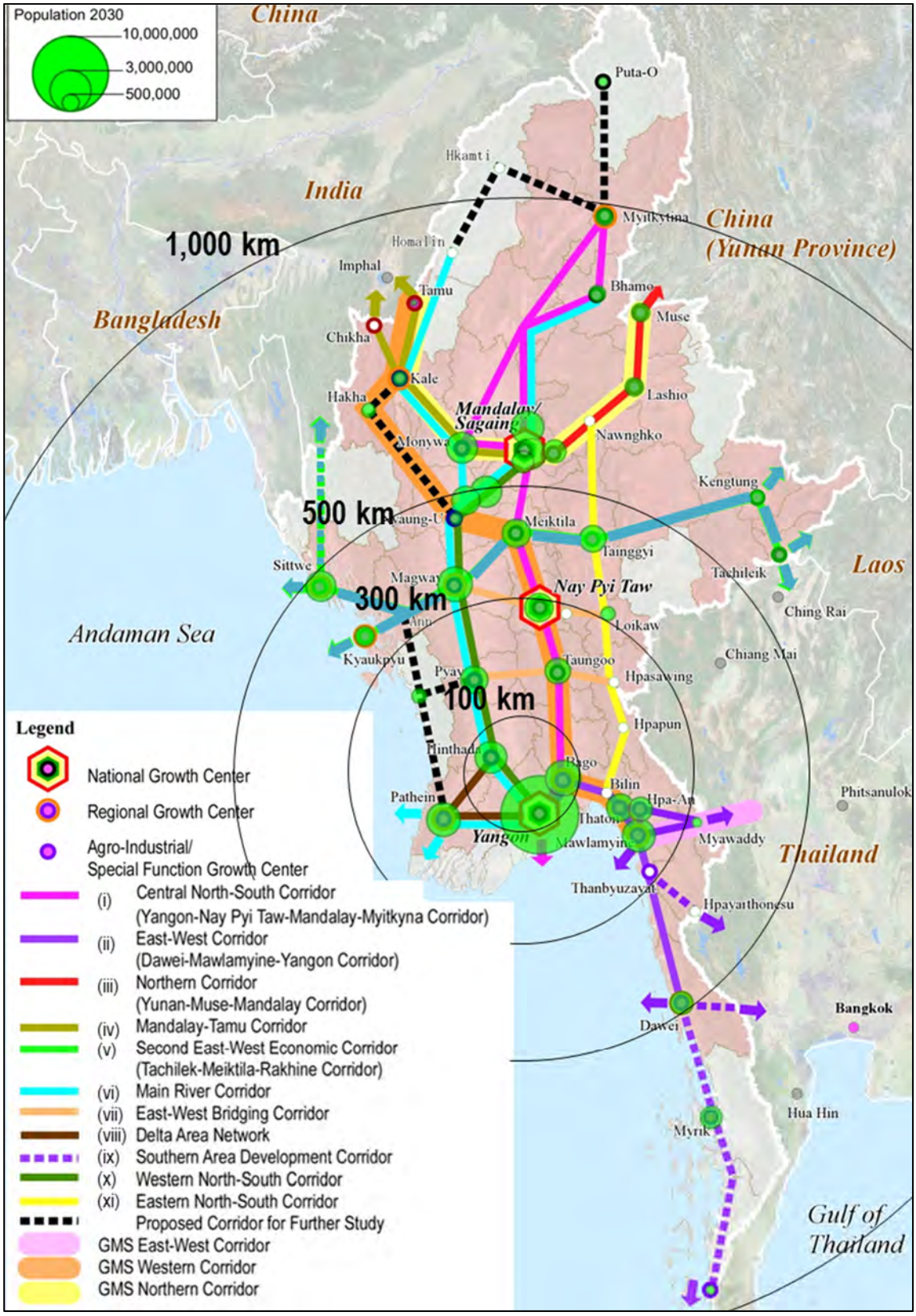
6.3 In 2012, Myanmar's population was 61 million and the country had a GDP of MMK47 trillion. Among the 10 development corridors, larger populations and associated economic activities can be seen along Central North–South Corridor (41% of the total population and 50% of GRDP), followed by the Western North–South Corridor (33% of total population and 42% of GRDP), East–West Corridor (28% of total population and 35% of GRDP), and Delta Area Network (21% of total population and 27% of GRDP). This indicates that connectivity improvement between Yangon's transport systems and the Central North–South Corridor should be given first priority, followed by the Western North–South Corridor, and the East–West Corridor. It should be noted that the Thilawa SEZ is now designated as the terminus of the East-–West Corridor by the Myanmar government.

2) Regional Transport Demand Characteristics

6.4 Each of the four important corridors has its own unique characteristics in terms of modal share of freight and passenger transport, which are mainly determined by two major factors, namely, natural conditions and history of transport infrastructure development in the modern era.

6.5 The dominant modes of transport along the Central North–South Corridor are land transport including roads and rail. There is no water transport along the corridor, while it includes national highways (NH No. 1, 2, and 3), and expressways, and railways (double track). The share of road

transport (truck) is dominant in freight transport, reaching about 91% in terms of ton-km in 2013, which is expected to increase slightly to 93% in 2030. With regard to passenger transport along



Source: Study on National Transport Development Plan (2014) JICA

Figure 6.1.1 Key National Transport Corridors, 2030

Table 6.1.1 Profile of National Transport Corridors, 2012

Development Corridor	Section	Code	Population (000)	Share to National (%)	GDP (MMK billion)	Share to National (%)
1. Central North–South Corridor	Yangon–Nay Pyi Taw	A1	11,714	41	13,170	50
	Nay Pyi Taw–Mandalay	A2	6,323		4,457	
	Mandalay–Myitkyna	A3	7,035		5,648	
2. GMS East–West Corridor	Yangon–Hpa-An–Myawaddy	B1	14,052	28	14,543	35
	Mawlamyine–Dawei	B2	2,753		2,039	
3. GMS Northern Corridor	Mandalay–Muse	C1	6,042	10	4,503	10
4. Mandalay–Tamu Corridor	Mandalay–Tamu	D1	8,722	14	6,992	15
5. New East–West Corridor	Tachilek–Meiktila–Kyaukpyu	E1	10,636	17	6,938	15
6. East–West Bridging Corridor	Hpasawing–Pyay	G1	2,664	12	1,727	11
	Loikaw–Magway	G2	4,767		3,214	
7. Delta Area Corridor	Yangon–Pathein	H1	8,992	21	10,076	27
	Pathein–Hinthada	H2	3,766		2,651	
8. Southern Area Development Corridor	Thanbyuzayat–Hpayarthonesu	J1	2,537	8	1,482	8
	Dawei–Thai Border	J2	811		781	
	Dawei–Kawthaung	J3	1,756		1,679	
9. Western North–South Corridor	Yangon–Pyay–Magway	K1	12,810	33	14,388	42
	Magway–Mandalay	K2	7,096		5,468	
10. Eastern North–South Corridor	Bilin–Loikaw	L1	3,896	12	2,550	9
	Loikaw–Nawnghko	L2	3,247		1,900	

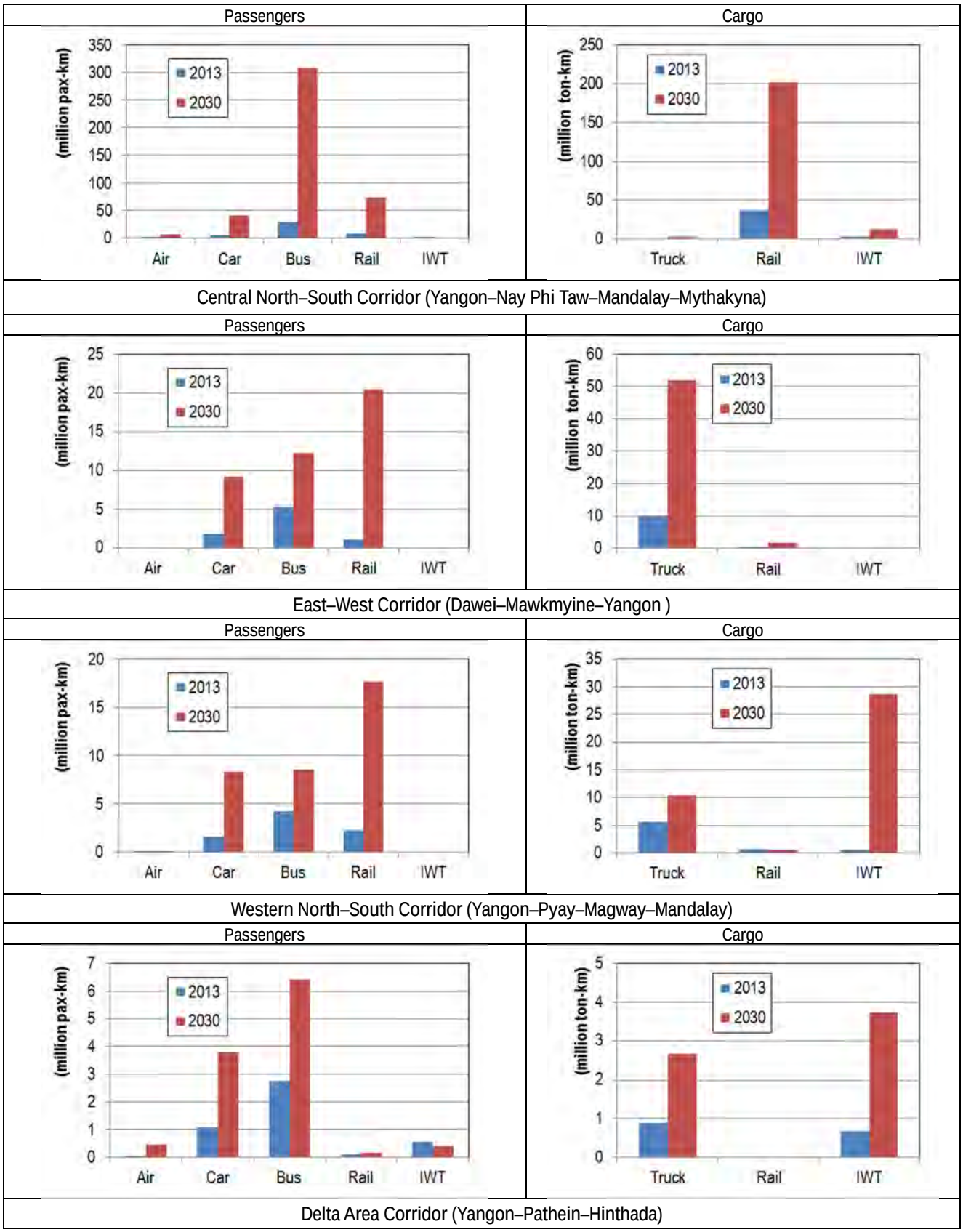
Source: MYT Plan (2014)

the Central North–South Corridor, the share of bus transport is dominant in terms of passenger-km, reaching about 66%, followed by rail transport at 17%. The share of rail transport in passenger transport demand is expected to increase to 32% in 2030 due to the ongoing improvement of the Yangon–Mandalay railway. This demand forecast shows the importance of the connectivity improvement between industrial centers, such as the Thilawa SEZ and the Hlaing industrial area in Greater Yangon, and the national land transport system for freight movement and the improvement of the Yangon central station and intercity bus passenger terminals for passenger movement.

6.6 In terms of modal share, the East–West Corridor shows similar characteristics with those of the Central North–South Corridor, but the expected modal share of rail passengers along the former corridor in 2030 is higher than that of the latter corridor because of rail improvement between Yangon and Bago as part of the Yangon–Mandalay railway improvement.

6.7 The Western North–South Corridor has unique characteristics in comparison with other corridors, that is, the modal share of water transport is high due to the traditionally developed inland water transport system along the Ayeyarwaddy River. The share of freight transport by water transport means along this corridor is expected to increase from 9% in 2013 to more than 70% in 2030, which is desirable as this is an environment-friendly transport. With regard to passenger transport along the corridor, rail transport is expected to play a more vital role with the improvement of the Yangon–Pyay railway line.

6.8 In the delta area, the Delta Area Corridor, the dominant freight mode is road transport, reaching about 56%. However, this is expected to decrease to about 41% in 2030 as a result of improvements in the water transport systems in the delta area. The share of rail passenger transport is expected to increase as a result of improvements in the Yangon–Pathein railway line, while bus transport will still be the dominant mode in the delta area in 2030.



Source: MYT Plan (2014)

Figure 6.1.2 Transport Demand on Selected Corridors by Mode

6.2 Urban Logistics

1) Overview

6.9 As the economy grows, the increase in diverse goods movement within the city and to/from external areas and its effect on urban traffic in many ways are to be expected, especially because Yangon is the gateway connecting Myanmar, the global market, and other large consumption and production areas of different commodities. It is estimated that goods vehicle traffic demand will share 20% to 25% of total traffic demand in terms of PCU-km in 2035 due to the progress in industrialization and the increased demand for consumer goods.[1] At present, the major generators of goods traffic include ports, truck terminals, wholesale markets, traditional bazaars, shopping centers concentrated in retail shopping areas, among others. Although a detailed survey and analysis of goods vehicle traffic are not undertaken in this study, it is important to take it into account in urban transport planning.

2) Classification of Goods and Proposed Solutions

6.10 Based on the survey conducted in the study on the National Transport Development Plan in 2014 which received technical assistance from JICA, goods were classified into 17 types, as shown in Table 6.2.1.

Table 6.2.1 Classification of Goods

Code	Classified Commodity Type
COM01	Live animal & animal products
COM02	Fish and aquatic products
COM03	Vegetable and fruits
COM04	Grain and grain products
COM05	Other agricultural products (ex. plantation product)
COM06	Foodstuff, beverage and animal food
COM07	Petroleum, oil and gas
COM08	Coal, ore, stone and sand
COM09	Cement, construction material (incl. steel frame)
COM10	Fertilizer (incl. urea)
COM11	Garment, textiles and fabric
COM12	Wood and wood products
COM13	Paper and printed matter
COM14	Metal and metal products (excl. construction materials)
COM15	Industrial material, chemicals
COM16	Household articles, miscellaneous
COM17	Machinery and parts, transportation

Source: Survey Program for the National Transport Development Plan in the Republic of the Union of Myanmar, Sep. 2014, JICA

[1] In YUTRA (2013), the share of goods vehicle demand was approximately 18% of the total demand in terms of PCU.

6.11 They were further classified into three cargo categories based on their characteristics. Each category is described below in

(1) Category 1: Consumption Goods (Raw Materials)

6.12 In the past, Yangon City had depended on river transport for the procurement of most commodities and goods, e.g., daily consumer goods, coal, timber, etc. Due to the development of land infrastructure, especially roads, trucking might play a key role in inner-city logistics in Yangon from now on. However, the expanding truck haulage has created some problems inside the city, e.g., traffic congestion, waste gas, and so on. Furthermore, an excessive reliance on truck haulage for inner-city logistics poses risks when a disaster strikes.

6.13 The characteristics of relevant logistics facilities are briefly as follows:

(i) Some public wholesale markets, e.g., Thiri Mingalar Market (vegetable and fruits, Hlaing T/S), Sin Min Market (chicken and duck, Hlaing T/S), San Pya Market (fish, Kyee Myin Daing T/S), etc., are allowed to use large trucks on the inner ring road;

(ii) Thiri Mingalar Market (Hlaing T/S) near Shwe Padauk Market (fish, Hlaing T/S) mainly turned over vegetable and fruits was removed from Kyee Myin Daing T/S three years ago as a countermeasure to traffic congestion;

(iii) The surrounding areas of the Bayint Naung Truck Terminal in Hlaing T/S is a major distribution center of rice and paddy; and

(iv) The sanitary conditions of these public wholesale markets, which also include a 'wet' section, are not good.

6.14 The upper-middle class in Yangon is expected to expand from now on according to a rapid economic growth in Myanmar, especially in Yangon. Corresponding to the needs of the upper-middle class, the existing public wholesale markets should be upgraded. An efficient allocation of the wholesale markets along the ring road and an upgrade of their facilities and sanitary environment are needed. Furthermore, the location/relocation of food processing industries as value-added industries near wholesale markets should be promoted. Now, one local private company, the Dagon Group Inc., is developing a modern wholesale market through consultations with the YCDC.

(2) Category 2: Consumption Goods (Manufactured Materials)

6.15 As manufactured consumer goods are expected to increase in a large scale in the east and the west of Yangon where population growth and density are high. There exists one public market in each township selling such goods as fresh fish, vegetables, milled rice, dressed meat, flowers, and fabrics. Most daily consumer goods are sold in Yangon City through markets.

6.16 With the expected burgeoning of the upper-middle class in Yangon, existing traditional markets should be upgraded and a modern distribution system needs to be developed in the city.

6.17 A few local modern retailers, such as City Mart and Star Mart, are opening modern retail markets in high-density areas. The commodity handling portion in modern retail markets has remained low and the distribution system should be upgraded. There is a need to shift to modern retail markets and efficient distribution systems, for instance, a modern storage and distribution system combined with a barge and a truck haulage. A modern and mechanized logistics system with an ICT system will be able to improve efficiency.

(3) Category 3: Energy, Intermediate, and Industrial Goods

6.18 Industrial goods, such as coal, petroleum, cement, timber, fertilizer, meal, machinery, chemicals, and industrial materials, are transported to the west of Yangon City and the CBD through inland water and coastal shipping. Because this type of traffic will increasingly affect

urban traffic in and around the CBD negatively, there is a plan to relocate the port function to Thilawa and others. The shift of industrial goods to Thilawa Port will contribute to a decrease in logistics costs for manufacturers in Thilawa SEZ and other industrial parks located in the city.

6.19 A proposed approach includes the integration and partial relocation of the existing port facilities, such as Pansoedan, Thuwanna, river jetty, and many private ports in central Yangon, to Thilawa Port. Cargo transport, especially container transport, is important to exchange goods. Space for container storage, cargo warehouse, and other logistics functions are also needed in the dry port.

Table 6.2.2 Freight Flow Volume in Yangon

Unit: ton/day

Year	Inside Yangon	Outside Yangon	Total
2013	107,769	91,529	199,298
2030	491,562	474,155	965,717
2030/2013	4.6	5.2	4.8

Source: Survey Program for the National Transport Development Plan in the Republic of the Republic of the Union of Myanmar, Sep. 2014, JICA

3) Development Direction

6.20 On the basis of the aforementioned study, the following actions are preliminarily proposed:

(i) Upgrading public wholesale markets for Category 1 commodities, including:

- Relocating and developing wholesale markets along the ring road;
- Upgrading facilities and sanitary conditions; and
- Attracting good processing industries near wholesale markets.

(ii) Upgrading traditional markets for Category 2 commodities, including:

- Upgrading traditional markets, and
- Upgrading distribution systems.

(iii) Shifting port function to Thilawa and other ports

- Shifting the handling of increasing volumes of industrial cargos from highly populated areas to Thilawa Port and the hinterland, and
- Integrating port facilities in highly populated areas and relocating some functions of existing port facilities to Thilawa Port.

6.21 Myanmar Railways is considering the construction and operation of a dry port as an important work in freight transport. For the construction of the dry port along the Asia Highway and Trans Asia Railways in Asia and Pacific, Myanmar signed “the intergovernmental Agreement on Dry Port” on on 7 November 2013. Myanmar proposed eight potential locations of dry ports. They are Yangon, Mandalay, Tamu, Muse, Mawlamyine, Bago, Monywa, and Pyay.

6.22 In Yangon, Myanmar Railway is considering a dry port in Ywarthargyi in East Dagon Township. The nearest seaports are the Asia World Port Terminal, Myanmar Industrial Port, and Botahtaung Port, all of which are located along the Yangon River, and Myanmar International Terminal Thilawa near the mouth of the sea. The Ywarthargyi dry port can easily be linked to the Yangon–Bago–Pyinmana–Meilkhita–Mandalay Road network. Furthermore, it is also situated on the Yangon–Mandalay Railway line (main railway corridor), and the dry port itself has a railway line connected to Yangon–Bago, extending to Hanthawaddy International Airport, which will be the

biggest airport in the country. These are some of Yangon's inland waterway ports along the Yangon River which can easily be linked to the dry port as well.

Source: Study Team

Figure 6.2.1 Location of the New Dry Port in Ywarthargyi

6.23 The needed major activities in the dry port are listed below.

(i) Container handling and storage;

(ii) Container stripping and stuffing;

(iii) Break bulk cargo handling and storage;

(iv) Customs inspection and clearance;

(v) Light container repairs;

(vi) Freight forwarding and cargo consolidation service;

(vii) Banking, insurance, financing services; and

(viii) Use of pallet system for cargo transport.

7 URBAN ROADS

7.1 Urban Roads Development

1) Importance of Urban Roads

7.1 Roads are the most fundamental infrastructure in urban areas. They provide space not simply for the movement of vehicles and pedestrians but also places for various socio-economic activities, offering venue for various events and recreational activities. Roads connect main socio-economic centers to each other and to living quarters as well.

7.2 Roads also serve as an important open space as fire belt and evacuation route. The design of road space also enhances amenity and landscape. Roads can accommodate other urban utilities such as those for water supply, drainage, electricity, and telecommunications.

2) Sharp Increase in Road Traffic Demand

7.3 In the past years road traffic has increased rapidly due to the increase in road vehicles, as shown in Table 7.1.1. Between 2012 and 2016, the total number of vehicles in Yangon Region shot up from 269,000 to 773,000, or a 2.9 times growth. Even between 2014 and 2016, it increased by 1.5 times. It is an accepted fact across the world that vehicle ownership increases as an economy develops and household incomes rise. As with other cities, it is expected that vehicle ownership in Yangon will further increase and the impact on roads will become increasingly larger.

Table 7.1.1 Vehicle Ownership in Yangon Region

Type		No. of Units (000)			Rate 14/16
		2012	2014	2016	
Private Car		160	270	330	2.1
Truck	Light	16	49	124	7.5
	Heavy	11	17	17	1.6
Bus		11	13	16	1.4
Motorcycle		56	143	253	4.5
Others		13	22	34	2.5
Total		269	514	773	1.5

Source: Department of Road Transport Administration

Table 7.1.2 International Comparison of Vehicle Ownership

City	No. of Vehicles / 000 Pop
Yangon (2016)	45
Bangkok (2012)	400
Kuala Lumpur (2013)	480
Manila (2013)	100
Hanoi (2013)	80
Seoul (2013)	280
Taipei (2015)	220
Singapore (2014)	230

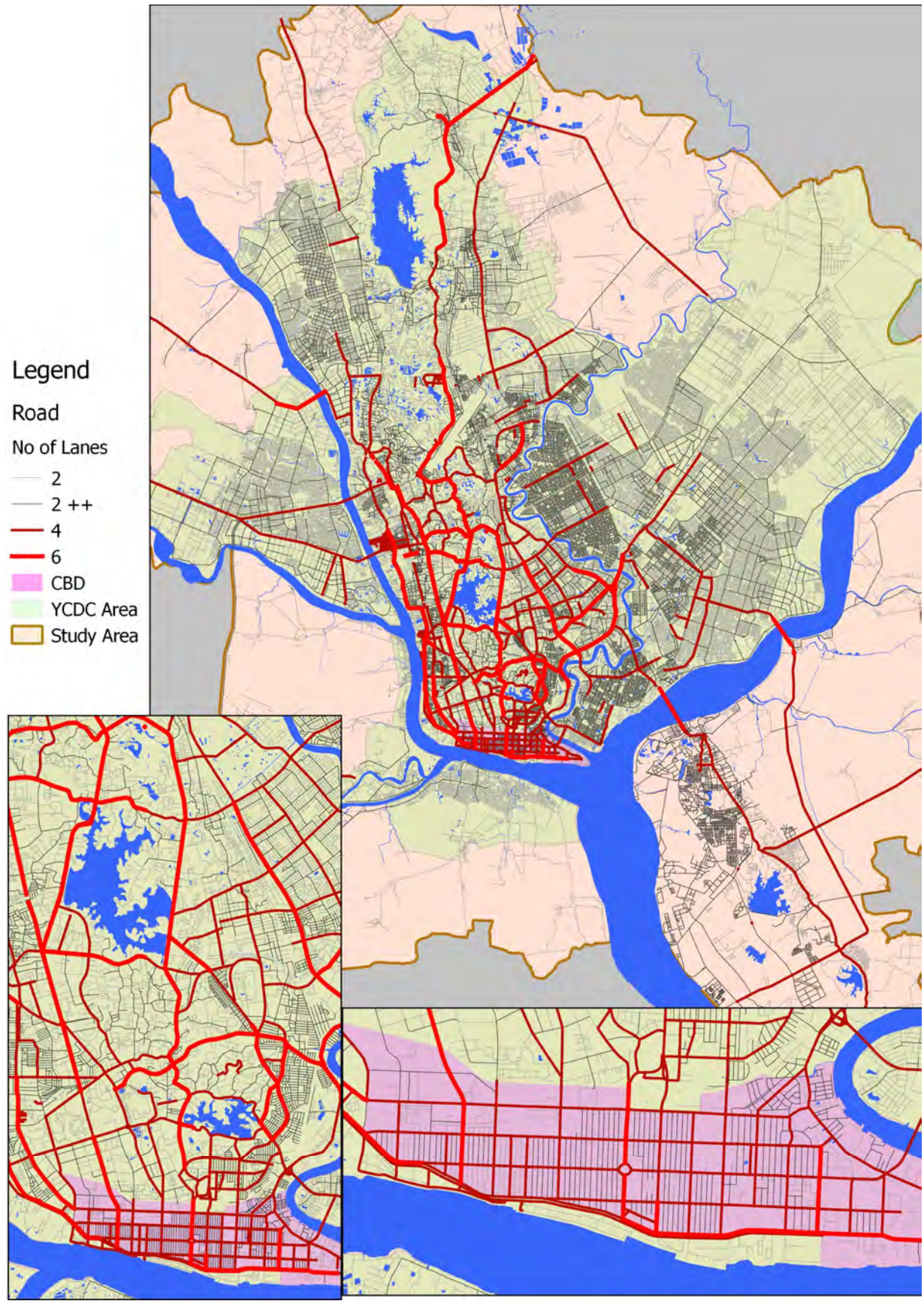
Source: Study Team

3) Major Planning Issues

7.4 Existing urban roads in Yangon Region are not provided in the same manner as the roads in the aforementioned destinations are built, that is, connected to each other, efficient, and effective. The major issues of the current urban road network and facilities in Yangon are as follows:

(i) Absolute lack of road infrastructure

- Insufficient traffic capacity for most of the primary and secondary urban roads network against traffic demand.
- Substandard road and bridge facilities for industrial and residential developments, including access to Thilawa SEZ, and Dala and Twantay new towns, among others.
- Many missing links are found in large urban blocks in the city centre area which reduces articulation of road network, decrease accessibility in the urban blocks and increase traffic concentration on main roads.



Source: Study Team.

Figure 7.1.1 Urban Roads in Yangon by Number of Lanes

(ii) Insufficient and improper maintenance of roads including pavement, drainage, road markings, and furniture.

(iii) Inadequate traffic management

- Excessive concentration of vehiculars to/from and within the CBD;
- Reduction of traffic capacity due to roadside parking and street vendors turning 4-lane roads into 2-lane roads and 6-lane roads into 4-lane roads in many locations;
- Insufficient traffic capacity of intersections, including roundabouts, and sole or independent traffic signal control without reflecting appropriate time required for directional flows especially during morning and evening peak hours; and
- Though eight flyovers were constructed, they are not working systematically, causing new bottlenecks at neighboring intersections.

(iv) Lack of pedestrian facilities, wherein sidewalks are not pedestrian-friendly, road crossings cause traffic accidents while negatively affecting traffic flow;

(v) Inadequate control of large cargo vehicles, such as cargo trucks and container trailers, which run on Kannnar Road - Bayint Naing Road, Than Thu Mar Road, and a part of CBD during the morning and evening peak hours, causing traffic congestion, conflicts, and accidents; and

(vi) Other factors which are not properly attended to such as:

- Lack of local traffic circulation management at and around large markets/shopping centers, schools, etc.;
- Inadequate U-turns;
- Inappropriate access control to/from buildings and local streets;
- Inadequate traffic control at at-grade railway crossings; and
- Inadequate arrangement for boarding/alighting of passengers at bus stops and terminals.

4) Urban Road Development Directions

7.5 Although traffic volume has increased significantly in the last three years and this high rate is expected to continue for a while, the construction of new major arterial roads or widening of existing major arterial and secondary roads in the city center to increase traffic flow capacity proves to be very difficult because of constraints in land acquisition and resettlement. Because the provision of new road facilities like the elevated inner ring road (IRR) and mass rapid transit (MRT) will likewise require considerable time under such restrictions, the direction of urban road development is proposed as follows:

(i) Maximum utilization of the existing road network and facilities including removal of bottlenecks, expansion of traffic management measures, expanded reliabilities and maintenance;

(ii) Development of missing links including widening of roads in existing urban areas in integration with improvements of the roadside environment; and

(iii) Development of new roads in urban areas even though it is not easy to do so. Yangon must continuously face this challenge in order to establish an adequate transport infrastructure as well as an effective land use. There are alternative approaches in developing new roads in urban areas, to wit:

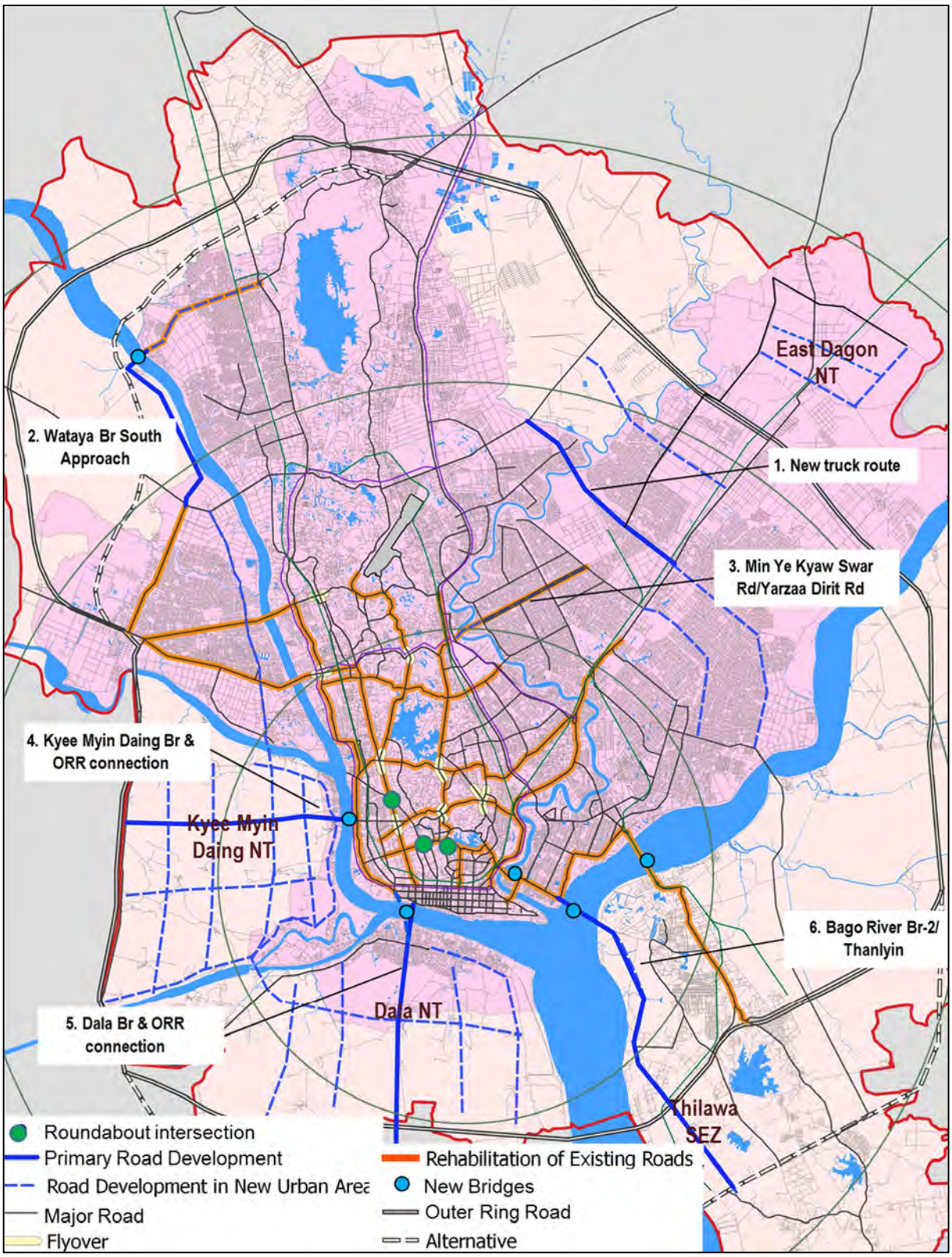
- When developing roads in urban areas, introduce alternative approaches which will not require acquisition of lands but readjustment of lands, and
- In greenfield projects, plan roads first to secure space and shoulder the cost of subsequent urban development which will follow the planned alignments. In this case, a road plan must be part of the statutory urban plan to force developers to comply.

Table 7.1.3 Proposed Urban Roads

Category	Project / Action	Timeframe
1. Asset Management	a. Preparation of a comprehensive inventory of primary/secondary roads and intersections	In 1–2 years
	b. Utilization of existing flyovers: Pyay Road from 8-mile junction to Bogyoke Aung San Street[1], Pyay Road between U Htaung Road intersection and Hledan intersection, U Htaung Bo Road–Kan Yeik Tha Street between Baho Road and Set Yone Road	Short-term
	c. Preparation of a bus stop database	Short-term
2. Rehabilitation and Minor Improvements	a. Improvement of intersections including additional flyovers / underpasses	Short-term
	b. Rehabilitation of main roads (i.e., Hlaw Ga Road, Anawratha Road, Hlaing River Road, Main Road No.6.	In 1–2 years
	c. Roundabouts in the city center: Pyay Road–Hanthawaddy Road intersection, U Wisara Road–U Htaung Bo Road intersection, Kabar Aye Pagoda Road–U Htaung Bo Road intersection.	Short-term
	d. All roads	Short-term
3. Construction of New Roads and Missing Links	a. 1. New truck route[3], 2. Wataya Bridge South Approach, 3. Min Ye Kyaw Swar Road–Yarzaa Dirit Road[3], 4. KyeeMyin Daing Bridge & ORR connection, 5. Dala Bridge & ORR connection, 6. Bago River Bridge -2 and Thanlyin Connection.	Short-term
	b. Main Road No.2, New Cargo Truck Route, Main Road No.4, Yadanar Road, Thilawa Access Road, Extension of Thilawa Access Road[4] to Thilawa Port, Kyauktan Road, Dagon Bridge–Thilawa SEZ Road.	Short-term
	c. New Thaketa Bridge[5], New Bago Bridge[6], Dala Bridge[7], Wataya Bridge, Kyi Myin Dine Bridge, Bago River Bridge 2 for Bago or Monkey Point	Short- to Medium-term
	d. East and west ring routes as new cargo truck routes	Short-term
4. Upgrading of Pedestrian Facilities	a. For all sidewalks provided along primary and secondary urban roads	Short- to Medium-term
	b. Primary and secondary urban roads in the city center on which daily pedestrian crossing exceeds 500.	Short- to Medium-term
	c. Standard 2.0-m wide sidewalk on which daily pedestrian traffic is less than 500 and 3.5 m sidewalk if more than 500.	Short- to Medium-term
	d. Primary and secondary urban roads in the city center on which daily pedestrian traffic exceeds 500.	Short- to Medium-term

Source: Study Team

[1] Flyover or underpass construction at the Parami Road–Hanthawaddy Road intersection.
[2] A flyover or underpass is required at the Pyay Road–Hanthawaddy Road intersection.
[3] Includes new bridge construction.
[4] Thilawa Access Road is an ongoing project under a JICA loan.
[5] Under construction using JICA grant.
[6] Under DD using JICA finance.
[7] Under DD using KOICA finance.



Source: Study Team.

Figure 7.1.2 Proposed Road Network Improvements

7.2 Removal of Bottlenecks

1) Overview

7.6 Because the development of an adequate road network for the entire urban area requires extensive measures, attending first to road traffic problems by corridor and area is proposed to increase traffic capacity and ensure smooth movement along major roads. In relation to this, a total of seven major corridors were surveyed to assess their current situation and problems. The survey was conducted in cooperation with the YRTA and the YCDC in January 2017.

(i) Pyay Road,
(ii) Kabar Aye Pagoda Road,
(iii) Kanner Road–Bayint Naung Road–Lower Mingaladon Road,
(iv) Yangon–Pathein Road
(v) Upper Pazuntaung Road,
(vi) Wai Za Yan Tar Road, and
(vii) Thanthumar Road–No. 2 Main Road.

7.7 The survey was conducted by teams of YCDC officials using a survey form to determine the following: (i) congestion at and around traffic-generating sources such as shopping centers and schools; (ii) structures of intersections; (iii) signal phasing; (iv) roundabouts; (v) congestion caused by boarding/alighting passengers at and around bus stops; (vi) congestion caused by waiting taxis or boarding/alighting taxi passengers; (vii) roadside parking; (viii) jaywalking; (ix) poor pavement conditions; (x) congestion on sidewalks due to vendors and parked vehicles; (xi) inadequate use of space under flyovers; (xii) unclear lane markings; and (xiii) poor road facilities.

2) Identified Bottlenecks

7.8 Identified bottlenecks are summarized in Table 7.2.1 and illustrated in figures shown on the next pages. The most major cause of bottleneck is the roadside parking due to the lack of parking space, long signal phase, disordered loading by bus/taxi were also observed at various places. Details and main outputs of the survey are included in Technical Report No.3. In addition to the findings on the survey, flood prone area could be serious bottleneck.

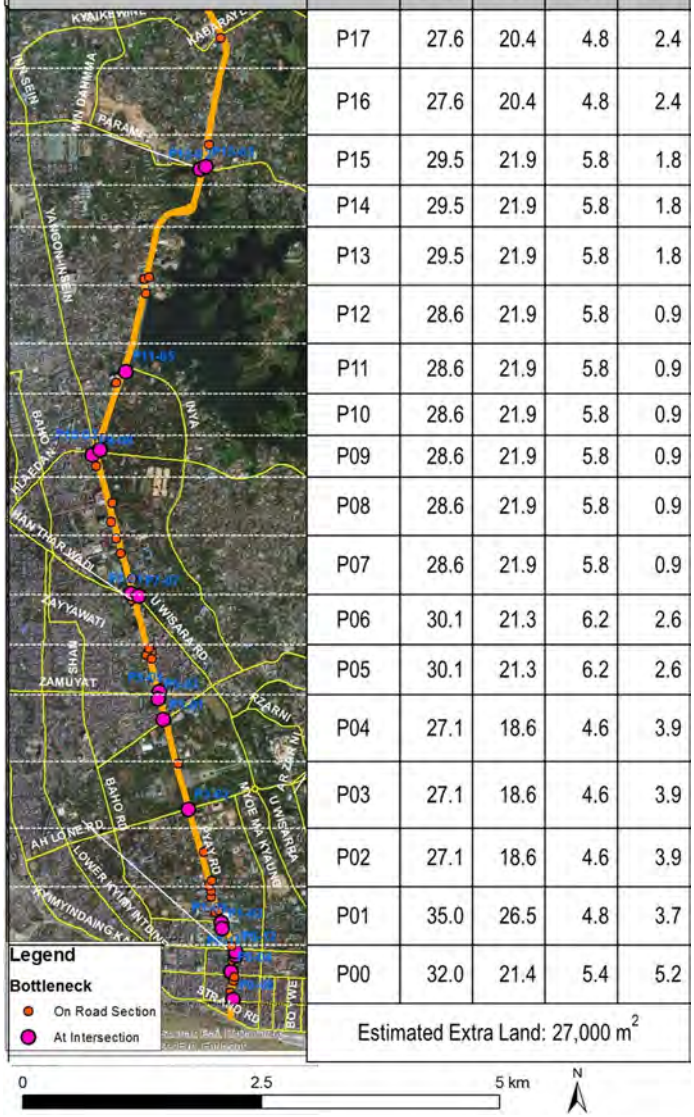
Table 7.2.1 Identified Bottlenecks by Corridor

Bottleneck		No. of Bottlenecks by Corridor (Unit: Number of Location)						
		Pyay Road	Kabar Aye Pagoda Road	Kyi Myint Daing Kannar, Bayint naung, Lower Mingalar Don Road	Yangon–Pathein Road	Wai Za Yan Tar Road	Upper Pazuntaung Road–Thanthumar Road–No.2 Main	4 Corridors in CBD
Survey Section Length (km)		11.9	12.7	23.6	5.5	8.1	16.5	20.2
Congestion at Traffic Generator		8	0	3	0	1	1	4
Congestion at Intersection	By structure of intersection	3	2	0	1	0	0	4
	By signal phase	10	10	8	9	9	0	3
	By roundabout	1	4	0	0	0	0	0
Roadside Parking		16	12	47	7	21	17	51
Loading by Bus/ Taxi	Congestion by bus	13	0	0	0	0	0	1
	Congestion by taxi	8	2	0	0	0	0	0
Walking Condition	Poor crossing conditions	6	2	3	1	0	1	2
	Jaywalking	3	4	0	0	0	0	0
	Poor pavement conditions	27	19	1	0	0	3	26
	Congestion at sidewalk	23	17	53	4	28	22	36
Others	Unused space under flyover	3	5	0	0	0	0	0
	Unclear lane markings	3	0	2	0	0	0	2
	Poor road facility	7	4	0	3	2	0	2
Total		131	81	117	25	61	44	131

Source: Study Team.

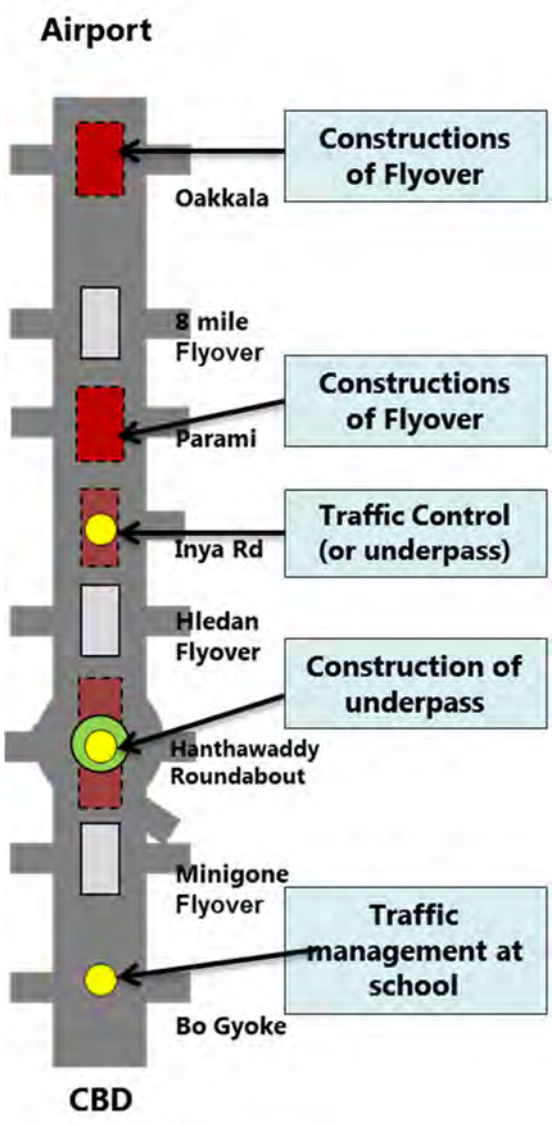
7.9 A possible solution for Pyay Road, which is one of the most significant corridors connecting Yangon Airport and the CBD, is to construct flyovers at intersections with Oakkala and Parami roads, and underpasses[1] at the intersection with Inya Road and at Hanthawaddy roundabout. With these, the corridor will avoid major bottlenecks at intersections, reducing travel time to approximately 30 minutes.

Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	P17	27.6	20.4	4.8	2.4
	P16	27.6	20.4	4.8	2.4
	P15	29.5	21.9	5.8	1.8
	P14	29.5	21.9	5.8	1.8
	P13	29.5	21.9	5.8	1.8
	P12	28.6	21.9	5.8	0.9
	P11	28.6	21.9	5.8	0.9
	P10	28.6	21.9	5.8	0.9
	P09	28.6	21.9	5.8	0.9
	P08	28.6	21.9	5.8	0.9
	P07	28.6	21.9	5.8	0.9
	P06	30.1	21.3	6.2	2.6
	P05	30.1	21.3	6.2	2.6
	P04	27.1	18.6	4.6	3.9
	P03	27.1	18.6	4.6	3.9
	P02	27.1	18.6	4.6	3.9
	P01	35.0	26.5	4.8	3.7
	P00	32.0	21.4	5.4	5.2
	Estimated Extra Land: 27,000 m^2				



Source: Study Team.
1) ROW: Right of Way, CW: Carriageway, SW: Sidewalk, EL: Extra Land

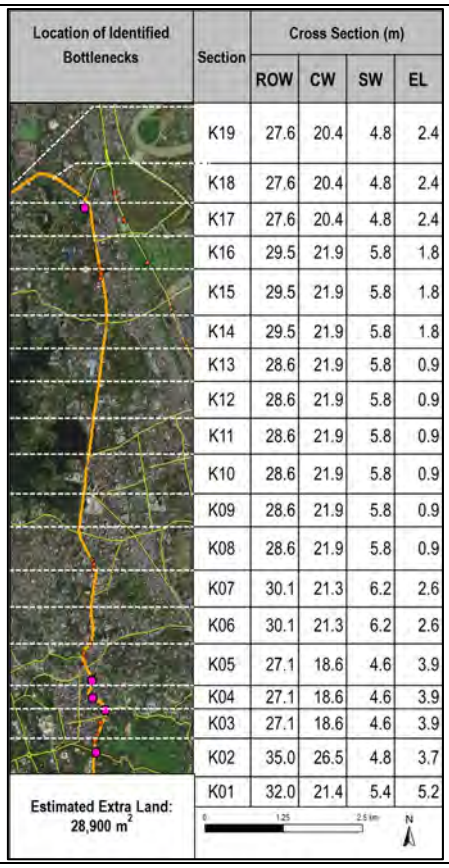
Figure 7.2.1 Identified Bottlenecks on Pyay Road and Proposed Measures



Source: Study Team.

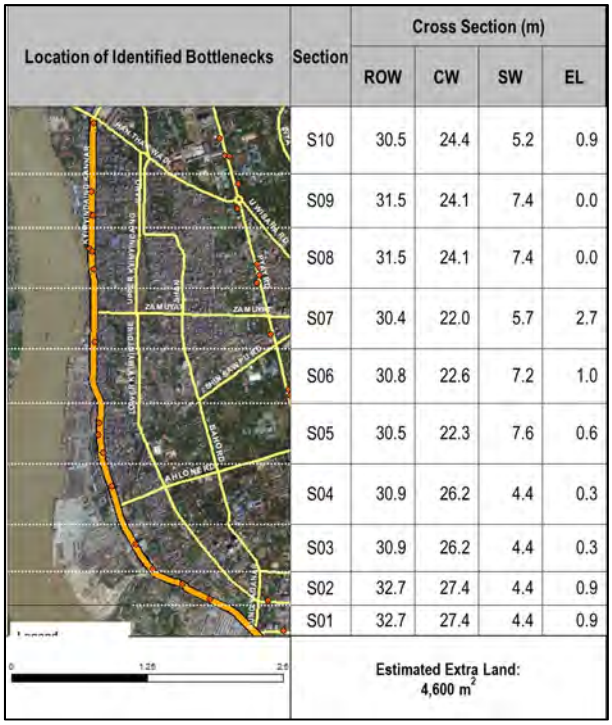
Figure 7.2.2 Proposed Concept of Making Pyay Road a Semi Access-controlled North–South Arterial Road

[1] With provision of drainage pump station



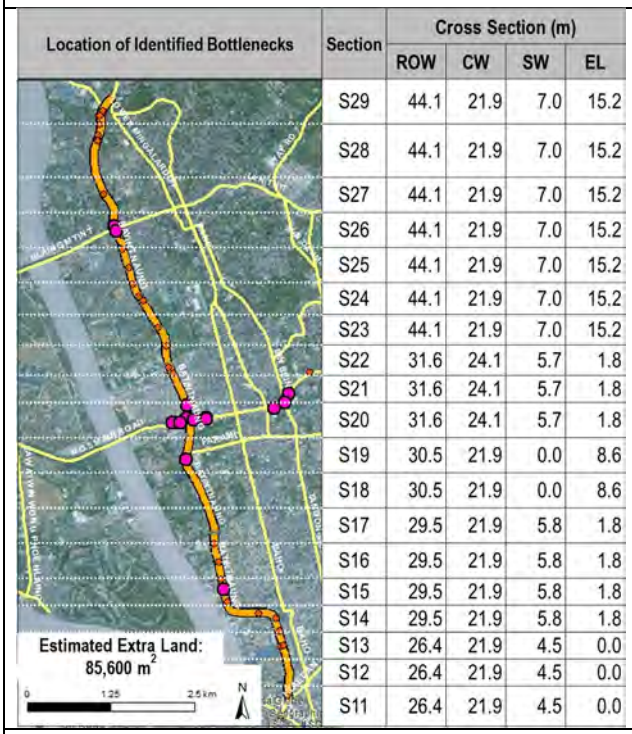
Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	K19	27.6	20.4	4.8	2.4
	K18	27.6	20.4	4.8	2.4
	K17	27.6	20.4	4.8	2.4
	K16	29.5	21.9	5.8	1.8
	K15	29.5	21.9	5.8	1.8
	K14	29.5	21.9	5.8	1.8
	K13	28.6	21.9	5.8	0.9
	K12	28.6	21.9	5.8	0.9
	K11	28.6	21.9	5.8	0.9
	K10	28.6	21.9	5.8	0.9
	K09	28.6	21.9	5.8	0.9
	K08	28.6	21.9	5.8	0.9
	K07	30.1	21.3	6.2	2.6
	K06	30.1	21.3	6.2	2.6
	K05	27.1	18.6	4.6	3.9
	K04	27.1	18.6	4.6	3.9
	K03	27.1	18.6	4.6	3.9
	K02	35.0	26.5	4.8	3.7
Estimated Extra Land: 28,900 m²	K01	32.0	21.4	5.4	5.2

Kabar Aye Pagoda Road



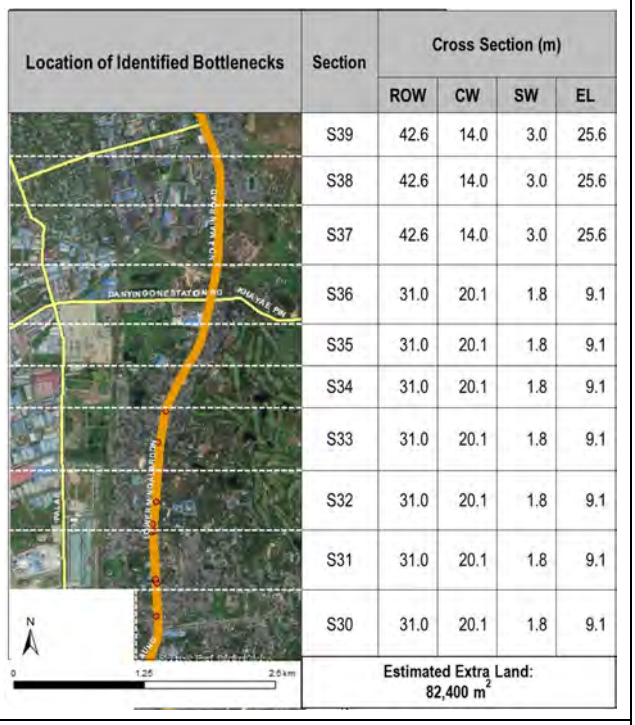
Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	S10	30.5	24.4	5.2	0.9
	S09	31.5	24.1	7.4	0.0
	S08	31.5	24.1	7.4	0.0
	S07	30.4	22.0	5.7	2.7
	S06	30.8	22.6	7.2	1.0
	S05	30.5	22.3	7.6	0.6
	S04	30.9	26.2	4.4	0.3
	S03	30.9	26.2	4.4	0.3
	S02	32.7	27.4	4.4	0.9
	S01	32.7	27.4	4.4	0.9
Estimated Extra Land: 4,600 m²					

Kyee Myint Daing Kannar Road



Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	S29	44.1	21.9	7.0	15.2
	S28	44.1	21.9	7.0	15.2
	S27	44.1	21.9	7.0	15.2
	S26	44.1	21.9	7.0	15.2
	S25	44.1	21.9	7.0	15.2
	S24	44.1	21.9	7.0	15.2
	S23	44.1	21.9	7.0	15.2
	S22	31.6	24.1	5.7	1.8
	S21	31.6	24.1	5.7	1.8
	S20	31.6	24.1	5.7	1.8
	S19	30.5	21.9	0.0	8.6
	S18	30.5	21.9	0.0	8.6
	S17	29.5	21.9	5.8	1.8
	S16	29.5	21.9	5.8	1.8
	S15	29.5	21.9	5.8	1.8
	S14	29.5	21.9	5.8	1.8
	S13	26.4	21.9	4.5	0.0
	S12	26.4	21.9	4.5	0.0
Estimated Extra Land: 85,600 m²	S11	26.4	21.9	4.5	0.0

Bayint Naung Road



Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	S39	42.6	14.0	3.0	25.6
	S38	42.6	14.0	3.0	25.6
	S37	42.6	14.0	3.0	25.6
	S36	31.0	20.1	1.8	9.1
	S35	31.0	20.1	1.8	9.1
	S34	31.0	20.1	1.8	9.1
	S33	31.0	20.1	1.8	9.1
	S32	31.0	20.1	1.8	9.1
	S31	31.0	20.1	1.8	9.1
	S30	31.0	20.1	1.8	9.1
Estimated Extra Land: 82,400 m²					

Lower Mingalardon Road

Source: Study Team.

1) ROW: Right of Way, CW: Carriageway, SW: Sidewalk, EL: Extra Land

Bottleneck
- On Road Section
- At Intersection

Figure 7.2.3 Identified Bottlenecks on Major Corridors (1)

Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	W13	41.8	20.4	1.2	20.2
	W12	31.7	18.0	7.0	6.7
	W11	37.5	18.6	7.3	11.6
	W10	30.6	29.0	1.6	0.0
	W09	30.6	29.0	1.6	0.0
	W08	30.6	29.0	1.6	0.0
	W07	30.6	29.0	1.6	0.0
	W06	30.6	29.0	1.6	0.0
	W05	32.3	28.7	2.4	1.2
	W04	28.9	23.8	4.2	0.9
	W03	28.9	23.8	4.2	0.9
	W02	33.7	28.0	4.2	1.5
	W01	30.8	29.6	1.2	0.0

Estimated Extra Land: 28,100 m²

Wizar Yan Tar Road

Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	N10	13.9	6.7	3.0	4.2
	N09	13.9	6.7	3.0	4.2
	N08	13.9	6.7	3.0	4.2
	N07	13.9	6.7	3.0	4.2
	N06	13.9	6.7	3.0	4.2
	N05	13.9	6.7	3.0	4.2
	N04	13.9	6.7	3.0	4.2
	N03	13.9	6.7	3.0	4.2
	N02	13.9	6.7	3.0	4.2
	N01	13.9	6.7	3.0	4.2
	T07	25.4	22.6	1.7	1.1
	T06	25.4	22.6	1.7	1.1
	T05	25.4	22.6	1.7	1.1
	T04	26.4	22.3	2.6	1.5
	T03	26.4	22.3	2.6	1.5
	T02	26.4	22.3	2.6	1.5
	T01	26.4	22.3	2.6	1.5

Estimated Extra Land: 31,300 m²

Thanthumar Road–No. 2 Main Road

Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	KY01	28.6	20.1	6.5	2.0
	KY02	28.6	20.1	6.5	2.0
	KY03	28.6	20.1	6.5	2.0
	KY04	28.6	20.1	6.5	2.0
	KY05	28.6	20.1	6.5	2.0
	KY06	28.6	20.1	6.5	2.0
	KY07	26.8	18.6	1.8	6.4
	KY08	26.8	18.6	1.8	6.4
	KY09	26.8	18.6	1.8	6.4
	KY10	n.a	n.a	n.a	n.a
	KY11	n.a	n.a	n.a	n.a
	KY12	n.a	n.a	n.a	n.a
	KY13	n.a	n.a	n.a	n.a

Estimated Extra Land: 20,000 m²

Yangon–Pathein Road

Location of Identified Bottlenecks	Section	Cross Section (m)			
		ROW	CW	SW	EL
	U09	23.8	21.9	1.9	0.0
	U08	27.9	21.9	2.0	4.0
	U07	31.9	21.9	2.0	8.0
	U06	30.7	21.9	4.1	4.7
	U05	31.0	21.9	2.8	6.3
	U04	28.5	21.9	3.9	2.7
	U03	31.5	21.9	4.2	5.4
	U02	32.2	24.1	2.5	5.6
	U01	28.6	24.1	4.5	0.0

Estimated Extra Land: 24,300 m²

Upper Pazuntaung Road

Bottleneck
- On Road Section
- At Intersection

Source: Study Team.
1) ROW: Right of Way, CW: Carriageway, SW: Sidewalk, EL: Extra Land

Figure 7.2.4 Identified Bottlenecks on Major Corridors (2)

7.3 Development of Missing Links in Built-up Urban Area

1) Issues

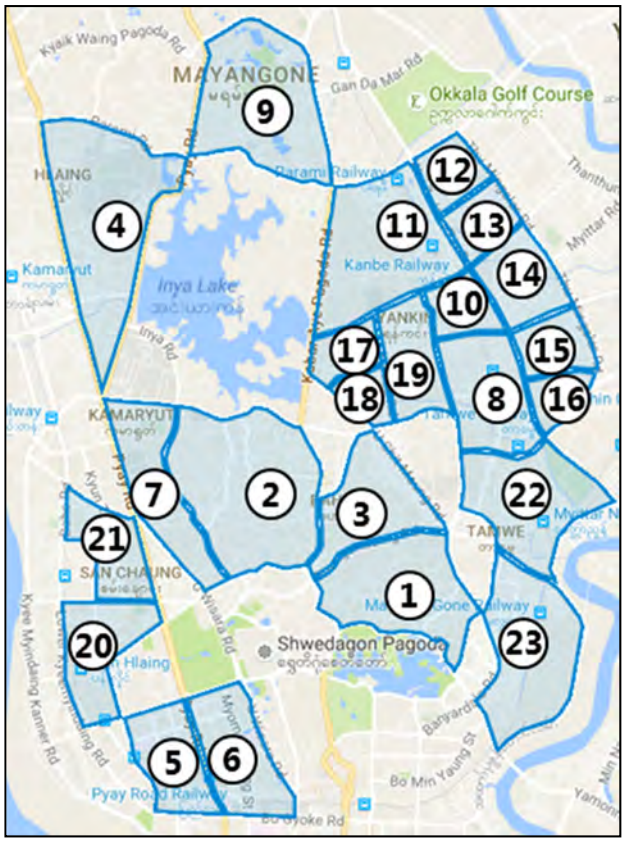
7.10 While Yangon lacks road infrastructure substantially, there are also missing links which can help connect the roads by widening or constructing relatively short road sections. However, these missing links are mostly located in built-up urban areas. It is considered difficult in terms of land adjustment, buildings of affected parties, financial constraints, and institutional arrangements, among others. Notwithstanding these current constraints, Yangon must continuously attend to the challenge to promote sustainable urban development.

7.11 Missing links in Yangon represent the following two types:

(i) **Substandard or Missing Sections of Road Network:** As shown in Figure 7.3.1, in many locations roads are not connected to each other with appropriate standards. Missing links include both substandard road sections and new links.

(ii) **Large Urban Blocks without Secondary and Distributor Roads:** Urban blocks surrounded by major roads are so large and are not provided with adequate secondary and distributor roads. As shown in Figure 7.3.1, many urban blocks are not provided with an appropriate road network, creating the following negative effects:

- People have to walk long distances to access bus routes which is a factor in the shift to cars and taxis, and
- Cars and other vehicles tend to enter major roads, amplifying traffic congestion.



ID	Area (ha)	Estimated Population	Density (no./ha)
1	178	21,191	119
2	296	13,611	46
3	131	30,536	233
4	293	45,964	157
5	108	8,021	74
6	130	8,372	64
7	146	5,249	36
8	140	15,335	109
9	182	6,471	36
10	56	5,674	101
11	186	32,064	173
12	59	16,827	285
13	59	10,938	184
14	92	18,303	198
15	63	12,077	190
16	41	8,609	211
17	47	9,048	193
18	38	8,946	233
19	64	9,438	148
20	114	36,232	317
21	90	37,042	412
22	171	30,629	179
23	201	83,110	413

Source: Study Team

Figure 7.3.1 Large Urban Areas without Proper Secondary/Distributor Roads

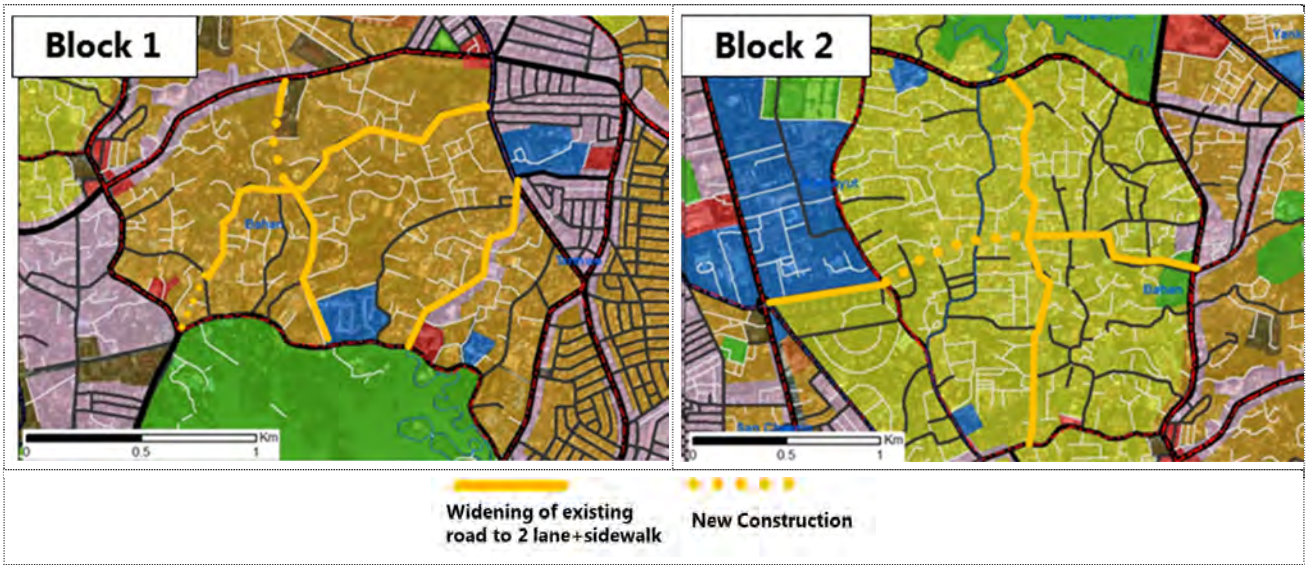
2) Objectives

7.12 The objectives of constructing the missing links are:

(i) To mitigate traffic concentration on primary roads;

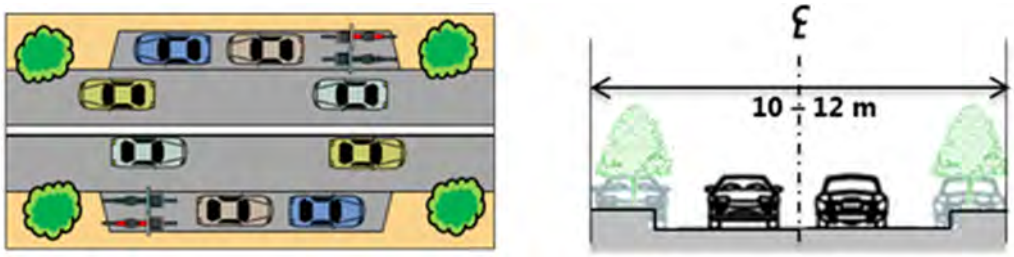
(ii) To strengthen overall network capacity; and

(iii) To improve accessibility to localities.



Source: Study Team

Figure 7.3.2 Development Concept for Existing Roads



Source: Study Team

Figure 7.3.3 Development Concept for Missing Links

3) Proposed Approach

7.13 The considered approach for constructing missing links is two-fold, i.e.:

(i) To designate right of way (ROW) in the official urban plan, and

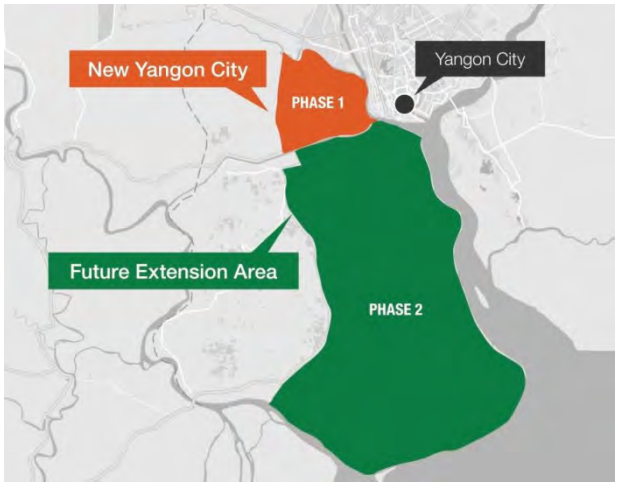
(ii) To introduce alternative methods, such as land readjustment, with the agreement of land owners along subject roads.

7.4 Development of Missing Links in New Urban Area

1) Issues

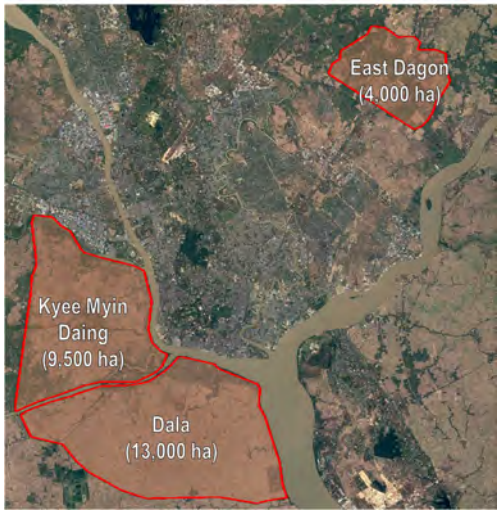
7.14 As well as the road development in built-up urban areas, road development in new urban area also should be carefully discussed to promote sustainable development. In order to distribute the urban function concentrated in the existing CBD and adjoining areas, three new towns in East Dagon, Kyee Myin Daing, and Dala are proposed to be developed in Suburbs.

7.15 To ensure the mobility and accessibility in the proposed new town, the road network with high road density should be developed. The comprehensive road systems with hierarchy. For new town projects by private developer, the construction of roads, drainage, sewage ditch, parks and other infrastructures shall be borne by the developer



Source: NYDC

Figure 7.4.1 New Yangon City Development Phase 1 and Phase 2



Source: Study Team

Figure 7.4.2 Location of New Town Projects Proposed in SUDP

2) Objectives

7.16 The objectives of constructing the road development in new urban areas are:

(i) To ensure the mobility and accessibility in the proposed new town

(ii) To strengthen overall network capacity; and

(iii) To encourage investment for urban development

3) Proposed Approach

7.17 The considered approach for constructing missing links is two-fold, i.e.:

(i) To designate right of way (ROW) in the official urban plan, and

(ii) To introduce alternative methods, such as land readjustment, with the agreement of land owners along subject roads.

7.5 Urban Expressway Development

1) Role of Urban Expressways

7.18 Mega cities need both high-quality transit network and urban expressway network. In the Transport Network, The urban expressway network consists of an Inner Ring Road (IRR), Outer Ring Road (ORR) and Radial roads for both arterial roads and expressway.

7.19 Road area to the total urban area in Yangon is only 4.5%, which is much lower than other large cities in the world. And there is significant difficulty to construct new road in built-up urban areas in terms of land adjustment, buildings of affected parties, financial constraints, and institutional arrangements. To minimize the land acquisition and resettlement in built-up area, the “elevated viaduct” structure on the existing arterial roads was proposed to extend the road capacity.

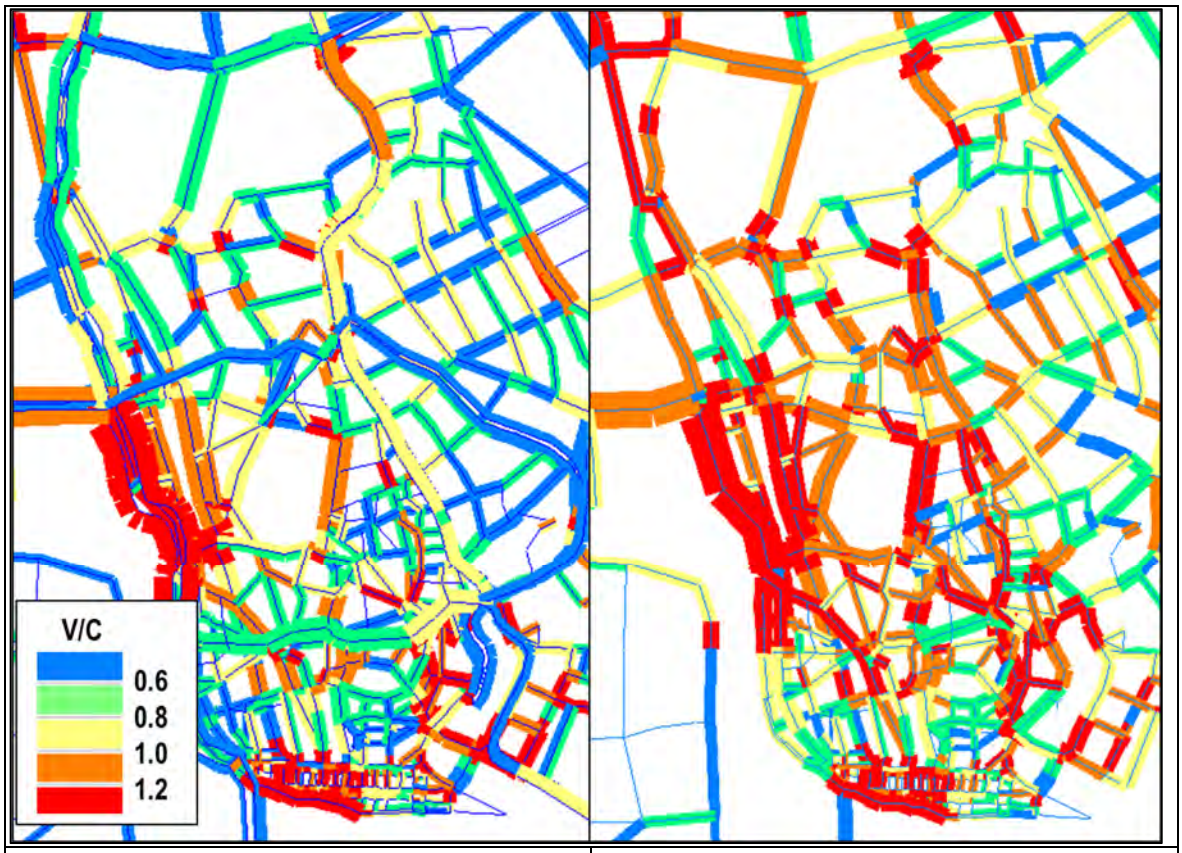
7.20 Especially, an IRR should be ideally located to improve road traffic, in particular:

(i) To absorb CBD traffic effectively;

(ii) To divert long-distance passengers and goods traffic to/from port; and

(iii) To establish efficient connectivity to Dala and the southern region via the Dala Bridge.

7.21 The IRR is proposed as an elevated toll road and as part of an integrated urban expressway network. It will comprise of the Dala Bridge and connections to Yangon–Mandalay extension, other link roads, and the outer ring road (ORR).



With Urban Expressways	Without Urban Expressways

Source: Study Team

Figure 7.5.1 Impact of Urban Expressways

2) Proposed Urban Expressway Network

7.22 In view of the limited opportunities to increase traffic capacities of at-grade urban roads, a network of expressways with controlled access is proposed. The basic objectives of expressway development in Yangon are as follows:

(i) To divert long-distance, intercity, and through traffic from urban roads which are mainly of large vehicles such as trucks and buses;

(ii) To divert north–south traffic on Bayint Naung Road–Kanner Road–Wai Za Yan Tar Road, including port traffic, to elevated expressways;

(iii) To divert CBD traffic to/from hinterland urban areas; and

(iv) To integrate emerging urban areas in Dala, Kyee Myin Daing, and Thilawa, among others.

7.23 The expressway network has a total length of 190 km and is composed of the following sections:

(i) Yangon–Bago–Hanthawaddy New Airport (36.2 km);

(ii) Yangon–Pyay (21.5 km);

(iii) Yangon–Thilawa (18.8 km);

(iv) Yangon–Hlegu (18.0 km);

(v) Yangon–Pathein (15.2 km);

(vi) IRR Western Half: Insein–CBD–Dala (19.1 km);

(vii) IRR Eastern Half: Mindak–CBD (20.2 km);

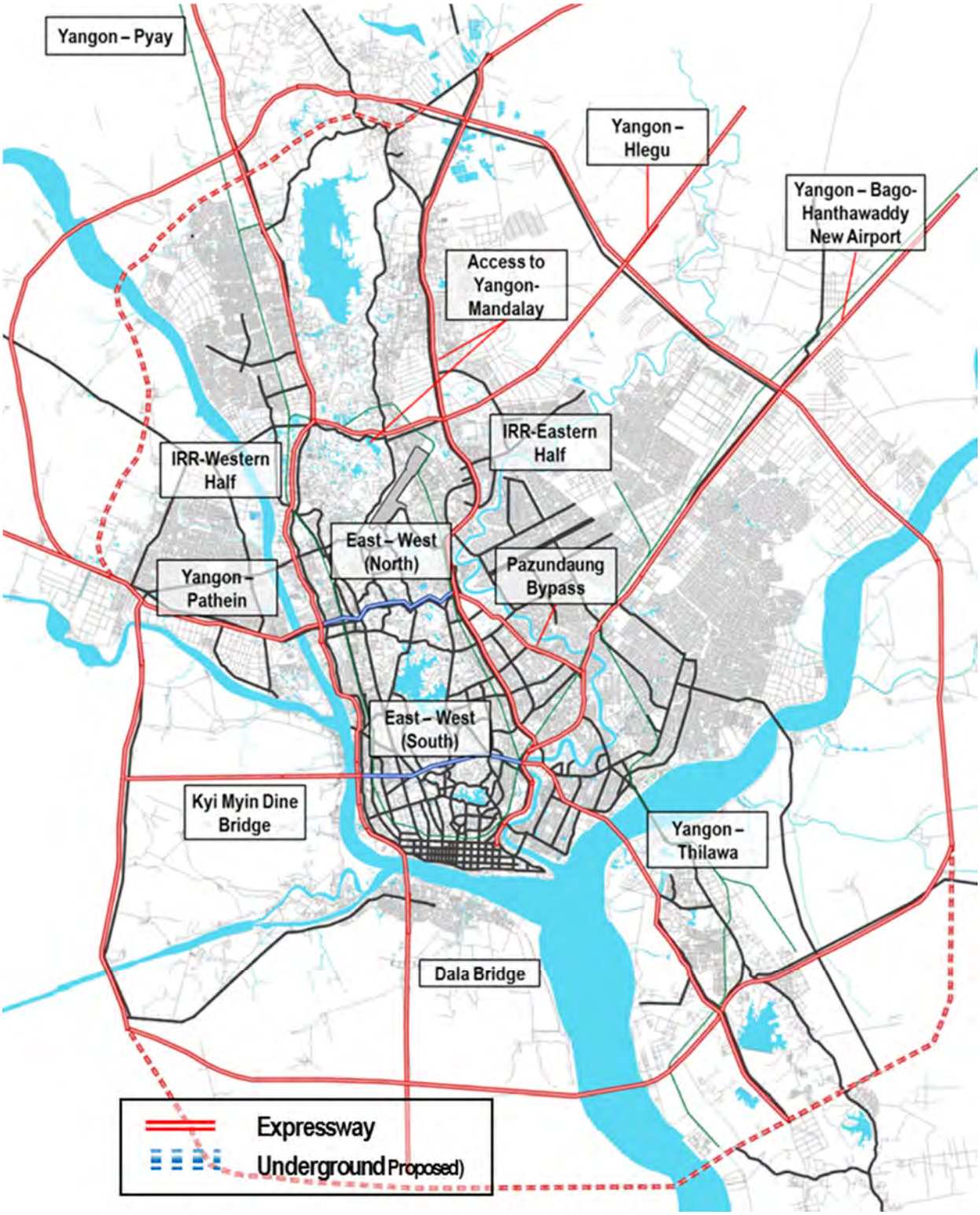
(viii) Access to Yangon–Mandalay Expressway (21.3 km);

(ix) Pazundaung Bypass (6.4 km);

(x) Northern East–West Smart Tunnel (6.3 km); and

(xi) Southern East–West Smart Tunnel (6.9 km).

7.24 The International Finance Corporation (IFC), a member of the World Bank Group, promotes private sector investment on the urban expressway network. The PPP-F/S is on going as of July 2018.



Source: Study Team

Figure 7.5.2 Proposed Urban Expressway Network

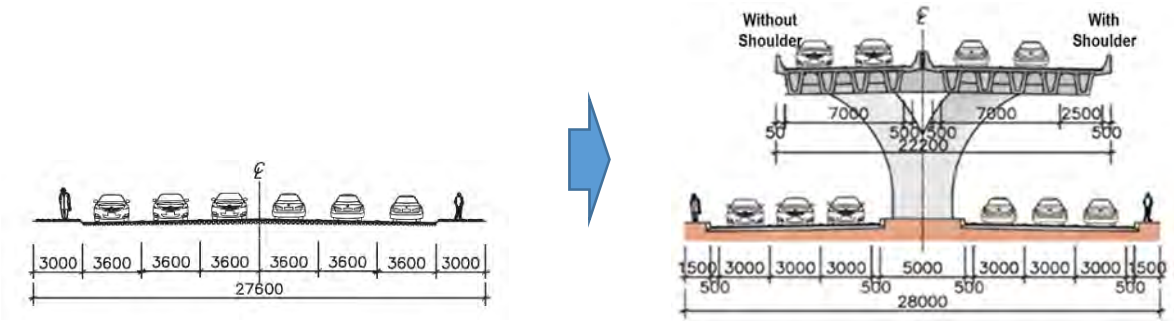
3) Basic Design Concept

(1) Elevated / Underground Section

7.25 As the design standards in Myanmar specify the width of lane to be 3.75 m, the same applies to the inner city of Yangon. Meanwhile, in the United States and other countries recently, road widths in urban areas tend to be narrower. Therefore, it is appropriate to apply this model of urban road standards in the city of Yangon. On the basis of this, the optimization of road width (i.e., 3.6 m →3.0 m) can be applied to the construction of viaducts and waiting lanes for left-turning vehicles, etc.

Consequently, the plan proposes the construction of viaducts which can secure the same number of lanes as existing roads have and minimize widening of roads, i.e., land acquisition. The basic concept of developing the urban expressway proposed in YUTRA-YUEX is summarized below.

7.26 Besides, expressways should have a minimum number of ramps to balance performance and cost for target vehicles, mainly those traveling long distances. Additionally, in order to minimize the space for ramps, straight ramps are recommended in general. On routes where the construction of expressways impedes viaduct structures, e.g., the planned expressway from east to west, the construction of tunnels can be an alternative.



Existing Road　　Existing Road + Inner Ring Expressway [1)]

Source: Data collection survey for the Yangon Urban Expressway (YUEX) Project.
1) 2.5m width of the road shoulders on the expressway is provided along the alignment for emergency parking and road operation and maintenance services. The road shoulder could be omitted by the provision of the parking bay (lay-bay space) with certain intervals (i.e. 200 m)

Figure 7.5.3 Urban Expressway Concept for Wai Za Yan Tar Road Section

7.27 The table below shows the proposed standards for the geometric structures of the YUEX at pre-FS level and those stipulated by the Ministry of Construction of Myanmar.

Table 7.5.1 Basic Design Plan for the YUEX

Item	Section	Standard in Myanmar	Proposed
Design Speed	Expressway	80 km/h	80 km/h (mainline) 60 km/h (junction) 40 km/h (interchanges)
	Arterial Road	55–72 km/h	55–72 km/h
Width of Carriageway	Expressway	3.6 m	3.5 m
	Arterial Road	n/a	3.0 m (urban area)
Number of Lanes	Expressway	n/a	Determined by traffic analysis
	Arterial Road	Minimum 4 lanes	Minimum 4 lanes
Minimum Curve Radius	Expressway	Not clearly specified. The design standard of PWD is now under revision.	350 m
	Arterial Road		Varies
Width of Shoulders	Expressway		2,5 m (outer) / 0.5 m (inner)
	Arterial Road		0.5 m
Vertical Clearance		16.5 feet	5.0 m

Source: Data Collection Survey for the Yangon Urban Expressway (YUEX) Project.

(2) Tunnel Section

7.28 In case of narrow widths and problematic alignments of existing roads especially when in comes to locations of the base of viaducts, tunnel structures should be considered as an option at the feasibility study stage to minimize the effect on the ground and the longitudinal flow of traffic.

7.29 For an examination of the tunnel structure, this section provides an overview of advanced examples such as the SMART Project (Stormwater Management and Road Tunnel Project) implemented in Kuala Lumpur2. Prior to the construction of this tunnel, there were frequent floods as a result of urbanization which also hindered the expansion of the river. At the same time, there was road congestion with the increase in traffic volume. Through the SMART Project, whose primary objective was to control flooding in the city, the construction and operation of the underground tunnel for both of flood control also mitigated congestion This tunnel has a three-layer structure: Under ordinary usage, the upper two layers serve as motorway (only for regular-sized vehicles). The lowest level functions as water conveyor.

7.30 This structure that such a plan for storm-water retention tank in the upstream and a stilling pool in the downstream should be examined at the stage of adopting expressway tunnels with a flood-preventive function. The attenuation ponds to reduce the flood water level at the corridor preventing spillover should be carefully selected.

[2] http://smarttunnel.com.my/

4) Operation and Management

(1) Organizational Structure

7.31 For the development of the expressway network, the following describes items to be expected and considered:

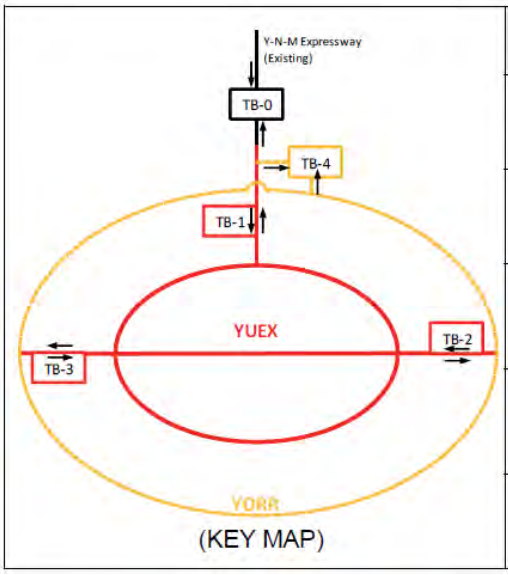
7.32 In view of efficient management and measures implemented by administrative agencies and user-friendliness, integrated operation within ORR of urban expressway considering interoperability is indispensable regardless of embodiment of the construction, e.g., classification of PPP. In order to realize this, an organizational structure for the urban expressway company should be established under the YRTA. Supervising relevant organizations will enable coordination with other projects regarding routes, construction, maintenance, and management.

Source: Study Team

Figure 7.5.4 Organizational Structure for the Urban Expressway Company

(2) Toll System

7.33 The following shows a proposal on the toll system, wherein a flat rate is applied to YUEX.



Toll Barriers	Function of Booths		Mode of Tariff
	Ticketing	Payment	
TB-0	IN Booths	OUT Booths	Distance/Area (Y-N-M Expressway)
TB-1	-	IN Booths (YUEX)	Flat (YUEX)
TB-2	IN Booths (YORR)	IN Booths (YUEX) & OUT Booths (YORR)	Distance/Area (YORR) Flat (YUEX) (IN Booths of YUEX and OUT Booths of YORR could be integrated.)
TB-3			
TB-4	IN Booths (YORR)	OUT Booths (YORR)	Distance/Area (YORR)

Source: Data collection survey for the Yangon Urban Expressway (YUEX) Project.

Figure 7.5.5 Toll Collection Plan for the YUEX

7.34 The table below compares the features of toll systems. Evaluation of each system varies according to usage, management system, introduction of ITS, etc.

Table 7.5.2 Comparison of Toll Systems

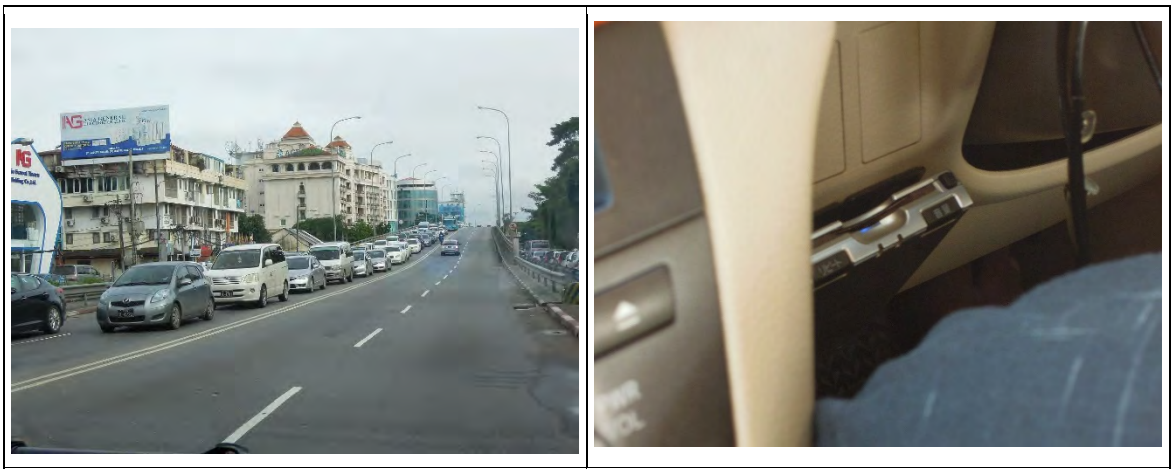
Toll System	Advantage	Disadvantage
1. Flat Rate	• Simple toll management • Toll collecting facility installed only at entrance (required stop once)	• Sense of unfairness disproportioned to the driving distance • Vulnerability for expansion of road network and flexible toll management
2. Distance-based Rate	• Sense of fairness proportioned to the driving distance • Expansibility for expansion of road network and flexible toll management	• Complicated toll management • Toll collecting facility installed at entrance and exit (required stop twice)

Source: Study Team

(3) Intelligent Transport Systems

7.35 In Myanmar, there are many second-hand Japanese cars, not yet worn out, which have retained their on-board units (OBUs) for electronic toll collection (ETC) or vehicle information communication system (VICS). This means that these vehicles are prepared for the introduction of ITS in Yangon, and when the infrastructure part is ready, it may be easier to introduce ITS of the same standard/ degree as those used in Japan. However, there are some difficulties to practically utilize due to the issues such as cryptography implemented to the Japanese ETC unit.

7.36 Furthermore, exclusive lanes for such vehicles for toll collection on expressways could be considered.



Source: Study Team

Figure 7.5.6 Popularization of Japanese Vehicles and ITS

7.37 One of the current global trends is the use of autonomous cars, which will be first introduced in access-controlled expressways. In view of such advanced technology and in preparation for the introduction of ITS, efficient operation of expressways through the adoption of existing ITS technologies should be considered in this study.

7.6 Development of Outer Ring Road [3]

1) Role of Outer Ring Road

7.38 Yangon is expanding outward and various developments are proposed in the suburban area. In particular, the urbanization of Thilawa area is remarkable. And Outer Ring Road (ORR) is positioned as both of interurban corridor and urban corridor.

(i) **As Interurban Corridor:** Thilawa area having Thilawa Port and Thilawa SEZ located in the Greater Yangon is the south end of North-South Corridor as well as the west end of East-West Economic Corridor in Asian Economic Corridors. Both corridors are the two of most important corridors for Myanmar economy, and thus early implementation between Y-M Expressway and Dala area is necessary.

(ii) **As Urban Corridor:** Traffic demand of southern part between Thilawa and Dala areas on YORR is expected to be increased depending on the development of Dala area.

2) Implementation Phase

7.39 To develop as interurban corridor and urban corridor, the Eastern Section which runs from the existing Yangon-Mandalay expressway through the Thilawa SEZ along the No.7 Road to Dala crossing the Yangon River is positioned as the priority project and “The Project Formulation Study for Construction of the Yangon Outer Ring Road (Eastern Section) in the Republic of the Union of Myanmar, March 2017” was conducted by MLIT in 2016-2017. Demand of southern part between Thilawa and Dala areas on YORR depends on the development of Dala area. and the project cost is huge compared with the length of this section. Therefore, Eastern Section was divided into two phases; Section from Y-M Expressway to Thilawa area will be constructed by 2024 in Phase 1, while Section 2 from Thilawa to Dala area will be constructed by 2035 in Phase 2.

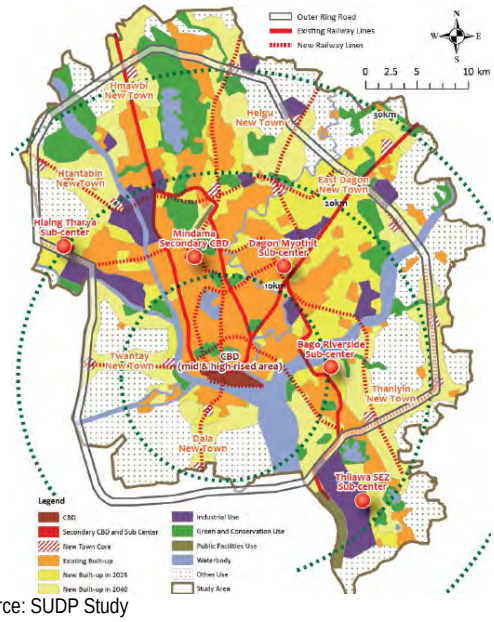
Source: Study Team,

Figure 7.6.1 Phasing Development Plan of ORR

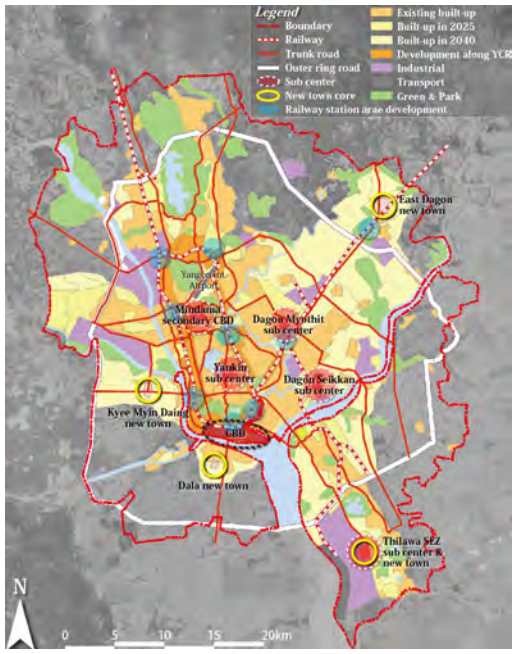
[3] The Project Formulation Study for Construction of the Yangon Outer Ring Road (Eastern Section) in the Republic of the Union of Myanmar, March 2017

3) Proposed Cross Section of ORR

7.40 In YUTRA Study, landuse and spatial development plan in SUDP proposed to allocate urban centres along Outer Ring Road. However, the spatial development plan was modified in updated SUDP study and Only East Dagon Newtown and Thilawa SEZ are proposed along the Eastern Section of ORR (See Figure 7.6.2).



Source: SUDP Study

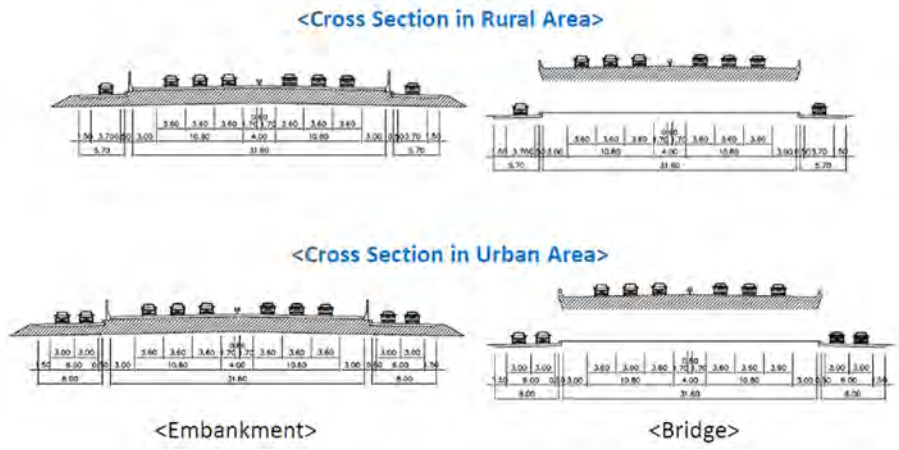


Source: Updated SUDP Study Team

SUDP (2013) Updated SUDP (2016)

Figure 7.6.2 Proposed Urban Spatial Structures

7.41 In the point of view, the Eastern Section of ORR is recommended to ensure traffic function and disordered development along ORR should be controlled. In Pre-F/S on the Eastern Section of ORR, the cross section is proposed to be expressway with service road as shown in Figure 7.6.3. The constriction of other sections will be far future. And large scale development projects are proposed in Dala, Kyee Myin Daing. It may be possible to construct arterial roads with future space for the expressway as proposed in YUTRA Study.



1) At the initial stage, construction of 4 lanes of expressway is proposed to minimize the initial construction cost.
Source: The Project Formulation Study for Construction of the Yangon Outer Ring Road (Eastern Section) in the Republic of the Union of Myanmar, March 2017

Figure 7.6.3 Phasing Development Plan of ORR

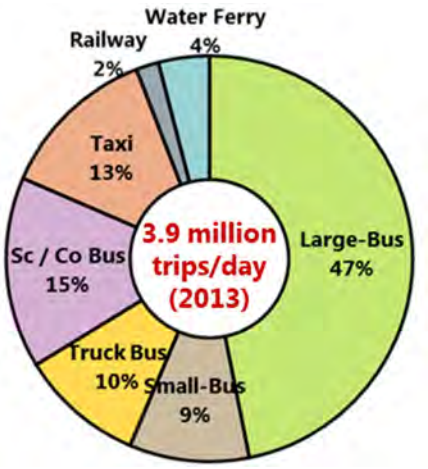
8 PUBLIC (BUS) TRANSPORT

8.1 Public Transport System in Yangon

1) Overview

8.1 Based on results of the comprehensive traffic survey conducted in 2013 in YUTRA Study, it was estimated that the total number of public transport passenger was 3.9 million a day, of which large bus shared 47%, followed by truck bus (10%) and small bus (9%). Public bus shared a total of 60% or 2.6 million passengers of the total demand (see Figure 8.1.1). Private bus, such as school bus and company bus, shared 15%, while railway and water ferry shared 2% and 4%, respectively. Taxi shared 13%, although the share has increased since 2013 as motorization has made rapid progress.

8.2 The most significant change since 2013 is the active intervention of the Yangon Region Government in strengthening the public transport system which comprises bus, circular rail, and water transport. The most notable improvement is the drastic reform of the bus industry and the bus system into Yangon Bus Service (YBS), which commenced in January 2017 and covers the introduction of new buses, improvement of bus facilities, reorganization of bus operators, restructuring of bus routes, and introduction of ICT. The circular rail, which is expected to complete its upgrading by 2023, is estimated to carry 200 thousand to 300 thousand passengers. The expansion of water transport is ongoing with private sector participation. Studies are also underway to further strengthen the circular rail through grade separation, upgrading of suburban commuter lines, and development of metro lines. The Government is committed to maintaining public transport share at a high level and quality.



Source: YUTRA Person Trip Survey (2013)

Figure 8.1.1 Modal Share of Public Modes in Yangon in 2013

2) Future Outlook

8.3 While future demand is estimated to increase substantially, there is a concern that private car use will increase at a much faster rate than other transport modes, as have been commonly experienced in other big cities in Asia during the process of urbanization associated with economic growth. As is summarized in Table 8.1.1, the demand for motorized travel will increase from 53.7% of all trips in 2016 to 70.1% by 2035.

Table 8.1.1 Estimated Travel Demand in 2016 and 2035

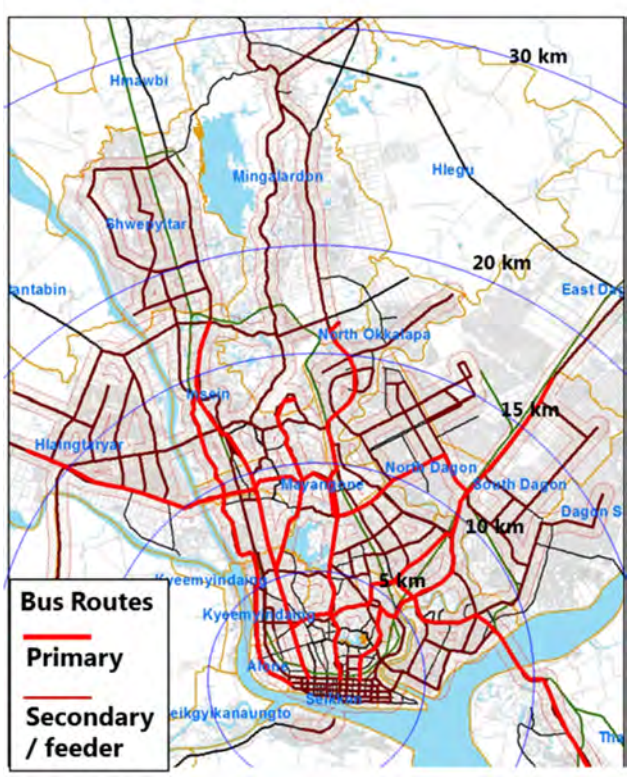
Trip	Mode	2016			2035			Growth (35/16)
		No. (000/day)	Share (%)		No. (000/day)	Share		
			Subtotal	Total		Subtotal	Total	
Non-motorized Trip	Walk	4,624	80.9	37.5	5,375	80.9	24.2	1.16
	Bicycle	1,091	19.1	8.8	1,268	19.1	5.7	1.16
	Subtotal	5,715	100	46.3	6,643	100	29.9	1.16
Motorized Trip	Motorcycle	357	5.4	2.9	550	3.5	2.5	1.54
	Car	1,118	16.9	9.1	4,186	26.8	18.8	3.75
	Taxi	1,019	15.4	8.3	2,280	14.6	10.2	2.24
	Public (Bus & Rail)	4,132	62.4	33.5	8,591	55.0	38.6	2.08
	Subtotal	6,625	100	53.7	15,608	100	70.1	2.36
Total		12,340	–	100	22,251	–	100	2.40

Source: Study Team

8.2 Reform of Bus System in Yangon

1) Previous Bus Service

8.4 The public bus network covers almost all of Yangon, but the quality of service and safety is low. The following figure shows the public bus network at the end of 2016.



Source: Study Team

Figure 8.2.1 Yangon Bus Network Before Restructuring

8.5 The Yangon Region Government took a small step in improving the bus transport system by launching three BRT Lite routes in partnership with the private sector in February 2016. And this represented a significant break from the past. This was followed by the establishment of the Yangon Regional Transport Authority (YRTA) in July 2016, a new management authority to regulate public transport. By the beginning of 2017, the Yangon Region Government completely restructured the public bus network and management and launched the Yangon Bus Service (YBS). This marked the beginning of significant changes in the public bus system of Yangon.

8.6 While previously the regional government had avoided putting money into bus transport, it has now allocated a large portion of its limited budget to improving public transport. This is nothing short of a capital subsidy. It is a slippery slope that could worsen the fiscal position of the Yangon Region Government, unless this subsidy is calibrated with major reforms of the bus transport industry along a sustainable path. Otherwise, the investment will not reap dividends, but increasing losses.

8.7 The main challenge was how to eradicate the following negative image of buses on roads:

(i) The general perception is that bus drivers lack discipline largely due to their penchant for competing against each other, whether belonging to the same company or not. This street competition for passengers is a result of the fragmented structure of the industry which compensates drivers through payment of commissions. Although the recent changeover to the

YBS and a salary-based system are supposed to fix this problem, it remains to be seen whether bus drivers' discipline will dramatically improve in the short term;

(ii) The traffic impact of bus operations is another issue. They tend to race to the next bus stop to overtake other buses and dwell at stops for a very long time to pick up as many passengers as possible, although the attitude has been improving lately; and

(iii) Nearly all of the vehicles in service were very old but new buses are being fielded to replace them.

8.8 From lessons on bus reform in other cities, the key factors for success in converting the preceding negatives into positives are the following:

(i) Strong political leadership at the local or city level to start and sustain the reform process;

(ii) A strong local institution—a role expected from the recently operational YRTA—that will be responsible for route planning, performance monitoring, support infrastructure;

(iii) Passenger feedback as part of the quality control mechanism;

(iv) Rapid deployment of modern technologies for bus management (e.g., GPS-based vehicle tracking, a unified smart card fare collection system, and central control center); and

(v) Need for calibrated subsidies up front, considering that fares are set too low against the high cost of procuring modern bus assets.

2) Restructuring of the Buses and Launch of Yangon Bus Service

8.9 As mentioned in the previous section, in July 2016, the Yangon Region Government formed the Yangon Region Transport Authority (YRTA) to replace the existing bus regulator, Ma Hta Tha (formally known as the Central Supervisory Committee for Motor Vehicles)[1]. The Ma Hta Tha had controlled the city's buses for more than 50 years and had built up a bad reputation for inefficient management as well as being subject to allegations of corruption in almost every aspect of its operation.

8.10 A month later in August 2016, the Yangon Region Chief Minister U Phyo Min Thein unveiled plans to introduce a new public bus system by January 2017.[2] On 17 January 2017, the Yangon Region Government launched the new public bus network called the Yangon Bus Service (YBS)[3], and the following major actions were taken[4]:

(vi) Dissolution of the Ma Hta Tha (Central Supervisory Committee for Motor Vehicles) as the bus regulator and operationally replaced by the YRTA;

(vii) Rationalization of more than 300 bus routes in Yangon to about 80 (as of January 2017);

(viii) Replacement of commission-based payments for bus drivers and conductors (which encouraged overcrowding on buses and unsafe driving) with monthly salary payments;

(ix) Establishment of eight companies under the management of the YRTA to replace the existing system where many companies and individuals owned bus vehicles and bus lines. (Previously, vehicles were owned by individuals with some owners operating as few as two or three buses).

[1] Soe, H. (2017). Breaking Yangon's gridlock. Frontier Myanmar. Retrieved 18 April 2017, from http://frontiermyanmar.net/en/breaking-yangons-gridlock
[2] Soe, H. (2017). Yangon transport authority flags delay to bus network reforms. Frontier Myanmar. Retrieved 18 April 2017, from http://frontiermyanmar.net/en/yangon-transport-authority-flags-delay-to-bus-network-reforms
[3] Soe, H. (2017). Testing times on the buses. Frontier Myanmar. Retrieved 18 April 2017, from http://frontiermyanmar.net/en/testing-times-on-the-buses
[4] Myint, S. (2017). Yangon's new bus service is a bold challenge to vested interests. Frontier Myanmar. Retrieved 18 April 2017, from http://frontiermyanmar.net/en/yangons-new-bus-service-is-a-bold-challenge-to-vested-interests

The eight companies are: Omni Focus Co., Ltd., Bandoola Transportation Co., Ltd., Yangon Public Bus Co., Ltd., Yangon Urban Public Transportation Co., Ltd., Power Eleven Co., Ltd., Sanwaila and San Raung Ni Co., Ltd., City Liner Bus Public Co., Ltd., and Golden South District Co., Ltd. The company structure of these companies are as follows:

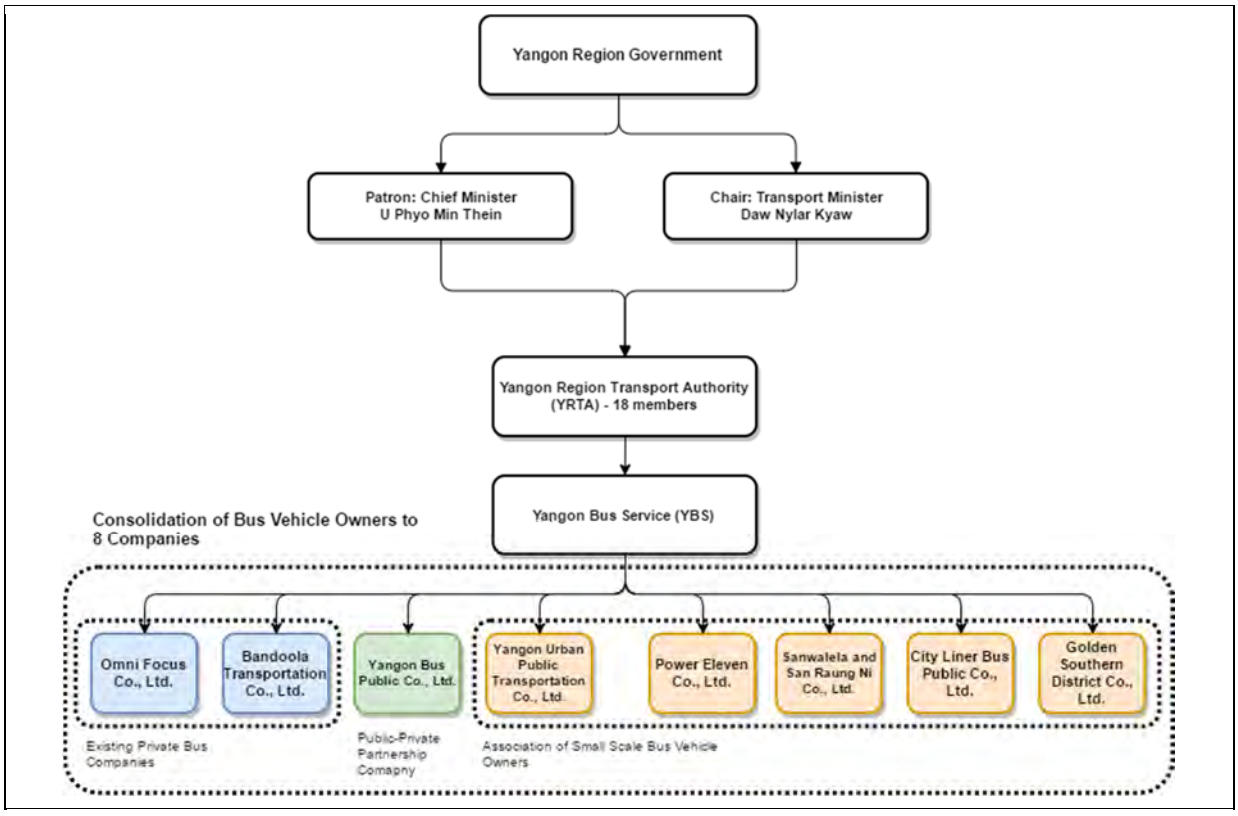
- One (1) public-private partnership company, namely, Yangon Bus Public Co., Ltd.,
- Two (3) existing private bus operators (from the previous system), namely, Yangon Urban Public Transportation Co., Ltd., Omni Focus Co., Ltd., Bandoola Transportation Co., Ltd.; and
- Four (4) associations of small-scale bus vehicle owners, namely, Power Eleven Co., Ltd., Sanwaila and San Raung Ni Co., Ltd., City Liner Bus Public Co., Ltd. And Golden Southern District Co., Ltd.

(x) Fares changed from MMK50 to MMK100 to flat fares of MMK100 for the three CBD loop routes and MMK200 for all other routes (as of January 2017);

(xi) Retirement of old bus vehicles (those built before 1996); and

(xii) Eventual change in payment of fares from cash to smartcards within months of the launch of the Yangon Bus Service (January 2017) to reduce problems of corruption among bus conductors.

8.11 The organizational chart for the Yangon Bus Service is shown in Figure 8.2.2



Source: Study Team, Soe, H. (2017). Testing times on the buses. Frontier Myanmar. Retrieved 18 April 2017, from http://frontiermyanmar.net/en/testing-times-on-the-buses

Figure 8.2.2 Organizational Chart of Yangon Bus Service as of January 2017

8.12 However, the rollout of the new Yangon Bus Service has been anything but smooth. The major problem has been the lack of buses. In the old system, there were about 6,000 vehicles (including standard buses, minibuses, and Dyna/Hilux buses); but in the new system, only 4,000 vehicles (as of 9 February 2017) became available because many were taken out of service permanently due to old age and poor condition. Also, some owners who were involved in the old system were unhappy with the reforms and refused to cooperate. Around 1,000 bus vehicles became available in July as the YRTA utilizes a USD44 million funding allocation from the Yangon Region Government [5].

Table 8.2.1 Reorganized Bus Operators (As of February 2017)

Group	Operators	Remarks	Current Status (As of October 2018)
1	YUPT	Previously known as "Ma Hta Tha, Myo Twin"	
2	YBPC	Previously known as "BRT-Lite"	
	Shwe Myo Daw		Stop its operation
	Myaut Pine Thar		Stop its operation
3	Bandoola	Previously known as "Parami"	
4	Omni Focus		
	Trans Link		
5	Power Eleven	Previously know as "45"	
	Ever Green		Consolidated as “Lucky Family, Shwepytahr Thar, Ever Green”
	Lucky Family		
	Shwe Pyi Tha Tharr		
6	SRT		Renamed as “YBS 31”
	San-wai-la		
	Northern District	Previously known as "Ma Hta Tha"	
	Khit Thit Bayint Naung	Previously known as "Ma Hta Tha, Western District"	
	Shwe Inwa		Renamed as “Shwe Lan Khin”
7	Future		Stop its operation
	City Liner		
8	Shwe Southern District	Previously known as "Ma Hta Tha"	
	Khone Baung Yangon		
	Htet Myat Thu		Renamed as “Golden Southern”

[5]https://www.mmtimes.com/national-news/yangon/26970-new-bus-fleet-to-improve-service.html
http://www.mizzima.com/news-domestic/ybs-inks-deal-yutong-purchase-1000-city-buses

Table 8.2.2 Bus Operators in YBS (As of October 2018)

Company		No. of Routes	Number of Owned buses	Average Number of buses Daily Operated	Operating Rate [1)]
001	Bandula	5	244	213	87%
002	YUPT	19	1230	975	79%
003	Yangon Bus Public Co.,Ltd	8	546	464	85%
004	Yangon Nothern Taikkyithar	1	84	57	68%
005	Omini Focus General Service Public Co.,Ltd	8	464	307	66%
006	Power Eleven Public Co.,Ltd	3	225	158	70%
007	Ever Green Lucky Family (65)	2	198	123	62%
008	Shwe Lan Khin	1	70	61	87%
009	Sanwaila	1	50	34	68%
010	Holiest Vim	4	174	114	66%
011	GYCT Co.,Ltd	10	696	344	49%
012	Khit Thit Bayint Naung	11	606	425	70%
013	Golden Southern	10	749	423	56%
014	Kong Baung	2	170	129	76%
015	Trans Link Co.,Ltd	2	60	54	90%
016	City Liner Co.,Ltd	1	16	8	50%
017	Rapid City	8	323	168	52%
018	People Partner	5	265	241	91%
019	YBS (22)	1	101	71	70%
020	YBS (31)	1	41	19	46%
021	YBS (33)	1	55	42	76%
022	YBS (45)	1	25	23	92%
023	YBS (63)	1	28	25	89%
024	YBS (73)	1	11	5	45%
025	YBS (76)	1	46	32	70%
026	YBS (79)	1	85	39	46%
027	YBS (80)	1	19	15	79%
Total		101*	6,581	4,569	69%

1)Average number of buses daily operating / number of owned buses

Source: YRTA

3) Initial Assessment of Yangon Bus Service

8.13 After the Yangon Bus Services (YBS) was launched, the Study Team conducted a bus passenger interview survey to gauge bus users' opinion with regard to the new bus service. By April 2017 or three months after the launch of the YBS, 2,400 bus passengers had been interviewed. Survey results are shown in Figure 8.2.3.

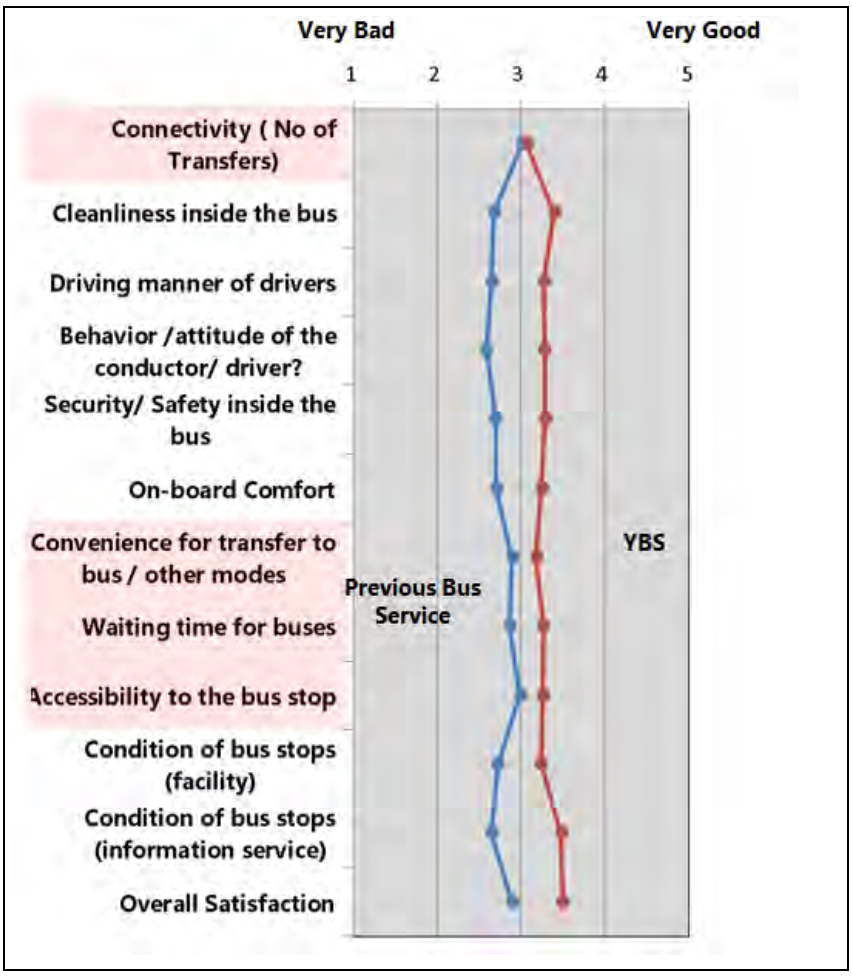
8.14 Results show that the overall satisfaction with the bus service increased after the YBS replaced the previous bus service. However, the users' opinion survey also shows that there are some aspects of the bus service that barely improved, to wit:

(i) Comfort in transferring to buses/other modes (number of transfers);

(ii) Convenience in transferring to other modes;

(iii) Waiting time; and

(iv) Accessibility of bus stops.



Source: Study Team
Note: Respondents totalled 2,400 bus users.

Figure 8.2.3 Bus Users' Opinion about Yangon Bus Service 3 Months After Launch

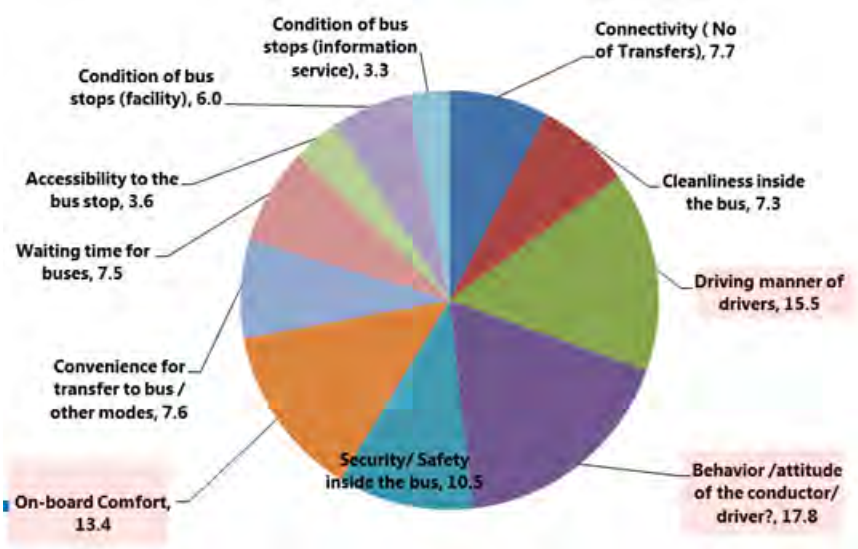
8.15 Bus users were also asked about the most important aspect they would like to see with regard to bus service improvement. Results are shown in Figure 8.2.4. The top three priority measures from bus users are as follows:

(i) Behavior/Attitude of conductor/driver (17.8%);

(ii) Driving manner of drivers (15.5%); and

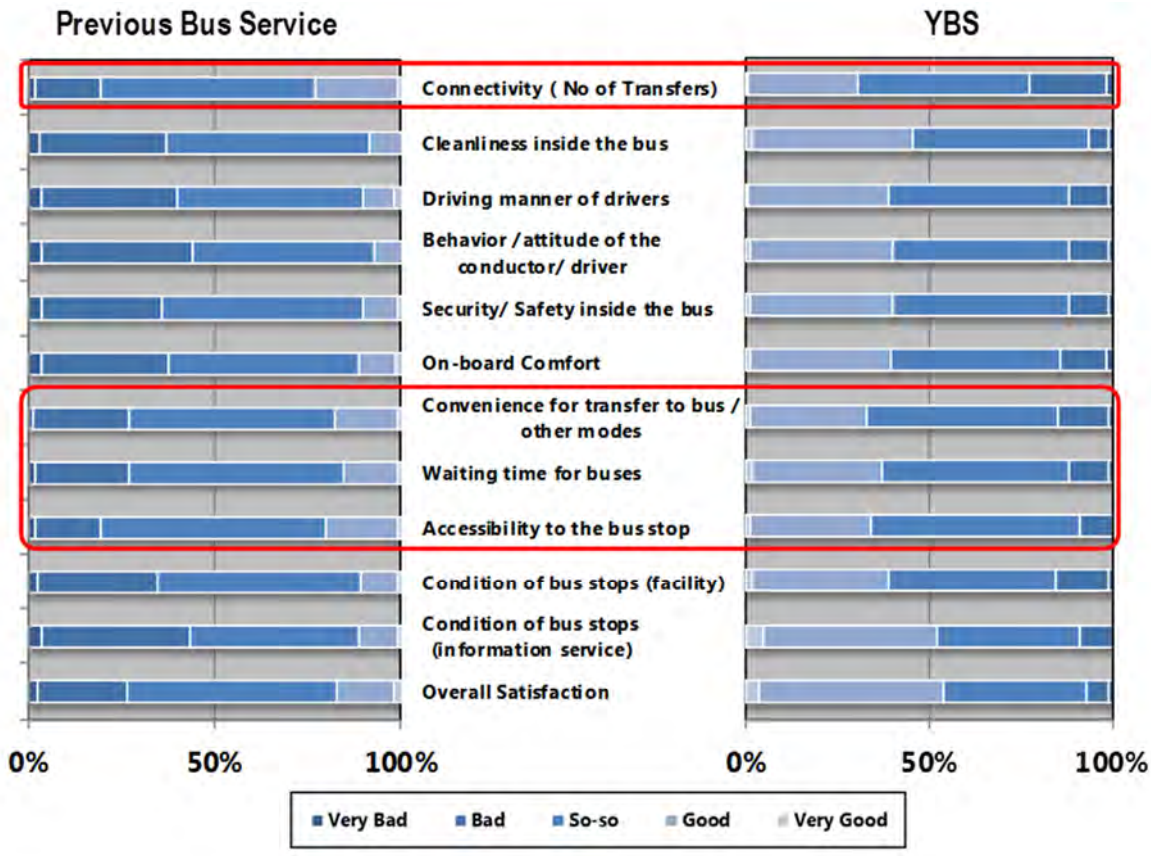
(iii) On-board comfort (13.4%).

8.16 From the results of this survey question, it is clear that for bus users better bus operation and management are required to provide better bus services. In addition, a "Yangon Bus Report" application provided to bus users where individual bus users could report problems with regard to bus services. One month after the YBS was launched (as of 12 February 2017), 764 problems were reported with the most problems coming from the G1 bus group (254 problems), followed by the G7 bus group (137 problems).



Source: Bus Passenger Interview Survey
1) Respondents totalled 6,996 opinions from 2,400 bus users.

Figure 8.2.4 Bus Users' Opinion about the Most Important Aspect for Bus Improvement [1)]



Source: Bus Passenger Interview Survey

Figure 8.2.5 Comparison between Previous Bus Service and YBS

8.3 Current Operating Characteristics of YBS

1) Supplemental Survey

8.17 In order to analyze the current bus operation and services supplemental surveys were conducted in March and April with the assistance of the YRTA. The scope of the survey is briefly as follows:

(a) **Objectives**

- To preliminary analyse current bus operating characteristics and user satisfaction/ needs, and
- To collect bus operation and passenger ridership data necessary for the Bus Management Information System (YBS-MIS).

(b) **Coverage and Survey Methods**

- All YBS routes;
- On-board survey: for total of 81 routes; and
- Bus passenger interview survey at selected bus terminals / stops: 2,400 bus passengers at 12 bus stops.

(c) **Survey Items Covered in the On-board Survey**

- Bus type and number of seats;
- Bus arrival / departure time at each bus stop;
- Number of boarding / alighting passengers at each bus stop;
- Assessment of level of service (LOS) (on-board congestion, on-board comfort, driving manner); and
- Happenings during the survey.

(d) **Survey Items Covered in the Bus Passenger Interview Survey**

- Socio-economic profile;
- Trip Information;
- Use of bus; and
- Assessment of YBS in comparison to the previous bus service.

8.18 Survey results were processed into a database for analysis of various features of the YBS operating characteristics. Details are explained in Technical Report No. 1.

2) Coverage of Bus Service and Route Connectivity

8.19 More than 300 bus routes were restructured to 81 routes, as shown in Table 8.3.1, Figure 8.3.1, and Figure 8.3.2. The findings on the coverage of bus service and route connectivity are as follows:

(i) The coverage of the bus network has expanded although the number of transfers has increased in some areas. For instance, in the Northwest / Northeast clusters, bus network coverage is extensive. On the other hand, in new urban areas, such as Hlaingthaya, Kyee Myin Daing, Dala and Thanlyin, the coverage is limited;

(ii) However, as it is not economical to connect all areas with big buses, adequate feeder services need to be provided. Measures to improve connectivity must include facilities, services, and fare integration; and

(iii) In order to supplement city bus services, companies have increasingly provided bus / truck bus services for their workers.

Previous Bus Route Coverage (Before YBS) | YBS Route Coverage (As of January 2017) | YBS Route Coverage (As of January 2019)

Source: Study Team

Figure 8.3.1 Comparison of Bus Route Coverage between YBS and Previous Bus Service

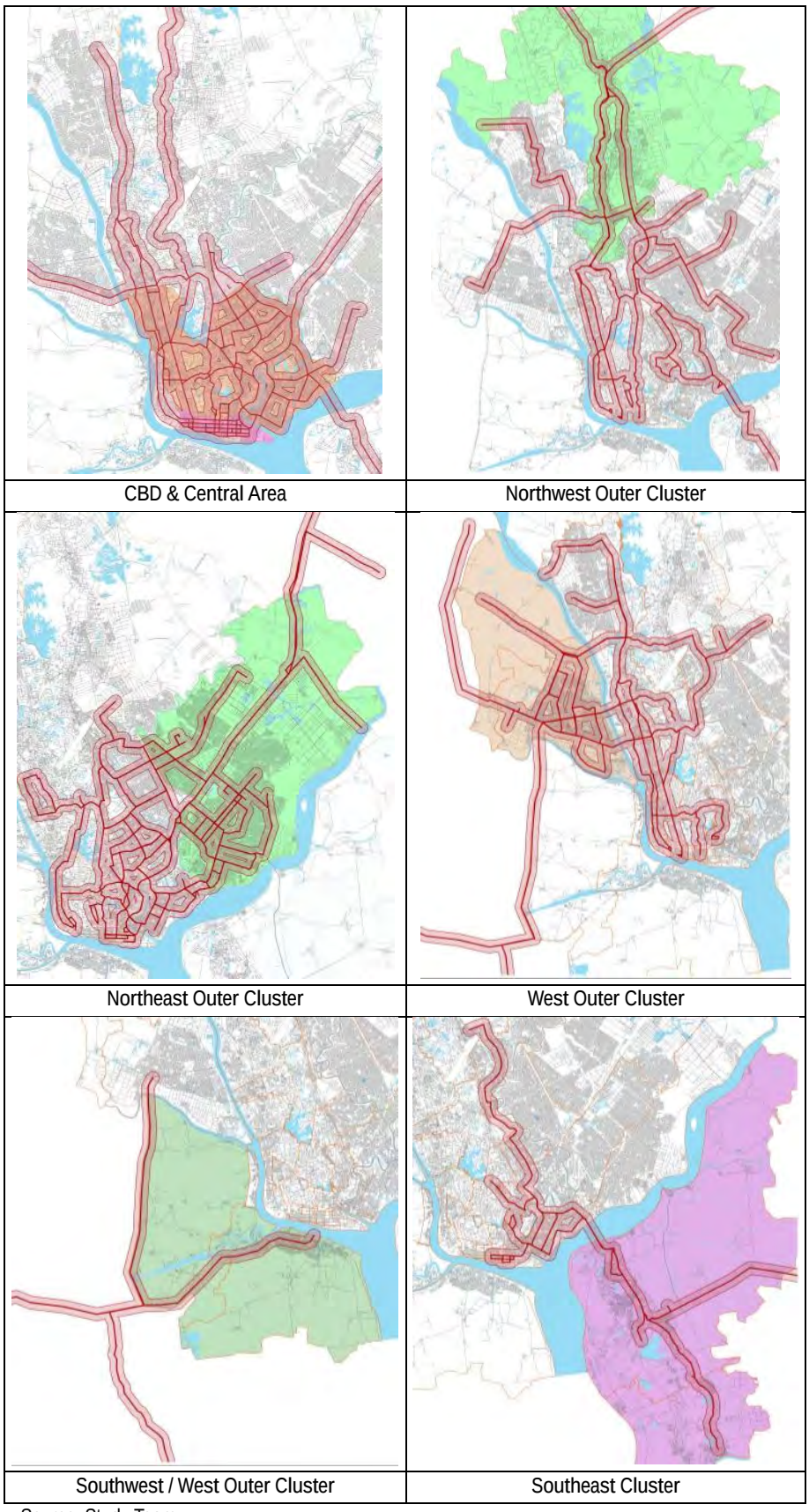
Table 8.3.1 Current Bus Routes (As of October 2018)

Company	YBS No	O-D		Trip Length Mile (round trip)	Number of Buses			
					City Bus	Mini Bus	other	Total
YUPT	2	Aungmingalar Highway Bus Terminal	Yuzana Garden City	32.0	25	-	-	25
	3	Yuzana Garden City	50 Street	28.0	50	-	-	50
	4	Yuzuna Garden City	Sule	22.0	98	-	-	98
	7_1	South Dagon 71/72	Sule	30.0	55	-	-	55
	7_2	Cargyi Gate	Sule	24.0	105	-	-	105
	7_3	South Dagon(Kyi Su)	Sule	30.0	86	-	-	86
	8_1	Inwa Housing	Shwedagon Pagoda	26.0	25	-	-	25
	8_2	168 ward	St. Paul	32.0	-	17	-	17
	10_1	National Village	Dagon University	34.0	30	-	-	30
	10_2	National Village	Dagon University		-	32	-	32
	11	Aungmingalar Highway Bus Terminal	Shwedagon Pagoda	35.2	-	40	-	40
	15_1	Dagon University-Bayint Naung-Danyingone		30.9	30	-	-	30
	15_2	Dagon University-Pyay Rd-Danyingone		30.0	20	-	-	20
	17	Shwepaukkan	Dagon Ayeyar Terminal	34.0	-	44	-	44
	24_1	Kyansitthar Rd-Kyaung Rd-Botahtaung Pagoda		26.0	30	-	-	30
	24_2	Dagon University	Botahtaung Pagoda	26.0	20	-	-	20
	26	Dagon University	Botahtaung Pagoda	32.0	35	-	-	35
	28	Dagon University	Sule	28.0	30	-	-	30
	29	Dagon University	Sule	28.7	84	-	-	84
	36_1	Shwepaukkan	Sule	28.9	40	-	-	40
	36_2	Htaukkyant	Sule	42.0	60	-	-	60
	36_3	Aungmingalar Highway Bus Terminal	Sule	26.0	20	-	-	20
	40	Shwe Pyithar/Aungmingalar Highway Bus Terminal-Thakhinmya Park		40.0	67	-	-	67
	58	Thakhinmya Park	Linsataung	12.0	45	-	-	45
	59_1	South Dagon(Thein Kyaung)	Hnin Si Kone St	30.0	30	-	-	30
	59_2	South Dagon(Thein Kyaung)	Hnin Si Kone St		-	24	-	24
	65	Hlawgar (Lain Kone)	Botahtaung Pagoda	44.0	60	-	-	60
	84	green 49 old gate	7/8 Junction	30.0	-	28	-	28
	Subotal				1,045	185	0	1,230
Bandula	12	50 kwae	Sule	26.0	43	-	-	43
	14	Parami(Bayli)	Thakhinmya Park	36.3	43	-	-	43
	25	Dagon University	Maharbandula Road	30.0	47	-	-	47
	30	Dagon University	Thakhinmya Park	33.8	72	-	-	72
	38	South Okkalar (Bayli)	Thirimingalar Market	16.8	39	-	-	39
	Subotal				244	0	0	244
Khit Thit Bayint Naung	15	Dagon University	YTU	36.0	-	34	-	34
	18	Khayaypin Avenue	Tamwe Bali	30.0	-	36	-	36
	21	WYU	Mawtin	25.0	152	-	-	152
	35	Htaukyant	Mawtin	29.3	92	-	-	92
	52	Tan Tapin	Mee Gwat Zay	38.0	-	21	-	21
	53	Ahlaeywar(Tour Gate)-Naung Tone Rd-Ahlaeywar(Tour Gate)		22.0	-	56	-	56
	54	86 old gate-Kyansitthar Rd-86 old gate		20.0	-	18	-	18
	61	WYTU	Sule	28.0	106	-	-	106
	68	Shwepyithar	WYTU	40.0	-	33	-	33
	69	Shwepyithar	Dagon Ayeyar Terminal	36.4	-	28	-	28
	75	Thauwana Pagoda	Natsin St	18.0	-	30	-	30
	Subotal				350	256	0	606
Golden Southern	5	Yoe Ma Avenue	Botahtaung Pagoda	32.0	19	-	-	19
	33	Kyaut Tan	Workers' Hospital	44.0	-	41	-	41
	34_1	Khayan	Thein Phyu	92.0	26	-	-	26
	34_2				-	1	-	1
	34_3				42	1	-	43
	47	Hlaing Thar yar	Twantay	42.0	-	-	87	87
	48_1	Dala	Twantay	36.0	-	-	252	252
	48_2				-	-	17	17
	49	Hlaing Thar yar	Konegangone	70.0	-	-	39	39
	50_1	Dala	Konegangone	64.0	-	-	85	85
	50_2				-	-	46	46

Company	YBS No	O-D		Trip Length Mile (round trip)	Number of Buses			
					City Bus	Mini Bus	other	Total
	51_1	Kayan	Bago	76.0	-	2	-	2
	51_2	Kayan	Bago		-	-	13	13
	70	TTU	Maharbandula Bridge	32.0	41	-	-	41
	95	Kyaut Tan	Workers' Hospital	44.0	37	-	-	37
	Subotal				165	45	539	749
Omini Focus General Service Public Co.,Ltd	20	Dagon Ayeyar Bus Terminal	Thein Phyu	40.4	70	-	-	70
	27	Mental Hospital	Thein Phyu	37.5	63	-	-	63
	56	Thakhinmya Park-Botahtaung Pagoda-Thakhin Mya Park		12.0	30	-	-	30
	83	Dagon Ayeyar Bus Terminal	Shweli Road(65) Ward	42.0	50	-	-	50
	85	Tuchaung	Ayeyar Wun	39.0	51	-	-	51
	Airport	Yangon International Airport	Yangon International Airport	22.8	50	-	-	50
	98	Dagon Ayeyar Bus Terminal	Thakhinmya Park	23.0	55	-	-	55
	99	Dagon Ayeyar Bus Terminal	Shweli Road	28.0	95	-	-	95
	Subotal				464	0	0	464
Holiest Vim	1_1	Hlegu Market	Zawana	66.0	16	-	-	16
	1_2				-	6	-	6
	6	Ayeyar Wun	Dagon Ayeyar Bus Terminal	44.0	94	-	-	94
	46	Dar Pain	Zawana	44.0	-	5	-	5
	92	Htauk Kyant	Zawana	42.0	-	53	-	53
	Subotal			-	110	64	0	174
Kong Baung	31	TTU	Pansoedan	30.0	105	-	-	105
	64	Wai Bar Gi	Maharbandula Rd (Pansoedan)	30.0	65	-	-	65
	Subotal				170	0	0	170
Power Eleven Public Co.,Ltd	21	WYTU	Mawtin	41.0	50	-	-	50
	39	Shwepyithar(LaneKone)	Mawtin	26.0	52	-	-	52
	41_1	Hmawbi (TU)	Thakhinmya Park	66.0	44	-	-	44
	41_2				-	79	-	79
	Subotal				146	79	0	225
Yangon Bus Public Co.,Ltd	43	Wireless	Botahtaung Pagoda	34.0	30	-	-	30
	62	Dagon University-Kyimyindaing-Panpingyi St		34.0	45	-	-	45
	37_1	Htauk kyant	Sule	48.0	90	-	-	90
	37_2	Hmawbi	Sule	74.0	46	-	-	46
	37_3	Hlegu	Sule	62.0	45	-	-	45
	37_4	Oakkan	6 Htet Office	14.0	30	-	-	30
	72	Tharkayta	Sule	44.0	35	-	-	35
	87	Dagon University	Sule	48.0	60	-	-	60
	88	Dagon University	Pyitawthar	34.0	50	-	-	50
	89	Ayeyar Wun	Panpigyi St	30.0	70	-	-	70
	96	Hlawgar (Tar Sone)	Tharkayta	46.0	45	-	-	45
	Subotal				546	0	0	546
Yangon Nothern Taikkyithar	90_1	Oakkan	Thakhinmya Park	132.0	66	-	-	66
	90_2	Tikegyi	BOC Kwae	90.0	-	18	-	18
	Subotal				66	18	0	84
Shwe Lan Khin	40	Shwepyithar	Thakhinmya Park	40.0	70	-	-	70
	Subotal				70	0	0	70
GYCT Co.,Ltd	1	Hlegu Market	Zawana	66.0	11	13	-	24
	6	106	Dagon Ayeyar Bus Terminal	44.0	198	-	-	198
	9	87 ward	Kyat Tine	30.0	-	49	-	49
	16_1	Aungmingalar Highway Bus Terminal	Dagon Ayeyar Bus Terminal	35.6	-	14	-	14
	16_2				128	-	-	128
	19	Shwepaukkan (Sinpone)	Thakhinmya Park	50.0	57	-	-	57
	23	WYTU	Thakhinmya Park	30.0	74	-	-	74
	39	UCSY	Mawtin	48.0	34	-	-	34
	57	Thakhinmya Park-Botahtaung Pagoda-Thakhin Mya Park		12.0	35	-	-	35
	60_1	South Dagon-BayintNaung Road-Thirimingalar Market		34.0	-	36	-	36
	60_2				22	-	-	22
	100	South Dagon	Linsataung	28.0	25	-	-	25
	Subotal				584	112	0	696
Trans Link Co.,Ltd	80	Yadanar Rose Housing	Women Central Hospital	25.0	35	-	-	35

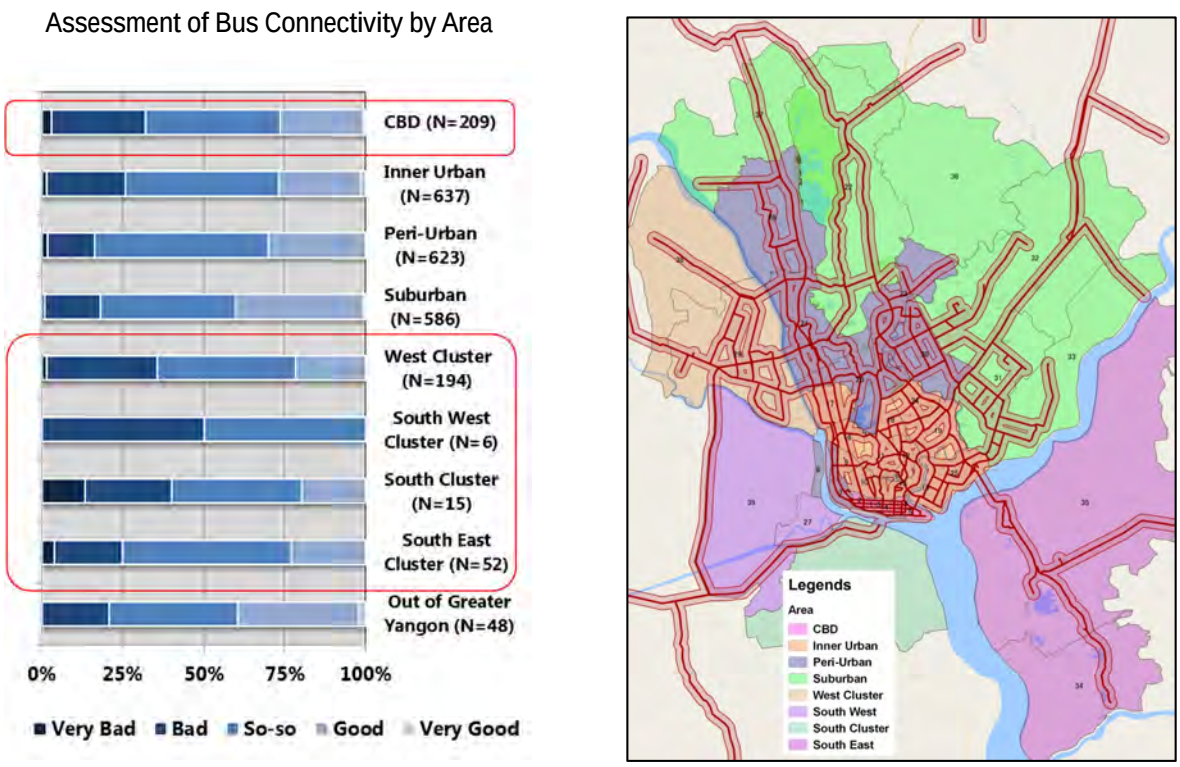
Company	YBS No	O-D		Trip Length Mile (round trip)	Number of Buses			
					City Bus	Mini Bus	other	Total
	81	East Dagon	Pansoedan	34.0	25	-	-	25
	Subotal			-	60	0	0	60
City Liner Co.,Ltd	86	Bandula Bridge	Thayattaw	24.0	-	16	-	16
	Subotal				0	16	0	16
Sanwaila	23_1	WYTU	Thakhinmya Park	30.0	42	-	-	42
	23_2	Twantay	Dala	18.0	8	-	-	8
	Subotal			-	50	0	0	50
Ever Green Lucky Family (65)	42_1	Hlawgar (Lain Kone)	Tharkyta (Yadanar)	56.0	23	-	-	23
	42_2				-	72	-	72
	65	Hlawgar (Lain Kone)	Botahtaung Pagoda	44.0	103	-	-	103
	Subotal				126	72	0	198
Rapid City	44	Hlegu Market	Mindama Housing	54.0	-	22	-	22
	66	Mental Hospital	UCSY	24.0	59	-	-	59
	67	Shwelin Pan-Pathein Rd-Shwelin Pan		27.6	-	11	-	11
	71	Thatyat Pinchaung	Sanpya Market	32.0	-	58	-	58
	74	Shwepyithar 81 old gate	Dagon Ayeyar Bus Terminal	19.0	-	28	-	28
	77	Shwepyithar(Kannar)	Sanpya	40.0	-	49	-	49
	79	WYU	Linsataung	43.0	37	-	-	37
	91	Taikgyi	No.(3) Junction	60.0	-	59	-	59
	Subotal				96	227	0	323
People Partner	78	Shwepyithar(LaneKone)	Yangon Central Station	30.0	50	-	-	50
	93	WYU	Yangon Central Station	30.0	50	-	-	50
	94	UCSY	Yangon Central Station	40.0	50	-	-	50
	32	MMU	Htaukkyant	68.0	50	-	-	50
	97	Ywarthargyi	Htaukkyant	32.0	65	-	-	65
	Subotal				265	0	0	265
Individual Owners	22_1	WYU	Thakhinmya Park	44.0	81	-	-	81
	22_2				-	20	-	20
	31	East University	Botahtaung Market	22.0	41	-	-	41
	33	Kyaut Tan	Workers' Hospital	50.0	-	55	-	55
	45	Hlegu Market	Minkone Market	38.0	25	-	-	25
	63	Kyauk Kone	Linsataung	14.0	-	28	-	28
	73	Shwepyithar	Htaukkyant	40.0	-	11	-	11
	76	East University	Sat Mu (1)	36.0	-	46	-	46
	79	East University	Linsataung	43.0	85	-	-	85
	80	Tharkayta	Upper Pansoedan Rd(Kyauk Kwae)	28.0	-	19	-	19
	Subotal			.	232	179	0	411
Total				-	4,789	1,253	539	6,581

Source: YRTA



Source: Study Team

Figure 8.3.2 Coverage of YBS Routes



Source: Bus Passenger Interview Survey

Figure 8.3.3 Comparison of Bus Service Coverage between YBS and Previous Bus Service

8.20 Results of a questionnaire survey conducted among bus passengers on bus connectivity in the areas of their residences show that their assessment vary by area. As shown in Figure 8.3.2, the percentage of dissatisfaction (very bad and bad) is high in the southwest urban cluster, followed by the west and south, but it is low in the inner urban, peri-urban, and suburban clusters.

3) Performance Indicators for Bus Operation

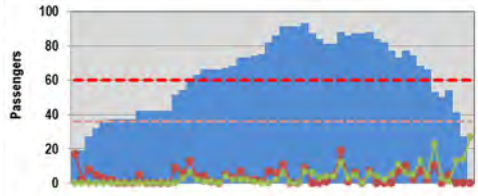
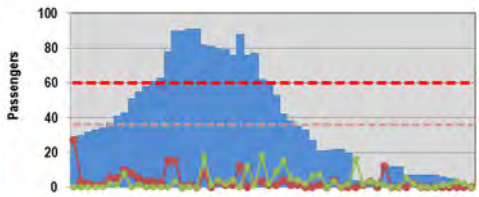
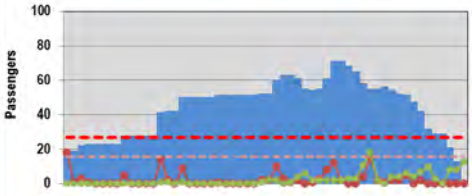
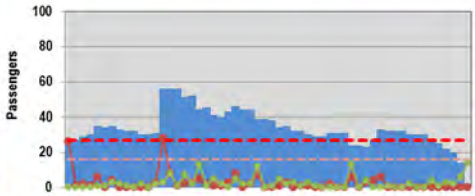
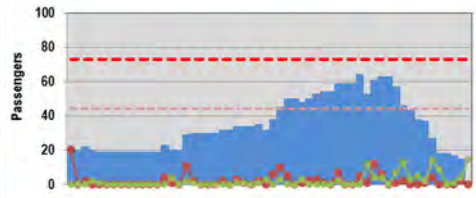
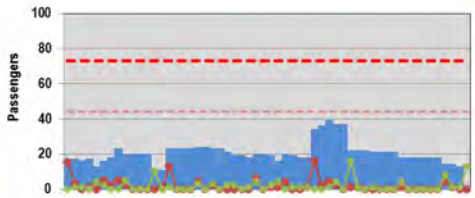
8.21 To study bus operation, one must first collect accurate data on bus operation and ridership. And to analyze bus performance on the new YBS routes, a survey was designed and conducted along the bus routes of YUPT, which is one of the largest new bus groups in Yangon. The survey collected bus operation data, as well as number of boarding and alighting bus passengers at each bus stop every morning, afternoon, and evening by assigning two surveyors on board. The specific data collected from the survey is shown in Table 8.3.1.

Table 8.3.1 Bus Data Collected from On-board Survey

Data Collected from the Survey	Key Performance Indicator Obtained from Analysis
1. Bus Operating Conditions • Departure time at each bus stop • Arrival time at each bus stop • Fuel consumption for each trip 2. Bus Passenger Ridership • No. of passengers boarding at each bus stop • No. of passengers alighting at each bus stop	1. Bus capacities 2. Travel speed and time between bus stops 3. Travel speed and time for each bus trip 4. Time spent on boarding/alighting at each bus stop 5. Load factor for sections between bus stops 6. Average load factor for each route 7. Bus passengers at each bus stop 8. Average travel distance of bus passengers

Source: Study Team

8.22 Figure 8.3.3 shows an example of the analysis on ridership pattern of bus passengers on bus route no. 6. The figure indicates the number of bus passengers boarding/alighting at each bus stop and the number of bus passengers on board along the route. When the number of on-board passengers exceed set capacities, the bus is considered overcrowded. When the data is collected from all bus trips every day, they can be used in bus allocation and scheduling, as well as route planning.

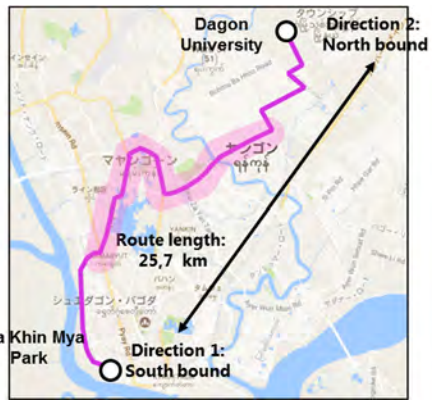
Time	Ridership Pattern	
	Direction 1	Direction 2
Morning		
Daytime		
Evening		

Source: On-board Survey

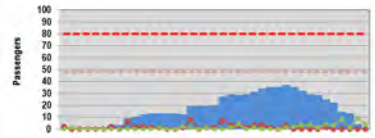
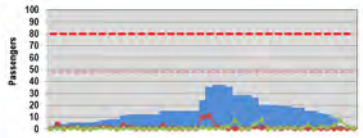
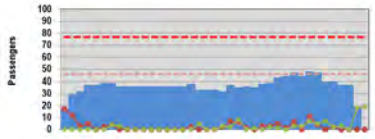
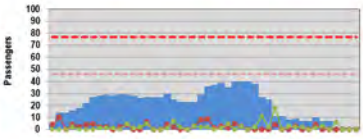
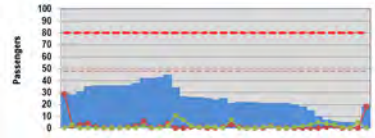
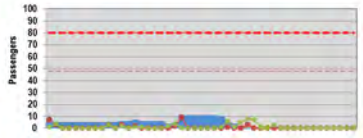
Figure 8.3.4 Ridership Pattern on YUPT Bus Route No.6

Route No. 25

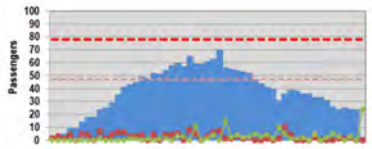
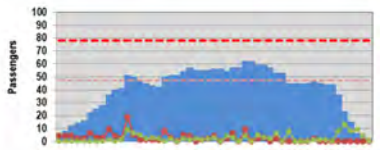
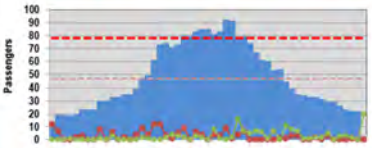
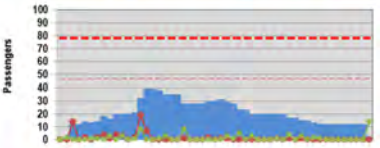
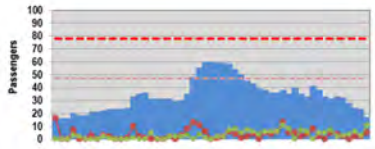
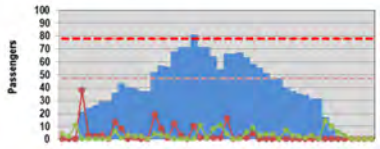
Route No.30



Route No. 25

Time	Ridership Pattern	
	Direction 1	Direction 2
Morning		
Daytime		
Evening		

Route No.30

Time	Ridership Pattern	
	Direction 1	Direction 2
Morning		
Daytime		
Evening		

Source: On-board Survey

Figure 8.3.5 Ridership Pattern on Selected YUPT Bus Routes

4) Preliminary Cost Analysis

8.23 The operating costs for different types of buses have been preliminary estimated for selected representative buses available in the market (see Table 8.3.6).

Table 8.3.2 Assumptions for Estimating Bus Operating Costs

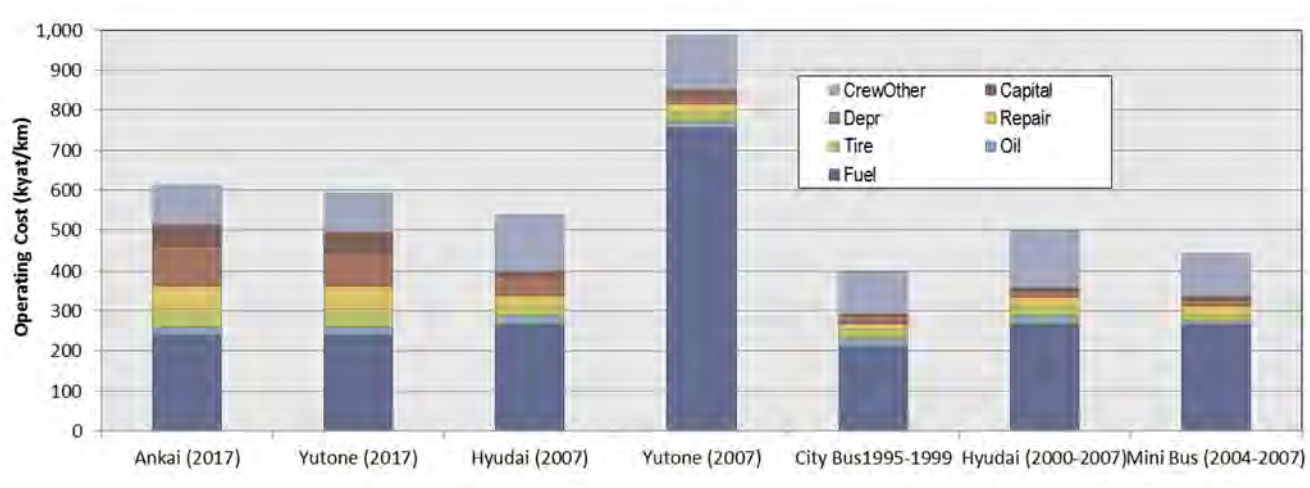
Item			Vehicle Type				
			Mini Bus (old)	Mini Bus (Old)	Standard Bus (Old)	Standard Bus (New)	Standard Bus (Advanced)
Typical Model in Yangon	Model		Hino BM	Hyundai County 2008	Hyundai Aero City (2002–2004)	Hyundai Aero City (2005–2007)	Hyundai 2015
	Image						
Cost (Market Price)	Vehicle		12,500,000	21,500,000	18,000,000	39,000,000	140,000,000
	Tire		60,000	60,000	90,000	90,000	90,000
	Maintenance		20,000	20,000	20,000	40,000	100,000
	Vehicle's Registration Fee		150,000	150,000	200,000	200,000	200,000
	Gasoline Permit		900,000	900,000	3,500,000	3,500,000	3,500,000
	Insurance		8,300	16,700	16,700	225,000	250,000
	Crew (Monthly)	Driver	200,000	300,000	350,000	439,000	330,000
		Conductor	100,000	150,000	180,000	228,000	-
Others	Vehicle Life (year)		8	10	8	10	12
	Salvage Value		0%	10%	0%	15%	20%
Estimated Bus Operating Cost (MMK/km)		25 km/h	217	259	371	551	882
		10 km/h	367	405	652	1,013	1,469

1): Estimated by Study Team based on interviews with bus operators.

Table 8.3.3 Assumptions for Estimating Bus Operating Costs

Vehicle Type		New Buses			Old Buses			
Model		Ankai (2017)	Yutone (2017)	Hyudai (2007)	Yutone (2007)	City Bus1995-1999	Hyudai (2000-2007)	Mini Bus (2004-2007)
Number of Holding		250	225	135	105	102	347	303
Market Price (Kyat)		82,442,630	82,442,630	21,000,000	20,087,000	12,000,000	21,000,000	20,000,000
Fuel	Main Fuel Type (Gasoline/ Diesel/ Others)	CNG	CNG	CNG	Diesel	CNG	CNG	Diesel
	Fuel Consumption Rate (L/ km)	0.50	0.50	0.56	0.63	0.44	0.56	0.218
	Fuel Price (Kyat/ L)	273	273	273	690	273	273	690
Oil	Oil Consumption Rate (L/ 1,000km)	3.70	3.70	3.40	2.25	3.90	3.4	2.06
	Oil Price (Kyat/ L)	3,100	3,100	3,000	3,100	3,100	3000	3100
	Unit Engine Oil Cost (Kyat/1000 km)	11,470	11,470	10,200	6,975	12,090	10,200	6,386
Tire	No. of Tires	12	12	6	6	6	6	6
	New Tire Price (Kyat / Unit)	240,000	240,000	240,000	240,000	240,000	240,000	135,000
	New Tire life (km)	50,000	50,000	50,000	50,000	50,000	50,000	50,000
	Unit Tire Cost (Kyat/ km)	58	58	29	29	29	29	16
Maintenance	Maintenance Cost (Kyat/ Month)	10,000	10,000	260,000	260,000	40000	260,000	40000
	Inspection Cost (Kyat/ Month)					150000		50000
Repair Cost		1,550,000	1,550,000	1,750,000	1,750,000	1,750,000	1,750,000	550000
Crew and Others	Drivers Wage (kyat/month)							600,000
	Car Insurance (Kyat/ Year)	1,121,490	1,121,490	350,000	360,000	150,000	350,000	150000
	SIM Card/Server Communication Expense (Kyat/ Month/Bus)	20,000	20,000	20,000	20,000	20,000	20,000	20000
	Unit Other Cost (Kyat/ Month)	1,141,490	1,141,490	370,000	380,000	170,000	370,000	170,000
Operating Information	Vehicle Life (year)	10	10	5	5	2	5	5
	Salvage Value (%)	20.0	20.0	20.0	10.0	10.0	10.0	10.0
	Average Operating km							200
Estimated Operating Cost (Kyat/km)	25 km/h	521	509	451	780	335	420	365
	15 km/h	612	594	538	988	397	498	441

Source: Estimated by Study Team based on interviews with YUPT



Source: Estimated by Study Team based on interviews with YUPT

Figure 8.3.6 Estimated Bus Operating Cost (Kyat/km) at 15 km/h of Operating Speed

6) Operating Issues of YBS

(1) Insufficient Reorganization

8.24 One of the expected impacts by reorganization of bus operators is transition from commission base (according to the fare revenue), into trip-based commission system or fixed salary system. The main characteristic of each system is as follows:

(a) **Sales-based type:** the drivers tend to wait for passengers at bus stops causing traffic congestion

(b) **Trip-based type:** the drivers may over-speed and overtake just to make more trips

(c) **Fixed salary system:** is desirable for safe driving. Provision of incentives (ex. For safety driving / operation manor) need to be studied

8.25 As of October 2018, many bus operators have shifted into fixed-salary system or trip-based system though some companies still apply conventional sales-based system. On the other hand, buses operating under the companies can be classified into individual-own and company-own. Drivers operating individually owned vehicles contract with the individual owner, not the company. The salary system is up to the each contract and most of them apply sales-based system.

(2) Vehicle Management Scheme

8.26 Operation Rate (average number of buses daily operating / number of owned buses shown in Table 8.2.1) is one of indicators to measure the service level of bus operators. The overall average operation rate of YBS was 69 % as of October 2018 and some operators show less than 50 %. Lower operation rate causes financial loss, overloading and left-off passengers. The most critical factor for low operation rate is the frequency of mechanical problems.

8.27 In the most of bus operators, drivers or maintenance staffs conduct pre-departure inspection. But they don't prepare any manual and regular inspection record. Some bus operators own their workshop facilities but many operators conduct repair and maintenance work on the roadside.

(3) Intra / Inter - modal Connectivity

8.28 As shown in Figure 8.2.3, modal transfer (comfort in transferring to buses/other modes and number of transfers) is one of big issues of YBS. Since rationalizing more than 300 bus routes, the number of passengers need transfer has been increased in average. Not only the marginal fare, there are some transfer impedances such as walking distance for transfer, psychological factor due to the lack of information. Bus terminal and intermodal facilities should be carefully developed to enhance smooth transfer.

(4) Driver's Working Hours and CNG

8.29 Working condition of YBS drivers is pointed out to be oppressive. The binding hour is longer and handling hour (periods which the drivers grasp the handle, including bus operation and dead-mileage) is higher than each Japanese Standard, which is 65 hours per week and 68.75 %, respectively.

8.30 The cause of the longer binding hours is CNG station. For the fuel for buses, CNG is dominant due to the cheaper price (half of the diesel fuel). However, the number of CNG stations is insufficient compared with the operating bus vehicles and severe traffic congestions can be seen around the CNG stations. Some drivers must wait for 3 hours to 6 hours to fill the CNG. The status of CNG station facilities is also oppressive.

(5) Training on Drivers:

8.31 Driving skill and manner of YBS drivers are highly related to the customer's satisfaction. As mentioned YBS drivers are working under oppressive condition and it is difficult for them to care about the safety, comfortable operation and service. Driver's Training Centre was established by MOTC and YRTA. The training centre issues type "E" driver's licence, which is required to drive passenger buses. However, there is no penalty for bus drivers who don't have type-"E" driver's license. Individual operators and some minor bus operators assign bus drivers without sufficient training and education.

(6) Operation Management System

8.32 Current operation system of YBS applies Dispatching Operation (Departure time of each bus is specified by the Dispatcher). Bus operators assign the staffs at origin, destination and major bus stops and arrival / departure time of each bus trip are recorded. This system was applied in the tram and buses of mega cities in pre-war Japan. But after World War II, it was changed into diagram operation (which is applied in the train), to achieve the efficient fuel consumption and efficient service providing.

8.33 To achieve high frequency of service in morning peak hour and ensure sufficient headway at evening peak hour, the interval at origin and destination should be efficiently adjusted. In Yangon, introduction of diagram operation is highly necessary.

(7) Financial Condition

8.34 It is reported that financial status of YBS operators are not good. Two Yangon public companies, the Yangon Bus Public Company (YBPC) and Yangon Urban Public Transportation Public Company (YUPT), have recorded losses totaling MMK 4 billion in the past three years. The companies had purchased a total of 1,000 new buses, 500 each, to operate under YBS. So far though, YBPC and YUPT have yet to break even on the capital expenditure taken for the new YBS buses. To achieve financial benefit, YBS operators has claimed the approval from YRTA to increase the bus fare (MMK 200 per trip, fixed fare) or introduce distance-based fare system.

8.35 After the restructuring into YBS, Bus operators have payed MMK 4,000 per day per operating bus fleet to YRTA as the management fee. However, development of necessary infrastructure for bus operators has not been implemented yet and bus operators are dissatisfied.

8.4 YBS Improvement Directions

1) Further Actions to Improve Yangon Bus Service

8.36 The Yangon Bus Service has recently been launched, and there are still many issues and problems which need to be addressed before Yangon can have a safe and reliable public bus system that meets the travel needs of bus users.

8.37 The Study Team has identified additional actions that can be undertaken by the YRTA to further improve the services of public buses in Yangon. These actions build on current ones which the YRTA has undertaken. The following table summarizes all of the further actions that are required. In the next section, the Study Team gives a proposal on how bus companies can be further improved and modernized institutionally.

Table 8.4.1 Current and Proposed Actions for the Yangon Bus Service

Area		Current Action by the YRTA	Proposed Action
1	Bus Operators Reorganization	• Consolidation of the many bus vehicle owners into 8 companies/groups.	• Only 2 of the 8 companies have a modern organizational structure (Yangon Bus Public Co., Ltd. and Bandoola Transportation Co., Ltd.) in which the company owns all of the bus vehicles. • For the other 6 companies (5 association companies) and the Omni Focus Co., Ltd., bus ownership is still split between the actual company and individual owners.
2	Bus Fleet	• Removal of old buses. • Acquisition of new buses (in March 2017).	• Required fleet size is still large. • Need for a system for the sustainable renewal of vehicles. • Establishment of a maintenance system.
3	Bus Operation Improvement	• Consolidation to 80 bus routes. • Introduction of loop routes in the CBD and restriction of buses that run through the CBD.	• Continuous monitoring of the supply and demand gap. • Need for further regulated bus operations. • Consideration for area/feeder services.
4	Bus Facilities Improvement	• Ongoing tender for bus stop improvements.	• Need for technical design guideline for bus stop and access facilities. • Improvement of bus depots and turn-around facilities.
5	Bus Corridor Traffic Management	• Traffic control from the traffic control center for bus corridors/intersections.	• Micro traffic management at bus stops and specific areas. • Consideration for bus priority measures.
6	Business Management Improvement	• Change in payroll system for driver/conductor to a salary-based system (not fully practiced).	• Strengthening of operation/management of buses including cost/revenue control. • Strengthening of capacities of bus personnel.
7	Bus User Services	• Bus route information • “Yangon Bus Report“	• Expansion of the dialogue with bus users.
8	YRTA Bus Sector Management	• Centralization of bus sector management under YRTA.	• Institutionalization of role-sharing between YRTA and bus companies/operators. • Technical support for bus companies/operators • Bus fare and subsidy policy • Preparation of bus operation rules and regulation and its enforcement

Source: Study Team

2) Stages for Modernization

8.38 In the reorganization of the bus network into the Yangon Bus Service in January 2017, eight companies were established. However, only one of these companies, the Yangon Bus Public Co. Ltd., was structured as a public-private partnership. Two of the companies are private bus companies which operated in the previous system and the remaining five are more like loose associations of small bus owners. The situation with regard to the structure and organization of the bus operating companies is still fluid. In this section, the Study Team explains how the bus operating companies could be modernized in general.

8.39 The bus modernization program can be seen to take place in several stages. The first stage is to group the 80 or more bus routes into five to eight clusters or transport corridors so that the routes within each group are synergistic with each other. More importantly, each cluster should have a similar market size (i.e., the potential demand should approximately be the same). In their assigned markets, the bus company should be granted a monopoly or exclusivity because they will have sufficient competition from other modes, primarily from increasing car ownership.

8.40 Establishment of the consortiums is the second stage. They must be registered as public limited-liability companies. Identifying the lead investor(s) who will initiate the incorporation of these seven companies is part of this step. The YRTA can designate or ask for proposals from existing bus operators for their willingness and readiness to take the lead. The first choice should be the biggest operator already operating in each of the eight corridors. Priority can also be given to the company willing and able to put in the largest equity, and thus require the least equity contribution from the government.

8.41 The third stage is for the lead investor to amalgamate other operators in his corridor of responsibility. This can be done by way of asset-for-stock swaps; in exchange for shareholdings in the new company, operators transfer their old buses into the company and forms part of its bus fleet. Valuation and acceptability of bus vehicles will pose a challenge. If no deal is agreed upon, the new company can either (i) order the old company to cease from operating in the route or (ii) enter into a leasing agreement so that the old operator can continue to render service under the supervision of the new company until such time that new vehicles are deployed by the latter to replace the former.

(1) Guidelines for the 1st Stage

8.42 As part of the launch of the Yangon Bus Service, bus routes were restructured and reduced from around 300 to around 80. However, because the new bus network was launched all at once literally overnight, the responsibilities for the bus routes and which company operates them are still not optimal. In fact, the Study Team has observed that the number of operated bus routes changes each month. The YRTA should consider how to allocate bus routes and clusters to each of the eight operating companies in an efficient and logical manner. Therefore, the following are general guidelines on how the bus routes in Yangon could be allocated to bus operating companies in a logical way.

8.43 Starting with the current set of around 80 bus routes, the YRTA can group them into five (5) service areas as shown in Figure 8.4.1. Tentatively, these route clusters can be named (and colored) as follows:

(i) Hlaing Tharya Cluster (red) covers the western zone of the city;

(ii) Insein Cluster (blue) covers the northern zone of the city;

(iii) Mandalay Cluster (green) covers the northeastern zone;

(iv) East Dagon Cluster (violet) covers the eastern zone; and

(v) Thanlyin Cluster (gray) covers the southern districts of the city.

Source: Study Team

Figure 8.4.1 Logical Clustering of Routes

8.44 The five service corridors as proposed should also be flexible. For example, the Hlaing Tharya Cluster can be merged with the East Dagon Cluster to form an east–west crosstown corridor. Another bus company could be assigned an inner town service area which roughly corresponds to the current CBD Loop. This CBD Loop has three routes (Routes 56, 57, and 58) at the moment and could actually be expanded to cover more than 5 km^2 in area, and obviate the need for the other five cluster routes to go inside the CBD. In the long term, the Yangon Circular Railway can perform the role for the larger circumferential bus corridor.

8.45 Once the 80 or so bus routes get clustered into five groups, the newly formed bus companies can be assigned their set of routes based on their dominant areas of operation. As this happens, the current set of routes needs to be modified primarily to reduce overlaps and shorten route distances. The average length of the current bus routes is 30 km while the longest is at 67 km. It is difficult for a bus operator to maintain headways for longer routes.

8.46 The current proposed grouping has five classifications (northern, southern, eastern, feeder, and CBD Loop). Many of the existing routes overlap and encroach on one other's territory thus

exacerbating competition on the street and causing road accidents. For example, the Northern District bus lines extend all the way to the south, while the Eastern District bus lines are all over the city from north to south.

8.47 A major change (from the old to the new clusters) is the inclusion of feeder routes in the area of responsibility of the bus company. These feeder routes should be served with minibuses, rather than standard or big buses.

8.48 A separate meeting with each group can be undertaken to identify the lead company among them. Alternatively, the YRTA can issue the guidelines for re-grouping and give the bus operators a time to select the groups they wish to join and agree as to who will be their leader. The lead company will be tasked to consolidate or merge the other operators into one public company, as well as be responsible for supervising the operations of existing paratransit in their area.

8.49 As can be seen in the preceding figure, there will be some zones of overlap among the eight bus companies, which is actually fine as these overlaps create opportunities for interline transfers, some degree of competition, and wider coverage.

(2) Guidelines for the 2nd Stage

8.50 During the launch of the Yangon Bus Service, eight bus operating companies were established and the aim from the regional government was for the these companies to be established as public-private partnerships. However, only the Yangon Bus Public Co. Ltd. can be considered a true public-private partnership. The following are general guidelines from the Study Team on how the remaining seven companies could be restructured to become true, modern public-private partnerships.

8.51 **Legal Framework:** The Myanmar Companies Act (formerly the Burma Companies Act) was enacted in 1914 and has served as the legal foundation for incorporated businesses in Myanmar. A revision of this law is now in process. Administered by the Directorate of Investment and Company Administration (DICA), the Myanmar Companies Act provides the legal framework for things such as:

(i) Incorporation and registration of companies;

(ii) Company management;

(iii) Financial reporting and audit requirements;

(iv) Share allocation and raising of capital;

(v) Appointment of a board of directors;

(vi) General meetings and other procedures; and

(vii) Liquidating the company

8.52 On the other hand, foreign investments are governed by the Foreign Investment Law of 2012. It is up for revision, with the draft now being deliberated at the Union Parliament (Pyidaungsu Hluttaw). It will be administered by a new body to be called the Myanmar Investment Commission. DICA is proposed to serve as the Secretariat of the Commission.

8.53 To overcome the lack of capital, it would be advisable to allow the entry of foreign investments in a public limited-liability bus company. A safe assumption is that such foreign direct investment would have to be under a joint-venture arrangement with a government agency, if the Yangon Bus Public Co. Ltd. is any precedent.

8.54 **Incentives to Encourage Formation of the Bus Companies:** Understandably, there will be reluctance from domestic investors to put money into the bus companies. It is simply not profitable, due primarily to low fares imposed by the government. To overcome this reluctance, the following incentives are proposed:

(i) Monopoly in their corridor of responsibility (i.e., no other operator will be allowed to provide bus services in the company's set of routes/area of operation except in some roads where segments of their routes converge);

(ii) Tax-free importation (i.e., zero import tariff) of bus vehicles conforming to the new standards imposed by the YRTA;

(iii) Right to establish a gas fuelling station for its own use and for third parties;

(iv) Delegation of powers of the former Bus Supervisory Committee and Bus Line Committee to the new company in so far as existing operators that are to be consolidated into the new company are concerned including paratransit operators in their exclusive zone;

(v) Validity of 10 years or more for license or franchise to operate;

(vi) Exemption from paying corporate income taxes for a period of five years from start of earning revenues using the new buses;

(vii) Freedom to modify and restructure its set of routes, including the corresponding level of service in terms of frequency and schedule, subject only to compliance with minimum service obligations;

(viii) Freedom to offer various types of services, such as premium or air-conditioned, regular or non-air-conditioned, express, shuttle, feeder, and trunk routes;

(ix) Government subsidy commensurate to the interest cost of loans—whether foreign or domestic—incurred in the procurement of new buses (equivalent to interest-free loan), or equity infusion into the company of up to 40% of total, as in the case of the Yangon Bus Public Co. Ltd., and/or land grant for use as bus depot;

(x) The 1,000 new buses to be procured in 2017 can be allocated to all of the bus companies either as equity contribution of the government in the shareholdings (which is simple and transparent) or on a long-term lease (which is more complicated);

(xi) Foreign exchange cover to be absorbed by the government to shield the company from devaluations on their foreign loans, if any;

(xii) Freedom to engage in other business-related activities, such as advertising inside or outside buses; and

(xiii) Equal treatment of all the bus companies such that any preferential treatment given to one automatically applies to the other companies to ensure a level playing field.

8.55 **Possible Role of Foreign Investments in the Bus Companies:** Due to the scarcity of domestic capital, the above incentives may not be sufficient to entice Myanmar citizens to invest in the new bus companies. Foreign investments may be an additional source, aside from government equity and/or incentives. Foreign direct investments can be attracted in the following manner:

(a) **One Brand, One Company:** Invite one bus manufacturer from each country (such as China, Japan, South Korea, Sweden, Germany) to supply on a sole source basis the vehicle requirements of one company and provide technical assistance to that company. This will also address the skills shortage and need for capacity building in bus operations and maintenance. Thus, each bus company will have a technology partner who can also provide financing by way of equity and export credit (10-year repayment period to be more attractive to foreign suppliers who want to enter the Myanmar truck/bus market).

(b) **Foreign Exchange Cover:** The loan or credit, if not on total investments, can be shielded from fluctuations in foreign exchange. This will require approval from the Ministry of Finance.

(c) **100% Foreign Ownership of the Bus Company:** In relation to the one-brand, one-company scheme, the bus supplier/manufacturer can set up shop in Myanmar to import the buses and offer the units to bus company on a lease-to-own basis, as well as set up shop to provide maintenance and manufacture/fabrication of bus bodies. This will have the added benefit of encouraging greater local content in the manufacture of buses in Myanmar.

3) Internal Workings of the Bus Company

(1) Model Organization

8.56 Among the eight bus companies that were established when the Yangon Bus Service was launched, the Study Team observed that only two have a modern organizational structure: the public-private partnership Yangon Bus Public Co. Ltd. and the privately owned Bandoola Transportation Co., Ltd. Therefore, for the other six companies, modernization of operations is still necessary. In the following section, the Study Team proposes how these six companies can be modernized in general.

8.57 A model bus company with adequate capital is usually organized to cover four main departments or functions by itself:

(a) **Operations:** Its business objective is to maximize revenues (passengers per bus unit) via the productive use of bus assets (revenue-km run per bus per day). The department (comprising about 60% of total company workforce) will have the following divisions:

- Scheduling, Dispatching and Inspection – proper scheduling of buses and drivers, as well as field inspectors;
- Operations Training – recruitment and continuous training, skills upgrading of drivers; and
- Field Operation – supervises the drivers and conductors.

(b) **Shop and Maintenance:** Its business objective is to minimize non-operational buses and increase bus availability at the least cost to the company. This department (comprising about 25% of the total company workforce) will have the following divisions:

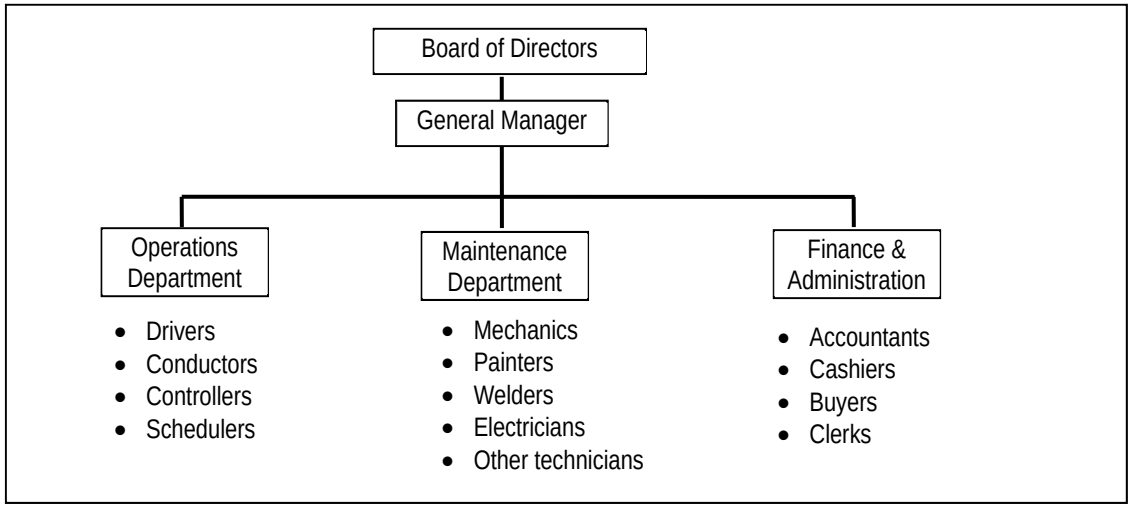
- Preventive Maintenance – to handle such tasks as oil change, greasing, adjustment of brakes/clutch;
- Electrical-Mechanical General Repair;
- Major Repairs and Body Works – such as overhauling, fuel pump calibration, painting and metal fabrication;
- Works Planning and Control – to handle the scheduling of maintenance activities; and
- Maintenance Supply and Storage – to handle the procurement and inventory of spare parts.

(c) **Administration and Finance:** A support department with the following four divisions:

(i) Administration – to handle human resources, property and security of assets, as well as general services;

- Legal – to handle claims arising from accidents, customer complaints, and regulatory compliance reporting to government, and other legal requirements;
- Finance – to handle comptrollership, accounting, funds management, payroll, ticket distribution and control, revenue verification, and internal audit; and
- Planning, Marketing and Public Relations – its business objective is to perform bus route

and service planning, monitor bus supply and demand in every route, formulates public information and marketing programs, and maximize non-fare revenue generation.



Source: Study Team

Figure 8.4.2 Typical Organizational Structure of a Bus Enterprise

8.58 In recent times, companies outsourced (i.e., contracted to another entity) some of the above functions rather than gear up to deliver them internally. The most popular outsourced service is e-ticketing wherein the prepaid tickets, software, and the devices needed to make them work are provided by a third party.

8.59 A variant of the above organization is to outsource the entire repairs and maintenance, except for routine or preventive maintenance works. This scheme will be appropriate under the following conditions:

(i) A bus leasing program is established, whereby the bus supplier (which is 100% foreign-owned) sets up shop to sell or lease the units to a bus company;

(ii) The procuring bus company has no capability to perform the required maintenance because of the absence or lack of trained mechanics and technicians; and/or

(iii) The vehicle supplier intends to gain a foothold in the Myanmar automotive market and sell his products and support services to other bus companies and third parties.

(2) Size of the Bus Company

8.60 The initial estimate for the whole Yangon Region is for a fleet size of 2,500 standard buses. This excludes minibuses and paratransit modes that can be seen though officially not recognized in Yangon. A gradual replacement can be planned over a period of five years beginning with the oldest units and non-compliant to the new technical standards. Assuming an initial fleet of 500 buses, the indicative number of employees is shown on Table 8.4.2.

Table 8.4.2 Manpower for a 500-Bus Fleets

Department	Job Class/Type	Headcount
Operations	Drivers	750
	Conductors	750

	Controllers/Schedulers	100
Maintenance	Preventive Maintenance	250
	Electro-Mechanical	25
	Major Repairs & Body Works	100
	Works Planning & Control	50
	Materials Inventory	25
Finance and Administration		150
Planning, etc.		70
Total		2,270
Manpower to Vehicle Ratio		4.54

Source: Study Team

8.61 The above numbers are not to be taken as mandatory. Each company may choose to emphasize one function over the other, in which case one department would tend to be larger than the norm. The growth rate of the fleet may also differ, such that one company may grow to 500 buses sooner than the others, while another company may take longer. Because the vehicles are new at year 1 and would still enjoy the warranty from manufacturers, the maintenance organization can start small in size with the manning of the major repairs division deferred to later years. Extensive ICT use can also reduce the headcount across various departments especially on indirect personnel. The global ratio (< 5.0 employees to vehicle ratio) should be maintained to reduce overhead cost.

8.62 In terms of capitalization, a company with a fleet of 500 new buses, each costing approximately USD120,000, should have a balance sheet of at least USD70 million to include depot and other cost items. At a 70:30 debt-to-equity ratio, that implies USD21 million (MMK29.4 billion at 1,400/$) equity. If the government participates at up to 49% of the equity, the private sector would have to contribute the balance of about MMK15 billion. There is a large amount of risk which investors may not take without some reform in the fare policy.

4) Management Systems for New Bus Companies

(1) Starting Point

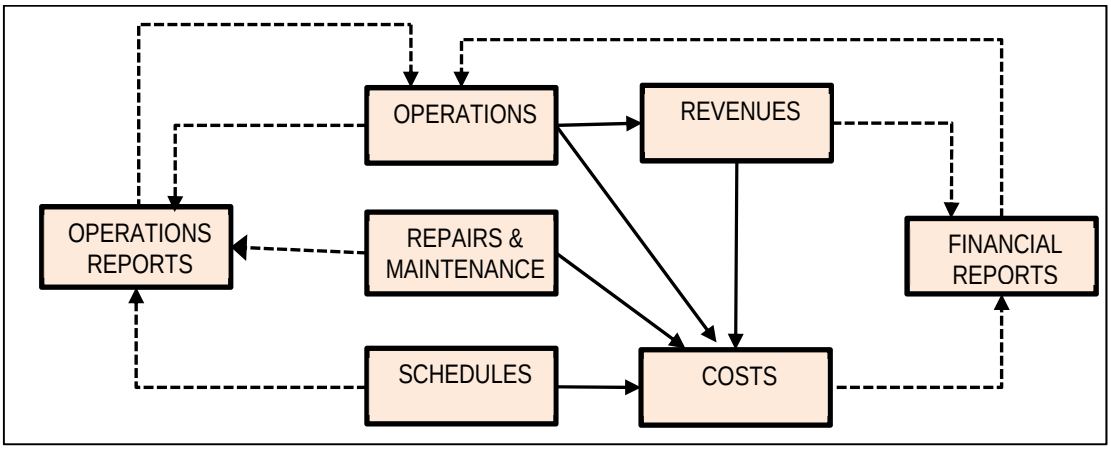
8.63 A brief assessment of the existing bus operators revealed weaknesses in their management systems. It is therefore difficult to build on these current practices. It is less cumbersome to start with new systems and organizations in each of the bus companies.

8.64 Three bus companies[6] (Yangon Bus Public Co. Ltd., SRT 1, and Omni Focus) have started to update their systems. The BRT Lite routes operated by the Yangon Bus Public Co., Ltd. and the bus route operated by SRT 1 are equipped with smart card payment systems (incompatible with each other) and GPS and CCTV; however, their information systems are still rudimentary. Vehicle maintenance is currently limited to routine and preventive maintenance procedures supported by mechanics from suppliers. The Bandoola Transportation Co., Ltd. has a more organized operations and maintenance departments; it also operates tourist buses, taxis, and city buses.

(2) Operational or Interdepartmental Relationships

[6] This was the situation before the bus network restructuring and the launch of the Yangon Bus Service in January 2017. SRT 1 was a Ministry of Transport and Communications backed bus operating company that only operated one bus route for the purposes of showing what a modernized bus route in Yangon could look like. However, before the launch of the Yangon Bus Service, the financial situation of the SRT 1 deteriorated and the company stopped operations before the Yangon Bus Service was launched.

8.65 The grouping of employees into departments is meant for efficiency. However, it sometimes leads to a silo mentality that downplays the importance of interdepartmental relationships, as illustrated in Figure 8.4.3 and Figure 8.4.4.



Source: Study Team

Figure 8.4.3 Management Reports and Departmental Interactions

8.66 Based on the market situation (load profile along the route and during the day) on every route, the Operations Department assigns a specific number of buses. For this number of buses, a "Basic Schedule of Dispatches" and its faithful implementation highly depends on the availability of buses that Maintenance could provide. The dispatching of extra trips, when warranted, is also dependent on operational buses that Maintenance can release. The Basic Schedule of Dispatches is simply a time schedule of trip departures from a station or terminal for each particular bus.

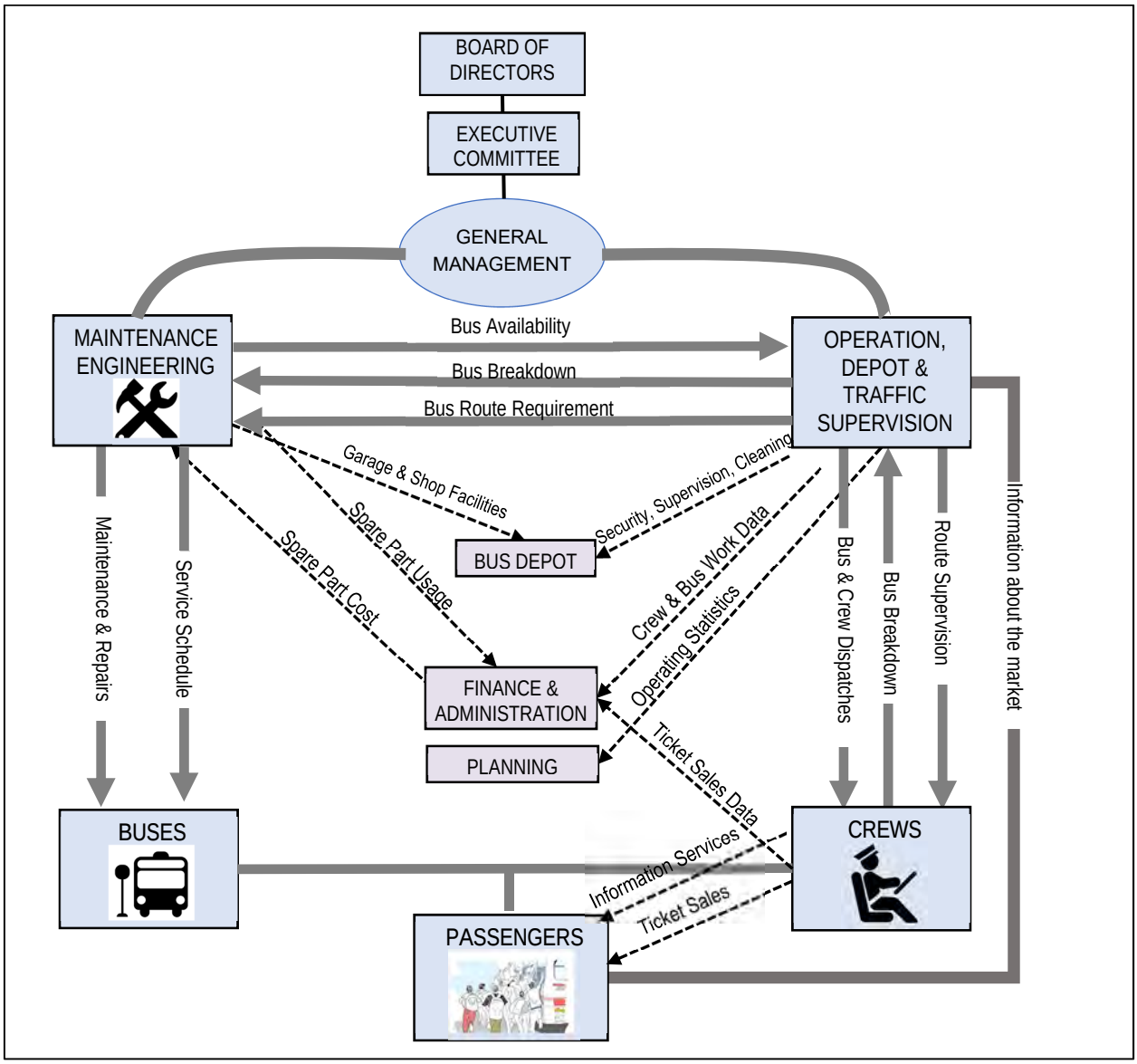
8.67 Permanent crews (driver + conductor) are assigned per bus, and in general, they are permanently assigned specific trip schedules daily. A head dispatcher is responsible for the generation of trip schedules, as well as the designation or approval of rest days. In cases where a crew fails to report for his scheduled trip, the head dispatcher most often takes charge of assigning a relief crew who is normally on standby at the depot waiting for such opportunities. A similar procedure is followed when a regular member of the crew unexpectedly takes a leave of absence. Rest days are programmed on a fixed day basis, but sometimes are not followed because a crew still in transit or no relief is available. It is a good labor practice, if not a legal requirement, to give each employee one rest day per week. And if that employee is required to render service on his rest day, he is entitled to a premium pay akin to working on a holiday.

8.68 Statistics are derived from a conductor's trip and collection reports, which should include kilometers run per bus per route, revenue per bus per route. Flash reports of revenue collections and kilometers run are prepared daily, and statistics vary as the number of bus runs fluctuates daily.

8.69 The preventive maintenance checkup of a bus follows the manufacturer's recommendation, usually every 5,000 km for oil change and checkup of components as per the manufacturer's checklist. The Maintenance Department advises Operations when a particular bus is due for checkup or oil change, depending on its cumulative kilometers run. Sometimes, Maintenance just embargo the vehicle when it is due for maintenance. Like rest days for crews, compliance with the bus service schedule is dependent on the availability of reserve buses. Tension between Maintenance and Operation could occasionally erupt when more buses are needed on the route but available units are short. In such a case, a policy ought to be adopted on when one prevails over the other.

8.70 There are now available computerized bus management systems that integrate the systems of

bus and crew assignments vis-à-vis the schedule of both preventive maintenance and route dispatches. The materials planning, procurement, and control system is also integrated into such a system, together with accounting and finance.



Source: Study Team

Figure 8.4.4 Operational Relationships in a Bus Company

(3) Key Performance Indicators

8.71 Key performance indicators (KPIs) refer to a set of performance measures to assess internal management, support decision making within the organization, and provide comparative information for the YRTA, and to identify best practices. It enables a bus company to benchmark its performance against that of other operators in Yangon, as well as in other cities in the world.

8.72 Benchmarking is defined as a systematic process of continuously measuring, comparing, and understanding an organization's performance and change:

(i) In the performance of a diversity of key business processes;

(ii) Against comparable peers anywhere else in the world; and

(iii) To gain information which will help participating organizations to improve their performance.

8.73 Table 8.4.3 provides a comprehensive list of KPIs in six areas that an international group (International Bus Benchmarking Group) has adopted. The last column shows the initial set of KPIs that the six Yangon bus companies ought to adopt and for the YRTA to impose as minimum KPIs.

Table 8.4.3 Key Performance Indicators for Bus Transit

Success Dimension		Performance Measure		KPI for YBS
G	Growth & Learning	G1	Passenger boardings	☑
		G2	Vehicle kilometers	☑
		G3	Staff training (categories)	
C	Customer	C1	Passenger-km/revenue capacity km	
		C2	Actual/Scheduled revenue-km & hour	
		C3	Dynamic customer information	
		C4	Low floor buses (see Note a)	☑
		C5	% Buses on time	
		C6	Regularity (Excess waiting time)	
		C7	Customer satisfaction	☑
P	Internal Processes	P1	% of Fleet used in peak (see Note b)	☑
		P2	Revenue/total vehicle-kilometer	☑
		P3	Total vehicle hours per labor hour	
		P4	Staff absenteeism rate	
		P5	Mean distance between failures (see Note c)	
		P6	Lost vehicle kilometer	
S	Safety & Security	S1	Number of vehicle accidents per vehicle-km	☑
		S2	Number of staff accidents/million staff hours	
		S3	Number of passenger accidents/boarding	
		S4	Number of 3rd party accidents	☑
		S5	Incidences of on-board crime	
F	Financial	F1	Total cost per total vehicle-kilometer	☑
		F2	Total operating cost per total vehicle-km	
		F3	Service operation cost/total vehicle-km	
		F4	Maintenance cost/total vehicle-km	
		F5	Administration cost/total vehicle-km	
		F6	Service operating cost/revenue vehicle-km	
		F7	Total fare revenue/total operating cost	☑
		F8	Total operating cost/passenger boarding	
		F9	Fare revenue/passenger boarding	
E	Environmental	E1	Diesel/CNG fuel consumption/100 veh-km	☑
		E2	Diesel/CNG fuel consumption/passenger-km	
		E3	Fuel consumption/total vehicle ton-km	
		E4	% of fleet meeting Euro 4 standards	
		E5	CO^2 emissions per vehicle-km & pax-km	

Source: International Bus Benchmarking Group

(4) Commercially Available Software

8.74 The new bus companies will be better off in the long run if they start their operations with more intensive use of available software in the market. In that way, newly hired employees will be trained to work with these systems in place rather than undergo subsequent re-training and change in their working habits. Usually, these ready-made software address one or all of the following aspects: fleet management, electronic fare payment, and traveler information.

8.75 Without endorsing any one product or company, or being exhaustive, some of the top-rated transit management systems are the following:

(a) Optibus on Schedule empowers schedulers to prepare vehicles and drivers schedule using a proprietary Interactive Schedule Optimization (ISO) methodology that can evaluate all the possible scenarios in real time. The scheduler changes preferences and parameters, compares multiple scenarios, and investigates the impact of what-if scenarios. This unique process leads to the most optimal schedule that meets the operator's business objectives;

(b) Pantonium is a web-based application software designed to optimize routes in real time so a company can reduce the number of vehicles needed per trip and make each trip as efficient and profitable as possible;

(c) Telenav is a GPS-based tracking service that locates vehicles and receive informative reports regarding driving habits and fuel consumption;

(d) Route Coordinator is a routing and scheduling software that is designed for small and medium-sized transportation organizations; including GPS tracking with AccuTrack, and generate data inputs to maintenance;

(e) Locomate offers vehicle tracking, scheduling, route management, dispatch, bus terminal, depot management, inventory and maintenance systems;

(f) Fleet Maintenance Pro is maintenance tracking software for quick and easy tracking and organizing preventive and repair maintenance of the bus fleet, with automated and color-coded alerts when a certain vehicle or piece of equipment is due for service. Any unexpected maintenance performed on a vehicle will be also be recorded and saved; and

(g) SureFleet is a fleet maintenance software designed to track and report on preventive fleet maintenance, repair costs, fuel purchases and more; customized maintenance alerts and tracking by days, miles, engine hours, and fuel. It also provides the ability to customize trip inspections, manage fleets and sub-fleets, manage driver qualifications, track fuel, create work orders, receive email alerts, and run reports

(5) Investing in Capacity Development

8.76 Without a commensurate investment in human capital, the investment in new buses and new systems will be for naught. Trained human resources are critical to the long-term sustainability of the bus transport system in Yangon.

8.77 It is therefore strongly recommended that the YRTA tap as much external assistance as possible in implementing the proposed reforms in the public sector as well as reforms in the bus operators side.

8.78 Such a technical assistance package should have the following objectives:

(i) To assist the YRTA implement Phase 1 of the Bus Modernization Project, particularly the formation of the bus companies and the acquisition of 2,500 new buses;

(ii) To assist in the development of institutional capabilities within the YRTA for planning, monitoring, and regulation of the bus transport sector; and

(iii) To assist in the establishment and development of professionally managed bus companies, capable of efficient fleet operation of buses after amalgamation of existing transport operators into five to eight bus companies.

8.79 The technical assistance will include assistance for the following main tasks that constitute the major components of the planned Bus Modernization Project:

(a) **Advisory and institutional development mainly to the public sector (YRTA):**

- Route planning, design, and implementation
- Consolidation of operators into five public bus companies
- Revision of the system of franchising and licensing of bus operators
- Design of new policies on fares and subsidies

(b) **Technical and managerial assistance mainly to the bus companies (5–8 entities)**

- Assist each of the bus companies in organizing an expanded fleet and delivery of adequate services on its routes, and
- Assist them in evolving into autonomous fleet operators, including provision of training and advice in operation, maintenance, and financial aspects of transit management.

8.5 Bus Pilot Project

1) Objective and Scope of Pilot Project

8.80 While the YBS has been undergoing reform and improvement since the beginning of 2017, this study intends to facilitate its further improvement by conducting the following actions on a pilot basis (see Table 8.5.1):

(i) Comprehensive YBS transport survey;

(ii) Bus operation and management information concept formulation;

(iii) Micro traffic management planning; and

(iv) Trainings and workshops.

Table 8.5.1 Outline of the Bus Pilot Project

Action	Objective	Scope
1. Comprehensive YBS Transport Survey	• To preliminary analyze current bus operation characteristics and satisfaction/ needs of bus users • To collect bus operation and passenger ridership data necessary for Bus Management Information System	• All 81 bus routes • On-board survey on operation/ ridership data • Bus passenger interview survey at selected bus stops
2. Bus Operation and Management Information Concept Planning	• To prepare concept plan for bus operation and management information system though ICT	• Data collection through ICT (IC-card, GPS, Wi-fi) from selected routes
3. Micro Traffic Management Planning	• To prepare traffic circulation and management plans for smooth bus operation and boarding / alighting	• Preparation of plans for selected bus terminals
4. Training and Workshops	• To share the outputs of 1,2,3 above with bus operators • Toe learn experiences of foreign bus operators	• To conduct workshops and training for bus operators using guidelines and teaching materials.

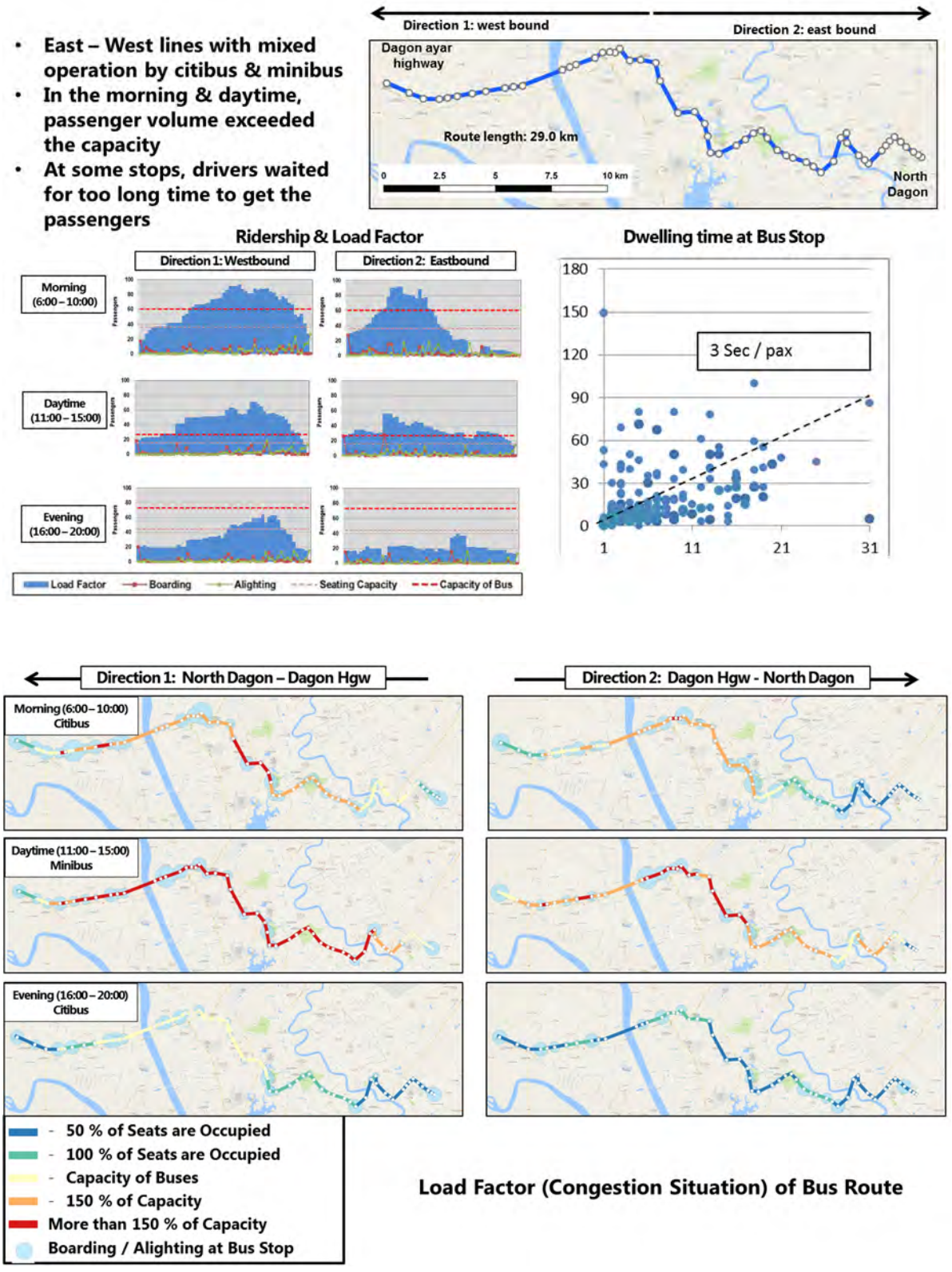
Source: Study Team

8.81 The collected data from the Comprehensive YBS Transport Survey can be further analyzed and shown in visual signage to better understand bus operational characteristics, as shown in Figure 8.5.1.

8.82 While the survey was completed in April / May and data has been analyzed, other useful data and information were collected based on which bus operation and management information system could be worked out. The data collected is included in Technical Report No. 2. Main data collected in the survey include the following:

(a) **On-board Survey: Survey items are:** (i) bus type and number of the seats; (ii) bus arrival / departure time at each bus stop; (iii) number of boarding / alighting passengers at each bus stop; (iv) assessment of LOS (e.g., on-board congestion, on-board comfort, and driving manner); and (v) happenings during the survey such as traffic accidents, illegal activities.

(b) **Bus Passenger Interview Survey:** Survey items are: socio-economic profile; (ii) trip information (OD, purpose, access); (iii) frequency of bus use; (iv) comparison between YBS and the previous bus service.



Source: Study Team

Figure 8.5.1 Bus Operating Characteristics on Route No. 6 (Example)

2) Formulation of Bus Operation and Management Information System

8.83 Because it is important that the YBS is operated and managed based on updated and objective data, key performance indicators must include among others the following:

(a) **Operating Performance Indicators:** Passenger volume, fleet utilization, distance travelled by buses, breakdown in services, fuel consumption, staff ratios (no. of staff/ bus), accident rate, dead mileage (km run without revenue), and cost of bus operation.

(b) **Quality of Service Indicators:** Waiting time, walking distance to bus stops, transfer between routes and services, journey times, and travel expenditure.

8.84 These data were first collected manually through an on-board survey for all routes. During the pilot project, the same data were collected through ICT, as shown in Figure 8.5.2.

8.85 Bus Route 37 and 7 were selected and ICT devices were installed to collect relevant data. For Bus Route 37, GPS, CCTV, IC card, tablet and wi-fi were provided, while for Bus Route 7, tablet and wi-fi are provided. Once it was found that necessary data could be collected through the appropriate set of ICT devices, the data were stored as big-data under the YRTA to be controlled and analyzed based on appropriate applications for the benefit of bus stakeholders including bus operators/ companies, bus users, and the YRTA itself.

3) Micro Traffic Management Planning

8.86 This pilot project component intended: (i) to facilitate smooth operation of bus boarding/ alighting in selected problem areas, (ii) to ensure the safety of pedestrians in critical areas, and (iii) to promote improved overall circulation of road traffic at critical bus stops. Two areas were selected for preliminary study, i.e., Tha Khin Mya Park and Sule Pagoda area.

8.87 Site survey and preliminary planning work had been conducted. Figure 8.5.4 shows a tentative output for Tha Kyin Mya Park Terminal.

4) Workshop/ Training

8.88 In the pilot project, a series of workshops were conducted to (i) generate an understanding of the importance and benefits of role-sharing among bus operators, bus users, and the YRTA to promote improved YBS services, and (ii) conduct practical training in and knowledge sharing on database operation and management.

8.89 Workshop topics included the concept of YBS-MIS and training of bus personnel in safety. A total 2 workshops were organized for YRTA members and staffs from bus operators, and many stakeholders attended. Figure 8.5.5 shows the results of workshops.

■ **b'smart**

1. Telematics
- GPS, acceleration sensor, etc.

■ **Pilot Project**

2. ICT Data collection 1
- Tablet, Wifi
- GPS, CCTV, IC card

➡ **Bus route 37**

3. ICT Data collection 2
- Tablet, Wifi

➡ **Bus route 6 or 7**

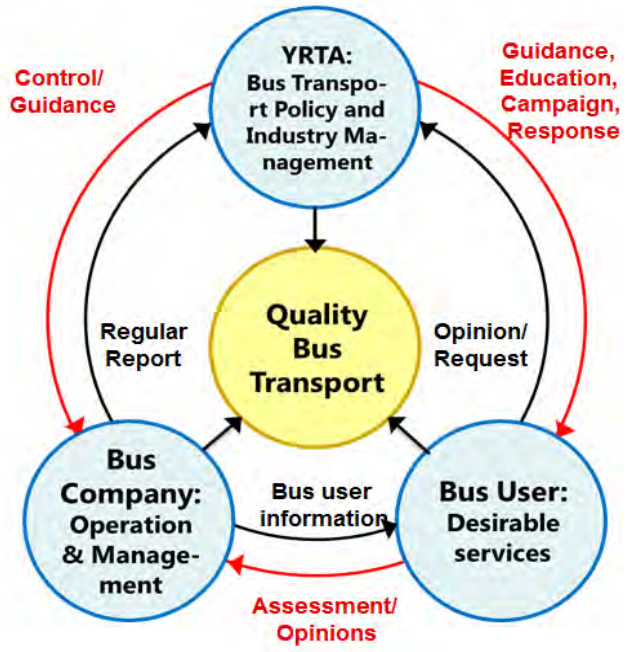
4. Manual Data collection
- On-board survey
- Data collection from operator
- User interview

Bus Operation MIS

1	2	3	4	Indicators
✓	✓		✓	Distance Traveled by Buses
✓	✓			Dead Mileage
✓	✓		✓	Journey Times
✓	✓	✓	✓	Fuel Consumption
	✓	✓		Cost of Bus Services
✓	✓	✓		Accident Rate
	✓	✓	✓	Service Satisfaction
	✓	✓	✓	Operating Ratio
	✓		✓	Passenger Volume
			✓	Waiting Time
			✓	Walking Distance to Bus Stops
			✓	Interchanges between Routes and Services
			✓	Travel Expenditure
			✓	Fleet Utilization
			✓	Staff Ratios
			✓	Breakdown in Services

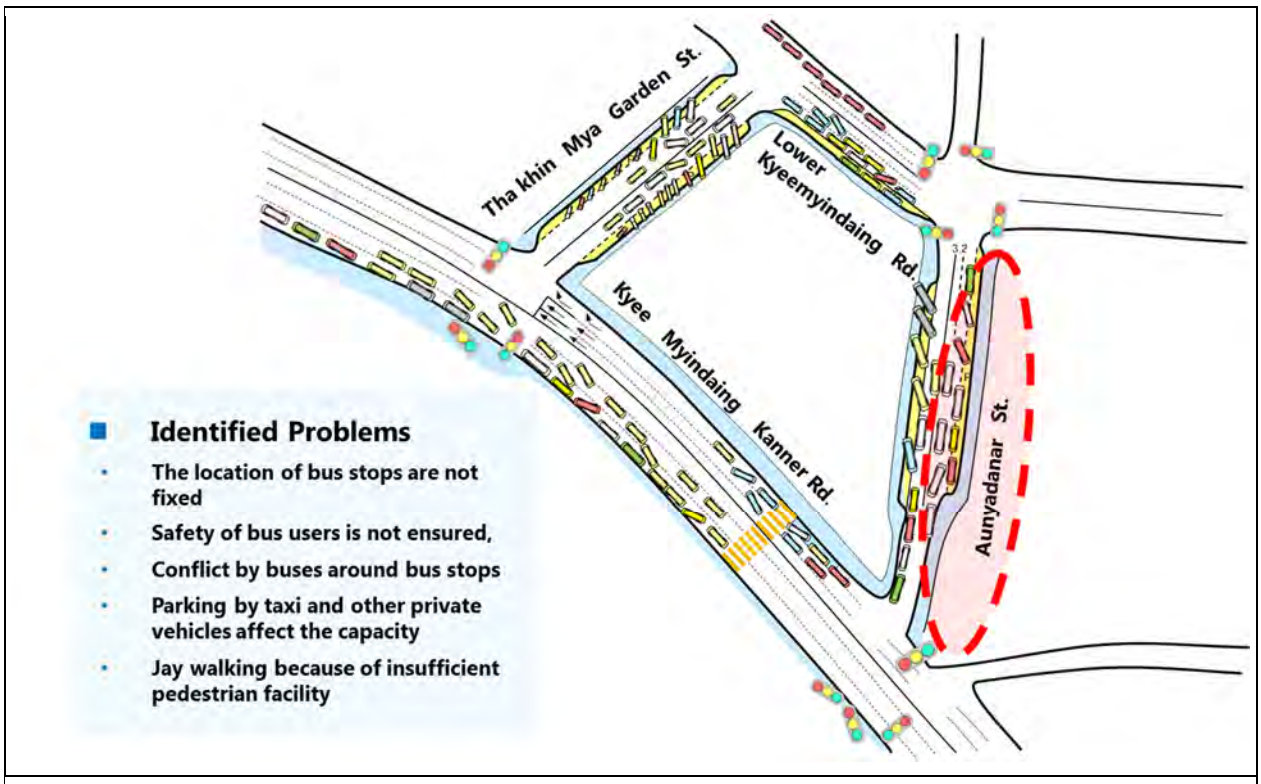
Source: Study Team

Figure 8.5.2 Data Collection through ICT Devices

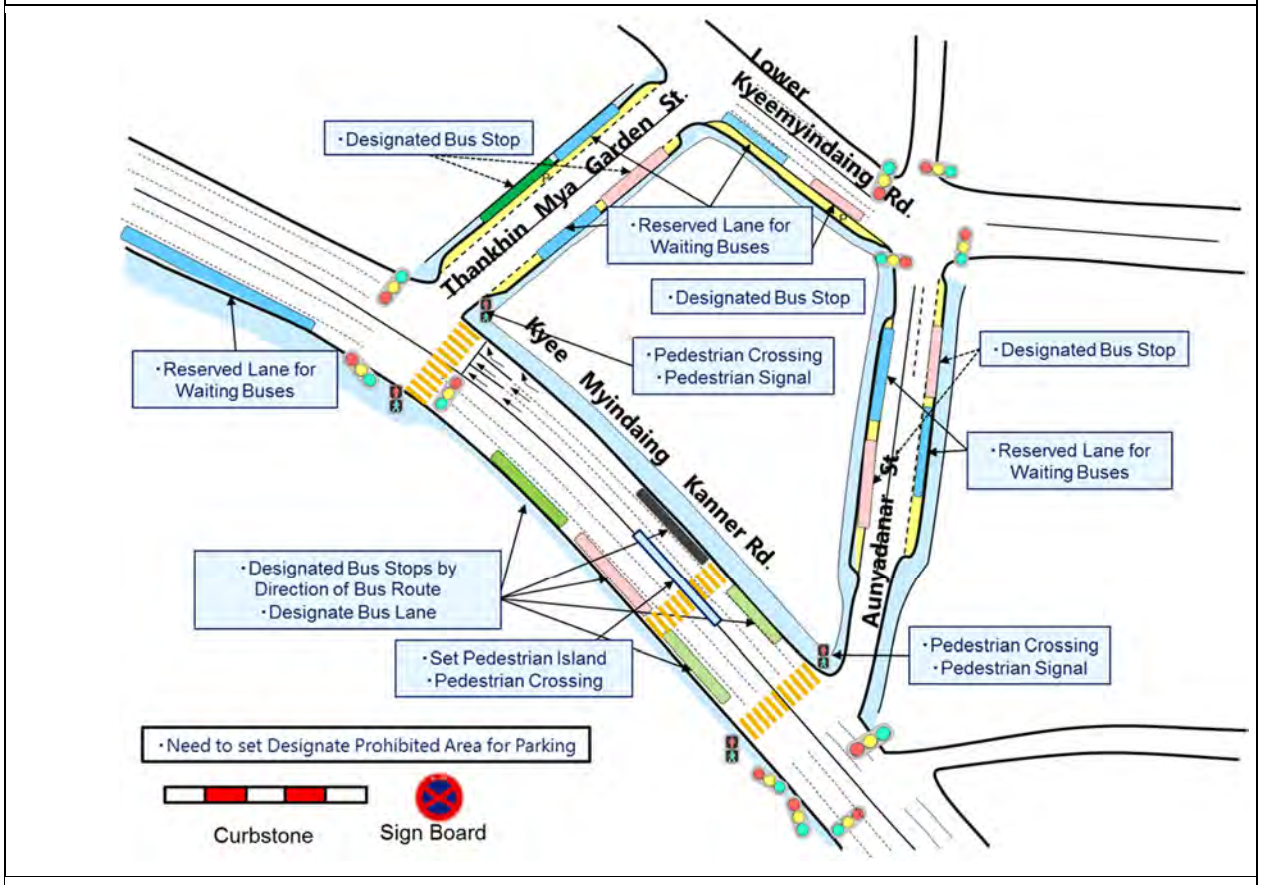


Source: Study Team

Figure 8.5.3 Role Sharing among Bus Operators, Bus Users, and YRTA in Bus Operation and Information Management System



Current Situation



Proposed Option

Source: Study Team

Figure 8.5.4 Preliminary Improvement Plan for Tha Khin Mya Park Terminal Area

<table>
<tr><td colspan="2">1st WORKSHOP on “Pilot Project on Bus Transport Modernization”</td></tr>
<tr><td>Venue: Meeting Room of IBIS Hotel, 369 Laydaungkan Road, Yangon, Myanmar
Date & Time: 20 June 2017 (Tue) 9:00-11:30
Participants: Total 38 participants
Members and Staffs of YRTA, JICA Study Team and Members of Bus Operators

  </td><td>Programs on Workshop:
1. Questionnaire for Bus Company:
- Overall Existing operation system
- Bus Maintenance and Bus Depot
- Difficulties & future requirements
2. Delivering 1st presentation
- Comprehensive YBS survey
- Bus operation management information
- Micro Traffic Management Planning
- Training and Workshops
3. Delivering2nd presentation
- On-Board survey
- Bus user Interview
- YBS Route Performance
4. Bus Map
- Delivering to YBS bus map to attendees</td></tr>
<tr><td colspan="2">2nd WORKSHOP on “Pilot Project on Bus Transport Modernization”</td></tr>
<tr><td>Venue: Meeting Room of IBIS Hotel, 369 Laydaungkan Road, Yangon, Myanmar
Date & Time: 24 August 2017 (Thu) 13:30-16:30
Participants: Total 72 participants
Members and Staffs of YRTA, JICA Study Team and Members of Bus Operators

  </td><td>Programs on Workshop:
1. Introduction of Yokohama City Bus Operation:
- Outline of Yokohama City Bus
- Bus Route Planning
- Bus Operation Management
- Human Resource Development
2. Introduction of Bus Driver manual
- Introduction
- Bus Driver Manual
3. Outline of Bus Management Information System
- Concept & Overview of Pilot Project
- Free Wifi Service for Bus Users
- Bus Operation & Driving Management by Tablet PC
- Crowd Level Estimation by Video Analysis
- Travel Speed Calculation by Probe Processing
4. Micro Traffic Management
- Preliminary Analysis on Tha Khin Mya Park
- Preliminary Analysis on Sule Pagoda</td></tr>
<tr><td colspan="2">Contents:</td></tr>
</table>

Source: Study Team

Figure 8.5.5 Results of Workshop on Bus Pilot Project

9 TRAFFIC MANAGEMENT AND SAFETY

9.1 Main Issues

1) Traffic Congestion

9.1 Mobility of the people and their accessibility to services have been worsening day by day due to traffic congestion, the causes of which vary and are complex because they are interrelated. Traffic congestion does not only affect traffic safety and environment (air quality, noise pollution, living conditions, and landscape), but socio-economic activities as well. The main causes of traffic congestion include the following:

(i) Lack of traffic control at bottlenecks, such as schools and shopping centers, and presence of roadside vendors;

(ii) Increasing number of private cars and improper maintenance of old vehicles;

(iii) Excessive, disorderly, and illegal roadside parking;

(iv) Poor pavement conditions and lack of traffic control measures;

(v) Bad driving manner;

(vi) Uncoordinated traffic signal cycle time and flow control at intersections both for vehicles and pedestrians;

(vii) Picking up/ Dropping off of passengers by buses and taxis on-street affect the traffic flow;

(viii) Poor walking conditions and jaywalking;

(ix) Lack of large-truck traffic management;

(x) Lack of enforcement capacity; and

(xi) Others including slow response to traffic accidents, construction work, and related traffic control, etc.

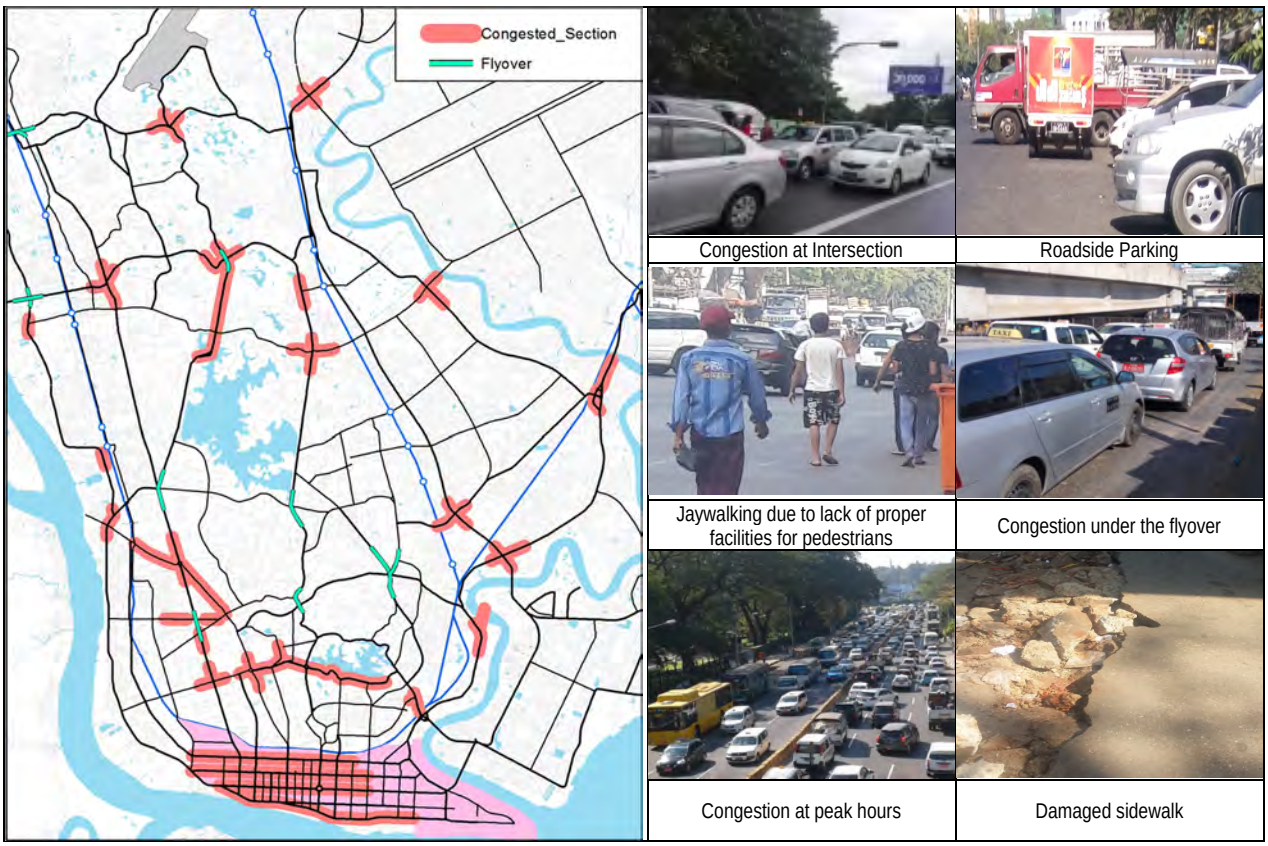
9.2 Because the causes of traffic congestion are many and interrelated, this makes it difficult to plan for effective measures and to implement them effectively. For planning purposes, measures can be grouped into four categories, as follows:

(i) Provision of adequate infrastructure and facilities for both vehicles and pedestrians;

(ii) Control and management of road vehicles and vehicular traffic;

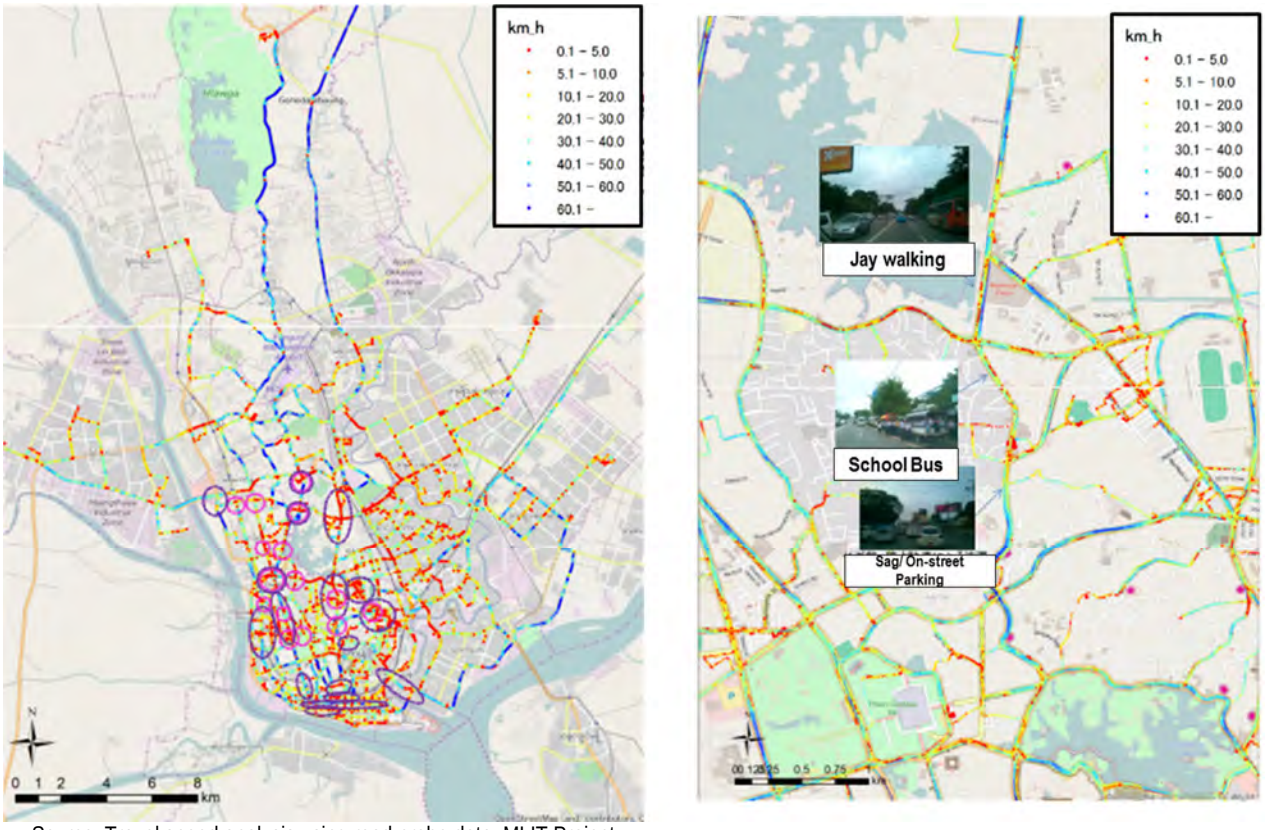
(iii) Education and awareness enhancement of road users, i.e., drivers, passengers, and pedestrians; and

(iv) Establishment of proper enforcement mechanism and capacity.



Source: Study Team.

Figure 9.1.1 Popular Locations and Causes of Traffic Congestion



Source: Travel speed analysis using road probe data, MLIT Project

Figure 9.1.2 Identification of Traffic Bottlenecks using Probe Data

2) Level of Services of Road Traffic

9.4 A popular indicator to assess road congestion is travel time on roads. Surveying travel speed using free flow method (a car travels more or less according to the overall flow of traffic) was done to compare the current situation with that during YUTRA time. For this, five road sections were selected, as shown in Figure 9.1.3. Preliminary findings are shown in Table 9.1.1 and briefly described below.

(i) Although in general, the traffic situation has worsened along the selected corridors, travel conditions improved along Pyay Road where a flyover was constructed. The improvements are also attributed to the signalization of major intersections;

(ii) Travel speed varied considerably not only by time and direction, but also by day. Nevertheless, it was found that road traffic situation is tolerable in spite of the significant increase in the number of road vehicles during the last several years; and

(iii) It was found that there were ample opportunities for traffic management could contribute to the improvement of road traffic in Yangon

Figure 9.1.3 Selected Roads for Travel Speed Survey

Table 9.1.1 Comparison of Travel Speeds on Selected Roads, 2013 and 2017

Selected Road	Length (km)	Time Period	Direction	Ave. Travel Speed (km)	
				2013	2017
1. Pyay Road (Lan Thit to Bogyoke Aung San Road)	15	Morning	To CBD	15.3	15.4
		Daytime	To CBD	21.4	35.4
		Evening	From CBD	17.5	22.9
2. Kabara Aye Pagoda Road (Thu Dhamar to Bogyoke Aung San)	13	Morning	To CBD	28.6	18.5
		Daytime	From CBD	19.8	16.1
		Evening	From CBD	15.7	11.6
3. Bayint Naung–Kyee Myin Daing Kannar (Hlaing River Road to Aung Yadanar Road)	14	Morning	To CBD	22.5	28.8
		Daytime	From CBD	15.5	19.8
		Evening	From CBD	8.6	16.6
4. No. 2 Main Road (Anawarahta Road to Bogyoke Aung San)	13	Morning	To CBD	25.8	24.1
		Daytime	From CBD	26.3	21.0
		Evening	From CBD	20.9	n/a
5. Parami Road (Bayint Naung to Thanthumar)	8	Morning	East to West	20.9	11.9
		Daytime	East to West	19.5	18.1
		Evening	West to East	14.1	12.3

Sources: YUTRA Travel Speed Survey (2013), and Study Team

9.2 Proposed Solutions and Measures

1) Elimination of Bottlenecks on Main Corridors

(1) Pyay Road

9.5 Pyay Road is one of the most important north–south traffic corridors connecting Yangon Airport and the CBD via the city centre. The road is relatively wide and can accommodate six lanes or more with central median and sidewalk. The road has a total of 14 intersections including flyovers at intersections with 8 Mile Road, Inya Road, and Minigone Road, and one non-signalized intersection with Min Ye Kyaw Swar.

9.6 Traffic management problems are typically seen in the following locations:

(i) In front of Taw Win Centre;

(ii) In front of People's Park;

(iii) In front of Myenigone/Maharmying bus stop;

(iv) In front of Grand Garden Insurance;

(v) In front of the University of Yangon;

(vi) In front of the International Business Center;

(vii) South of AD Intersection; and

(viii) In front of the 7 Mile bus stop.

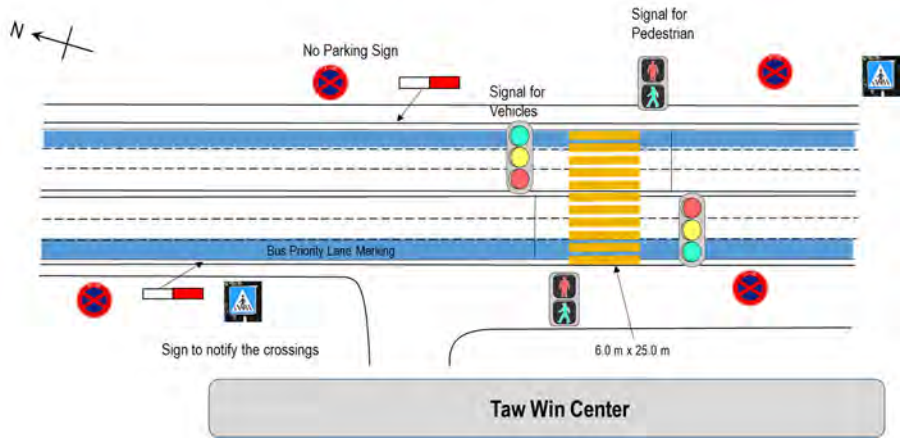
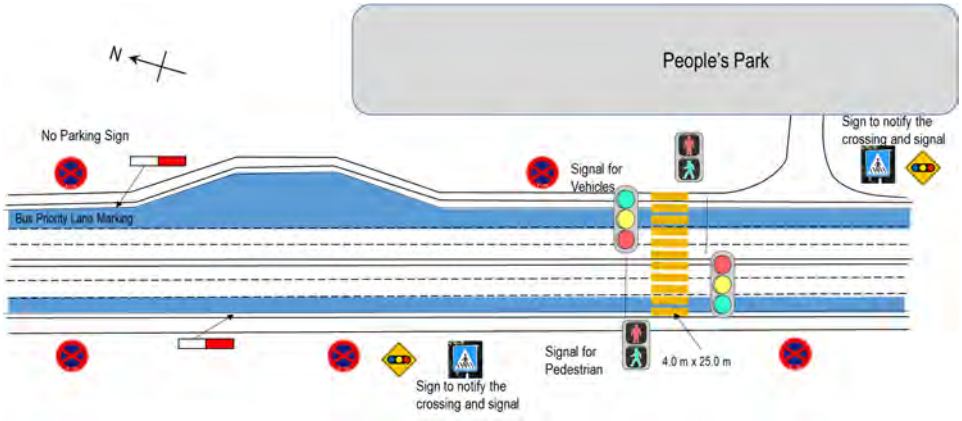
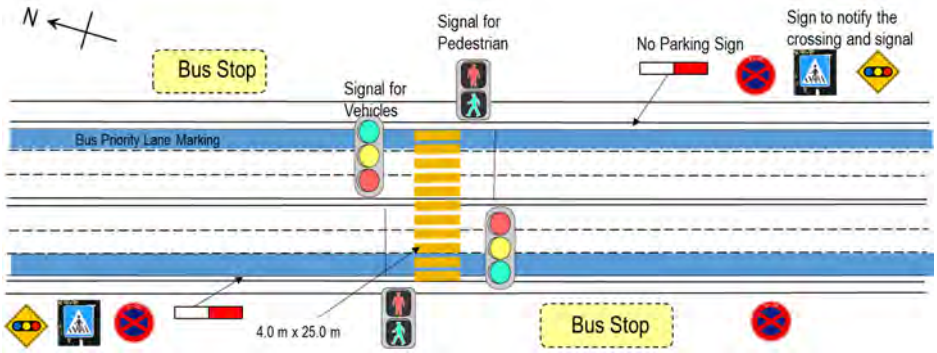
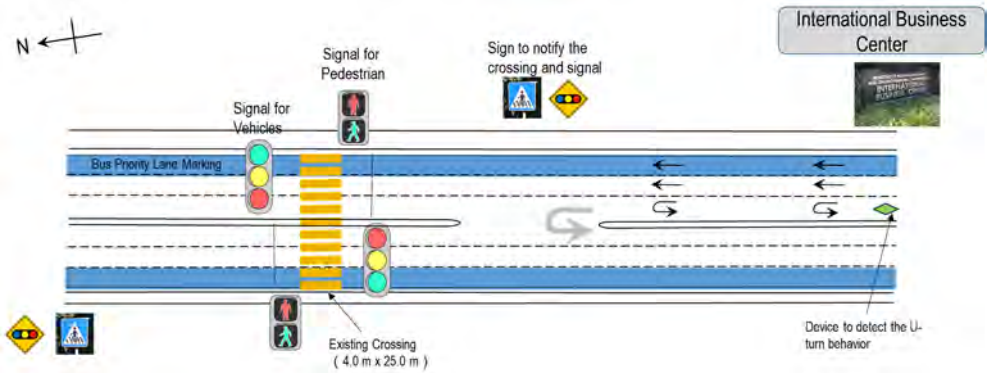
9.7 The possible measures to improve the situation include: (i) repair of traffic markings on pedestrian crossings, (ii) installation of push button pedestrian signal, (iii) installation of traffic signals for vehicles, (iv) designation of no-parking areas and provision of traffic markings and signs, and (v) provision of signs for pedestrian crossings.

9.8 For selected locations, the proposed measures are listed in Table 9.2.1. Those for four locations, i.e., Taw Win Centre, People's Park, Myenigone/Maharmying bus stop, and the International Business Centre are shown in Figure 9.2.1.

Table 9.2.1 Proposed Traffic Management Measures for Problem Areas on Pyay Road

Problem Area	Proposed Traffic Management Measure						
	Installation of Pedestrian Crossing	Installation of Push-button Signal for Pedestrians	No-parking Marking / Signboard	Bus Priority Lane Marking and Signboard	Guidance on Bus Stop Location	Enforcement of Traffic Regulations	Others (Signal Management, etc.)
1. Taw Win Centre	○	○	○	△	-	○	-
2. People's Park	△	○	○	○	△	○	-
3. Myenigone/ Maharmying Bus Stop	○	○	○	△	△	○	-
4. Grand Guardian Insurance	○	○	○	△	△	○	-
5. University of Yangon	○	○	○	△	△	○	-
6. International Business Center	○	○	-	-	-	△	○
7. AD Intersection South	-	-	-	-	-	-	○
8. 7 mile Inter-section Bus Stop	○	○	○	△	△	○	-

Source: Study Team
1) ○: Key Measure △: Secondary Measure

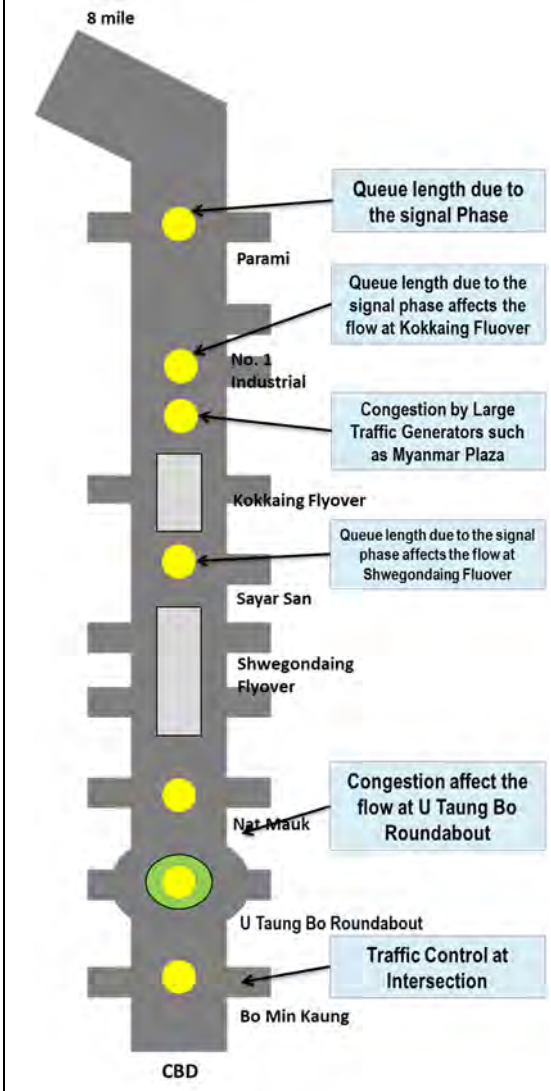
Taw Win Centre	
People's Park	
Myenigone/ Maharmying Bus Stop	
International Business Centre	

Source: Study Team

Figure 9.2.1 Traffic Bottlenecks and Proposed Management Measures for Pyay Road

(2) Kabar Aye Pagoda Road

9.9 Kabar Aye Pagoda Road is also one of the most important north–south traffic corridors. The road is relatively wide and can accommodate six lanes or more with sidewalk. The road has a total of 16 intersections including flyovers at 8 Mile, Kokkaing, and Shwe Gone Daing roads. The main bottlenecks on and proposed solutions for the corridor are shown below.

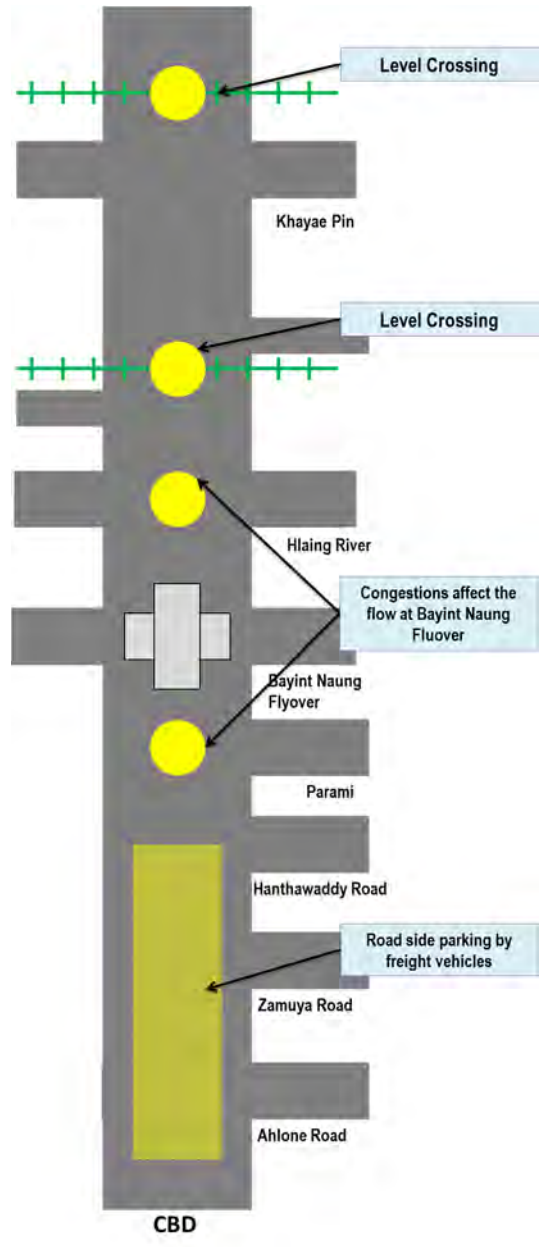
Corridor	Main Problem Area	Proposed Solution
		1. Short-term Solutions (i) Adjust signal phasing (ii) Control traffic at commercial areas (iii) Control disorderly bus loading/unloading, especially at commercial facilities (iv) Control roadside parking ・ Improve traffic signs and lane markings ・ Train traffic enforcers ・ Micro-manage traffic at flyover intersections 2. Mid-term Solutions (i) Construct underpasses / flyovers (ii) Strengthen traffic management

Source: Study Team.

Figure 9.2.2 Traffic Bottlenecks and Proposed Management Measures for Kabar Aye Pagoda Road

(3) Kannar Road–Bayint Naung Road

9.10 Kannar Road–Bayint Naung Road is a north–south traffic corridor along the waterfront area. The road is relatively wide and can accommodate six lanes or more with sidewalk. Port facilities are located along this road and a lot of freight vehicles can be seen on the corridor. On this corridor, the inner ring road (IRR) is proposed to be developed. Enough road width is prepared and there is a certain amount of room for further expansion. Roadside parking by freight vehicles can be seen on many sections, thereby affecting traffic flow.

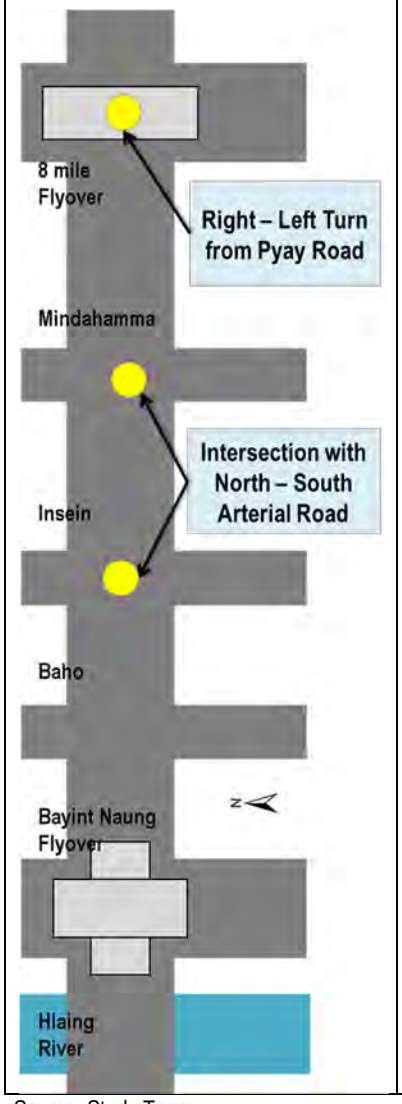
Corridor	Main Problem Area	Proposed Solution
		1. Short-term Solutions ・ Adjust signal phasing ・ Control traffic especially freight vehicles ・ Control traffic at disorderly bus loading/unloading points ・ Control roadside parking ・ Improve traffic signs and lane markings ・ Train traffic enforcers ・ Micro-manage traffic at flyover intersections 2. Mid-term Solutions ・ Strengthen traffic management ・ Readjust road space with development of IRR ・ Relocate port functions

Source: Study Team

Figure 9.2.3 Traffic Bottlenecks and Proposed Management Measures for Kannar Road–Bayint Naung Road

(4) Yangon–Pathein Road

9.11 Yangon–Pathein Road is an east–west traffic corridor connecting the inner urban area and Hlaingtharyar. The road is wide and can accommodate six lanes or more with sidewalk. In Yangon, the number of east–west corridors is limited; hence traffic tend to concentrate on the existing corridors and intersections with north–south corridors can be bottlenecks (see Figure 9.2.4).

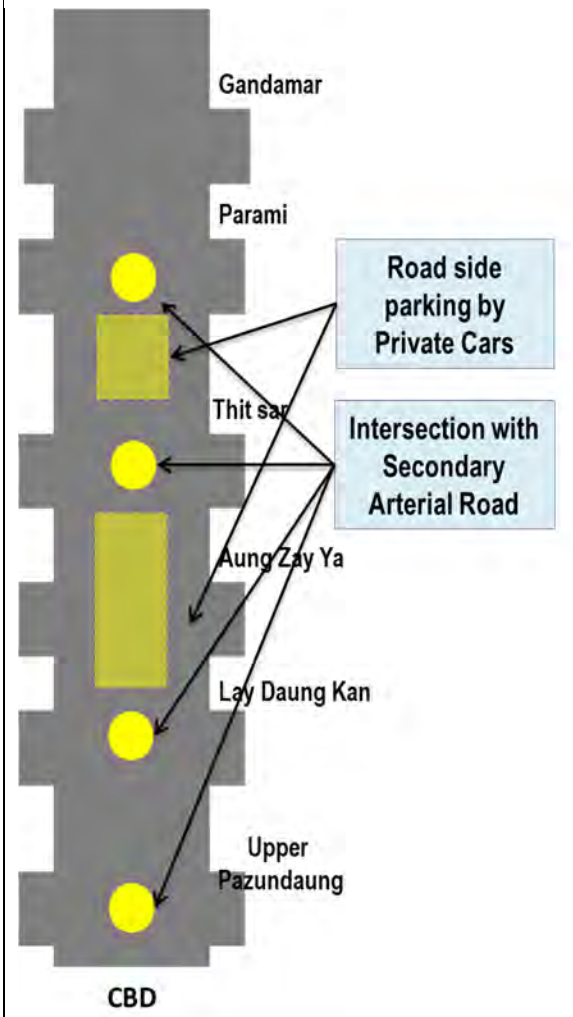
Corridor	Main Problem Area	Proposed Solution
		1. Short-term Solutions ・ Adjust signal phasing ・ Control traffic at commercial areas ・ Control traffic at disorderly bus boarding/alighting points ・ Control roadside parking ・ Improve traffic signs and lane markings ・ Train traffic enforcers 2. Mid-term Solutions ・ Make Pyay Road a semi-access-controlled road ・ Readjust road space with development of IRR ・ Strengthen traffic management

Source: Study Team

Figure 9.2.4 Traffic Bottlenecks and Proposed Management Measures for Yangon–Pathein Road

(5) Wai Zayan Tar Road

9.12 This is the north–south traffic corridor in the eastern part. The road is relatively wide and can accommodate six lanes or more with sidewalk. On this corridor, the inner ring road (IRR) is proposed to be developed. Enough road width is prepared and there is some room for further expansion. Additionally, bus operation on this corridor is restricted. Roadside parking by private vehicles can be seen at many points, thereby affecting traffic flow. Some intersections become bottlenecks.

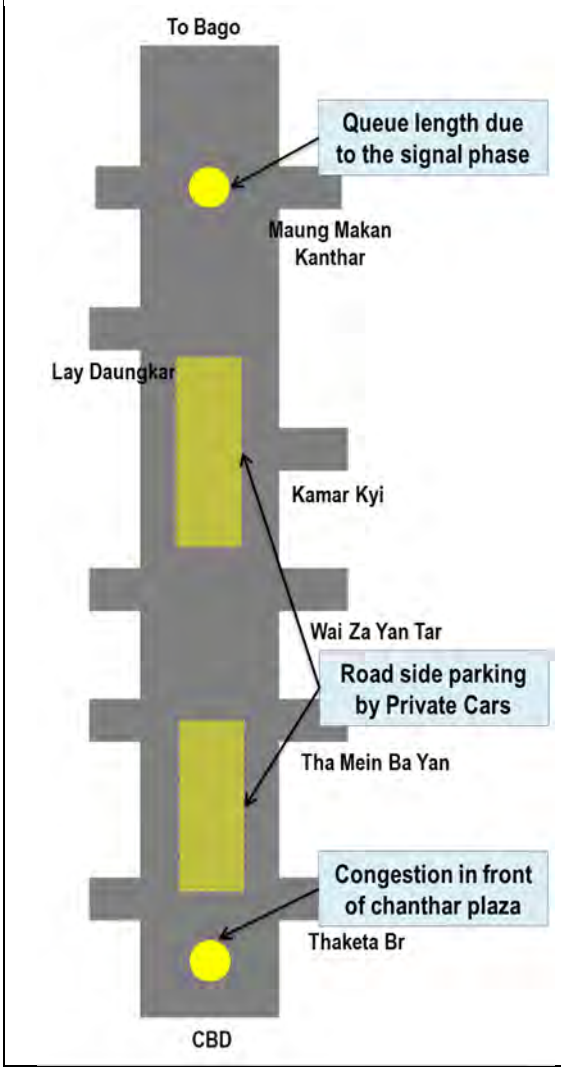
Corridor	Main Problem Area	Proposed Solution
		1. Short-term Solutions ・ Adjust signal phasing ・ Control traffic at schools/commercial areas ・ Control traffic at disorderly bus boarding/alighting points ・ Control roadside parking ・ Improve traffic signs and lane markings ・ Train traffic enforcers ・ Micro-manage traffic at flyover intersections 2. Mid-term Solutions ・ Make Pyay Road as a semi-access- controlled road ・ Construct underpasses/flyover ・ Strengthen traffic management

Source: Study Team.

Figure 9.2.5 Traffic Bottlenecks and Proposed Management Measures for Wai Zayan Tar Road

(6) Upper Pazuntaung Road–Thanthumar Road–No. 2 Main Road

9.13 This corridor connects Yangon with Bago Region and is used for intercity traffic. Road width is prepared and there is some room for further expansion. Roadside parking by private vehicles and freight vehicles can be seen at many points, thereby affecting traffic flow. The main bottlenecks and proposed solutions are shown below.

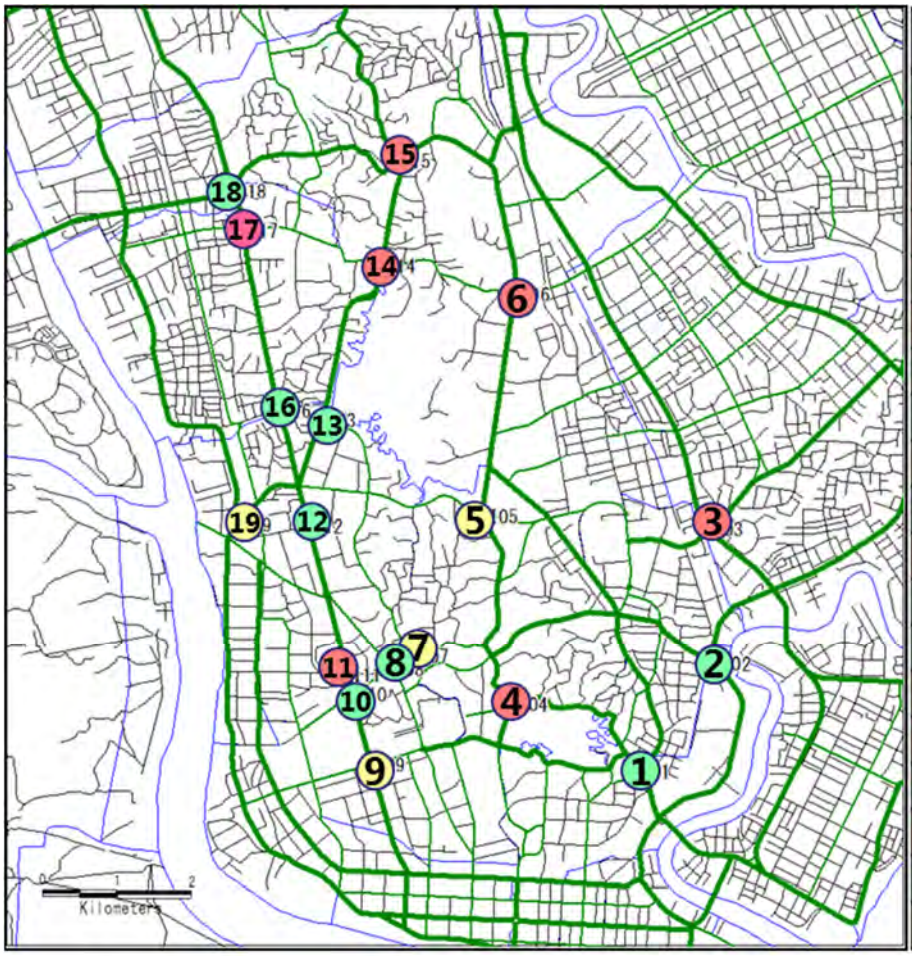
Corridor	Main Problem Area	Proposed Solution
		1. Short-term Solutions ・ Adjust signal phasing ・ Control traffic at schools/commercial areas ・ Control traffic at disorderly bus boarding/alighting points ・ Control roadside parking ・ Improve traffic signs and lane markings ・ Train traffic enforcers ・ Micro-manage traffic at flyover intersections 2. Mid-term Solutions ・ Construct underpasses/flyovers ・ Provide off-street parking ・ Strengthen traffic management

Source: Study Team.

Figure 9.2.6 Traffic Bottlenecks and Proposed Management Measures for Upper Pazuntaung Road–Thanthumar Road–No. 2 Main Road

2) Intersection Improvement

9.14 In many cities, intersections often cause the most critical traffic congestion on the road network. It is also the case in Yangon: Traffic volumes at intersections are lower than the theoretical capacities, even as intersections are seriously congested, as shown in Figure 9.2.7.



ID	V/C 1)
1	0.72
2	0.79
3	0.98
4	0.94
5	0.83
6	0.91
7	0.81
8	0.78
9	0.90
10	0.77
11	0.95
12	0.74
13	0.80
14	0.93
15	0.97
16	0.80
17	0.97
18	0.65
19	0.82

Source: YUTRA Study (2013).
1) V/C: Volume Capacity Ratio
2) Since YUTRA Study, 5 flyovers had been constructed.

Figure 9.2.7 Estimated Volume–Capacity Ratio of Major Intersections in Yangon

9.15 Underutilized road capacities are also seen in many road links due to lack of traffic control and management as identified in previous section. Improving intersections include the following:

(a) **Optimization of Traffic Signal Phasing:** An example made in YUTRA based on micro traffic simulation model for an intersection clearly shows the positive impact of optimizing traffic signal phasing (see Figure 9.2.8). It is expected that the newly established Traffic Control Centre will improve traffic flow at critical intersections both for vehicles and pedestrians.

(b) **Channelization:** On the basis of traffic volume and directional flow road design, lane arrangement must be optimized to facilitate vehicle traffic flow for each direction.

(c) **Provision of Safety Facilities:** As it is at intersections where different types of vehicle traffic and pedestrian traffic merge, thereby creating various conflicts, proper safety facilities and measures must be provided.

Table 9.2.2 Impact of Optimizing Traffic Signal Phasing

Indicator	With	With-out	Improvement	
			A-B	A/B
Ave. Delay (second)	316	164	-152	0.51
No. of Stops	4.5	2.5	-2.0	0.56
Ave. Travel Speed (km/h)	17.4	26.3	+8.9	1.51

Source: YUTRA Study (2013).

Figure 9.2.8 Example of Micro Traffic Simulation Conducted in YUTRA Study

3) CBD Traffic Improvement

(1) Socio-economic Profile

9.16 The CBD is the traditional and most vibrant area in Yangon City with more than 650 ha of land area facing Yangon River. At present, 220,000 persons reside here.

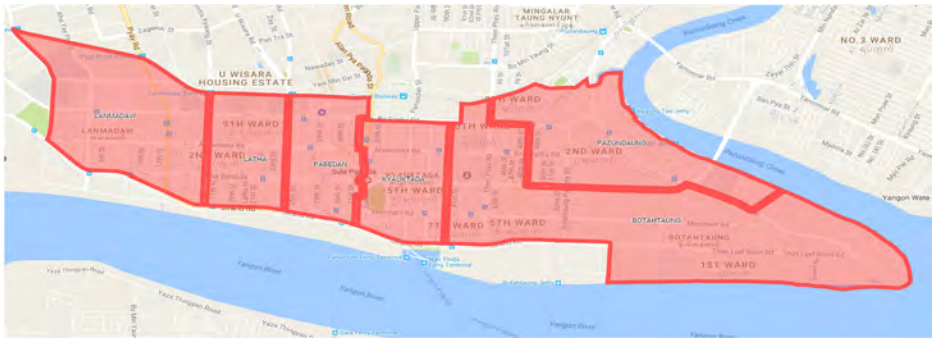


Figure 9.2.9 Yangon Central Business District

Table 9.2.3 Socio-economic Characteristics of CBD Residents

Indicator		CBD			Total
		Western Section (Lamadaw / Latha)	Central Section (Pabedan, Kyauktada)	Eastern Section (Pazundaung, Botataung)	
Net Land Area (ha)		187.5	134.0	330.4	651.9
Population	No.	72,304	60,330	89,623	222,256
	Density (no./ha)	385.7	450.3	271.2	341.0
	AGR (%/y)	-0.1	-2.4	-0.1	-0.8
Household Profile	No. (000)	18,739	15,157	22,102	55,998
	No. of HH Members	3.9	4.0	4.1	4.0
	Ave. HH Income (000 MMK/m)	373	339	337	350
	Ave. Living Area (m^2)	20.2	18.8	20.9	20.1
Ownership of Vehicle (no./000 people)		170	95	79	114

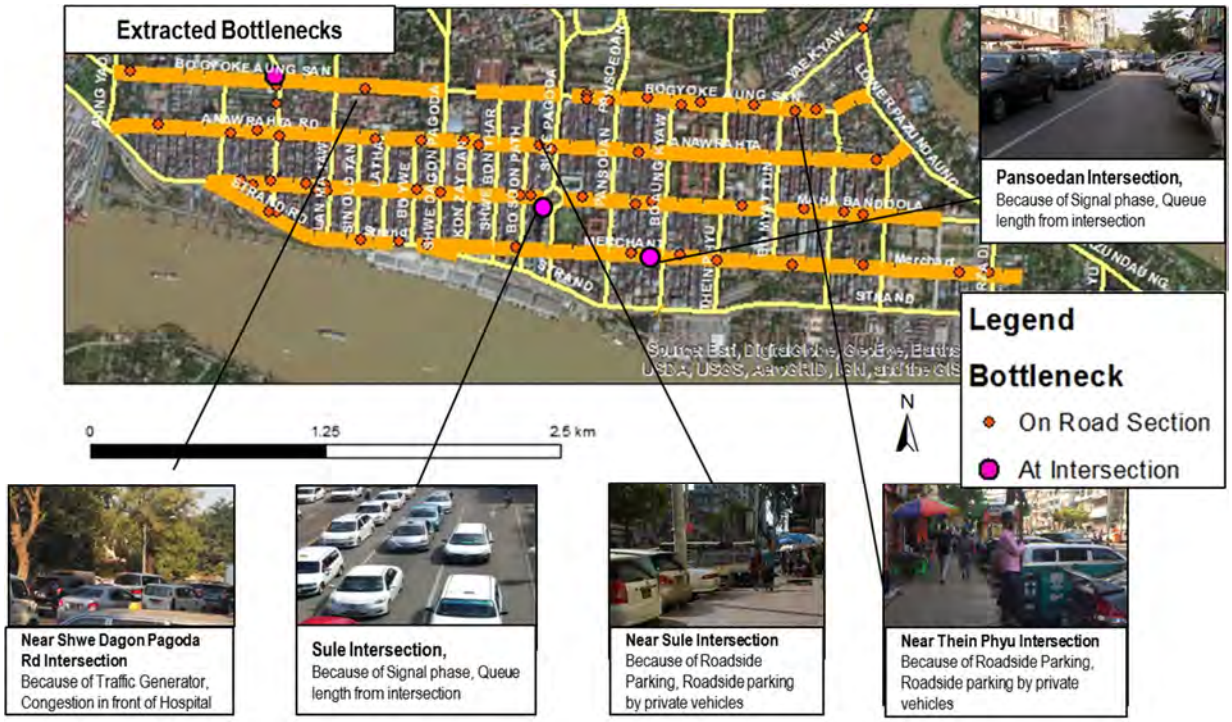
Source: Household Interview Survey Conducted in 2013

(2) Transport Conditions

9.17 The CBD has a good network of roads which are articulated in complete grid form and in hierarchy, comprising wide primary roads and densely provided secondary roads. Road to area ratio is about 22%, which is the highest in the city and comparable to those in developed cities. Notwithstanding the high availability of roads and its accessibility to river and rail transport, including the circular rail, traffic congestion here is the most serious in the city due not only to high travel demand but also to poor conditions and management of existing transport facilities and space.

Roadsides are occupied by parked vehicles and vendors, while proper traffic management measures and enforcement are lacking, as shown in Figure 9.2.10.

9.18 The CBD's riverfront is mostly occupied by port and logistics facilities with a little exception provided for ferry and other purposes. Constraints in using the riverfront reduce opportunities to expand water transport services. Although the circular rail is located within walking distance, proper access is not provided and railway services are insufficient nor attractive.



Source: Study Team.

Figure 9.2.10 Identified Bottlenecks on CBD Corridors

(3) CBD Traffic Demand Characteristics

9.19 The CBD is both a significant traffic-generating and attracting area. On the basis of the updated OD table, CBD-related traffic demand was analyzed, as shown in Table 9.2.3. The main findings are as follows:

(i) In 2016, a total of 1 million person trips a day was generated in the CBD, of which 0.7 million moved within the CBD;

(ii) There were approximately 705 thousand person trips within the CBD, of which 574 thousand trips were by walking, 48 thousand by public transport, and 38 thousand by car/taxi;

(iii) There were approximately 346 thousand person trips moving between the CBD and outer areas, of which 182 thousand trips used public transport and 155 thousand trips by car/ taxi;

(iv) The future intra-CBD travel demand will decrease, but the demand between the CBD and outer areas will increase substantially from 346 thousand trips in 2016 to 625 thousand in 2035. It is also expected that the demand for car/ taxi will increase significantly; and

(v) The analysis suggests that the CBD will require improved access both by public and private modes of transport.

9.20 In 2013, approximately 25,000 vehicles were owned by households in CBD. It is roughly estimated that the total number of private cars owned by CBD residents is 15,000 units. Estimated vehicle ownership is 114 per 1,000 people, more than twice of value of Greater Yangon. Based on the assumption that only 20% of them have their own parking places, almost 12,000 cars park on

roads or public space. Besides the residents, those who commute to the CBD and visit it for business also require parking space for their vehicles, the number of which is roughly estimated to be 80 to 100 thousand a day. Residents need permanent parking space, while visitors need facilities for specific time depending on their purposes. This large demand for parking is based on the fact that streets and public space are occupied by vehicles which cause serious traffic congestion.

Table 9.2.4 CBD-related Travel Demand (000 Passenger Trips/day)

Mode	2016				2035			
	Within CBD	To/From CBD	Total		Within CBD	To/From CBD	Total	
			No.	%			No.	%
Walk	574	13	587	55.9	477	20	497	39.8
Bicycle	45	4	49	4.7	40	9	49	3.9
MC	0	0	0	0	0	0	0	0
Car	21	71	92	8.7	15	160	175	14
Taxi	17	75	92	8.8	19	143	162	13
Public	48	182	230	21.9	71	293	364	29.2
Total	705	346	1,050	100	622	625	1,247	100
GV(PCU)	2	27	29	-	2	66	68	-

Source: Study Team

(4) Proposed Solutions

9.21 As traffic problems facing the CBD are complex, it is difficult to work out immediate solutions. However, the following initial measures can be suggested:

(i) Designation of parking and non-parking space clearly on roads and public space;

(ii) Pricing on designated parking space both for residents, shops, and visitors;

(iii) Designation of areas for street vendors and pricing on the space;

(iv) Provision of public parking facilities/ space in fringe areas of the CBD which are connected to the CBD circular transport services; and

(v) Conduct of comprehensive survey on parking and traffic flow in the CBD to formulate parking and circulation plans.

4) Traffic Safety

9.22 Traffic safety has worsened as motorization has progressed not only in Yangon and Myanmar but also in other developing cities. According to WHO, in Southeast Asia, approximately 316,000 people die on the roads or 865 fatalities each day. About 20 to 50 times that number are injured or become disabled and require long-term care, costing as much as 3% of the GDP.

9.23 Although it is often explained and shown as statistics that human error is the main cause of traffic accidents, it could have been avoided by using better road safety technology such as barriers, rumble strips, signage, among others. Considering that the causes of traffic accidents are complex, a good set of data must be collected by authorities.

9.24 To attend to traffic safety issues, the following areas must be taken into account:

(i) Development of an updated accident database and scientific analysis method.

(ii) Provision of infrastructure tailored to the needs of vulnerable road users, especially pedestrians;

(iii) Introduction of vehicles with higher safety standards;

(iv) Awareness enhancement on traffic safety among all road users;

(v) Increase in responsiveness to post-crash emergencies; and

(vi) Firm policy commitment and improved enforcement.

9.3 Proposed Actions

9.25 There is a wide range of measures and actions that can be introduced to Yangon to improve the traffic situation for both vehicles and pedestrians. They are briefly as follows:

(a) **Road Vehicle Management**

(i) Improvement of the vehicle registration system

(ii) Development of a vehicle inspection system

(b) **Traffic Enforcement**

(i) Establishment of an institutional framework

(ii) Capacity building among traffic enforcers

(c) **Traffic Engineering**

(i) Management of the Traffic Control Centre

(ii) Expansion of traffic signals for vehicles and pedestrians

(iii) Improvement of pedestrian facilities/ walking environment

(iv) Provision of signage and land markings

(d) **Traffic Safety Education**

(i) Preparation of traffic rules/regulations

(ii) Traffic safety education for school children

(iii) Traffic safety campaign for the public and communities

(e) **Parking Management**

(i) Establishment and enforcement of parking regulations

(ii) Development of public parking facilities

(f) **Traffic Control**

(i) Regulation of loading/unloading for bus, taxi, etc.

(ii) Expansion of traffic flow control and other measures

(g) **Bus Terminal Traffic Circulation:** This is conducted as a component of the pilot project in the study.

(h) **Traffic Demand Management:** There are various ways to manage traffic demand, as follows:

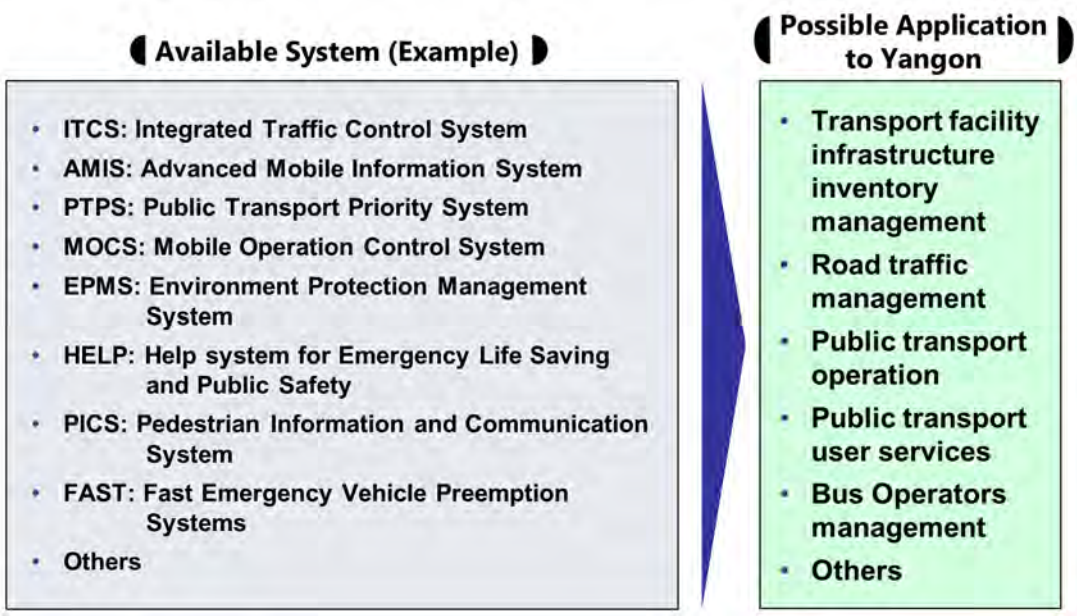
(i) **Staggered Time for Work and School Trips:** Shifting office and school hours is effective in lowering the concentration of work and school trips during the morning peak hours.

(ii) **Control of Vehicle Ownership and Use:** This intends to discourage ownership and use of cars through: (i) high taxes on vehicle purchases, (ii) high registration fees, and (iii) high fuel tax.

(iii) **Road Pricing/ Area Licensing Scheme:** This is an advanced congestion charging system practiced in many cities in the world. When urban rail and public transport are provided, this measure can be applied in the CBD of Yangon.

(iv) **Shared Use of Vehicles:** This encourages the use of cars/ taxis by multiple users.

(i) **Introduction of ITS & ICT:** There is a wide range of ITS and ICT for traffic management which can be updated every day and is applicable to Yangon where telecommunications have improved significantly.



Source: Study Team.

Figure 9.3.1 Introduction of ICT and AI for Urban Transport/ Traffic Management

10 URBAN RAILWAY

10.1 Current Situation

1) Railway Network

10.1 At present, urban railway services are provided by Myanma Railway which has a total network length of 149 km and 59 stations using a conventional system. There are eight (8) lines, of which a branch line is exclusive for freight service for Yangon Port (see Table 10.1.1). The characteristics of the main lines are briefly as follows:

(a) **Circular Line:** This line is operated in two sections: the western section from Yangon Central to Da Nyin Gone via Insein (20.3 km and 21 stations) and the eastern section which runs from Yangon Central to Da Nyin Gone via the western side of the Circular Line, which has 25.8 km and 17 stations.

(b) **Pyay Line:** This stretches from north of Da Nyin Gone to Hmawbi, a 26.5-km section with six stations and a 3.0-km spur which serves the Computer University of Yangon.

(c) **Yangon–Mandalay Line Section in Yangon Area:** This is part of the north–south main line section from Yangon to Mandalay. The section from Yangon Central to Dabein is a 36.0-km section with seven stations and a 6.4-km spur which serves the Dagon University in northeast Yangon.

(d) **Thilawa Line:** This is a 26.7-km branch line to the industrial area in southeast Yangon and has five stations and a 5.0-km spur which serves the East University of Yangon.

10.2 At present, existing railway lines excluding intercity services are carrying approximately 80,000 passengers a day.

Table 10.1.1 Existing Railway Lines in Yangon

Type	Line Name	Urban Rail Service			
		Section	Length (km)	No. of Stations	Track
Main Line	Circular Rail	Entire section	46.0	38	Double
	Yangon–Mandalay	Central Station–Dabein	36.1	6	Double
	Yangon–Pyay	Danyingone–Hmawbi	19.4	4	Double 7.6 km (Yangon–Hlawga) Single 11.8 km (Hlawga–Hmawbi)
Branch Line	Thilawa	Toe Gaung Gale–Okhposu–Thilawa	26.2	5	Single
	Eastern University	Okhposu–Eastern University	5.4	1	Single
	Dagon University	Toe Kyaung Ka Lay–Dagon University	8.0	1	Single
	Computer University	Hlawga–Computer University	2.9	1	Single
	Yangon Port (Freight)	Pazundaung–Botahtaung–Kyee Myin Daing	9.9	2	Single
Total		Passenger	144.0	56	
		Freight	9.9	2	

Source: Study Team

Source: Study Team

Figure 10.1.1 Railway Network in Yangon, 2016

2) Ongoing Railway Improvement Project

10.3 At present, improvement projects to increase transport capacities and safety in the short term are ongoing and include the following:

(a) **Yangon Circular Rail Line Upgrading Project:** This project intends to improve the signal system, introduce a new diesel/electric multiple unit (DEMU), improve the platforms, and rehabilitate the track and civil structure. The project is expected to be completed by 2021 and increase transport capacities to 300,000 passengers or more a day.

(b) **Yangon–Mandalay Line Improvement Project (Phase 1):** This project intends to improve the track, civil structure, and signaling system in the suburban section of Yangon. The project is expected to be completed by 2021.

(c) **Yangon Central Station Operation Control Centre Project:** This project intend to improve the interlocking system at the Yangon Central Station yard and is expected for completion in 2017[1].

3) Existing Problems and Issues

10.4 With regard to the existing rail service in the Greater Yangon area, the main issues are summarized as follows:

(i) **Decreasing Levels of Service (Speed, Punctuality, Riding Comfort, Cleanness, and Safety):** The operation of the YCR Line commenced in January 1959. After about half a century since then, the deteriorated state of the facilities, equipment and rolling stock with limited partial rehabilitation cause reduced travel speeds: have fallen to almost half (15 km/h) of that when it started, train delays, derailments, accidents and other operational problems.

(ii) **Low Ridership against Increasing Demand:** The population in the city has grown. The existing rail system in Yangon carries about 75,000 passengers per day, while an improved YCR Line (with EMU) is expected to carry about 700,000 passengers or more per day upon its completion.

(iii) **Deteriorated Infrastructure, Equipment, System, and Rolling Stock:** In almost all aspects the existing rail and related facilities need improvement, including roadbed, rail track, signalling and train control system, telecommunication, level crossings, and rolling stock.

(iv) **Insufficient Maintenance of Track and Other Facilities:** The deformation of the track due to heavy rainfall in the rainy season is one of the main causes of derailments. Because of the limited technical capacity of workers and machines, the level of maintenance work has remained at low level. Improvement of track condition together with the introduction of mechanical maintenance methods with modern machines is required to achieve a decent maintenance work level.

(v) **Aged Rolling Stock:** The MR's existing rolling stock need to attract the Yangon residents by improving its performance, comfort level, and design which does not favor vulnerable groups. The interior of the rolling stock is not properly designed nor furnished for commuters, and its ride comfort is far below the desired level of a transit system in an international gateway.

(vi) **Bottleneck Section:** Priority in the current train operation is given to the long-distance Yangon–Mandalay Line. The operation of the YCR Line is sometimes disrupted to give way to the former at a cross-over rail segment between Pa Zun Taung Station and Yangon Central Station. This crossing operation needs to be improved by installing a signal system on the YCR Line.

[1] The name of project is "Project for Installation of Operation Control Center System and Safety Equipment"

(a) **Increasing Road Traffic crossing Manually Operated Level Crossings:** All of the existing level crossings along the YCR Line (27 in total) are manually operated by MR staff. The closing time of level crossings tends to be longer because of the manual operation and selfish behavior of car drivers. Sometimes trains need to stop at level crossings because cars do not give way. Replacement of existing manually operated level crossing system with an automated system is needed to improve the level of safety.

(b) **Deteriorated Station Buildings:** Almost all of the existing station facilities are heavily deteriorated and in need of rehabilitation. There are no decent facilities, such as toilets, platform ceiling, benches, and passenger information boards, which have resulted in low levels of service.

(c) **Poor Accessibility to Rail Stations:** There are no feeder bus services to/from the existing rail stations; in other words, there is no integration between rail and bus service in Yangon. In addition to this, roads to/from rail stations are not well developed nor maintained. Hence, it is quite difficult for vulnerable groups to use the existing rail service. A universal design must be incorporated in the modernization of MR's system.

(d) **Traffic Congestion:** Parallel roads to the YCR Line are major arterial roads in the city, namely Pyay road, Insein Road, Baho Road, and Waizayandar Road. Traffic congestion and travel time on these roads have been increasing. Improving the YCR Line will contribute to the improvement of traffic along these major arterial roads.

4) Additional Grounds for Developing a Modern Transit System

(a) **Short Distances between Stops on YCR West:** Some of the stations here are less than one kilometer apart. This is not an ideal distance for a high-speed commuter rail system because it limits the maximum speed that could otherwise be achieved between station to reduce journey times and make rail more competitive and attractive to passengers currently using other modes.

(b) **Long Distances between Stops on YCR East:** There are a number of stations here which are more than 1.5 km apart. This limits the catchment area of the stations and makes them less attractive to passengers because they have to use another mode to reach their final destinations.

(c) **Few Stations on Pyay, Mandalay, and Thilawa Lines:** The station density is too low even for a suburban rail system. Ideally, suburban rail stations should be 2.0 to 2.5 km apart. On all these three lines, a number of new stations could be introduced either close to existing developments or certainly through TOD to enhance patronage and make the lines more viable.

(d) **Too Many Level Crossings:** At-grade level crossings require trains to obey yet another unnecessary signal along the way. The high number of level crossings located one after the other, like on YCR East section, limits the number of trains that could be operated.

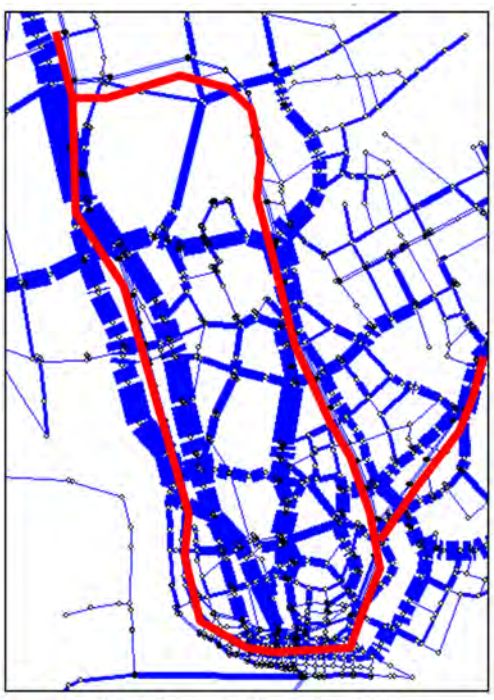
10.2 Direction of Urban Railway Development

1) Important Role of Urban Railway

10.5 The results of the demand forecast clearly indicates that Yangon needs a good urban rail system together with urban roads and expressways, public transport system, and adequate traffic management that work as a network. In order to promote and establish a public-transport-based urban area, Yangon requires a competitive (i.e., high-quality, high-capacity level of service) and affordable public transport system wherein urban rail functions as the backbone that integrates other public transport modes including bus, BRT, taxi, and ferry. Certainly, as wide urban areas cannot be served by railway alone, connectivity to feeder services is critical. BRT and bus must serve other major corridors not covered by urban rail.

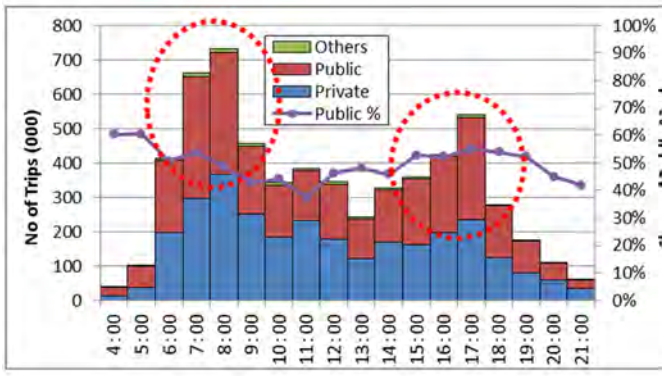
10.6 The development of urban rail in Yangon must not only be looked into from the transport perspective but also from the urban development aspect. Urban rail can be a key driver and catalyst to promote integrated urban development and achieve the desired spatial structure. The development of a high-quality urban rail can also generate tremendous opportunities for TOD when properly designed and can capture the value from those developments, thereby improving people's mobility, infrastructure accessibility, and public convenience.

10.7 In Yangon, as shown in Figure 10.2.1, public transport demand is distributed along the existing Circular Rail and rail corridors. When rail is provided with high-capacity trains, peak hour traffic in the morning and afternoon shown in Figure 10.2.2 can be absorbed effectively by rail which would help reduce road traffic during peak hours.



Source: Study Team

Figure 10.2.1 Distribution of Public Transport Demand and Location of Circular Railway Line, 2016



Source: Study Team

Figure 10.2.2 Hourly Distribution of Traffic Demand in Yangon, 2013

2) Key Considerations in Urban Railway Development

10.8 As urban rail requires large investment and lengthy time for implementation, the following points must be duly considered:

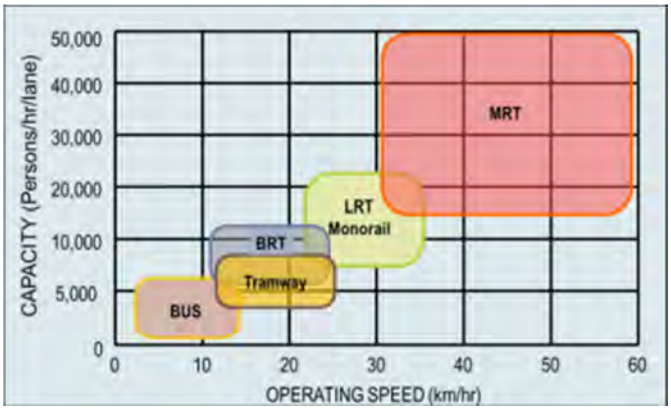
(a) **Match between System and Location:** The system must suit the characteristics of locations/routes and depend on the demand.

(b) **Integration of Different Lines:** Urban rail lines must be integrated properly to ensure smooth travel of passengers.

(c) **Consideration of Proper Structure:** In consideration of other urban traffic on roads and the availability of space for constructing urban rail facilities, a proper rail structure (at-grade, elevated, or underground) must be selected.

(d) **Phased Development:** As the investment cost is always high, it is important to consider development by stages.

(e) **Funding and TOD:** Urban rail development must be integrated with urban development to promote the desired land use based on a TOD concept for value capture (TOD is described in Chapter 12).



Source: Study Team

Figure 10.2.3 Broad Classification of Mass Transit

Source: Study Team

Figure 10.2.4 Examples of Urban Rails in Selected Asian Cities

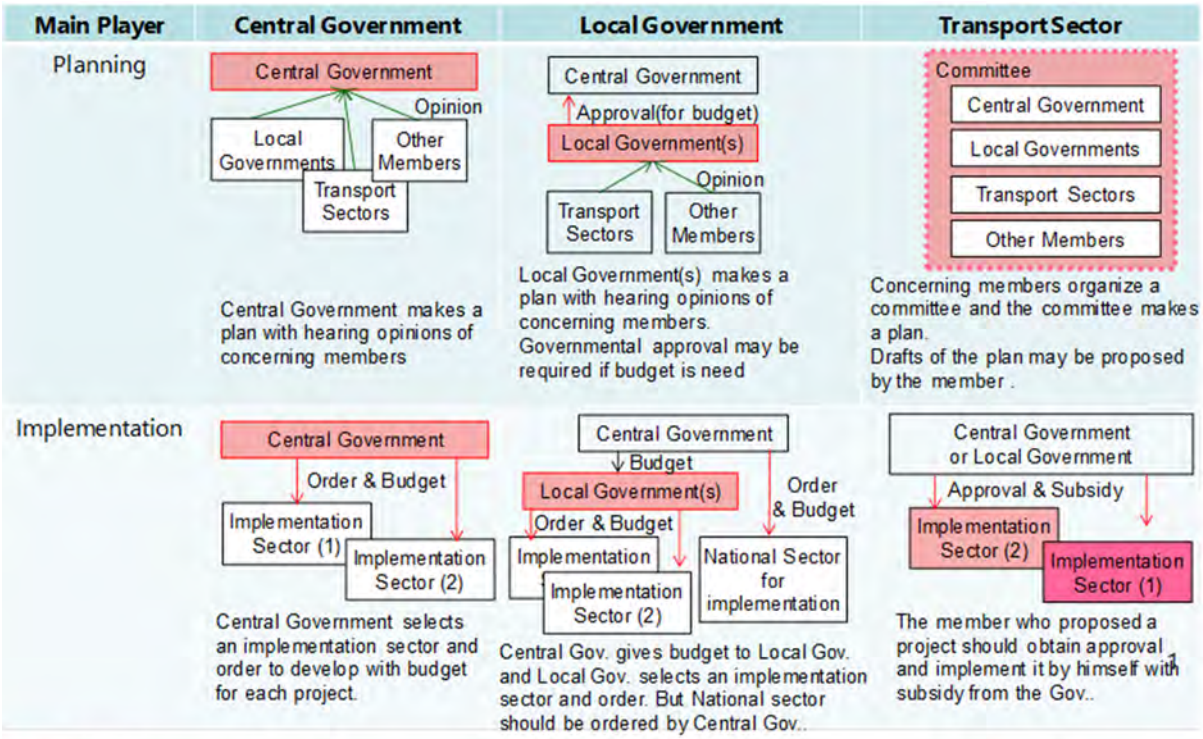
Table 10.2.1 Types of UMRT

Item		Metro/Heavy Rail (Elevated)	Metro/Heavy Rail (Underground)	Monorail (Straddled Type)	AGT
Image					
Capacity(Passengers / cars with seats + 6 pax / m 2)		220	220	122	115
PPHPD (Capacity per car * 6 cars * 30 trips/hr/direction)		40,000	40,000	22,000	21,000
Moving Gear		Steel wheel	Steel wheel	Rubber tire	Rubber tire
Maximum Speed (km/h) (Average)		100 (40)	100 (40)	80 (36)	60[1] (36)
Max. Track Gradient (%)		3.5	3.5	6	6
Min. Curve Radius (m)		300 (200)	300 (200)	70	50
Rough Construction & Procurement Cost (USD mil./km)		50–100	140–200	45–100	45–60
Required Space		• Larger • Many land acquisition and resettlement may be required. • Large depot land is required if at-grade.	• Smaller • Some land acquisition and resettlement may be required.at station area • Large depot area is required if at-grade	• Medium • Some land acquisition and resettlement may be required, especially at station area. • Moderate depot area is necessary.	• Smaller • Some land acquisition and resettlement may be required, especially at station area. • Moderate depot area is necessary.
Environmental Impact	Noise Level	90 dBA (normal speed) 85 dBA (reduced speed)	Low because built underground	70 dBA (normal speed) 65 dBA (reduced speed)	65 dBA (normal speed) 60 dBA (reduced speed)
	Landscape	Become worse becuse overhead structure is large	Good because no overhead structure	Become not so bad because overhead structure is slim	Become worse a little because overhead structure is medium-sized
Emergency Exit		Track can be used as escape route.	Special countermeasure is required in case of fire	Special countermeasure is required in case of fire	Track can be used as escape route
Car Maintenance		Common	Common	Replacement of rubber tire is necessary	Replacement of rubber tire is necessary
Past Experiences		Many	Many	Moderate	Moderate
Manufacturers		Many	Many	Limited	Limited

Source: Study Team
[1] A new type of automated people mover runs at120 km/h.

3) Institutions

10.9 In order to develop urban railway, it is necessary to establish not only the infrastructure but also the soft part such as railway policy, laws, etc. Typical examples in the other countries are shown in the figure below. The Myanmar government must select its own policy and laws prior to developing its urban railway.



Main Player	Central Government	Local Government	Transport Sector
Examples in foreign countries	Bangkok. Singapore	Cities in UK, Germany, France	Cities in Japan
Combination with other public transports	△: If One ministry can manage all mode of public transports, it may be 'O'	O	×: Discussion for combination may be very difficult.
Consistency with city development	×	O	×
Consistency with main lines/inter-city transport	O	×	O: Myanmar Rail can propose a consistent plan with main lines
Issues in Yangon	• It may be difficult for Central Government to understand current situation of Yangon because they are far from Yangon.	• 'Greater Yangon' should be organized for this. • Myanmar Rail is a national sector and many projects are concerning with it. Therefore many coordination may be need.	• No transport sectors except Myanmar rail is existing.

Source: Study Team

Figure 10.2.5 Types of Railway Planning and Development Organizations

10.10 Organizations that will be responsible for the development and operation of urban railway is also an important matter to think about. Listed below are some alternatives based on the experiences of other countries.

(a) For New Lines

(i) Develop and operate by the local government;

(ii) Develop and operate by a company owned by the local government;

(iii) Develop by 1 and operate by 2;

(iv) Give concession to a private company

- Build-Operation-Transfer;
- Build-Lease-Transfer: Operate by 1 or 2; or
- Develop by 1 and give concession for operation to a private company.

(b) For Lines of Myanma Railways (Urban transport only)

(i) Develop and operate by Myanmar Rail;

(ii) Develop by Myanmar Rail and operate by local government;

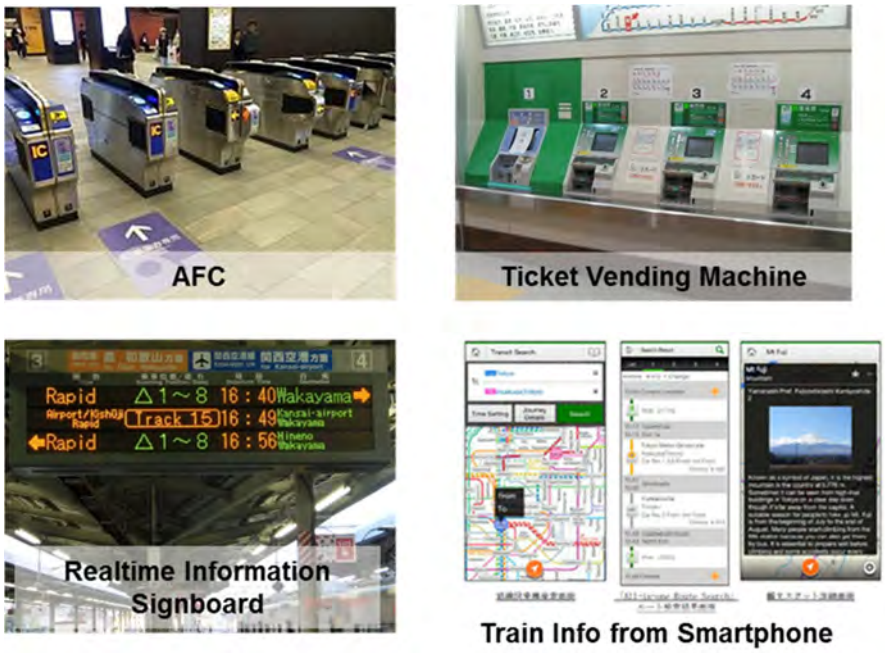
(iii) Develop by Myanmar Rail and operate by a company owned by the local government;

(iv) Develop by the local government, transfer to Myanmar Rail, and operate by 1, 2, or 3.

4) Introduction of Railway ICT

10.11 In addition to improving railway infrastructure, it is essential to enhance passenger convenience and user-friendliness such as easy fare deposit system, real-time provision of train operation information, etc. In order to establish transparent tracking of revenue and expenditure, it is recommended that an automatic accounting system be introduced.

10.12 Railway ICT includes an automatic fare collection (AFC) system using smart cards controlled by a centralized automatic accounting system, signboards providing real-time traffic information, and seamless information provision to smartphones



Source: Study Team

Figure 10.2.6 Components of Railway ICT

10.3 Proposed Urban Rail Network

10.13 The proposed urban rail network intends to promote a public-transport-based spatial structure and urban development as defined in the updated SUDP. The CBD and planned subcentres and new towns will be connected to each other with a high-quality mass transit network, and emerging urban developments will be guided by the network. The overall characteristics of the network are briefly explained here.

(1) Circular Rail

10.14 The circular rail will form the main urban transit backbone covering existing urban areas where demand concentrates. When the circular rail is strengthened, it is expected that urban development along the route will be promoted significantly. The circular rail must function as the most important foundation both for public transport and urban development.

10.15 The ongoing upgrading of the circular rail is expected to complete in 2021 and serve 200 thousand to 300 thousand passengers in the short term. It will be further strengthened by elevating the rail in at-grade sections where it currently crosses with major roads. The elevation of the circular rail must be implemented in integration with urban development based on the TOD concept at and around the stations to facilitate access to/from feeder services and to promote commercial development to capture added value.

10.16 Grade separation must be implemented without stopping railway operation and by section. The priority sections are Kyee Myin Daing–Insein and Malwago–Yegu which are located in busy urban areas and cross with a number of at-grade roads.

(2) Suburban Commuter Lines

10.17 When the circular rail is upgraded, existing MR lines must likewise be improved to provide commuter services that connect the urban center and suburban areas in the north and northeast, where public transport demand is high. Suburban commuter lines are as follows:

(a) **Yangon–Mandalay Line:** An improvement project (phase 1) is ongoing. The section between Yangon and Ywa Tar Gyi stations must be improved so that the line can provide urban services. The improvement should include modernizing the safety system, developing station areas, and procuring new rolling stock.

(b) **Yangon–Pyay Line:** At present, there is no upgrading work. Facilities are deteriorated and old-fashioned. The section between Hlawga and Hmawabi stations has a single track. Necessary improvement work for Danyingone and Hmawbi include the rehabilitation and modernization of track, civil structure, stations, and safety system. For the Danyingone and Hlawga section, which has double tracks, it must be provided with automatic color light signal. Procurement of additional rolling stock is also needed for the entire line.

(c) **Thilawa Line:** The single-track line is deteriorated and requires thorough upgrading including double tracking of the Thanlyin bridge crossing Bago River.

(d) **Branch Lines:** There are three short-distance, single-track branch lines, namely the Eastern University Line, Dagon University Line, and Computer University Line. These lines are also deteriorated and do not function adequately. It is proposed that intermediate capacity modes, such as monorail and AGT, be introduced when the main lines are properly upgraded.

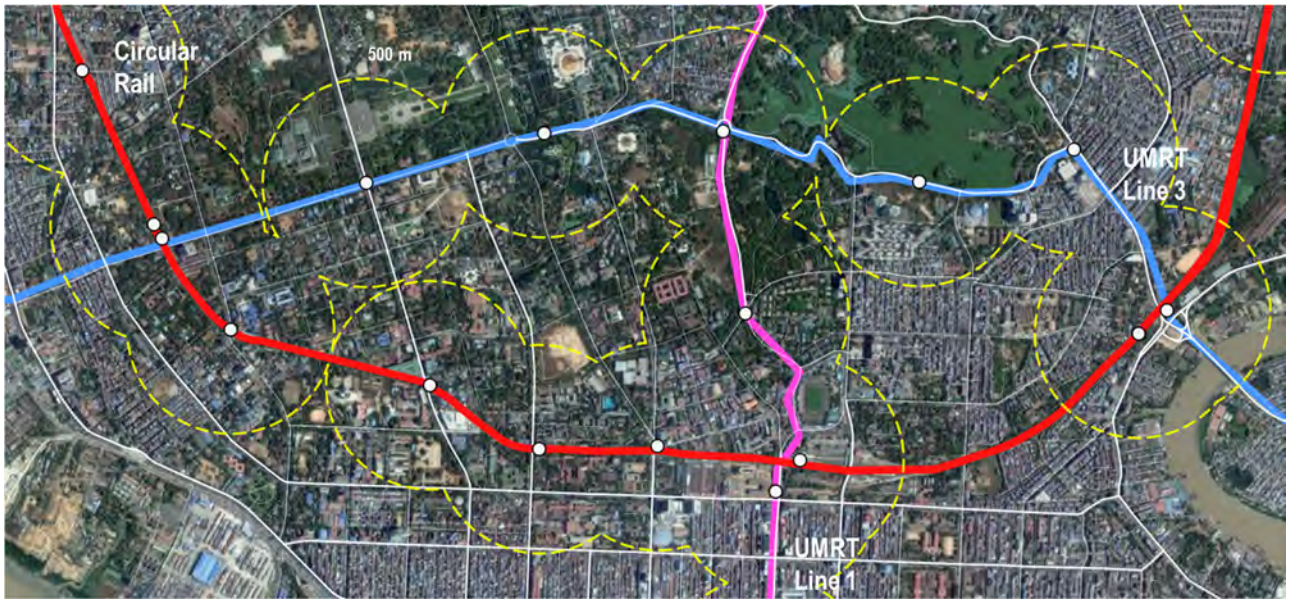
(3) New UMRT Lines

10.18 Yangon which is expected to grow into a mega city needs new urban rail lines. In order to meet the future demand and promote the envisioned urban development, three new lines which will be integrated with the circular rail and form part of the mass-transit network are proposed to be developed.

(i) **UMRT Line 1, North–South Line:** This line will serve the urban areas in Yangon, connecting the CBD with Dala in the south and with Dagon, Bahan, Yankin, and Mayangon along Kab Aye Pagoda Road. A pre-feasibility study (pre-FS) conducted on the line revealed that it is economically feasible and will provide high-quality public transport services along one of the most congested roads in the city.

(ii) **UMRT Line 2, East–West Line:** The urban areas in Yangon are not provided with good east–west connections—the circular rail functions as the north–south public transport axis. Line 2 has two objectives: In the short term, it can carry current and future large traffic demand by connecting high-demand areas to the upgraded circular rail. For the medium to long term, Line 2 will encourage the development of subcentres along its route and will integrate the main urban rail lines, i.e., the circular line, UMRT Line 1, Yangon–Mandalay Line, and Thilawa Line. Line 2 is expected to establish a new transit backbone, encourage TOD, and decrease the excessive concentration of socio-economic activities in the CBD.

(iii) **Possibility of Proposed UMRT Line 3, East–West (South) Line:** Although this line was studied in YUTRA, it was not included in the final proposed network. Because the SUDP showed an updated spatial structure featuring new sub-centers and towns in Dala, Kyee Myin Daing, and Twantay, all of which would generate large demand, this scenario was tested in the study. It revealed that the development of an urban rail connecting these emerging areas via the city center will be necessary. It was also found that when this line is constructed underground, most parts of the city center will be served by urban rail within walking distances (see Figure 10.3.1).



Source: Study Team

Figure 10.3.1 Assumed Coverage of Urban Railway Network in the City Center (with UMRT Line 3)

(4) Port Access Line

10.19 The current rail line connecting to the existing port will cease when the port is relocated from the CBD to Thilawa and other areas.

(5) Hanthawaddy Airport Line

10.20 This line will connect Yangon to the planned Hanthawaddy international airport near Bago City. The distance between Yangon and the new airport is approximately 70 km. A preliminary study on the route and system is ongoing. Although the objective is to provide speedy access to the new airport, the integrated urban development along the line must also be considered because it is difficult to justify the huge investment if the line will only serve the new airport.

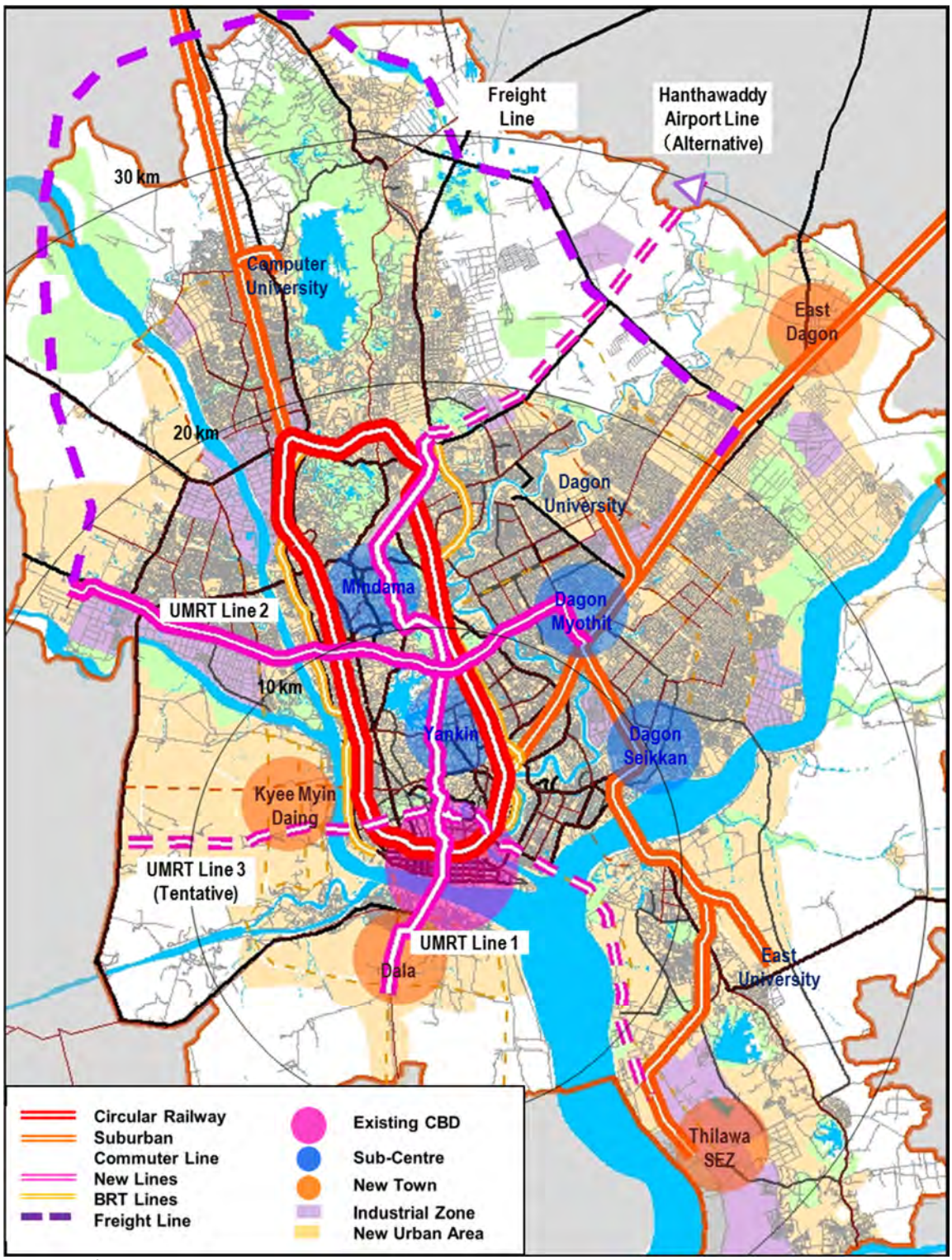
(6) Suburban Freight Line

10.21 This line intends to provide freight transport service in outer areas of the city because suburban commuter lines need to provide frequent passenger services, leaving no room for freight operation. Moreover, safety issues arise from frequent passenger and freight transport.

Table 10.3.1 Profile of Proposed Urban Rail Lines in Yangon

Line/ Section			Length (km)	Structure	No. of Stations			System	Estimated Cost (USD mil.)
					At-grade	Elevated	Under-ground		
Circular Rail			46.0	Grade-separated	17	21		MRT	350 (upgrading) 2,375
Suburban Commuter Lines	Yangon–Mandalay		36.1	At-grade	6			MRT	450
	Yangon–Pyay		19.4	At-grade	7			MRT	625
	Thilawa		26.2	At-grade	5			MRT	1,025
	Branch Lines	East University	5.4	Elevated		5		Monorail/AGT	100
		Dagon University	8.0	Elevated		8		Monorail/AGT	100
		Computer University	2.9	Elevated		3		Monorail/AGT	100
UMRT	Line 1: North–South		20.5	Elevated / Underground	3	6	12	MRT	4,270
	Line 2: East–West		21.9	Elevated / Underground	1	22 (14)	0 (8)	MRT	1,870

Source: Study Team



Source: Study Team

Figure 10.3.2 Proposed Urban Rail Network Plan for Yangon City

10.4 Proposed Action Plan

Table 10.4.1 Proposed Action Plan for Yangon Urban Rail Network Development

Line	Proposed Action			Planning Horizon				Preliminary Cost (USD mil.)
				Short-term (2020)	Mid-term (2021–2025)	Long-term		
						2026–2030	2030<	
Circular Line	1. Upgrading	Ongoing: Entire Line	System, rolling stock		2021			280
			Civil, track	2019				70
		Planned	Station	2020				3
		1 Road Over Bridge		2020				5
	2. Grade Separation	Section 1: Kyee Myin Daing–- Insein	Civil, track, station		2025			260
			System		2025			180
			Rolling stock		2025			90
		Section 2: Insein–Danyingone	Civil, track, station		2025			280
			System		2025			180
			Rolling stock		2025			90
		Section 3: Danyingone–Mingaladon	Civil, track, station			2030		250
			System			2030		170
			Rolling stock			2030		80
		Section 4: Mingaladon–Malwagone	Civil, track, station			2030		140
			System			2030		90
			Rolling stock			2030		50
		Section 5: Malwagone Yangon Central	Civil, track, station				2033	260
			System				2033	170
			Rolling stock				2033	80
Suburban Lines	Yangon–Mandalay	Section: In Greater Yangon	System				2032	180
			Rolling stock				2034	270
	Yangon–Pyay Line	Section: In Greater Yangon	Civil, track, station			2028		100
			System			2028		375
			Rolling stock			2030		150
	Thilawa Line	Section 1	Civil, track, station		2023			160
			System		2023			340
			Rolling stock		2023			150
		Section 2	New Bago Bridge		2025			375
UMRT	UMRT 1 North–South Line	Section 1 (Dala–YGN)	Civil, track, station			2030		750
			System			2030		130
			Rolling stock			2030		60
		Section 2 (YGN–Airport North)	Civil, track, station				2035	2,440
			System				2035	600
			Rolling stock				2035	290
	UMRT 2 East–West Line	Section 1: Hlaing Thayar–Oak Kyin	Civil, track, station			2026		430
			System			2026		290
			Rolling stock			2026		140
		Section 2: Oak Kyin–Toe Kyaung G	Civil, track, station				2031	500
			System				2031	340
			Rolling stock				2031	170
Other Lines	CBD Circular LRT		Civil, track, station				2030	90
			System				2030	90
			Rolling stock				2030	70
	Outer Circular Rail Line	Section 1	Civil, track, station		2025			190
			System		2025			270
		Section 2	Civil, track, station			2028		150
			System			2028		240
	Hanthawaddy Airport Access		Civil, track, station				2035	790
			System				2035	1,310
			Rolling stock				2035	530

Source: Study Team

11 INLAND WATERWAY TRANSPORT

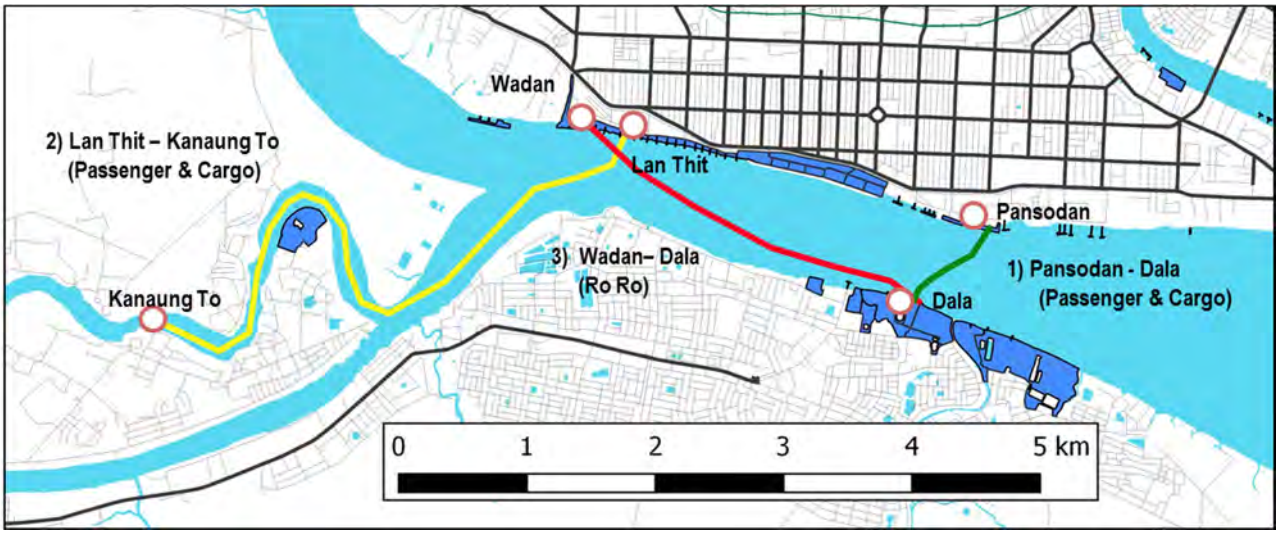
11.1 Current Situation

1) Overview

11.1 Traffic congestion has been worsening in Yangon due to the increase in the number of cars, buses, trucks, and etc. which is associated with rapid economic growth. In addition to cargo transport, passenger transport is considered as one of the reasons for the worsening traffic congestion. Therefore, it is necessary to take countermeasures from the aspect of logistics for passenger and cargo. In particular, it is expected that cargo which passes around Yangon City will increase due to industrial activities at Thilawa SEZ and other industrial zones.

2) Existing Routes and Operation

11.2 There are three major water transport routes in Yangon. These are the routes connecting Yangon and the opposite side of the river, as shown in Figure 11.1.1. Table 11.1.1 shows the three existing routes and Figure 11.1.2 shows the present condition of the jetties and ships that operated in these routes. Besides the three, there is a service transporting passengers for short distances at Yangon Port using small boats.



Source: Study Team

Figure 11.1.1 Regular Inland Water Transport Routes

Table 11.1.1 Current Inland Water Transport Services

From Pansodan to Dala

Ship Type	Ferry
Route Distance (km)	1
Schedule	• 46 services/day (one-way trip) • From Pansodan first service 5:30 and last service 21:30 • From Dala first service 5:00 and last service 21:00
Number of Passengers[1)]	• Number of passengers : 9,792,173 – Average per 1 month : 816,014 – Average per 1 service : 295
Cargo Volume[2)] (ton)	• Cargo volume : 41,307 – Average per 1 month : 3,442 – Average per 1 service : 1.25
Fare[3)] (MMK)	• Passenger : 100 • Cargo[4)]: measured rate system – 1–50 viss : 50 – 51–100 viss : 100 – More than 400 viss : 500 – Bulk/Fouling cargo : twice of normal fare

From Wadan to Dala

Ship Type	RO-RO
Route Distance (km)	2
Schedule	• 10 services/day (one-way trip) • From Wardan first service 7:00 and last service 18:30 • From Dala first service 6:30 and last service 18:00
Number of Passengers[1)]	• Number of passenger : 102,226 – Average per 1 month : 8,519 – Average per 1 service : 14.2
Cargo Volume[2)] (ton)	• Cargo volume : 183,532 – Average per 1 month : 15,294 – Average per 1 service : 25.5
Fare[3)] (MMK)	• Passenger : 100 • Cargo[4)]: measured rate system – Less than 2 tons : 2,000 – 3 tons : 3,000 – General cargo : 1.6 kyat/viss

From Lan Thit to Kha Naung Toh

Ship Type	Ferry
Route Distance (km)	6
Schedule	• 8 services/day (one-way trip) • From Lan Thit first service 5:30 and last service 17:30 • From Kha Naung first service 6:00 and last service 18:20
Number of Passengers[1)]	• Number of passenger : 782,778 – Average per 1 month : 65,232 – Average per 1 service : 135
Cargo Volume[2)] (ton)	• Cargo volume : 1,838 – Average per 1 month : 153 – Average per 1 service : 0.3
Fare[3)] (MMK)	• Passenger : 200 • Cargo[4)]: measured rate system – 100 viss : 100 – Bulk cargo : 1.5 times of normal fare – Fouling cargo : 1.25 times of normal fare

Source: IWT

1) The number of passengers show the total for both directions. The period for tallying is April 2015 to March 2016.
2) The cargo volume shows the total for both directions. The period for tallying is April 2015 to March 2016.
3) MMK100 = JPY8.4 (as of 17 August 2016)
4) 1 viss = 1.6 kg.

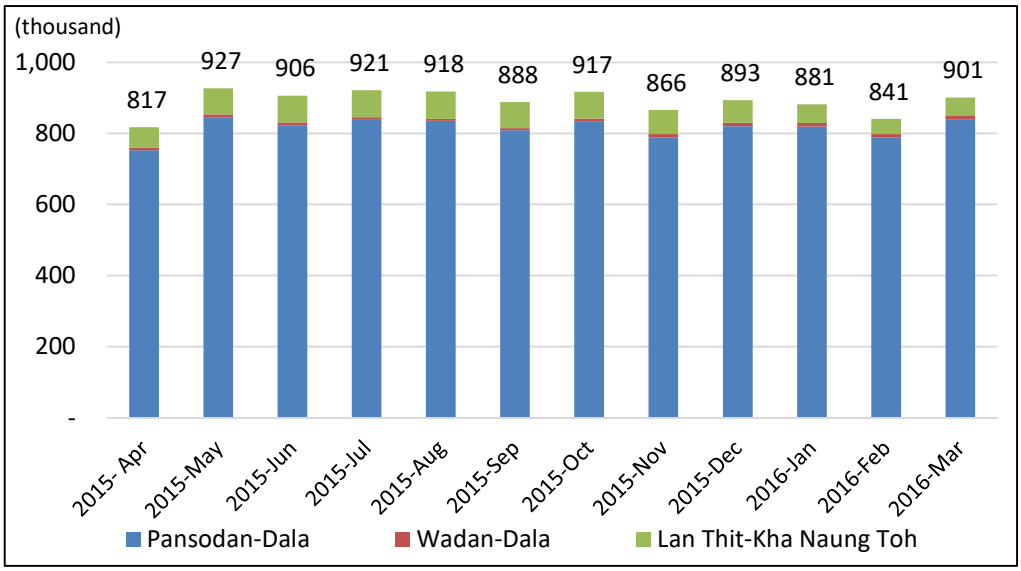
	
Dala Jetty	Ferry operating Pansodan–Dala Route
	
Pansodan Jetty	Wadan Jetty
	
Lan Thit Jetty	Kha Naung Toh_New Jetty
	
Ferry operating Lan Thit–Kha Naung Toh Route	Kha Naung Toh Old Jetty

Source: Study Team

1) The pontoon in Kha Naung Toh is currently being utilized because the existing fixed-type jetty had deteriorated.

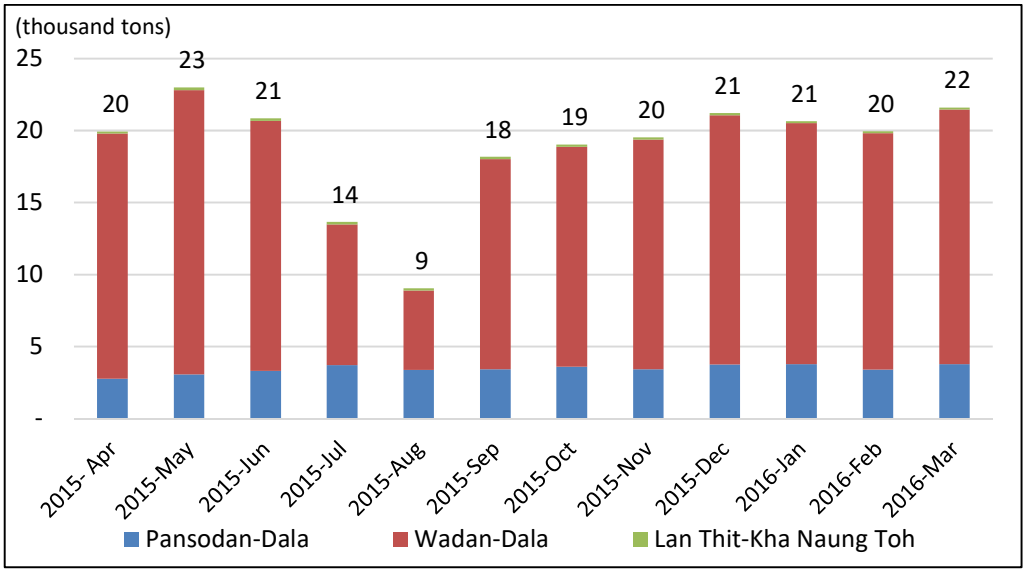
Figure 11.1.2 Present Condition of Jetties and Ships Operating in Existing Routes

11.3 Figure 11.1.3 and Figure 11.1.4 show the number of passengers and cargo volumes in recent years handled by IWT. Regarding the number of passengers, around 90% comprise passengers from Pansodan to Dala. The total has been in the range of 0.8 million to 1.0 million, which shows a stable demand. Regarding cargo volume, around 80% was accounted for by cargo from Wadan to Dala and carried by RoRo ships. For other routes serviced by ferry, cargo volume is not so high because passengers bring few cargo. Around 20,000 tons of cargo had been transported every month, except during the months with heavy rainfall (July and August).



Source: IWT

Figure 11.1.3 Number of Passengers by IWT Route



Source: IWT

Figure 11.1.4 Cargo Volumes by IWT Route

3) Ongoing Projects

(a) Introduction of Yangon Water Bus (Yangon Water Bus)

11.4 The Yangon Regional Transport Authority (YRTA) is planning to operate passenger transport by high-speed water taxis on the Hlaing River and Nga Moe Yeik Creek for more convenient transport and to reduce traffic congestion in Yangon City. Two local joint venture companies submitted tender application forms to YRTA for the operation, and Tint Tint Myanmar won the tender.

11.5 In October 2017, the first phase of Yangon Water Bus was started to operate between Insein and Bothtaung area (as shown in Figure 11.1.5). As of June 2018, The second phase (Botahtaung to North Dagon) and third phases (Botahtaung to Thanlyin) are planned to be operated within 2018.

11.6 The operation of first phase was planned to target about 20,000 commuters and run every 20 minutes from 6 am to 6:30 pm. Recently, the company has amended the schedule several times and reduced the frequency of service to meet a commuter demand.

11.7 The feasibility study for water taxi route survey was implemented beginning June 2016. Besides the YRTA, external experts, the Department of Marine Administration, Myanma Port Authority (MPA), Directorate of Water Resource and Improvement of River System, and experts from Japan, France, and England made a survey of the Hlaing River, Nga Moe Yeik Creek, and Pazundaung Creek. As a result of the survey, seven small ports will be set up along the Hlaing River for the Hlaingthaya–Pansodan route, and 11 small ports along Nga Moe Yeik Creek for a North Dagon–Nyaung Tan route.

(b) New Jetty Construction by Private Company

(i) **Pun Hlaing Golf Estate:** The jetty (pontoon type) was constructed by the MPA in 2015, with the management and maintenance being controlled by a private company. Only one vessel owned by that company is being operated from Pun Hlaing Golf Estate to Thilawa Area for tourists. Passenger capacity is 60 and rental fee is MMK200,000 per hour. Currently, an office building is under construction at Pun Hlaing Golf Estate; it is expected to finish in 2017. When finished, a ferry will service the staff of that company from Star City to Pun Hlaing Golf Estate. The company's current building, which is located near Bogyoke Market downtown will be demolished and all offices will be moved to the new building.

(ii) **Star City Area:** At Star City, a jetty which is the same type as that being used at Pun Hlaing Golf Estate will be constructed by a private company. This jetty will extend far out to the sea because of the shallow water near the coast. The construction permit has been acquired already from the MPA. A contractor will conduct dredging work before the installation of the jetty. As of January 2017, the project is behind schedule. The initial schedule is shown below and it is under the bid evaluation at present.

- Bidding (design build): October 2016
- Bid evaluation: November 2016
- Award and construction start: Late November 2016

11.8 The plan is to operate the service for public transport (mainly for commuters); however, the detailed operation plan was not disclosed during the bidding period.

Source: YRTA

Figure 11.1.5 Water Taxi Routes and Image of Water Taxi

Source: Study Team

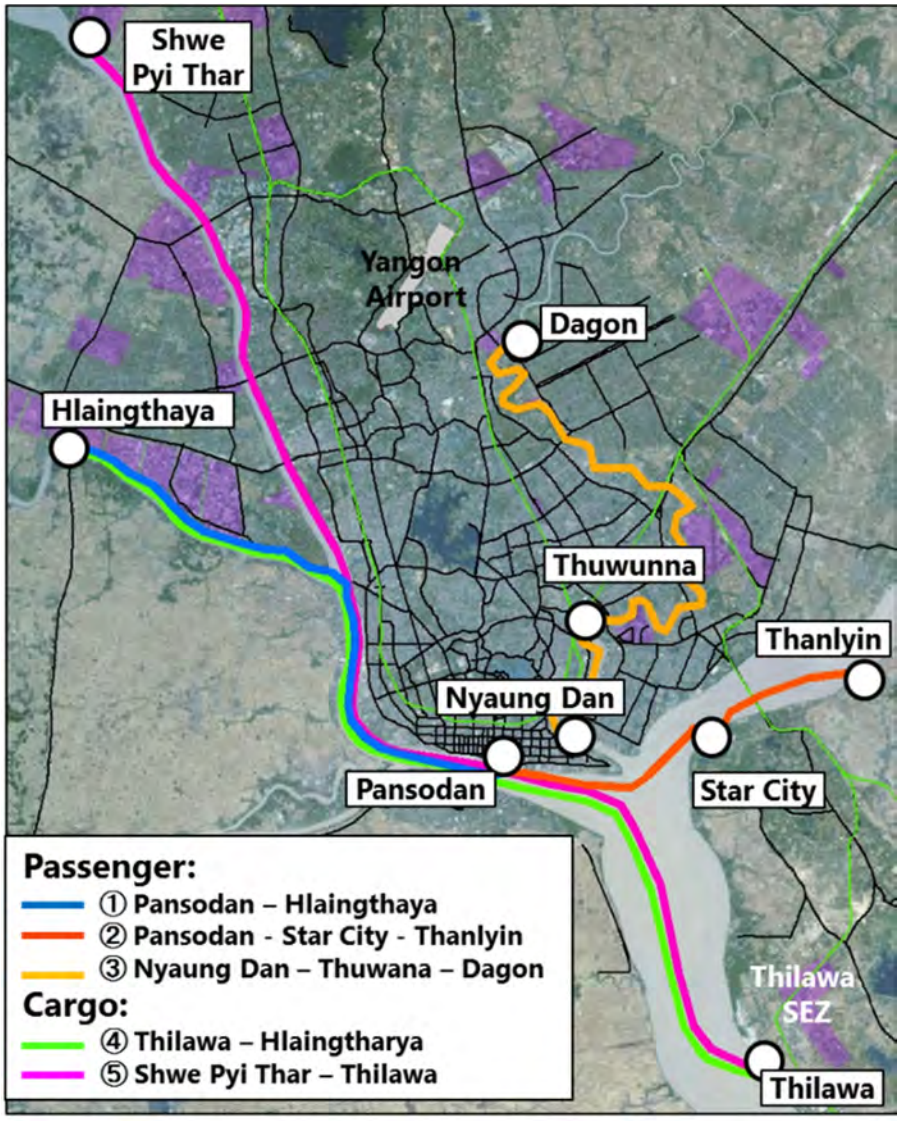
Figure 11.1.6 New Jetty at Pun Hlaing Golf Estate

11.2 Development of New IWT Routes

1) Proposed Routes

11.9 It can be said that the development of inland water transport is effective in order to relieve road congestion. Five routes with potentially high passenger and cargo demand are proposed, as shown in Figure 11.2.1 in consideration of the future development of Yangon City and the industrial zones.

11.10 As mentioned above, the Yangon Region Transport Authority (YRTA) under the Yangon Regional Government is working to develop new inland water transport routes. According to them, the Pansodan–Hlaingthaya and Nyaung Dan–Thuwana–Dagon passenger routes have high priority due to an estimated high demand among Yangon citizens.



Source: Study Team
1) Prepared by the Study Team based on Google Earth.

Figure 11.2.1 Proposed New IWT Routes

11.11 The outline of each route and the reason for their selection are summarized below.

(a) Pansodan–Hlaingthaya

11.12 This route has a length of 21 km and will serve passengers. The reasons for selecting this route are as follows:

(i) There are seven development plans for industry zones in Hlaingtharya (refer to Figure 11.2.3) and it is expected that the population of workers will increase in these areas including during the construction period. Therefore, traffic congestion becoming worse in case of utilizing land transport is a concern; and

(ii) In case land transport will be used between Yangon to Hlaingtharya, the route will pass Bayint Naung Bridge which has high traffic volume; many trucks transporting cargo use this bridge because it connects Yangon to Pathein. For this reason, it would be effective to divert road traffic to water transport.

11.13 It should be noted that the water depth of Pun Hlaing River is currently not sufficient for safe operations. After the dredging work conducted by DWIR three years ago, the river has become shallow again due to sand sedimentation.

Source: Study Team

Figure 11.2.2 Present Condition of Pun Hlaing River

(b) Pansodan–Star City–Thanlyin

11.14 This route has a length of 15 km and will serve passengers. The reasons for selecting this route are as follows:

(i) Significant increase in working population is expected along with the development of Thilawa SEZ; hence, traffic congestion from Yangon to Thilawa Area will become even more severe. Even now, traffic around Thanlyin Bridge is remarkable; and.

(ii) It is logical to diversify the traffic volume around Thanlyin Bridge which is the main traffic bottleneck at present. A new jetty for this route will be constructed in the near future and passenger service will be operated by a private company.

(c) Nyaung Dan–Thuwana–Dagon

11.15 This route is about 27 km long and will serve passengers. The reasons for selecting this route are as follows:

(i) Dagon and Thuwana are the main residential areas in Yangon, with a very high population density. It is estimated that there is a large demand from passengers living in areas along or near the riverside such as South Oakkalapa, North Oakkalapa, South Dagon, and North Dagon.

(ii) There are many wards between Thuwana and Pansodan, the major ones being 5th Ward, 6th Ward, Taung Lone Pyan Ward, Sat San Ward, Ku Toet Seik Ward, and Pathein Nyunt Ward. The Thuwana National Stadium is also located here. Therefore, there is heavy traffic in this area.

(d) Thilawa–Hlaingtharya

11.16 This route has a length of about 41 km and will serve both passengers and cargo. The reasons for selecting this route are as follows:

(i) There is a large demand for cargo transport by barge between Thilawa Port, which is an international port, and developing areas such as Hlaingtharya; and

(ii) The current land route between Yangon to Hlaingtharya passes Bayint Naung Bridge. Many trucks transporting the cargo between Yangon to Pathein pass this bridge, resulting in severe traffic congestion.

11.17 The optimal route including the via-terminal in Yangon Main Port will be decided in consideration of cargo volume and transport time.

(e) Thilawa–Shwe Pyi Thar

11.18 This route is about 48 km and will serve cargo only. The reasons for selecting this route are as follows:

(i) There are four development plans for industrial zones in Shwe Pyi Thar (refer to Figure 11.2.3) and industrial development is expected in the future. Accordingly, it is expected that there would be a large demand for cargo transport by barge between Thilawa Port and Shwe Pyi Thar. In addition, the Insein Market and Thiri Mingalar Market, both crowd drawers, are located along the route between Yangon and Shwe Pyi Thar. It will thus be effective to offer water modes to ease road congestion;

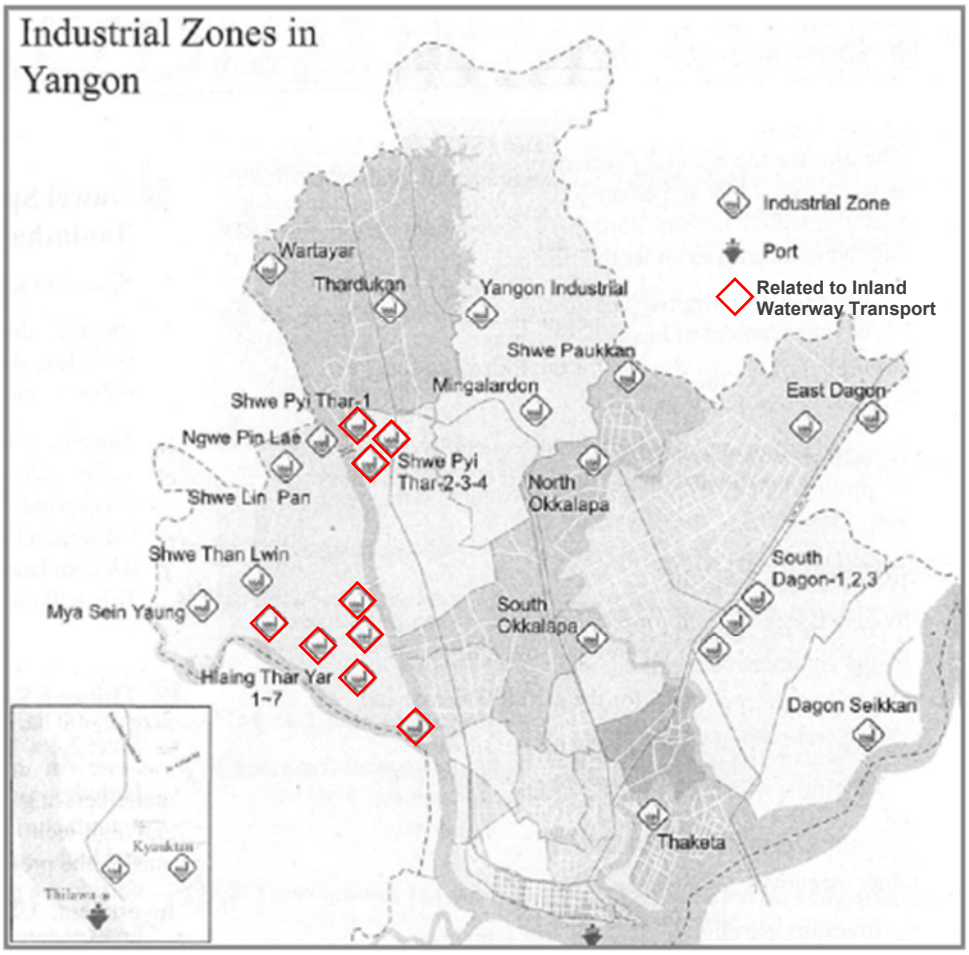
(ii) The plan for container cargo being transported between the MITT terminal and Shwe Pyi Thar by barge is being pushed forward already. The operation was expected to start in December 2016. The selection of the operator is progressing. It is estimated that barge size could be about 40 TEUs. Like the Thilawa–Hlaingtharya route, it is necessary to decide on the optimal route and the terminal at Yangon Port giving due consideration to cargo volume and transport time; and

(iii) Water transport offers more advantages when transporting large quantities at long distances. Therefore, this route is considered particularly effective because it is one of the longest routes in Greater Yangon.

Table 11.2.1 Profile of Industrial Zones Related to Inland Waterway Transport

Name	Area Aggregate	Administrator
Shwe Pyi Thar (1)	336 acres, 385 lots	Shwe Pyi Thar (1) Industrial Zone Management Committee
Shwe Pyi Thar (2/3/4)	SPT2=204.512 acres SPT3=394.504 acres SPT4=388.312 acres	Shwe Pyi Thar (2/3/4) Industrial Zone Management Committee
Hlaingtharya (1/2/3/4/6/7)	Total area=1401.44 acres, Industrial area=1087.98 acres	Hlaingtharya Industrial Zone Management Committee
Hlaingtharya (5)	222.933 acres	Hlaingtharya 5 Industrial Zone Management Committee

Source: Myanmar Industry Directory 2015-2016



Source: Myanmar Industry Directory 2015-2016

Figure 11.2.3 Location of Industrial Zones in Yangon

2) Issues on Water Transport Development in Yangon

11.19 The following matters are considered technical issues aimed at promoting the use of water transportation. Especially, Monkey Point where three rivers cross is dangerous area. In 1986, the capsizal accident of Tine Lone Kyaw happened by the influence of the strong wind during the monsoon. It is necessary to decide the detailed route and location of via-terminal by fully considering of the natural condition of each river such as the water depth, current, wind and etc.

(a) Securing of Punctuality

11.20 In case existing ships are used, there is a possibility that operating schedules would not be followed The strong current of the Yangon River, especially during the rainy season, and the current fleet's lack of propulsion power will not allow ships to reach their destinations upstream on time.

There are also some areas where ships cannot operate at night; they need light to pass under low-clearance bridges.

11.21 Table 11.2.2 and Table 11.2.3 show the estimated travel times for passenger and cargo by mode, respectively. For estimating travel times via water transport, current speeds of existing deteriorated ships were adopted, while future travel times were estimated using high-performance ships. Based on the results, ships with high performance (such as speed boats for passenger transport and tugs with marine engines for cargo transport) should be introduced to shorten operating time.

Table 11.2.2 Comparison of Estimated Passenger Travel Times by Mode

Unit: Hour

	Bus	Taxi	Railway	Water Transport (Present) Downstream - Upstream	Water Transport (Future) Downstream - Upstream
Pansodan - Hlaingtharya	1.5 - 2.0	1.25 - 1.75	1.5	1.0 - 2.5	0.8 - 1.5
Pansodan - Thanlyin	1.0 - 1.5	1.0 - 1.5	1.00	0.8 - 1.5	0.5 - 1.0
Nyaung Tan - Dagon	1.0 - 1.5	1.0 - 1.5	1.50	1.2 - 3.0	1.0 - 2.0

Source: Study Team
1) Where there is no railway service, time was added for using bus or walking to reach the destination. Regarding water transport, time was estimated on assumed speeds plus seven minutes each to embark and disembark. During actual operation, speed limits will be followed.

Table 11.2.3 Comparison of Estimated Cargo Travel Times by Mode

Unit: Hour

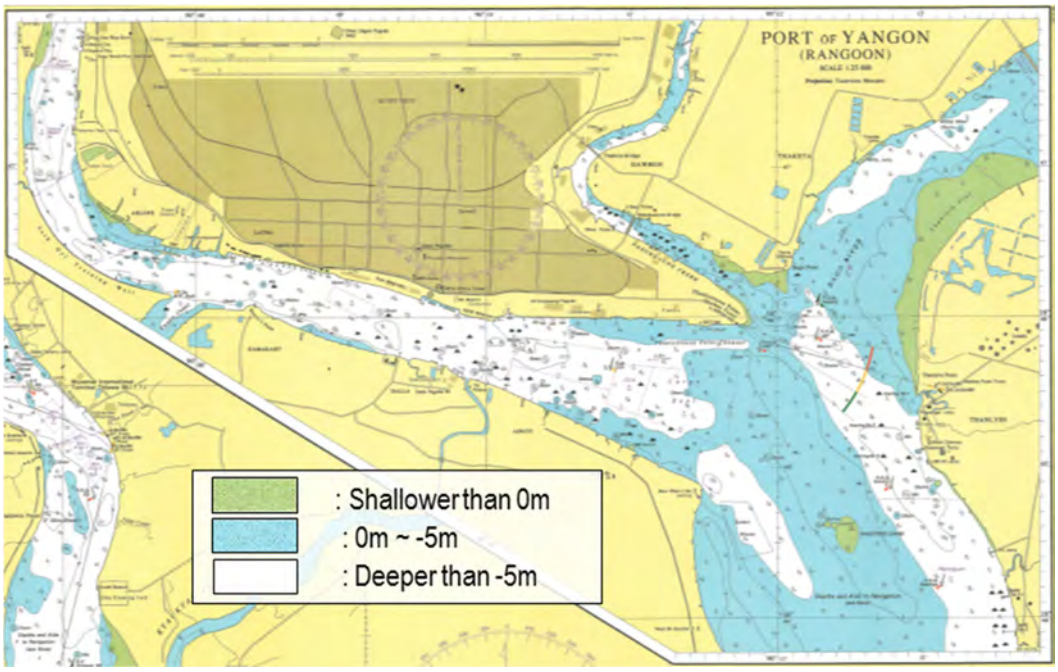
	Truck	Water Transport (Present) Downstream - Upstream	Water Transport (Future) Downstream - Upstream
Thilawa - Hlaingthaya	2.5 - 3.0	3.1 - 6.8	2.2 - 4.5
Thilawa - Shwepyitha	2.5 - 3.0	3.7 - 8.1	2.5 - 5.4

Source: Study Team
1) Regarding water transport, time is estimated on assumed speeds. During actual operation, speed limits will be followed.

(b) Securing of Safety

11.22 Serious accidents with casualties had occurred in Myanmar such as the sinking accidents in Sagain Region and Rakhine State. Ageing vessels and overloading of passengers or cargo are thought as the main causes, among others as listed below.

(i) **Water Depth:** There is a risk of ships getting stranded during the dry season because the water depth is not sufficient in some areas (Figure 11.2.4). In particular, the area between Pansodan and Star City, the water level is 4 m or less during low tide. There are also even shallower parts where the water depth is about 2 m.



Source: International Chart Series, Yangon River and Approaches 833 Edition Number: 3 Edition Date: 1st August 2013

Figure 11.2.4 Water Depth around Yangon Port

(ii) **Wake Size:** There is a tendency for a large ship or speed-ship to create a wake as it travels along the river. It is necessary to secure the safety especially of small ships that are easily influenced by the wake because the risk of capsizing is so high**.**

(iii) **Clearance between Ship and Bridge:** It is essential to ensure clearance between the ship and a bridge for safe operation because there are many bridges in Yangon. For example, from Nyaung Tan to Dagon, there are five bridges and enough clearance should be secured especially during high tide.

(c) Establishment of a Management and Implementation System

(i) **Clarification of Management Body and Establishment of Implementation System:** The Yangon Urban Transport Authority (YUTA), which is under the Yangon Regional Government, has played the role of manager of inland water transport. It is working to develop inland water transport such as selecting new routes. It is necessary though to clarify the management body for IWT and establish an implementation system.

(ii) **Development of Human Resources:** It is an important to secure and train human resources, such as captains, for safe operation especially while the problem of lack of channel maintenance exists.

(d) Consideration of Suitable Usage Fare

11.23 Table 11.2.4 shows the estimated fares for passengers on various modes. To provide a competitive fare for water transport, it is necessary to set it at the same level as that for existing transport modes such as bus. Regarding the cost of cargo transport, it is difficult to set it because the unit price changes depending on time period. Thus, cargo cost was omitted.

Table 11.2.4 Comparison of Fares by Mode

Unit: Kyat

	Bus	Taxi	Railway	Water Transport (Expected)
Pansodan - Hlaingtharya	300 - 500	5000 - 10000	100 - 300	400
Pansodan - Thanlyin	300 - 500	6000 - 8000	100 - 300	250
Nyaung Tan - Dagon	300 - 500	5000 - 8000	200 - 500	550

Source: Study Team
Note: The fare for water transport was estimated by averaging the unit price of existing services in Yangon (Pansodan–Dala, Wadan–Dala and Lan Thit–Kha Naung Toh). The unit rate is MMK20 /km.

3) Proposed Measures

(a) Passenger/Tourist Service

(i) Currently, the introduction of water taxis for commuters to reduce road congestion is under consideration by the YRTA. Full operation will be implemented based on the results of the trial operation by the Water Taxi Project.

(ii) It is thought that the number of IWT passengers decreases alongside the development of roads, railways (subways), and so on. However, water transport is expected to shift to servicing tourists once Yangon's riverfront is developed, as was seen in Bangkok and Paris. Ships and facilities will be utilized for tourists according to demand and usage situation.

(iii) Therefore, a stepwise development can be proposed.

(b) Cargo

(i) Because inland water transport is advantageous for heavy cargo and mass transport and creates less environmental impact, it is quite effective and efficient to use inland water cargo transport between Thilawa and Hlaingtharya or Shwe Pyi Thar. The barge used for transporting container cargo was built during a pilot project[1] (2016, JICA) and also IWT is planning to start container cargo transport service in the near future.

(ii) Current cargo demand is not so much because the handling volume for container and bulk in Yangon Port is very small relative to the population; however, the demand for cargo is expected to increase significantly. The container volumes Yangon Port is expected to handle by 2025 is estimated at about 4 million TEUs, according to "The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area" (2014, JICA).

(iii) In the short term, the trial operation will start utilizing the barge built by the pilot project, which is the plan of the IWT. Based on the results of the trial operation, full operation will commence.

[1] Verification Survey with the Private Sector for Disseminating Japanese Technologies for a Container Barge for Shallow Water on Ayeyarwaddy River, 2016, JICA

(c) Introduction of High-performance Ships

11.24 In order to ensure punctuality, a speed of about 12 to 15 knots is required for passenger boats. Ships which will not be affected by a wake should be introduced. In addition, ships should be selected in consideration of the shallow depths and low-clearance bridges to ensure safety. The assumed specifications of ships are shown in the table below.

Table 11.2.5 Assumed Ship Specifications

Item	Passenger/Tourism	Cargo
Speed	12–15 knots/hour	10 knots/hour
Limitation of passenger or cargo	100 passengers	50 TEUs

Source: Study Team

Terminal	7 (Asakusa, Hamarikyu, Hinode Pier, Odaiba Seaside Park, Palette Town, Tokyo Big Sight, Toyosu)	
Route	1. Asakusa-Hamarikyu-Hinode Pier	9.1 km
	2. Asakusa-Odaiba Seaside Park-Toyosu	14.5 km
	3. Hinode Pier-Odaiba Seaside Park	2.7 km
	4. Hinode Pier-Palette Town	4.2 km
	5. Hinode Pier-Tokyo Big Sight	4.1 km
Schedule	21 services/day (Varies by route, ship type, weekday/weekend and season)	

Fleets

Hotaruna (120 pax)

Himiko (80 pax)

Dokan (300 pax)

Irisu (150 pax)

Atakemaru (270 pax)

Source: Study Team

Figure 11.2.5 Water Transport in Tokyo

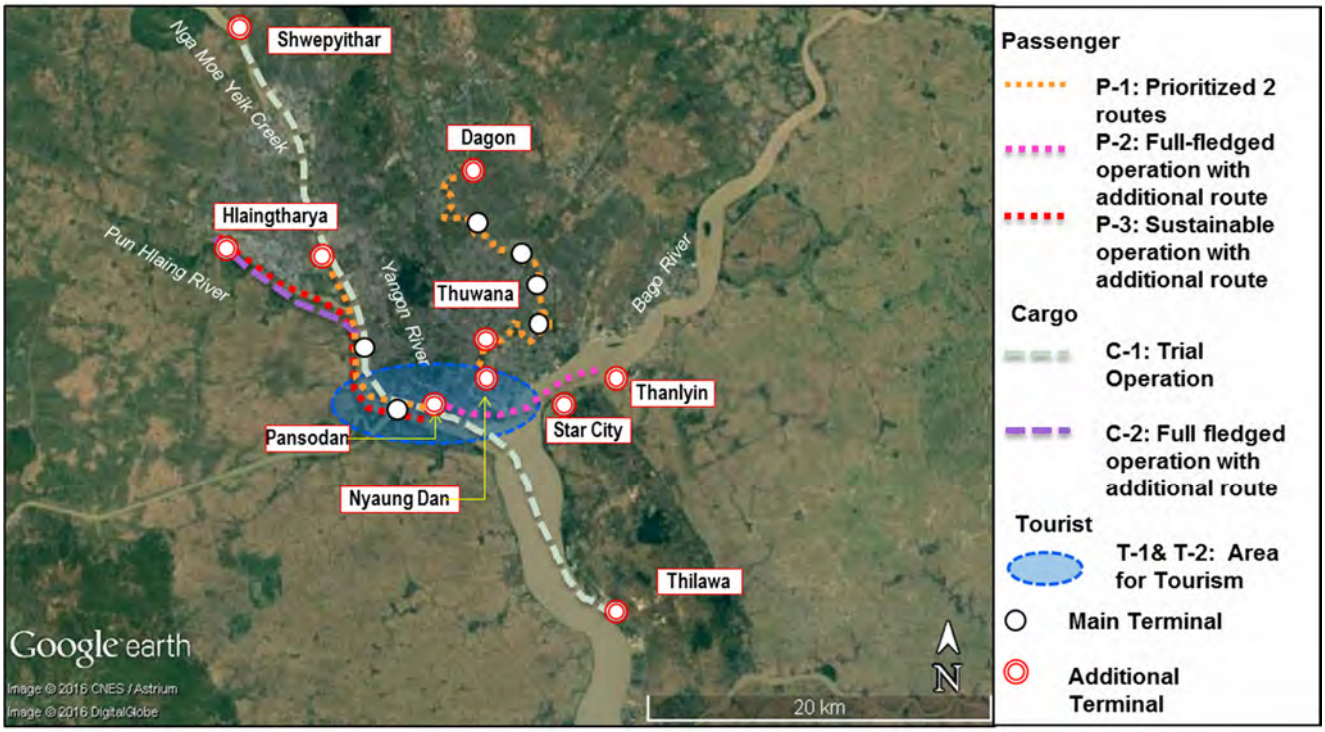
(d) Stepwise Operation

11.25 The stepwise operation is proposed in consideration of the usage demand in future. The ship and facility for the tourism will be effectively utilize the ship and facility for the passenger according to usage situation. Table 11.2.6 shows the outline of the stepwise operation and Figure 11.2.5 shows the expected implementation route and terminal of each term.

Table 11.2.6 Proposed Stepwise Operation

	Passenger/Tourism	Cargo
Short-Term (up to 2019)	P-1:Implement trial and start of operation as the public transport The trial operation and regular operation will be implemented in the two routes with the high priority by Water Taxi project, which is considered by YRTA currently (The trial operation is planned to start in April, 2017).	C-1: Implement trial and start of operation of container cargo transportation The trial transportation and regular operation of the container cargo will be implemented utilizing the barge built by the pilot project (2016, JICA) and the tug boat owned by IWT.
Mid-Term (2020-2025)	P-2: Implement of the full-fledged operation as the public transport The full-fledged operation as the public transport (commuter usage) will be started by increasing the routes and terminals.	C-2: Implement of the full-fledged operation of container cargo transportation The full-fledged operation of container cargo transportation will be implemented by the development of port's facilities and equipment, the ship building in Myanmar, the increasing the size of vessel and so on.
	T-1: Implement trial for the tourism usage The trial operation regarding the tourism usage of inland water transportation will be implemented in consideration of the decrease in commuting users due to the development of land transportation.	
Long-Term (2026-2035)	P-3: Implement of the sustainable operation as the public transport New route will be developed and the sustainable management system will be established in consideration of the commuter usage's demand.	
	T-2: Implement of the full-fledged operation for the tourism usage The regular operation for the tourism usage will be started along with the decreasing the number of commuter usage due to the development of the railway and road.	

Source: Study Team



Source: Worked out by Study Team based on Google Earth

Figure 11.2.6 Expected Implementation Route and Terminal by Term

4) Proposed Actions

11.26 It is proposed for inland water transport development in Yangon must look into both its function and planning direction. The possible functions of water transport include:

(i) Interurban freight transport;

(ii) Transport for daily activities;

(iii) Tourist transport; and

(iv) Interurban small freight transport.

11.27 Planning directions must consider:

(i) Improvement of existing urban water transport facilities and services;

(ii) Development of new opportunities for local water transport services;

(iii) Examples in foreign countries (Bangkok, Japan, etc.), pier to pier (in Paris), small-scale freight transport between commercial facilities along the Seine River; and

(iv) Redevelopment of waterfront including relocation of existing port facilities (TOD of water transport).

12 TRANSIT ORIENTED DEVELOPMENT

12.1 Understanding of TOD

1) Concept of TOD

12.1 Development of urban railway in large cities aims not only to provide fast, safe, comfortable and affordable public transport services but also to induce the following benefits on urban development in order to maximize the benefits of the railway development as well as to sustain the sound operation and maintenance of the railway.

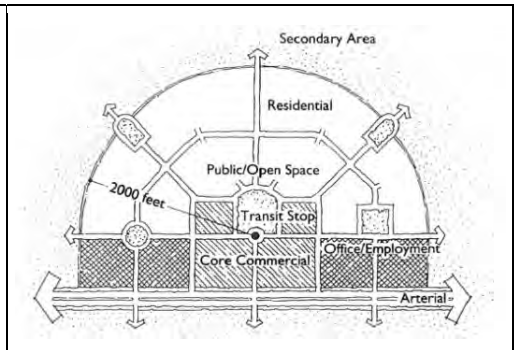
(i) Establish the urban railway corridor through the enhancement of transport network from stations to the existing urban and neighborhood centers to promote new development in the corridor.

(ii) Develop new residential areas in the urban railway corridor for all urban residents including low income people and informal settlers as these areas contribute to the holistic improvement on the living environment in Yangon as well as to the sustainable ridership of railway.

12.2 While a transit-oriented development (TOD)[1] was initially conceived as a counter-approach shifting from the auto-oriented development to the pedestrian-friendly compact urban development, recently it becomes to be heighted as a sustainable urban development approach since it aims to promote the public transport through the integration of transport and urban development with sound balance among social, economic and environmental aspects, which enables to achieve the benefits stated above. Therefore, TOD also contributes to the mitigation of environmental degradation such as reduction of CO2 emissions and improvements on air quality through the modal shift from private vehicle to the public transport. The modal shift to the public transport also contributes to the better utilization of urban space as it occupies less space per passenger than the private vehicle.

12.3 Thus, TOD is recognized as the strategic sustainable development approach to foster "Smart Growth" of the city through the synergy in an integrated transport and urban development as shown in Figure 12.1.2.

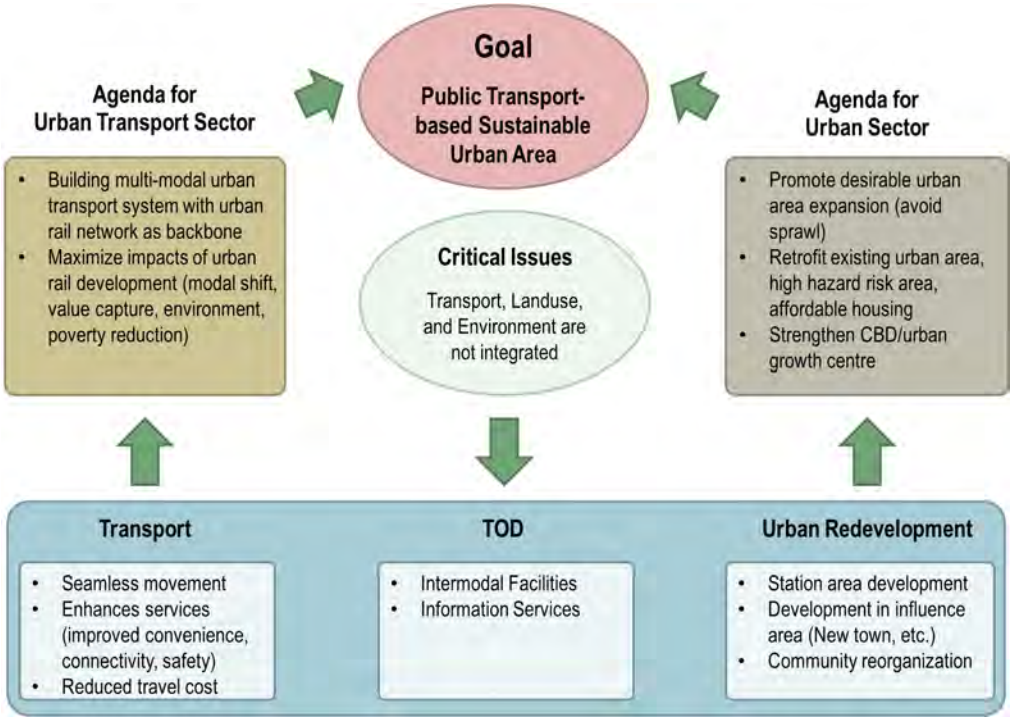
Design principles of TOD, stated by Peter Calthorpe, are to: (i) organize growth on a regional level to be compact and transit supportive; (ii) place commercial, housing, jobs, parks, and civic uses within walking distance of transit stops; (iii) create pedestrian friendly street networks that directly connect local destinations; (iv) provide a mix of housing types, densities, and costs; (v) preserve a mix of housing types, densities, and costs; (vi) preserve sensitive habitat, riparian zones, and high quality open space; (vii) make public spaces the focus of building orientation and neighborhood activity; (viii) and encourage infill and redevelopment along transit corridors within existing neighborhoods.



According to the Federal Transit Administration, USA, Positive effects of TOD can farther be listed as follows: (i) more efficient use of land, energy and resources; (ii) less oil and gas consumption; (iii) cleaner air; (iv)minimizes traffic increases; (v) encourages walking; (vi) increases transit ridership at a lower cost than if bus service or parking structures are needed to bring riders to stations; (vii) increases property values, lease revenues and rents; (viii) increases foot traffic for local businesses; (ix) creates opportunities to build mixed income housing; (x) height and density can pay for community benefits and affordability; (xi) reduces transportation expenditures, and (xii) promotes healthier lifestyles.

Figure 12.1.1 Basic Principle and Effects of TOD

[1] Transit Oriented Development (TOD) was first used by Peter Calthorpe in his book "*The Next American Metropolis: Ecology, Community, and the American Dream*", Princeton Architectural Press, 1993.



Source: Study Team

Figure 12.1.2 TOD as a Catalyst to Integrate Transport and Urban Development

2) Key Roles of TOD

(a) Smart Urban Growth

12.4 Concept of “Smart Growth” started to be developed in the United States aiming for the sustainable urban development and management in terms of environmental, economic and social aspects. Major organizations such as Smart Growth America and Smart Growth Network introduce the following 10 principles for a smart urban growth approach.

(i) Mix land uses

(ii) Take advantage of compact design

(iii) Create a range of housing opportunities and choices

(iv) Create walkable neighborhoods

(v) Foster distinctive, attractive communities with a strong sense of place

(vi) Preserve open space, farmland, natural beauty, and critical environmental areas

(vii) Direct development towards existing communities

(viii) Provide a variety of transportation choices

(ix) Make development decisions predictable, fair, and effective

(x) Encourage community and stakeholder collaboration in development decisions

12.5 All these principles are also necessary for the implementation of TOD. Therefore, in other words, implementation of TOD promotes the smart growth of the city.

12.6 Historically in Yangon, the central urban area has been developed in an efficient and compact manner with high population density. The population density is still quite high in Yangon CBD areas (341 person/ha; average of 6 townships in CBD, 234 person/ha; average of 6 townships adjacent to CBD).

12.7 However, rapid economic growth and motorization accelerates the urban sprawl through the development in the suburban areas. As a result, population growth in suburban areas becomes significant (e.g.135 persons/ha in Insein and Mayangone Township) enough to inhibit the population growth in the central urban area over the last decade.

12.8 Since many developed counties failed to control the sustainable size and density of CBD by allowing the rapid urban sprawl, Yangon should consider the revitalization of CBD as well as the control of new urban development and redevelopment in order to avoid the precedent mistakes.

12.9 Since urban railway can connect CBD and suburban areas in an effective and sustainable manner as shown in Figure 12.1.3, induce of the investment in the urban railway corridor through TOD based on the principles of smart growth previously introduced becomes essential for the sustainable city.

(b) Reorganization/ Revitalization of CBD

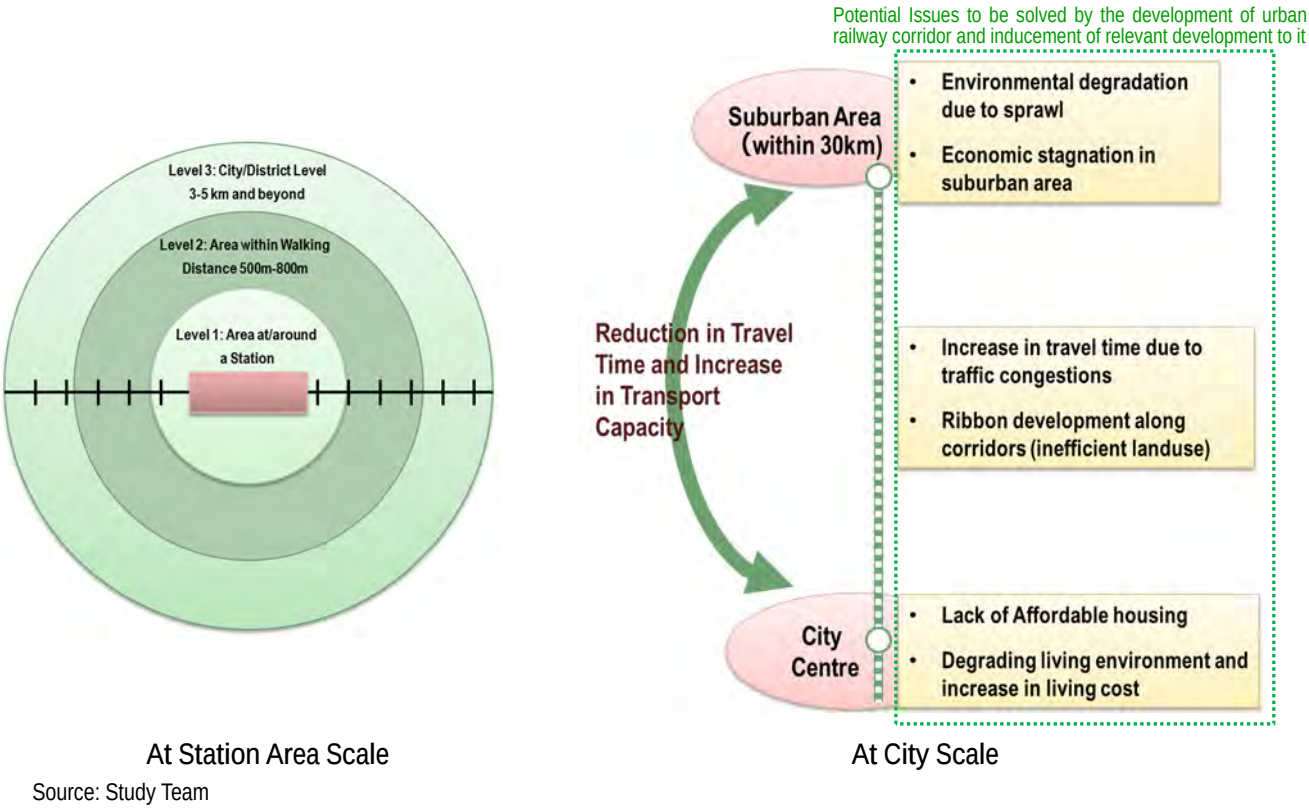
12.10 TOD can contribute to restructuring and improvement of CBD since it enables to reduce traffic congestions due to the modal shift from private cars to the public transport and results in the efficient utilization of urban spaces as previously described. TOD also contributes to the improvement of environmental conditions such as air quality and noise. Such improvement on the living/working environment becomes a major factor to attract business in CBD together with the convenient public transport and pedestrian access to be established by TOD. In Yangon, CBD plays the significant roles both in business and tourism. Therefore, holistic improvements of public transport through TOD is essential to stimulate multiplier effects by the development of both business and tourism sectors towards the attractive and sustainable CBD.

(c) Enhancement of Urban Development/Redevelopment of Station Areas

12.11 Establishment of urban railway corridor in a strategic manner for the solution of the potential urban development issues shown in Figure 12.1.3 can provide ample opportunities for competitive urban development/ redevelopment at and around urban railway stations. Since each station has different locational characters, issues as well as the interests of communities, investors and other concerned parties, planning and consultation for TOD should be carefully implemented among various stakeholders based on the smart growth principles previously introduced.

(d) Enhancement of Transport Network in Urban Railway Corridor

12.12 Establishment of safe, convenient and comfort public transport network form the station is fundamental both for the formulation of urban railway corridor as well as for the inducement of the relevant development necessary for the revitalization of CBD and urban development/ redevelopment to the corridor. Various elements including management should be incorporated for the establishment of public transport network towards successful TOD.



Source: Study Team

Figure 12.1.3 TOD Opportunities at Spatial Level

3) Key Interventions for Successful TOD

12.13 TOD aims to increase the ridership of urban railways in accordance with the increase in the satisfaction of passengers. In order to increase the level of satisfaction, seamless public transport transfer needs to be provided. Seamless public transport network in the urban railway corridor should be established based on the consideration for the synergy with the relevant urban development/ redevelopment to maximize the benefits of both transport and urban development/ redevelopment to induce the multiplier effects in terms of social, economic and environmental aspects. It should be emphasized that an overall goal of TOD is to establish the comprehensive public transport network in the urban railway corridor that includes compact urban areas with high mobility and accessibility as well as optimal land use ensuring the environmental conservation and mitigation of environmental degradation.

12.14 Main components of interventions required to implement TOD are as follows:

(i) **Access Roads Development:** Stations must be developed with good access roads for pedestrians and vehicles including bicycle, motorbike, car, taxi, bus, etc. to reach and depart to and from the stations.

(ii) **Station Plaza:** Stations must be developed with space at the front of stations for easy access to and egress from the stations by walk, bicycle, motorbike, car, taxi, bus and so on. In order to meet this requirement, adequate size of parking space and loading/unloading space facilities must be secured. Based on the consideration for the local characteristics and needs of the community, station plaza may also have to serve as a symbolic space for community and other activities.

(iii) **Pedestrian Access:** Walking is the most important transport mode for the access to the urban railway stations. Although the demand for pedestrian access varies by station, it normally exceeds the half of the transport mode. Therefore, the conditions of pedestrian

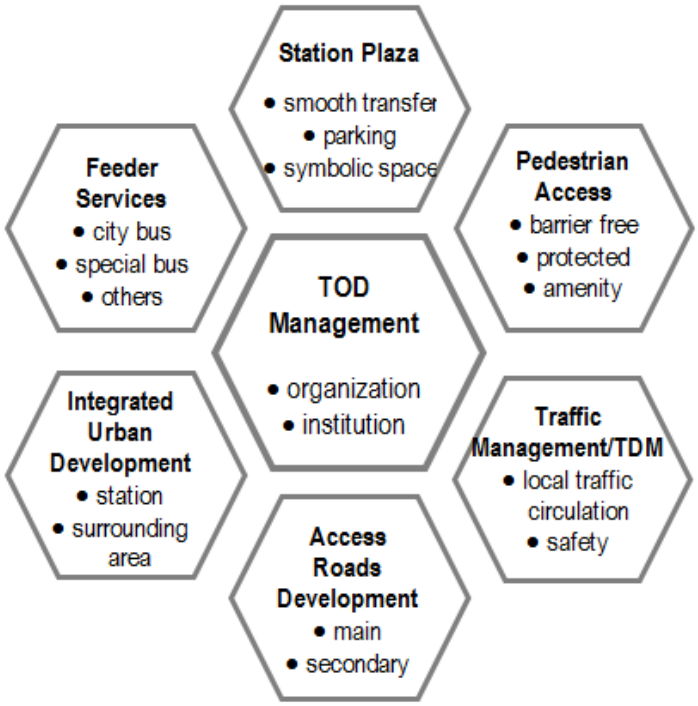
access must be improved in the most effective manner especially within walking distance from a station (less than 500-800 meter or 10 minutes' walk). Measures include smooth walkways (at-grade, elevated, underground) without physical barrier and intrusion by the vehicles, as well as with shade, trees and street furniture. Proper consideration and design for people with disablity, children and elderly people are also necessary.

(iv) **Traffic Management/ Traffc Demand Management (TDM):** Vrious types of traffic mode concentrate in the station area, especially during peak hours. In order to regulate traffic flow at and around the stations, proper traffic management must be provided including, among others, traffic signals both for vehicles and pedestrians, safety facilities. In addition to the current ban on motorcycle, drastic TDM will be necessary to maximize the utilization of public transport network including urban railways as well as to ensure the public health and safety.

(v) **Feeder Services:** Feeder service to the urban railway stations is fundamental to expand the catchment areas of the urban railway. In addition to the transfer to the existing bus service at the stations, transfer to the other types of public transport such as regional bus and water taxi services also should be considered where it is feasible.

(vi) **Integrated Urban Development:** Integrated urban developments in the urban railway corridor is essential not only for the increase in ridership but also for the smart urban growth through various types of urban development/ redevelopment with high quality living and working environment.

(vii) **TOD Management:** In order to comprehensively handle the above TOD components, management aspect is critical. Proper organization and inter-agency coordination mechanism including private sector and civil society must be established. Certain regulations and institutional arrangements are also necessary for the establishment of financial scheme that secures the budget both for planning and implementation including monitoring and evalutation.



Source: Study Team

Figure 12.1.4 Main Components of TOD

4) Intermodal Facilities

(a) Role and Functions of Intermodal Facilities

12.15 Intermodal facility is a key facility to make the main components of TOD shown in Figure 12.1.4 work in an efficient and effective manner for both urban railway users and non-users . Seamless transfer among various public transport modes is necessary for the entire door to door travel in order to implement the modal shift from the private vehicle to the public transport. Intermodal facility is able to provide safe and convenient seamless transfer at the station when it is appropriately designed for the necessary functions.

12.16 While the scale and elements of intermodal facility vary depends on the expected roles of each station, major activities at the intermodal facility applying for all stations including the aspects need to be considered for the appropriate design are summarized as follows;

(i) **Transfer:** For the establishment of sustainable urban public transport system in Yangon, securement of safe and convenient transfer between the urban railway and other transport modes such as bus, taxi, car, motorcycle, bicycle, etc. is necessary as previously explained. In order to implement the seamless transfer, transfer point such as bus stop/ bus berth, drop-off/ pick up area should be designed close to the station. In addition, pedestrian access including pedestrian walkway and bridge, which connects all transfer points should be provided.

(ii) **Parking**: Although access to the station by the private vehicle is not desirable for the stations in the urban center, adequate parking space should be allocated for the people with certain difficulties in the access to the station by public transport. It also helps to reduce illegal roadside parking as well as traffic congestion and accidents associated with it. In the suburban areas, convenient parking facilities near the station promote the commute by Park and Ride (P&R)[2] and will contribute to the increase of railway passengers and decrease the environmental degredation accordingly.

(iii) **Circulation**: In the station area, both railway users and non-users generate pedestrian circulation for various purpuses such as shopping, waiting and meeting. Thus, clear signage and sufficient width of walkway need to be constructed to control pedestrian flow in a safe and efficinet manner. Also, provision of urban amenities such as seating with shade, green open spaces as well as commercial faciliteis such as kiosk, café and surpermarket are necessary as they attract more users in the station area and result in the promotion of public transport at the intermodal facility including urban railway.

12.17 For planning and design of facilities, following aspects need to be considered as the fundamental design principles:

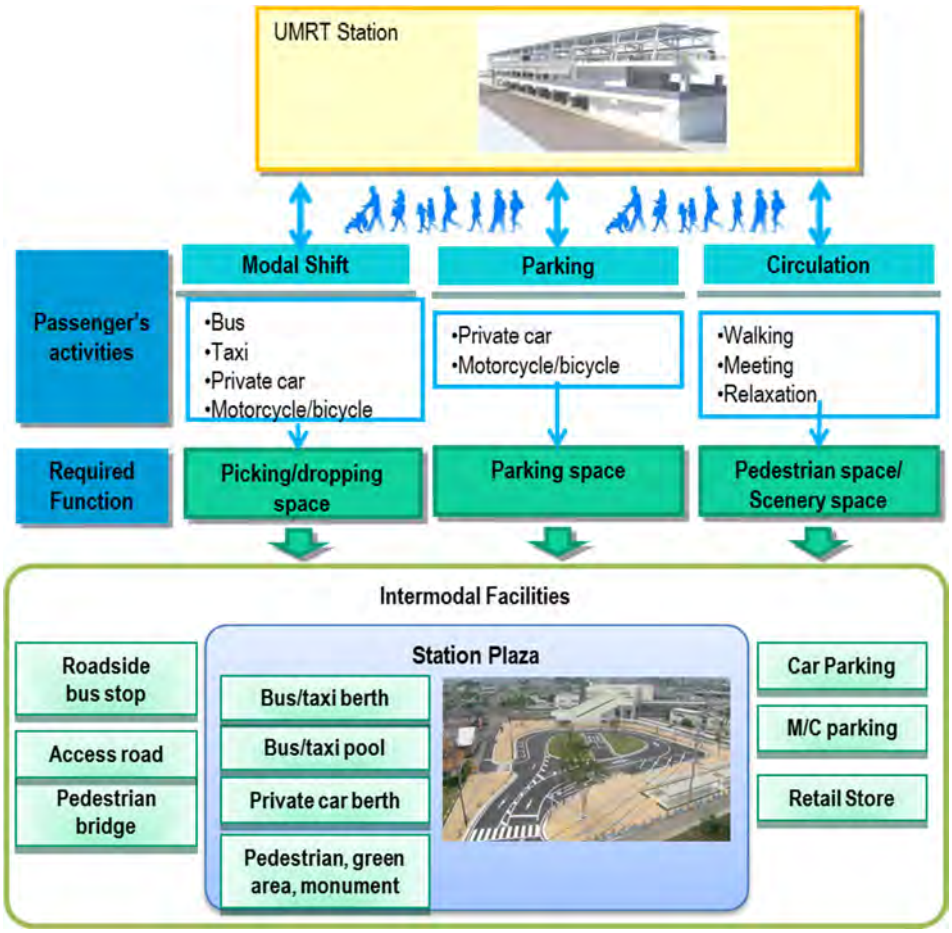
(i) **Universal design:** Universal design aims for the securement of health, safety and welfare for all and therefore, it is often referred as inclusive design whereas barrier-free design focuses on mobility/ accessibility and mainly targets elderly and people with disability. Since intermodal facility is expected to provide safe and convenient services for all users, universal design approach should be adopted including measures for multi-languages signage as a part of improvement on the mobility and accessibility.

[2] Park and ride (P&R) facilities are car parks with connections to public transport that allow commuters and other people headed to city centres to leave their vehicles and transfer to a bus, rail system (rapid transit, light rail, or commuter rail), or carpool for the remainder of the journey. The vehicle is stored in the car park during the day and retrieved when the owner returns. Park-and-rides are generally located in the suburbs of metropolitan areas or on the outer edges of large cities.

(ii) **Seamless door-to-door transfer:** Since seamless door-to-door transfer is essential for the promotion of public transport including urban railway as previously described, convenient, comfortable, safe, reliable, and affordable feeder service network should be established in the urban railway corridor and reflected on the design of intermodal facility.

(iii) **Walkable public space:** Pedestrian friendly environment in the public space increases the value and numbers of visitors for the adjacent facilities and result in the increase in the revenue of them including the urban railway station. Since creation of walkable negihborhoods is listed as one of the smart growth principles previously introduced, it should be highly considered for the implementation of TOD.

12.18 Due to its comprehensive functions, Intermodal facilities includes both transport facilities such as station plazas, bus stops, pedestrian bridges, access roads, car parking and motor cycle parking, and other amenity service facilities such as open space, green space and retail shops. Among these, the station plaza is a key facility since it is located at the center of traffic circulation and public open space. Therefore, it plays multiple functions with the components of (i) carriage way (one-way), (ii) bus berth and bus pool, (iii) taxi berths and taxi pool, (iv) berth for private vehicles, (v) pedestrian bridge, (vi) pedestrians' circulation space, and (vii) open space.



Source: Study Team

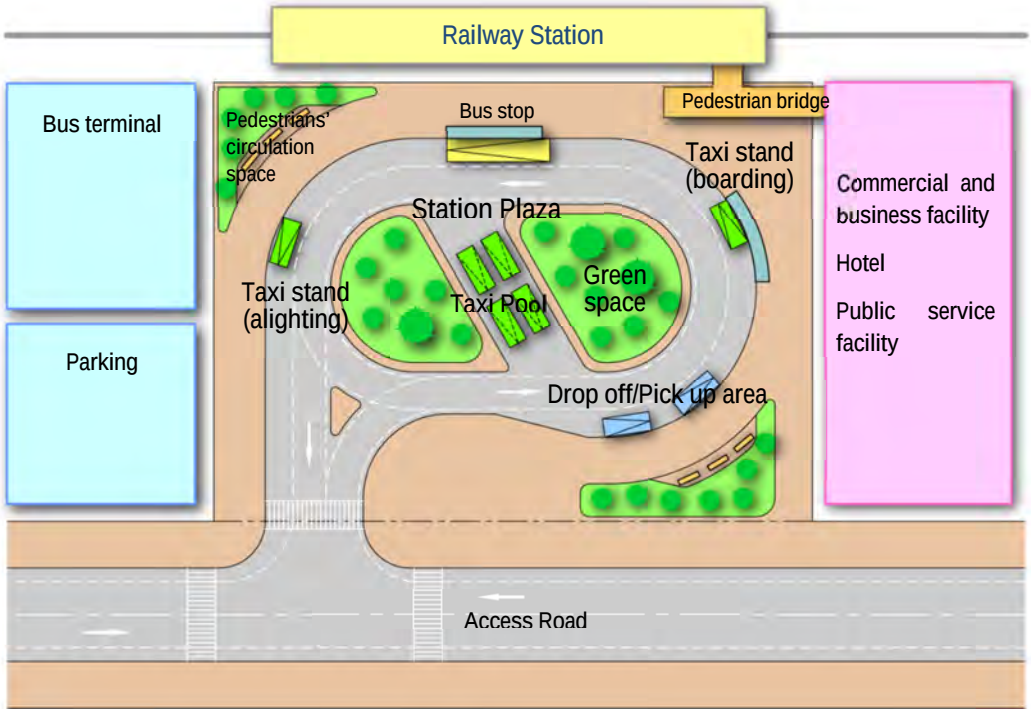
Figure 12.1.5 Role and Function of Intermodal Facilities

(b) Station Plaza

12.19 A station plaza has two major spatial functions; (i) transport function and (ii) social and environmental function. In terms of transport function, securement of safe, convenient and comfort access to the various public transport including urban railway adjacent to the station plaza is essential. As for social and environmental function, provision of the safe, convenient and comfort spaces for various activities such as walking, waiting and meeting is required. Since station plaza is the key component of intermodal facility, fundamental design principles (universal design, seamless door-to-door transfer, walkable public space) should be applied to design of both functions.

12.20 In the planning of the station plaza, roles of each station should be clarified to identify the necessary elements as well as the required scale of the elements. For example, the capacities of bus berth and taxi pool are estimated based on the future railway demand and modal share. While the station plazas at the suburban stations include relatively small pick-up/drop off area, bus stop and taxi stand to fulfill the transport function, the ones at urban central stations require the certain size of bus berth and stop, taxi pool and stand, pick-up/drop off to meet the transport demand. In addition, such station plazas at major stations often require the symbolic civic space with monument, illumination, water features etc. as a landmark to fulfil the social and environmental function.

12.21 Station plazas should be developed and managed based on the agreement between the railway operator and the road administrator according to their jurisdiction because the station plaza includes road facility as well as other relevant facilities. In Japan, railway companies need to reach the agreement with the concerned governmental agencies upon their responsible areas in construction, operation and maintenance both in terms of financial and physical aspects for the establishment of the station plaza. In order to physically clarify the responsible areas, station plaza is recommended to be officially designated as a transport facility with legal basis that also ensures necessary land acquisition/ expropriation and ROW.



Source: Final Report of "Special Assistance for Project Implementation (SAPI) for Ho Chi Minh City Urban Railway Project (Ben Thanh – Suoi Tien Section (Line 1))", 2014, JICA

Figure 12.1.6 Basic Layout of the Station Plaza

Station Plaza of Totsuka Station (bus rotary, taxi pool, pedestrian deck)	Station Plaza of Futako Tamagawa Station (bus rotary, taxl pool, pedestrian plaza with rooftop)
	

Source: Study Team

Figure 12.1.7 Station Plazas in Japan

(c) Bus and Taxi Facilities

12.22 Bus and taxi facilities are usually located in front of the station for smooth transfer of passengers. In order to improve the transfer environment, introduction of the relevant technologies such as bus location system (information of bus location and arrival time) is recommended in addition to the conventional approach such as installation of roofs, shelters and benches. If there are several bus stops in the station plaza, these bus stops (bays) should be located in parallel based on the consideration for the pedestrian circulation. As needed, additional facilities such as pedestrian crossing and bridges should be provided to secure the pedestrian safety.

12.23 In the central areas in the city where land availability is limited, urban railway terminal stations are often developed with integrated bus terminals and commercial facilities through multiple stories. For example, Nishitetsu Company, a railway and bus operator in Japan, developed a station building with a department store. Such integrated station facility can financially support the railway operation as it collects fee from the tenants. Also, increase in passenger can be expected due to the customers of the commercial facility.

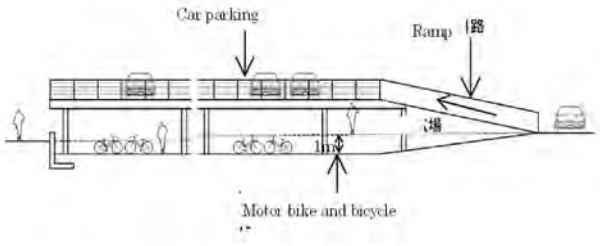
(d) Car Parking

12.24 Parking spaces should be planned and developed in consistency with urban planning including land use plan as well as transportation plan to meet the demand in the long run. As previously mentioned, access to the central area of the city by the private car is not desirable from the perspective of promotion of public transport, various needs should be acknowledged and required number of stalls need to be developed to avoid the illegal on-street parking. Especially for the integrated station facility with commercial facility previously introduced, car parking facility should be shared with commercial facility as the construction/ maintenance cost can be shared with the private sector. At the stations in the suburban areas, P&R facilities should be developed for the convenient and ecological commute to the city center.

12.25 In Japan, car parking and P&R facility are mostly developed by the public sector. Parking development, operation and maintenance are stipulated by various relevant laws. Road Law defines parking as a part of road facility and Parking Law stipulates the requirement for the parking area, on-street parking etc. Road Transportation Law controls parking meters of on-street parking and City Planning Law designates a parking development area and a parking in the area as a city planning facility required to ensure smooth traffic circulation in the commercial area .

12.26 In Yangon, car parking spaces are limited, especially in CBD. Car parking should be planned and developed efficiently and effectively including the consideration for the multi-storied and

underground parking facilities in addition to the surface car parking. In order to promote the involvement of private sector in the development of car parking, close coordination as well as the formulation of necessary legal framework are necessary.

Multi-story parking building, Hashimoto Station, Tokyo	Semi-underground parking for bicycle, motorcycle and car
	

Source: Study Team based on various sources

Figure 12.1.8 Example of Car Parking

(e) Motorcycle and bicycle parking

12.27 Since motorcycle is prohibited in the central areas in Yangon, provision of the motorcycle parking in the intermodal facility at the suburban station areas plays a similar role to P&R facility for cars promoting convenient and ecological commute to the city center. Bicycle parking is indispensable for all urban railway stations to implement the smooth transfer in a convenient and ecological manner.

12.28 Due to the smaller size of the parking stall comparing to the car, utilization of various spaces such as sidewalk, under the viaduct, underground space should be considered to maximize the utilization of limited urban spaces. Any types of parking needs to be located at the convenient place preferably within 200m from the station. Parking should be designed in order not to interfere with the pedestrian circulation based on the design principles including universal design previously introduced.

12.29 Existing bicycle and motorcycle parking are mostly developed by the local government, both pay and free parking. Similar to the car parking, certain coordination and establishment of the relevant legal framework is necessary for the involvement of private sector in the development and maintenance of bicycle and motorcycle parking in Yangon.

Pay bicycle parking on-siewalk, Nishisinjuku, Tokyo	New York	Parking under viaduct of UMRT, Odakyu Line, Tokyo
		

Source: Study Team from various sources

Figure 12.1.9 Examples of Bicycle Parking

(f) Pedestrian Facilities and Walking Environment

(i) **Pedestrian-friendly Walking Environment:** While various activities such as waiting, walking, bicycling etc. may occur in the intermodal facility, safety of pedestrians should be secured based on the design principles including universal design as previously described. “Complete streets” is a design approach to implement universal access for all users in a comprehensive manner based on the consideration for transport as well as social and environmental aspects. Such measures should be adopted for the development of intermodal facilities in Yangon.

(ii) **Pedestrian Bridge/ Deck:** While pedestrian bridge aims to ensure safe and comfortable pedestrian access over the busy arterial streets, the pedestrian deck is mostly constructed over the station plaza of big terminal stations in order to connect elevated stations and adjacent buildings with larger space than pedestrian bridge. As shown in Figure 12.1.10, a ring-shaped pedestrian deck over the major intersection enables pedestrians to access all directions in a safe and efficient manner. For the implementation of this important element of intermodal facility for the pedestrian safety and convenience, role sharing between public and private sector for construction and management should be clarified. In Japan, it used to be determined by the project basis due to the lack of specific rules until the guideline is prepared by the government.

Station plaza at Mizonokuchi Station, Kawasaki City	Pedestrian deck connecting commercial facility with Kawasaki Station, Kawasaki City
	
Pedestrian crossing at the intersection, Shin Yokohama Station, Yokohama City	“Pearl Ring” pedestrian crossing at the intersection creating openspace, Shanghai City
	

Source: Study Team

Figure 12.1.10 Examples of Pedestrian Deck

12.2 Opportunities and Approach to TOD in Yangon

1) TOD Potential in Yangon

12.30 Yangon aims at developing mass-transit based sustainable city wherein the city become competitive, livable and environment friendly. Development of extensive urban rail network comprising both existing and new lines will provide an ample opportunity to integrate public transport and urban development. TOD potential and opportunities for investment both by public and private sector are enormous at and around the rail stations as well as along the rail lines due to the consolidated government land with high potential for urban development/redevelopment as shown in Figure 12.2.1.

12.31 Yangon Circular Railway (YCR) is the only existing urban railway in the central area of Yangon and its upgrading project is about to start through the assistance of Japanese government. Therefore, identification of TOD opportunity along YCR based on the consideration for the future transport network including new urban railway (Urban Mass Rapid Transit: UMRT) is necessary in order to maximize the benefits of the upgrading project.

12.32 TOD can also be adopted for other transport modes such as airport, port and expressways, as long as certain possibility for the integration of transport and urban development exists and the key roles of TOD previously introduced in the previous section are incorporated. All types of TOD in Yangon can be referred to the precedent TOD projects in Japan as well as in the neighboring countries.

2) Opportunity for Urban Railway based TOD in Yangon

12.33 Urban railway based TOD is expected to bring about the most significant impacts on both transport and urban development in Yangon. Mobility and accessibility will be enhanced and efficient and effective landuse will be promoted and opportunities for value capture to fund public infrastructure will be created.

12.34 As previously described, assessment on the characteristics and roles of each station is the first step to identify the potential of TOD. Table 12.2.2 summarizes the evaluation of the accessibility, land availability and potential for TOD. It also categorizes the station type since elements to be included in the intermodal facility at the station vary according to the station type.

12.35 In general, locational character of urban railway falls into two major categories; urban or suburban/ neighborhood. In each category, certain stations are expected to play a central rolls based on their urban or neighborhood context. Such stations of urban or neighborhood center are the stations with high potential for TOD; i.e. required for both transport and integrated urban development. While passengers of urban center type station include office workers, tourists, local residents and business owners etc., passengers of neighborhood center type station are mostly local residents. Therefore, the facilities expected to be developed in the station area vary as shown in Table 12.2.1.

12.36 For the successful TOD, establishment of urban clusters based on the stations with high TOD potential listed in Table 12.2.3 is desirable. In order to establish the urban cluster, utilization of the government lands is necessary as they occupy the majority of areas in Yangon as shown in Figure 12.2.1. Such utilization allows to improve the efficiency of landuse, accessibility and mobility through TOD to maximize the benefits of upgrading YCR. For the establishment of the urban cluster, future transport network including UMRT also should be considered to induce the multiplier effects in the long run.

Table 12.2.1 TOD by Station Type in Yangon

	Urban Center (e.g. Yangon Central Station)	Neighborhood Center (e.g. Insein, Da Nyin Gone Station.)	Other Station (Urban or Neighborhood)
Transport Development	· Station Plaza with Transfer Facility / Feeder Services · Drop-off/Pick-up Area · Pedestrian Deck/Sidewalk · Car Parking	· Station Plaza with Transfer Facility / Feeder Services · Drop-off/Pick-up Area · Pedestrian Deck/Sidewalk · Park and Ride Facility (mainly motorcycle and bicycle)	· Transfer Facility / Feeder Service · Drop-off/Pick-up Area · Pedestrian Deck/Sidewalk
Urban Development	· Regional serving retail facility (department store etc.) · Office · Hotel, Service apartment · High-end condominium	· Community serving retail facility (supermarket etc.) · Office · Mixed income housing · School (nursing, vocational, language etc.) · Branch office of local municipality (township)	· Mixed income housing · Local retail facility

Source: Study Team

Table 12.2.2 Summary of Existing Conditions of YCR Stations

ID	Station Name	Station Type	Vehicular Access	Station Plaza	Pedestrian Access	Taxi Bay[1]	YBS[2] (No. of Lines)	Land Availability for TOD	Potential for TOD
1	Yangon Central	UC	A	○	A	○	12,36,28,29, 56	A	A
2	Payar Lan	U	D	–	C	–	11,8	C	C
3	Lanmadaw	U	D	–	C	–	–	C	C
4	Pyay Lan	U	D	–	C	○	39,21.27.35	C	C
5	Shan Lan	U	D	–	D	○	59	C	C
6	Ahlone Lan	U	D	–	D	○	59,22	C	C
7	Panhlaing	U	D	–	D	–	30,4,59	C	C
8	Kyee Myint Daing	U	A	–	B	○	75.30,11,22, 41	A	A
9	Hanthawaddy	N	B	–	C	–	11,41	C	C
10	Hledan	N	A	–	B	–	30,11,22,41	C	C
11	Ka Ma Yut	N	A	–	B	–	11	C	C
12	Thirimyaing	N	C	–	B	–	11	C	C
13	Oak Kyin	N	C	–	B	–	22	C	C
14	Thamine	NC	A/B	–	B	–	11	B	A
15	Thamine Myothit	N	C	–	B	○	22,11	C	C
16	Kyaoe Gone	N	C	–	B	–	11.22	C	C
17	Insein	NC	C	○	B	–	39,68,	A	A
18	Ywar Ma	N	E	–	D	–	39	C	C
19	Phawkan	N	E	–	D	–	–	C	C
20	Aung San	N	E	–	D	–	–	C	C
21	Da Nyin Gone	NC	C	–	D	–	17.40, 21, 72, 74	A	A
22	Golf Kwin	N	E	–	D	–	17	A	A
23	Kyite Ka Lae	N	E	–	D	–	41,37,41	A	A
24	Mingalardone Zay	N	E	–	D	–	–	A	B
25	Mingalardone	N	E	–	B	–	42	C	C

ID	Station Name	Station Type	Vehicular Access	Station Plaza	Pedestrian Access	Taxi Bay[1]	YBS[2] (No. of Lines)	Land Availability for TOD	Potential for TOD
26	Wai Bar Gi	N	E	–	B	–	–	A	A
27	Okkalapa	N	E	–	B	–	–	C	C
28	Pa Ywat Sate Gone	NC	E	–	B	–	–	C	C
29	Kyauk Yay Twin	N	E	–	B	–	16,42,18,15,29,19,10	A	B
30	Ta Ta Lay	N	E	–	B	–	64,10	C	C
31	Yaegu	N	E	–	D	–	–	A	A
32	Parami	N	E	–	B	–	30,6	C	C
33	Kanbe	N	C	–	A	–	38,12,29	C	C
34	Baukhtaw	N	E	–	B	–	–	C	C
35	Tarmwe	N	E	–	D	–	3,7	C	C
36	Myittar Nyunt	N	E	–	B	–	–	C	C
37	Ma Hlwa Gone	U	E	–	D	–	–	A	A
38	Pa Zun Taung	U	D	–	D	–	–	A	A

1, 2: Located within 200m from the station

Classifications

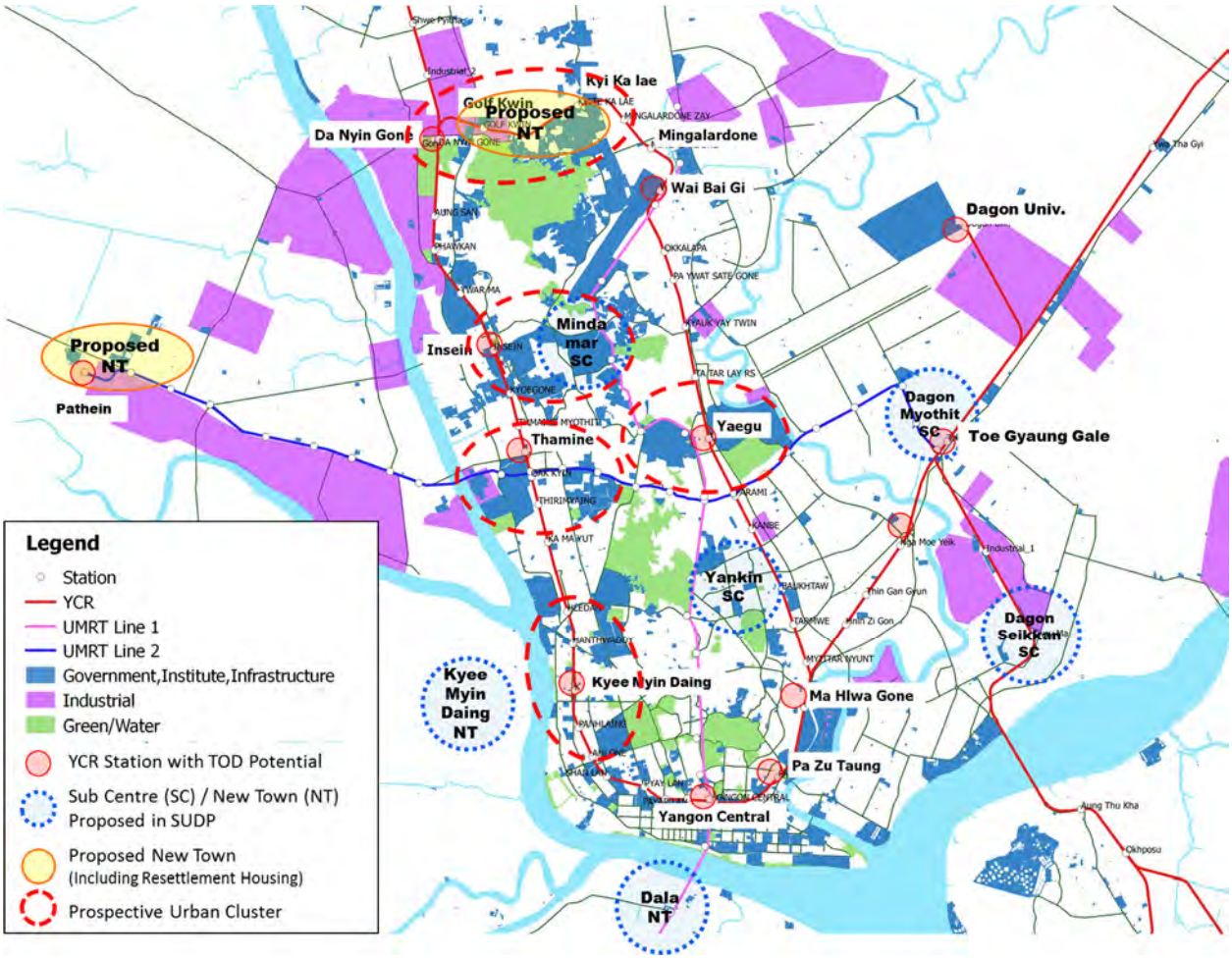
Station Type	
UC (Urban Center)	Located in Central Yangon with proximity to CBD and function of urban hub
U (Urban)	Located in Central Yangon
NC (Neighborhood Center)	Located outskirts of Central Yangon with feeder services and function of transport/community hub (daily boarding passenger >3,000 with feeder services)
N (Neighborhood)	Located in outskirts of Central Yangon
Vehicular Access	
A	Multiple major (and minor) access roads with direct access from both sides of the station
B	Multiple major (and minor) access roads above station (station under ROB) at both sides of the station
C	Single major direct access road at one side of the station
D	Single major access road above station (station under ROB) at one side of the station
E	Single minor access road at one side of the station
Pedestrian Access	
A	Multiple pedestrian access roads with designated sidewalk
B	Multiple pedestrian access roads without designated sidewalk
C	Single pedestrian access road with designated sidewalk
D	Single pedestrian access road without designated sidewalk
Land Availability	
A	Vacant land and/or area fenced off by MR (>2ha) exist in the vicinity of the station
B	Available land can be created by necessary urban redevelopment (e.g. improvement on the existing wet market)
C	No or limited land is available in the vicinity of the station
TOD Potential	
A	High potential with necessity to be implemented in short to long term
B	Moderate potential with possibility for the necessity of implementation in accordance with TOD at the categorized A stations
C	Low potential

Source: Basic Design Study on the Yangon Circular Railway Line Upgrading Project (Civil Work), Study Team

Table 12.2.3 YCR Stations with High Potential for TOD

Station Name	Approx. Available Land(ha)	Implementation Term	TOD Opportunity	Needs for Improvements on Accessibility
Yangon Central	26	Short	・ Establishment of a gateway for CBD ・ Consolidated government land (approx.. 26ha)	・ Enhancement on connection with CBD ・ (e.g. Shuttle bus service, additional sidewalk signage etc.)
Kyee Myint Daing	10	Long	・ Conservation of historic station building ・ Redevelopment of fenced off area by MR (total: approx. 5ha) ・ Redevelopment of informal settlement adjacent to the station	・ Construction of secured sidewalk ・ Replacement of footbridge ・ Control on on-street parking ・ Construction of station plaza including sufficient space for transfer to YBS and taxi
Thamine	11	Mid	・ Redevelopment of existing wet market ・ Junction point of N-S/E-W connection (potential gateway from/to Hlaingtaryar Township)	・ Construction of secured sidewalk ・ Replacement of footbridge ・ Control on on-street parking ・ Construction of station plaza including sufficient space for transfer to YBS and taxi ・ Relocation of existing wet market
Insein	90	Mid-Long	・ Establishment of new sub-center ・ Redevelopment of fenced off area by MR (approx. 26 ha), Insein Jail (approx..36ha) and adjacent vacant land ・ Junction of N-S and E-W axis (potential gateway from/to Hlaingtaryar Township)	・ Reconstruction of station plaza including relocation of YBS stations ・ Construction of secured sidewalk ・ Replacement of footbridge ・ Utilization of underused space of stadium for additional YBS station (along Baho road)
Da Nyin Gone	40	Short	・ Redevelopment of existing wet market ・ On-going PPP development on west side of the station ・ Consolidated government land (approx.. 40 ha; excluding the area for PPP development)	・ Construction of secured sidewalk and pedestrian bridge ・ Construction of station plaza including sufficient space for transfer to YBS and taxi ・ Relocation of existing wet market
Golf Kwin	233	Short-Mid	・ Consolidated government land mostly vacant for New Town Development	・ Construction of secured sidewalk and pedestrian bridge ・ Construction of station plaza
Kyite Ka Lae		Short-Mid Short		
Wai Bar Gi	10	Long	・ Proximity to regional bus station and airport ・ Vacant land adjacent to the station	・ Establishment of feeder service route connecting to regional bus station and airport (e.g. shuttle bus service) ・ Construction of secured sidewalk and pedestrian bridge ・ Construction of station plaza
Yaegu	91	Long	・ Consolidated government land (approx. 75 ha) ・ New junction of N-S and E-W axis (potential gateway to/from South Okkalapa and Thingangyun Township)	・ Construction of secured sidewalk and pedestrian bridge ・ Construction of station plaza
Ma Hlwa Gone	136	Long	・ Consolidated government land (approx. 75 ha) and fenced off area by MR (approx. 61 ha) ・ Integration with water transport and water front development	・ Construction of secured sidewalk and pedestrian bridge ・ Construction of station plaza ・ Enhancement on connection with waterfront area and water transport ・ (e.g. Shuttle bus service, sidewalk signage etc.)
Pa Zun Taung				

Source: Study Team



Source: Study Team

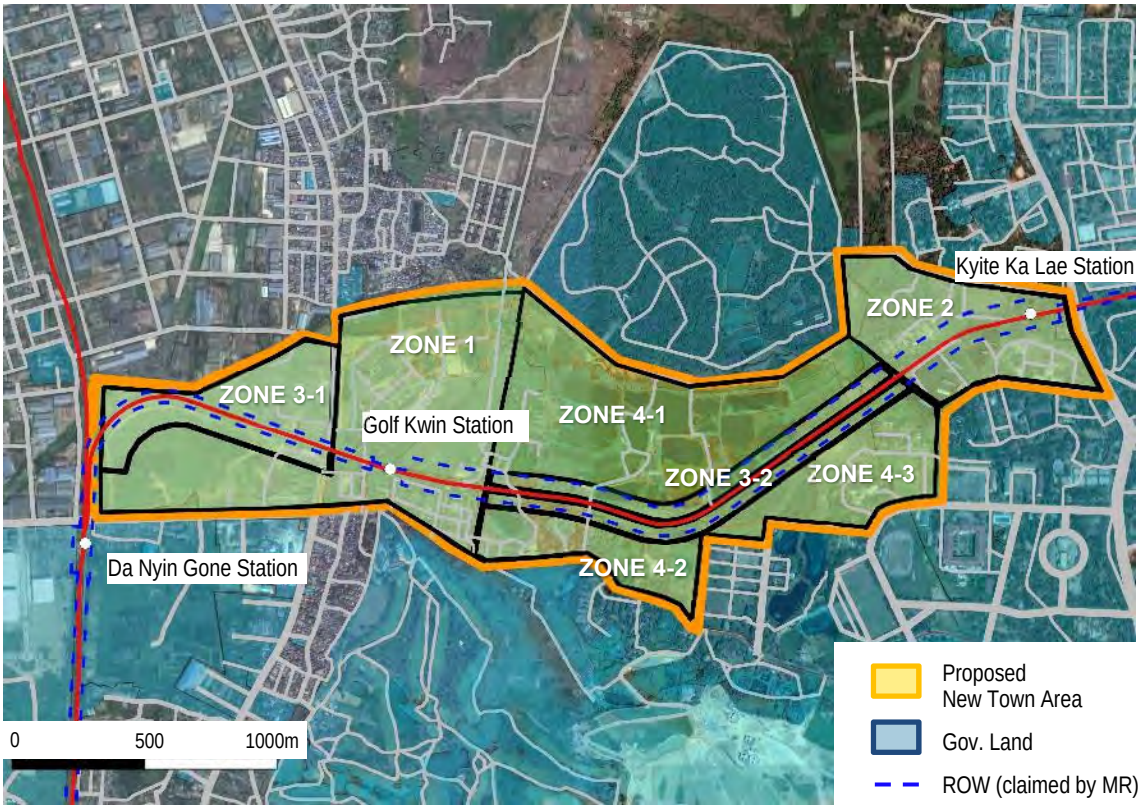
Figure 12.2.1 Potential Areas for Integrated Development

3) Selected Areas for Preliminary TOD Concept Planning

(a) New Town Development on the north of YCR

12.37 From the perspective of optimal value capture by the public sector through integrated development, it is critical to commence the integrated development along urban railway by utilizing the government land as shown in Figure 12.2.1 from the early stage prior to the escalation of land value. Such strategic integrated development provides the solution not only for the resettlement but also other social issues such as insufficient numbers of low income housing for the numbers of informal settlers. Also, optimal value capture at the early stage of the urban railway development allows to expand the areas of integrated development to induce private investment and ensure the sustainable management of the city.

12.38 As Figure 12.2.1 illustrates, New Town Development has been proposed along north section of YCR. The proposed area is located in Insein and Mingaradon Township and mostly vacant or relatively small farmland. According to the township office, proposed site is owned by the government such as army and Ministry of Industry as shown in Figure 12.2.2.



Source: Study Team

Figure 12.2.2 Proposed New Town Area along YCR

12.39 Due to the size of the area (Approximately 233 hectare), phased planning needs to be considered. As Figure 12.2.2 illustrates, first phase should be focused on the areas around the stations and adjacent to YCR (Zone 1, 2 and 3).

12.40 Since YCDC has not formulate the draft of zoning in this area, designation of zoning code as well as formulation of landuse plan will be necessary to control the density of the development and secure the sufficient open space and public facilities. Cost sharing with private sector for the construction of necessary public infrastructure as well as consideration for social and environmental aspects should be stipulated in zoning code and design guideline.

12.41 New town development in the government owned land includes tremendous opportunity to integrate low-income housing. Mix of various types of residence would expand the opportunity to solve not only the resettlement issue due to the establishment of the urban corridor along YCR but also informal settlement becoming a significant issue in Yangon. For example, approximately 8,500 low-income housing units (assuming 50 square meters per unit) can be accommodated in Zone 3-1 and Zone 3-2 in accordance with the zoning code shown in Table 12.2.4.

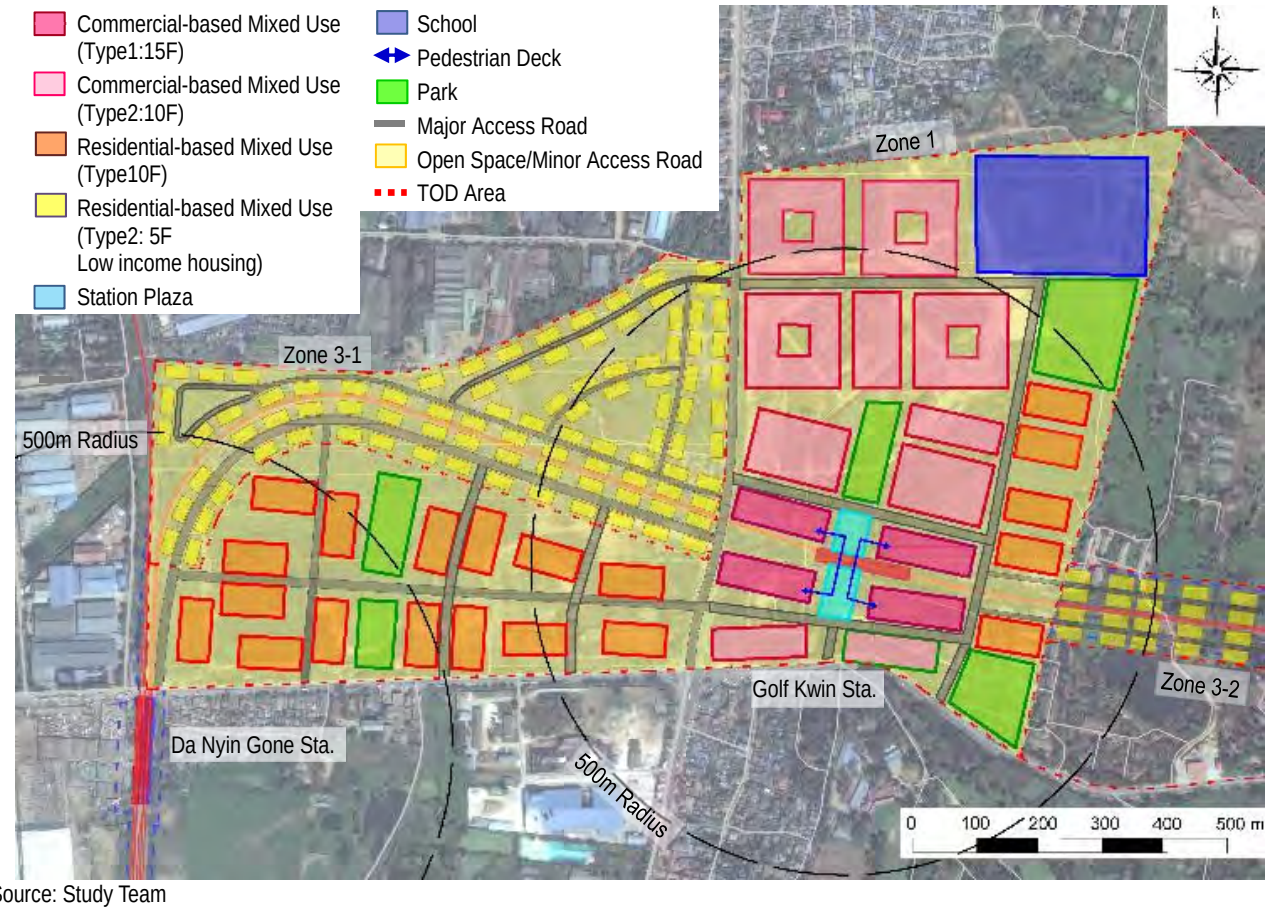
12.42 If the units in other zones are sold at market price, these low-income housing can be sold at affordable price (10 million Kyat; about 7,300 USD) and still certain revenue (approximate 1,273 million USD) is expected[3] from Phase 1 to proceed TOD in Phase 2 (Zone 4) and other areas.

[3] Under the condition that all government land is available without any land acquisition cost or cost for resettlement

Table 12.2.4 Example of Site-Specific Zoning Code, Cost, and Revenue (tentative)

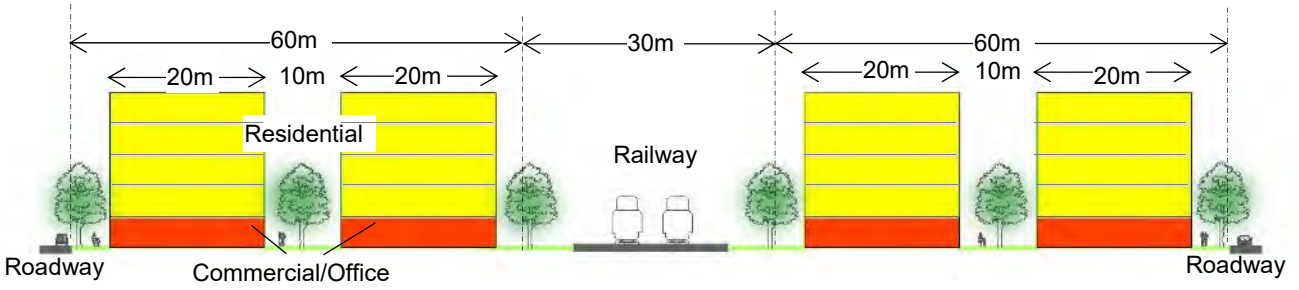
Phase	Zone	Area	Land Use	BCR	FAR	Max. Building Height	Preliminarily Construction Cost (Million USD)	Sales Revenue (Million USD)
Phase1	Zone 1	72ha	Residential (middle-income) Commercial, Office Park (Min. 6 ha in total) Station Plaza (Min. 1ha) School (Primary and Middle School; Min. 5ha) Road	0.5	5.0	45m	1756	2960
	Zone 2	27ha	Residential (middle-income) Commercial, Office Park (Min. 3 ha in total) School (Primary and Middle School; Min. 3ha) Road	0.5	5.0	45m	580	805
	Zone 3	44ha	Residential (low-income) Commercial, Office (SOHO etc.)	0.4	2.0	20m	292	136
Phase2	Zone 4	90ha	Residential (high-income) Commercial, Office Park (Min. 6 ha in total) School (Primary and Middle School; Min. 5ha) Road	0.5	5.0	45m	TBD	TBD

Source: Study Team



Source: Study Team

Figure 12.2.3 Example of Land Use Plan for Zone 1 and Zone 3-1 (tentative)



Source: Study Team

Figure 12.2.4 Example of Section of Zone 3-2 (tentative)

(b) Da Nyin Gone Station

12.43 Since land availability is the essential factor to implement TOD, strategic and practical approach for TOD is to acquire the lands that are currently open or underused around the station and consolidate them to increase the value of the property. Since suburban area generally has many available lands in relatively low price, consolidation of lands for TOD includes significant potential for the value capture.

12.44 Da Nyin Gone Station explicitly highlights this fact from both positive and negative aspects. As Table 12.3.5 shows, currently the station has the second largest number of passengers next to Yangon Central Station and it is expected to be more than 6 times in 2035.

Table 12.2.5 Current and Forecast of Passengers at Da Nyin Gone Station

2014	2025	2035	2035/14
5500	14900	33400	6.1

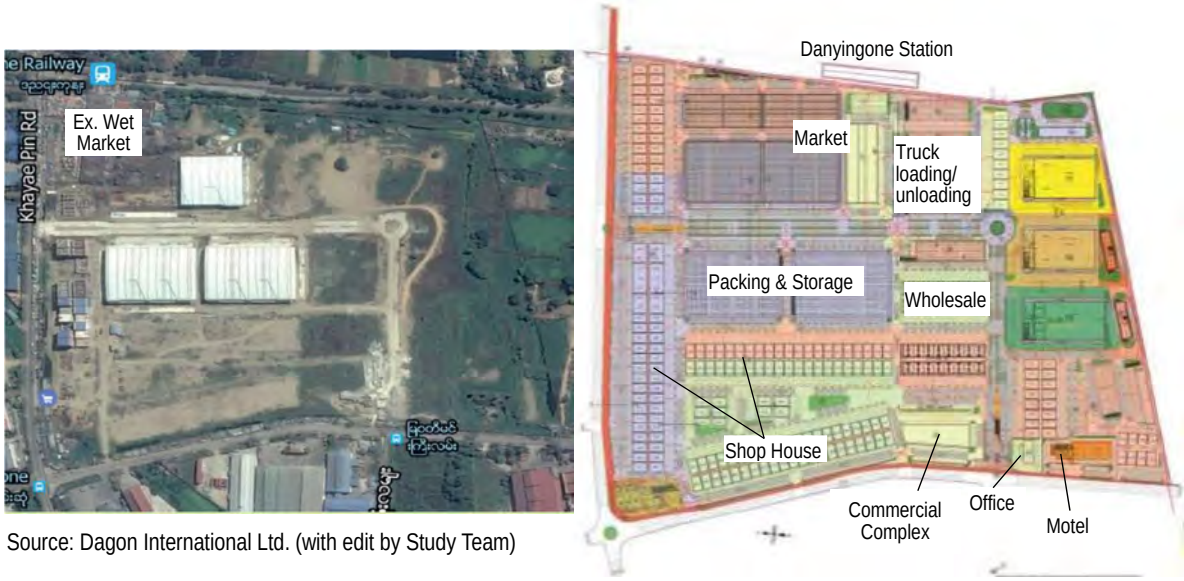
Source: Study Team

12.45 Due to the significant potential growth in the neighborhood and current land availability, the property owned by YCDC located west side of the station has been developed by the partnership with Dagon International Ltd. through Public-Private Partnership (PPP) as shown in Figure 12.2.6. Since this project includes the relocation of the existing wet market and construction of the new market, market department at YCDC is in charge. Due to the limited coordination with urban planning department, unfortunately this project has not been planned from the point of view of TOD. As Figure 12.2.6 shows, station plaza is not included and the commercial facility and motel are proposed at the farthest location from the station.

12.46 Currently five YBS bus routes include Da Nyin Gone Station. Considering the current number of YBS buses as well as passengers in 2035, approximately at least 1 hectare of station plaza will be required[4] for smooth transfer to the feeder services (bus, taxi etc.), the catchment area of the passenger during the peak hours, as well as the rest and social interaction.

12.47 In this type of PPP, the public side should control the private sector to maximize the benefits by the project based on the consideration for the social, economic and environmental aspects. For example, there surely is the possibility to construct the station plaza and pedestrian deck by the public fund if the large scale commercial facilities are allowed to be located in front of the station with the direct access to/ from the station. Inclusion of the development of the necessary transport facility by private fund in return for the provision of the development rights in the premier location is the popular PPP strategy adopted in various countries.

[4] According to the Japanese standard equation for station plaza area estimation (1953 Method).



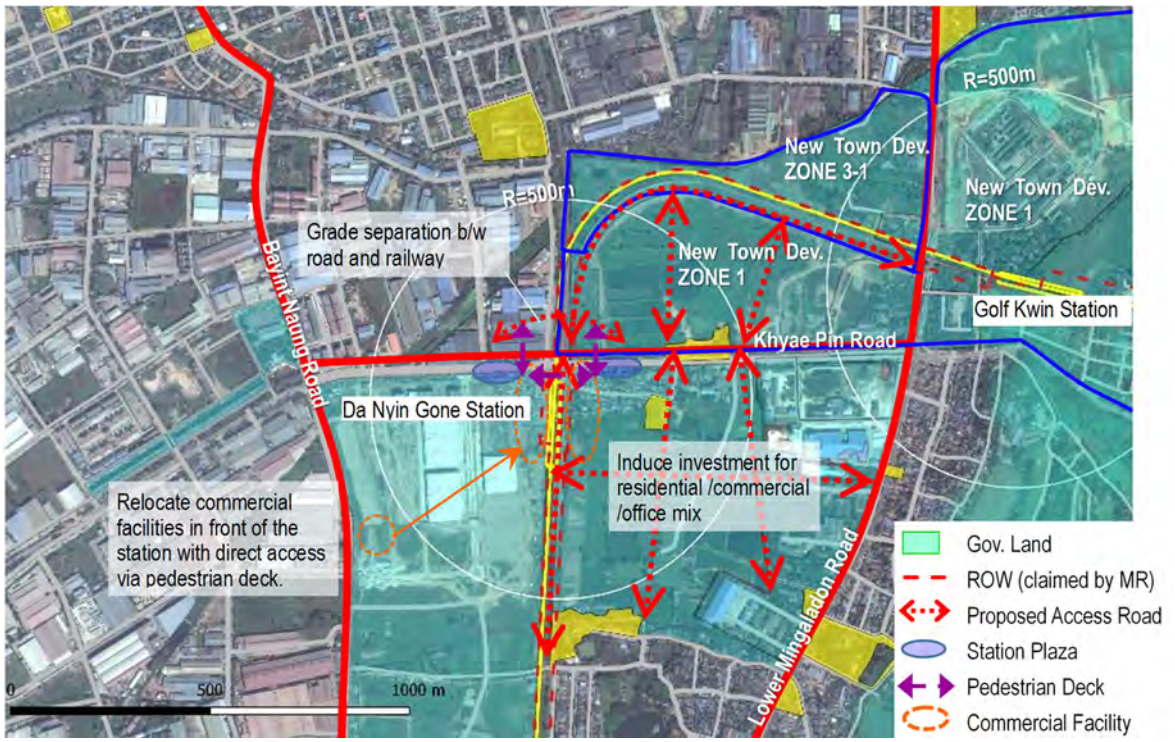
Source: Dagon International Ltd. (with edit by Study Team)

Figure 12.2.5 Current Construction Status (Dec. 2016; left) and Site Plan (right) for Danyingone Fruits, Vegetables, and Flowers Wholesale Market

12.48 Currently a part of construction for this PPP project has been suspended since Chief Minister pointed out the lack of consideration for YCR and directed to cancel the construction of several buildings located along YCR. Therefore, it is desirable to revise the plan based on the consideration for the TOD including east side of the station as well as New Town Development previously described.

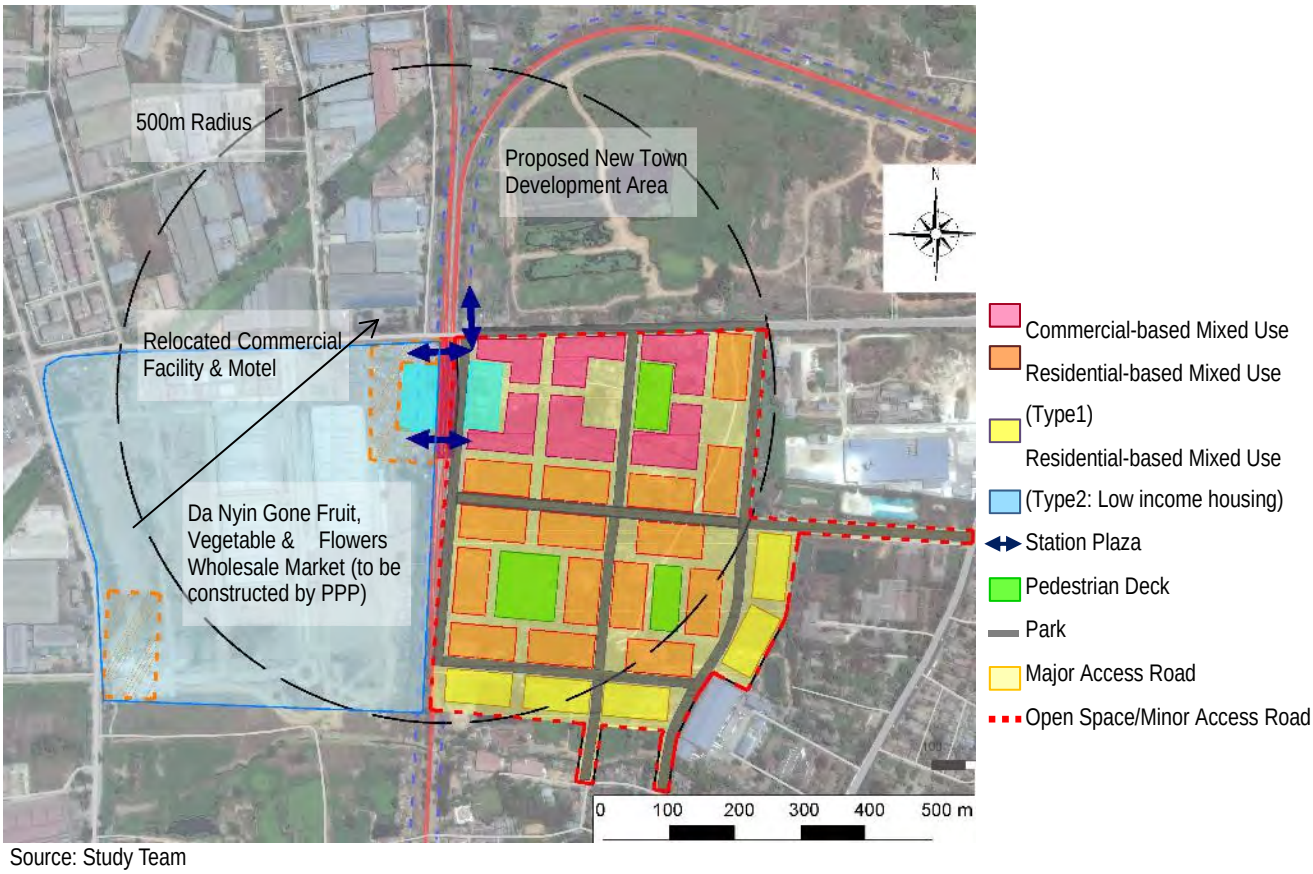
12.49 Similar to the proposed New Town Area, zoning code should be prepared by project basis as YCDC has not drafted the zoning code for this area yet. Through the promotion of mixed use development by mid-rise buildings (10-15 stories), efficient land use will be implemented with relatively low building coverage ratio (BCR) and floor area ratio (FAR). According to the example of land use plan shown in Figure 12.2.8, approximate 9,000 household can accommodate including 1,400 low-income housings under FAR 5.0 and BCR 0.5.

12.50 Consolidation of the property based on the coordination among various owners of the government properties allows inclusion of not only low-income housing but also public infrastructures such parks and pedestrian decks by private fund through PPP. Consolidation of government properties allows to implement the large-scale integrated development by PPP, which enables to require the development of necessary social infrastructure in return for the provision of the development rights. Table 12.2.6 summarizes the preliminary estimate of construction cost and the maximum revenue based on the example of land use plan shown in Figure 12.2.8.



Source: Study Team

Figure 12.2.6 TOD Concept Plan at Da Nyin Gone Station Area



Source: Study Team

Figure 12.2.7 Example of Land Use Plan for TOD at Da Nyin Gone Station Area

Table 12.2.6 Tentative List of Proposed TOD at Da Nyin Gone Station Area

TOD Project	Area (ha)
Commercial-based Mixed Use (15F)	4.0 ha
Residential-based Mixed Use (Type 1, 10F)	7.5 ha
Residential-based Mixed Use (Type 2: Low Income Housing, 5F))	2.5 ha
Station Plaza	0.5 ha
Park	2.2 ha
Urban Plaza	1.1 ha
Open Space	2.9 ha
Major Access Road	6.4 ha
Minor Access Road	2.9 ha
Total TOD Area	30 ha
BCR (Building Coverage Ratio)	0.47
FAR (Floor Area Ratio)	4.92
Construction Cost (Preliminary, Tentative)	593 million USD
Maximum Sales Revenue (Preliminary, Tentative)	778 million USD

Source: Study Team

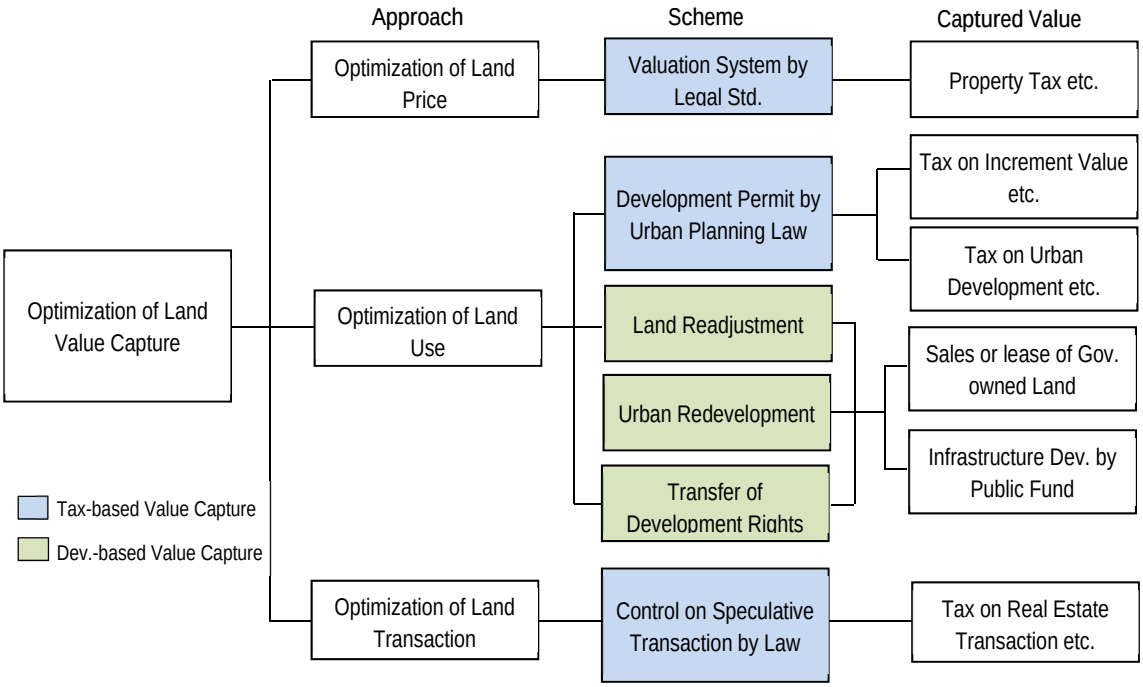
4) Value Capture by TOD

12.51 Timely and appropriate value capture by the relevant governmental agencies is critical for the implementation of TOD. While private developers are good at capturing the value to maximize their capital gain (profit generated by the increase in their property value), many governmental agencies fail to generate the capital gain from the governmental properties as well as to tax the capital gain by the private developers.

12.52 Potential value capture by the governmental agencies are divided into 2 types; 1. Tax-based value capture and 2. Development-based value capture. In Yangon, valuations for property tax and transaction tax are different. While valuation of property tax is extremely low[5], valuation of transaction tax is relatively close to the market value. However, it induces many real estate firms to sell and buy their properties internally without official registration and causes difficulty for the government to collect the transaction tax.

12.53 Optimization of land transaction, land price and landuse are the necessary approach to capture the value by TOD through both taxation and urban development. While certain legal framework and standard need to be established together with the relevant capacity enhancement to capture the value through taxation as shown in Figure 12.2.9, development based value capture can be implemented by the designation of TOD Planning Area and application of specific zoning code and development permit for the TOD Planning Area. Since it will take some time to establish the legal framework, it is more feasible to proceed the development based value capture and reflect its lesson learnt on the establishment of the legal framework for the implementation of tax-based value capture.

[5] According to the report by Renaissance Institute Myanmar (published in September 2017), average of property tax payment in Yangon is 203 MMK, which is less than the average cost of a cup of tea (350 MMK, about 0.26 USD).



Source: Land value and urban planning, Gakugei Publisher, 1983 (edited by Study Team)

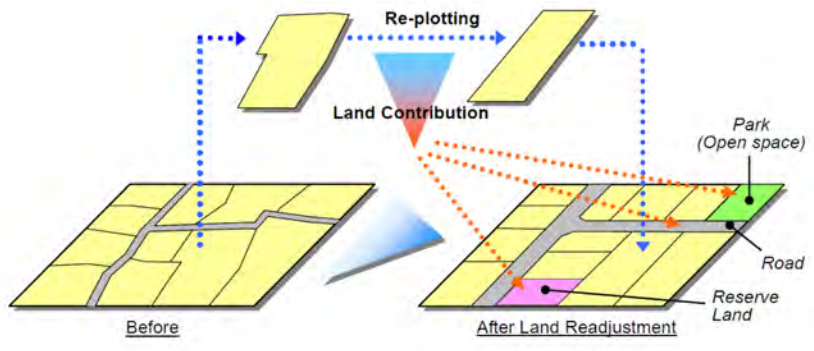
Figure 12.2.8 Optimal Approach for Land Value Capture

(a) Land Readjustment

12.54 In order to increase the value of the property through optimization of land use, consolidation of land with sufficient infrastructure such as roads and open spaces/ parks is fundamental.

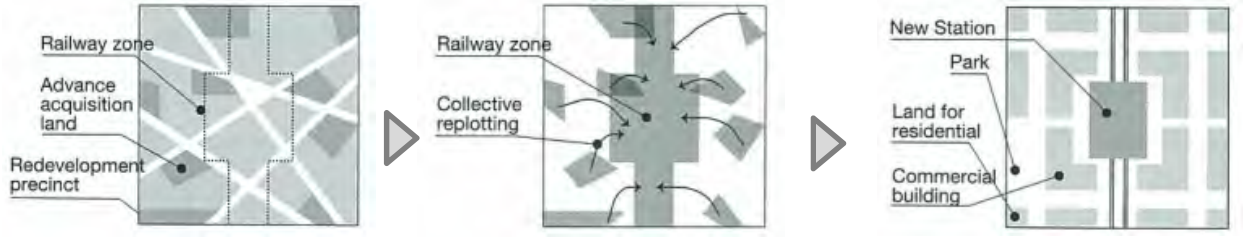
12.55 Land Readjustment (LR) is an integrated urban development measure including land re-plotting and infrastructure construction as shown in Figure 12.2.10. Cost of infrastructure development will be covered by the sales of reserved rand secured by land replotting. LR is a well-known urban development measure in Japan and the same or similar system is adapted in more than ten countries such as Thailand, India, Indonesia, Germany, Turkey and Nepal. While land owners in the LR site can maintain their property rights after the project, size of the property will be reduced due to the land contribution for the improvement on the plotting and infrastructure. Therefore, LR should be implemented based on the participation of the land owners and their consensus building.

12.56 Although the size of the property will be reduced, total value of the property will be increased due to the raise in the unit price of the property.



Source: Study Team

Figure 12.2.9 Land Readjustment Scheme



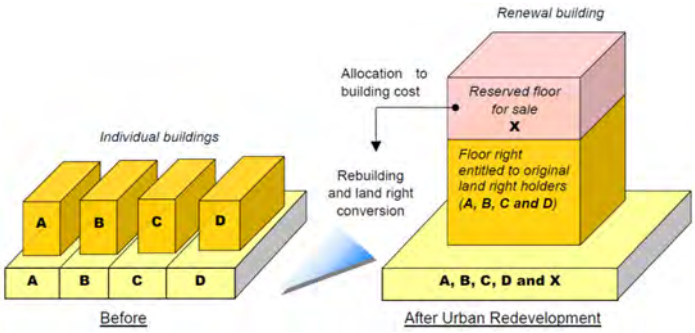
(i) Land acquisition in advance around the station area (ii) Collective replotting (iii) Development of station and intermodal facilities

Source: Study Team

Figure 12.2.10 Collective Land Re-plotting for Development of Station and Intermodal Facilities

(b) Urban Redevelopment

12.57 Urban Redevelopment (UR) is one of the development based value capture measures based on the land use right conversion system. This measure is used to consolidate the multiple lands with the individual owners to single property to construct new large-scale buildings with multi-family housing where existing owners can resettle as shown in Figure 12.2.12. Original land use right holders secure their land use right during the project implementation period, and their land use rights will be distributed to sectional ownerships of the new building. There is also a self-finance system to secure reserved floor for sale to cover the construction cost.

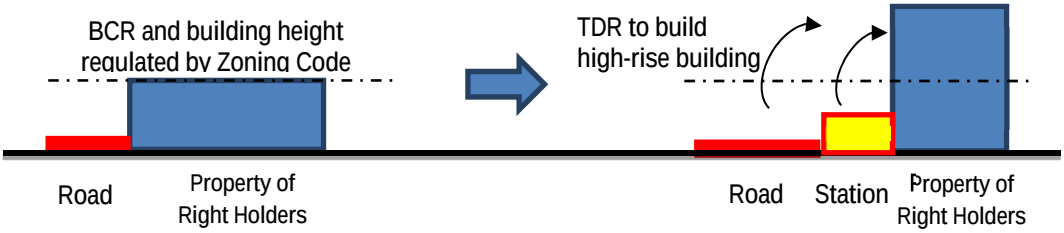


Source: Study Team

Figure 12.2.11 Urban Redevelopment Scheme

(c) Transfer of Development Rights

12.58 Transfer of Development Rights (TDR) is an incentive scheme that allows landowners to sell development rights of their land to a private developer or other interested party who can use these rights to increase the density of their development. Utilization of TDR allows to recover public transport infrastructure development cost by selling the development rights to the developer of the areas adjacent to the public transport. It also promotes TOD through the enhancement on efficiency and effectiveness of land use as shown in Figure 12.2.12.



Source: Study Team

Figure 12.2.12 Concept of Transfer of Development Rights

(d) Roadmap for Development-based Value Capture

12.59 Commencement of the integrated development along urban railway corridor from the early stage prior to the escalation of land value by utilizing the government land is critical in order to capture the value by the transport development,. Since the utilization of the government land is the simplest way to implement TOD in the most financially economical manner comparing the other schemes, it is important to start with the area mostly owned by the government.

12.60 Due to the least land acquisition cost, TOD in government property has better chance to generate revenue. The revenue can be utilized to proceed the TOD as shown in Figure 12.2.13. Therefore, TOD along YCR should start with the north as the land is mostly underused and owned by the government.

Source: World Bank, Financing Transit-Oriented-Development with Land Values, edited by JICA Study Team

Figure 12.2.13 Roadmap for Development-based Value Capture

Table 12.2.7 TOD Roadmap for Establishment of Urban Railway Corridor in Yangon

	Development	Area (ha)	Key Methods/Scheme
Short Term	New Town Development on North of YCR (Phase1: Zone 1-3)	143	Utilization of Gov. Land
	Da Nyin Gone Station Area	40	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment
	Yangon Central Station Area	26	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment, Air Right Transfer
Mid-term	New Town Development on North of YCR (Phase2: Zone 4)	90	Utilization of Gov. Land
	Insein Station Area (Phase 1)	76	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment
	Yaegu Station Area	91	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment
	Thamine Station Area	11	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment Redevelopment of Food Market
	Phathein Station Area and New Town Development (UMRT 2)	20	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment
Long-term	Kyeemyingdaing Station Area	10	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment Conservation of Historic Architecture (Station Building)
	Wai Bai Gi Station Area	10	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment
	Ma Hlwa Gone-Pa Zun Taung	196	Utilization of Gov. Land, Land Readjustment, Urban Redevelopment, Air Right Transfer
	Insein Station Area (Phase 2)	70	Utilization of Gov. Land (Redevelopment of Insein Jail)
	Station Area for other UMRT	TBD	

Source: Study Team

12.61 Value can be captured not only from the increment of the land value but also from the contribution by developers for the necessary public infrastructure as shown in Figure 12.2.14. There are several mechanism by which developers contribute directly to the provision of the necessary public infrastructure, including:

(i) **Development Impact Fee:** A one-time fee assessed on new development to offset the cost of infrastructure needs generated by a development

(ii) **Negotiated Development Contributions:** Direct provision of or payment for improvements on the public infrastructure by a developer in conjunction with a development

(iii) **Density Bonus Program:** A zoning tool that allows developers to build a higher density or height in exchange for provision of specific community benefits

12.62 Since public facilities require operation and maintenance, PPP scheme also should be considered. Build-Operate-Transfer (BOT) agreements allow the private sector to finance, design, build and operate investments on government land for a fixed term and commonly adopted under the previous government. While tendering process was previously overseen by the Myanmar Investment Commission (MIC) and President's Office, the process under the current government remains unclear and new BOT deals appear to have not signed as of late 2016.

12.63 Myanmar still lacks a privatisation law to regulate tenders of government land and buildings, and many aspects of the BOT tender process are not in line with international standards. Therefore, developers and investors have previously called for reforms to the tendering process since in many cases little or no guidance is offered regarding the type of development required, or the zoning regulations for the site.[6]

12.64 Considering the current conditions of PPP, formulation and enforcement of the detailed zoning code and design guideline by each project basis to fill the gap of legal and institutional framework is critical to implement the TOD roadmap in Yangon shown in Table 12.2.7.

[6] Frontier Myanmar, *Q4 2016 Yangon Real Estate Review*, Myanmar Real Estate & Construction Monitor

5) Institutional Arrangement for TOD Implementation

12.65 In order to commence TOD at the site owned by the government, certain coordination is required as the government properties are usually owned by various agencies. Therefore, it is desirable to establish a TOD Committee not only to consolidate the government land but also to designate the TOD Planning Area and formulate the necessary zoning and development code as well as design guideline for TOD implementation in Yangon.

12.66 TOD Committee members should include the property owner(s), stakeholders of urban development in terms of planning, construction and finance from both public and private sector as shown in Table 12.2.8. TOD Committee is supposed to lead the discussion with the owners of freehold land to reach the agreement for the temporal or permanent resettlement.

12.67 Since many relevant department of YCDC are involved in TOD Committee, YCDC is expected to play a central role as an intermediary body to link government agencies and local communities. In particular, strong initiative of YCDC will be required to consolidate the government land owned by the various agencies as well as to formulate the site-specific land use plan and zoning code for the implementation of TOD.

12.68 TOD Committee also should establish an operation and management system for each TOD. Necessary organizations are supposed to be formed such as Area Management Committee based on the participatory planning process with all relevant stakeholders from both private and public sectors.

Table 12.2.8 Major Members of TOD Committee

Ministry/ Agency	Department/ Commission /Institution	Current Role
Ministry and/or agency that owns the site(s) in TOD Planning Area		・ Manage the tender of BOT
Ministry of Construction (MOC)	Department of Urban and Housing Development (DUHD)	・ Support local governments for implementing urban regional policies and plans. ・ Planning and implementation of low income housing
	Department of Building Administration	・ Construction of public project (in response to the request with the budget from other department)
	Construction and Housing Development Bank (CHDB)	・ Provide mortgage-type of loans and finance for the developers of low-cost and affordable housing.
Ministry of Planning and Finance	Myanmar Investment Commission (MIC)	・ Manage and enforce the laws relevant to investment including PPP ・ Evaluate economic and business proposals that require government involvement
Ministry of Development Affairs (Mayor of YCDC)	City Planning and Land Administration Department	・ Formulate urban planning and regulatory codes for YCDC area.
	Engineering Department (Building)	・ Formulate building code and issue construction permit in YCDC area.
	Engineering Department (Roads & Bridges)	・ Planning and construction of roads and bridges in YCDC area
	Engineering department (Water & Sanitation)	・ Planning and construction of water and sanitation in YCDC area
	Market Department	・ Planning and construction market in YCDC area
Myanmar Railways		・ Operate railways in Myanmar
Myanmar Construction Entrepreneurs Association (MCEA; private association)		・ Planning and construction of new towns, low income housing, industrial zones etc. through the collaboration with the government.
Owner(s) of freehold land (if any) in TOD Planning Area		・ N/A

Source: Study Team

6) Proposed Actions

12.69 As previously described, both formulation of TOD plan including necessary land use plan, zoning code, and design guideline as well as institutional arrangement to implement the prepared plan are necessary to implement TOD in Yangon. Establishment of TOD Committee is the first step for the implementation and opportunities for the private investment should be studied by the initiative of TOD Committee. Based on the results of the study, pilot TOD can be commenced within 2 to 3 years. Potential candidates of the pilot TOD are 1. New town development on north of YCR and 2. Da Nyin Gone station area development shown in Table 12.2.7 as the short term projects.

12.70 As Table 12.2.9 shows, TOD project components include both planning and establishment of institutional and legal framework. For the successful implementation of TOD, both aspects need to be conducted simultaneously. Relevant capacity development and enhancement should also be conducted on-the-job (OJT) training basis through the planning and establishment of institutional and legal framework.

Table 12.2.9 Project Components of TOD in Yangon

Major Components	Project Components
TOD along Urban Railway	・ Integrated urban/suburban development at/around the stations ・ Access improvement especially within a walking distance from the stations ・ Development of intermodal facilities at the stations (introduction of transfer facility, integration with regional bus terminal etc.) ・ New town development ・ Integrated water transport and water front development ・ Utilization of the underground space at subway stations ・ Utilization of the space under viaduct
Implementation Framework	・ Establishment of TOD Committee ・ Establishment of operation and management system for TOD ・ Establishment of financial schemes for TOD
Legal Framework	・ Formulation of relevant laws and regulations for BOT, land adjustment, urban redevelopment, air-right transfer, appropriate valuation system, development permit and control on speculative real estate transaction ・ Clarification on collective land ownership for BOT projects built on government land (Amendment on Condominium Law)

Source: Study Team

13 PROPOSED TRANSPORT SECTOR PROJECTS

13.1 Proposed Transport Projects

1) List of Identified Projects

13.1 In order to implement the transport development strategies discussed in previous chapters and realize the desired future transport network, the Study Team and counterpart agencies have identified a total of 101 projects and actions under 10 subsectors and 34 categories (see Table 13.1.1). The subsectors are briefly described below, while project profiles are shown in Technical Report Vol. 6 Project Profiles.

(a) **Roads**: The roads subsector is composed of 24 projects on minor improvement/maintenance, rehabilitation, bottleneck removal, completion of missing road links, and construction of flyovers/underpasses, secondary roads, primary roads, new bridges, and outer ring roads.

(b) **Expressways**: The expressways subsector is composed of 11 projects on intercity and urban expressways.

(c) **Public Transport**: The public transport subsector is composed of 8 projects on bus transport modernization and BRT development.

(d) **Traffic Management and Safety**: The traffic management and safety subsector is composed of 16 projects on road vehicle management, traffic enforcement, traffic engineering, traffic safety education, parking management, traffic control, and traffic demand management.

(e) **Urban and Suburban Railway:** The urban/ suburban rail subsector is composed of 12 projects on circular rail, suburban commuter rail, and new lines.

(f) **Inland Water Transport:** The inland water transport subsector is composed of 7 projects on upgrading of existing services and the development of new routes.

(g) **Logistics:** The logistics subsector is composed of 4 projects on the upgrading of existing facilities, relocation, and new development.

(h) **Information and Communications Technology:** The ICT subsector is composed of 7 projects on the expansion of ICT for the YRTA and the expansion of ICT for public transport operators.

(i) **Transit-oriented Development:** The TOD subsector is composed of 4 projects on TOD on circular rail and TOD on other lines.

(j) **Institutions:** The institutions subsector is composed of 8 projects on strengthening of the YRTA, capacity building in public transport operation, ROW acquisition and resettlement, and TOD promotion.

Table 13.1.1 Preliminary List and Costs of Proposed Transport Sector Projects

Sector	Category	Code		Project Name	Cost (million USD)	Cost to Government (%)	Term [1), 2)]		
							S (17-20)	M (21-25)	L (26-35)
Roads	Minor Improvement/ Maintenance	R-01		Urban roads and bridges maintenance program	496	100	■	■	
	Rehabilitation	R-02		Rehabilitation program for priority roads and bridges (Hlaw Ga Rd, Hlaing River Rd, Main Rd No.5, No.6, etc.)	243	100	■		
	Improvement of Intersection	R-03		Program on road improvement of bottleneck intersection	32	100	■		
	Road Development in New Urban Area	R-04		Road Development in New Urban Area	2,120	20		■	■
	Bottlenecks Removal	R-05		Program on Removal of Bottlenecks for Major Corridors	107	100	■		
	Missing Link Development	R-06	1	Program to construct secondary roads in existing urban areas	79	100	■	■	■
			2	Program on road widening in urban blocks (5 packages)	356	100	■		
	Pedestrian Safety Facility	R-07		Pedestrian bridges, pedestrian crossing signals, wide sidewalk, relocation of electric poles, etc.	238	100	■	■	
	Primary Roads Development	R-08	1	Construction of new truck route	197	100	■		
			2	Wataya Br South Approach			■		
			3	Min Ye Kyaw Swar Rd/Yarzaa Dirit Rd				■	
			4	Kyi Myin Dine Br & ORR connection				■	
			5	Dala Br & ORR connection				■	
			6	Bago River Br -2 and Thanlyin Connection				■	
	New Bridges	R-09	1	New Thaketa Bridge	1,085	100		■	
			2	New Bago Bridge			■	■	
			3	Dala Bridge			■	■	
			4	Wataya Bridge			■		
			5	Kyi Myin Dine Bridge				■	
			6	Bago River Bridge 2 for Bago or Monkey Point				■	
	Outer Ring Road	R-10	1	East Section (Phase 1)	728	90		■	
			2	East Section (Phase 2)	1,948	90		■	■
			3	South-West Section	590	90		■	■
			4	North-West Section	870	90		■	■
	Subtotal				9,089	80		■	■
Expressway	Intercity Expressway	R-11	1	Yangon – Bago – Hanthawaddy New Airport	930	30		■	
			2	Yangon - Pyay	1,160	30		■	■
			3	Yangon - Thilawa	1,310	45		■	■
			4	Yangon – Hlegu	511	30		■	■
			5	Yangon - Pathein	511	30		■	
	Urban Expressway	R-12	1	North-South Backbone (Western Axis: Insein-CBD-Dala)	1,261	30		■	
			2	North-South Backbone (Eastern Axis: Mindamar-CBD)	1,333	30		■	
			3	Access to Yangon-Mandalay Expressway	536	45		■	
			4	Pazundaung Bypass	422	30		■	
			5	East-West Smart Tunnel (North)	819	50			■
			6	East-West Smart Tunnel (South)	897	50			■
	Subtotal				9,690	40			■
Public Transport	Bus Transport Modernization	P-01	1	Bus Industry Reform/Capacity Building	3	100	■		
			2	Bus Route Restructuring			■		
			3	Bus Fleet Renewal/Maintenance	240	50	■	■	
			4	Bus Terminals/Facilities Improvement	20	80	■	■	
			5	Bus Corridor Traffic Management	20	100	■		
			6	Bus Transport Sector Management (YRTA)	3	100	■		
	BRT Development	P-02	1	BRT under North - South Backbone Western (Kannur Rd - Bayint Naung Rd)	110	50	■	■	
			2	BRT under North - South Backbone Eastern (Waizayandar Rd)	110	50	■	■	
	Subtotal				506	54	■	■	■
Traffic Management and Safety	Road Vehicle Management	M-01	1	Improvement of Vehicle Registration System	10	80	■		
			2	Development of Vehicle Inspection System			■		
	Traffic Enforcement	M-02	1	Establishment of Institutional Framework	5	100	■		
			2	Capacity Building of Traffic Enforcers			■		
	Traffic Engineering	M-03	1	Management of Traffic Control Centre	50	100	■		
			2	Expansion of Traffic Signals for Vehicles and Pedestrians			■		
			3	Improvement of Pedestrian Facilities/ Walking Environment			■		
			4	Provision of Signage and Lane Marking			■		
	Traffic Safety Education	M-04	1	Preparation of Traffic Rules/Regulations	10	100	■		
			2	Traffic Safety Education for School Children			■		
			3	Traffic Safety Campaign for the Public and Communities			■		
	Parking Management	M-05	1	Establishment of Parking Regulations and Enforcement	100	80	■		
			2	Development of Public Parking Facilities			■	■	
	Traffic Demand Management	M-06	1	Introduction of Staggered Working/School Time	50	50	■		
			2	Expansion of Pricing (higher parking fee, fuel, vehicle tax)			■		
			3	Area Licensing Scheme Control (CBD)				■	
	Subtotal				225	80	■	■	■
Urban/Suburban Rail	Circular Rail	L-01	1	Upgrading of Existing Line and Services	350	80	■		
			2	Urgent Service Improvement	3	80	■		
			3	Elevation and Electrification of Circular Rail	1,100	90		■	■
			4	Improvement/Development of Access Transport	100	100	■		
	Suburban Commuter Rail	L-02	1	Yangon-Mandalay Line	1,350	80		■	■
			2	Yangon-Pyay Line	780	80		■	■
			3	Thilawa Branch Line	1,730	80		■	
			4	Outer Circular Rail Line	1,020	90			■

			5	Relocation of Depot / Workshop to Suburban Area and Regeneration of MR Land	540	50			
	New Lines	L-03	1	Development of UMRT Line 1 (North-South)	3,630	90			
			2	Development of UMRT Line 2 (East - West)	2,250	90			
			3	Yangon New Airport Access	1,350	100			
	Subtotal				14,203	90			
Inland Water Transport	Upgrading of Existing Services	W-01	1	Fleet Procurement	10	0			
			2	Facilities Improvement	30	60			
	Development of New Routes	W-02	1	Facilities Development	10	60			
			2	Fleet Procurement (Passenger)	18	0			
			3	Fleet Procurement (Freight)	10	0			
			4	Fleet Procurement (Tourism)	10	0			
	Improvement of Management System	W-03		Strengthening Organization	3	100			
	Subtotal				91	30			
Logistics	Upgrading of Existing Facilities	F-01	1	Upgrading of Public Wholesale Markets	140	10			
			2	Upgrading of Traditional Markets					
	Relocation and New Development	F-02	1	Relocation of Existing Port Function to Thilawa Port	511	60			
			2	Relocation of ICD and Development of New Truck Terminal along ORR	127	50			
	Subtotal				778	50			
ICT	Expansion of ICT for YRTA	C-01	1	Collection and Information of Traffic Data through ICT	5	100			
			2	Development of Bus Operation/Management Information system					
			3	Development of Public Transport User Information System					
	Expansion of ICT for Public Transport Operators	C-02	1	Introduction of Compatible ICT System among Public Transport Operators	50	50			
			2a	Provision of ICT Equipment for Public Transport Vehicles					
			2b	Provision of wifi & Digital Signage at Terminals					
			3	Development of Public Transport User Information System					
	Subtotal				55	50			
TOD	TOD on Circular Rail	T-01	1	Integrated Urban Development at/around the Stations	n.k	0			
			2	Development of Integrated New Town for Resettlement and those who need Affordable Housing					
			3	Effective Use of the Space under the Viaduct					
	TOD on Other Lines	T-02		Integrated Development with New Lines (UMRT)					
	Subtotal				-	-			
Institutions	Strengthening of YRTA	I-01	1	Establishment of Legal and Policy Framework	15	100			
			2	Strengthening of Organization and Staffing					
			3	Capacity Building including Study Tour					
	Capacity Building of Public Transport Operation	I-02	1	Development of Training Manuals/Guideline	3	100			
			2	Conduct of Training					
			3	Conduct of Workshops					
	ROW Acquisition and Resettlement and TOD Promotion	I-03	1	Introduction of "Land Readjustment and Urban Renewal System"	1	100			
			2	Development of PPP Guideline on TOD					
	Subtotal				19	100			

Source: Study Team
1) n.k: Not known

2) Estimated Cost of the Projects

13.2 Based on the preliminarily estimated costs of the projects and on the assumption of a possible participation of the private sector, the cost to the government was calculated. Although the share of the private sector varies by type of transport project and funding scheme, it was estimated that roughly 67% of the total cost would be shouldered by the government or about USD23.7 billion out of the total project cost of USD 34.6 billion.

Table 13.1.2 Estimated Project Costs by Subsector

Sector		Total Project (USD mill)	Cost to Government	
			% to Total	USD mill
Roads	Maintenance/Minor Improvement/ Rehabilitation/ Bottlenecks Removal/ Missing Links Development	1,551	100	1,551
	Flyovers/Underpass/Secondary Roads/ Primary Roads/New Bridges/Outer Ring Road	7,538	72	5,428
Expressway	Intercity Expressway	4,422	34	1,523
	Urban Expressway	5,268	38	2,004
Public Transportation	Bus Transport Modernization	286	57	162
	BRT Development	220	50	110
Traffic Management		225	100	225
Rail	Circular Rail	1,553	88	1372
	Suburban Commuter Rail	5,420	79	4,276
	New Urban Lines	7,230	92	6,642
Inland Waterway Transport		91	30	27
Logistics		778	49	384
ICT		55	55	30
TOD		n.k	n.k	n.k
Institutions		19	100	19
Total		34,656	67	23,707

Source: Study Team
1) n.k.=not known

13.3 The cost to the government is further classified into short, medium, and long term.

Table 13.1.3 Estimated Government Share in Project Costs by Subsector

Sector	Cost to Government (USD mill)			Total Project Cost to Government (USD mill)
	Short Term (2017–2020)	Middle Term (2021–2025)	Long Term (2026–2035)	
Roads	1,328	3,879	1,772	6,979
Expressway	0	2,124	1,403	3,527
Public Transportation	149	123	0	272
Traffic Management	178	0	0	178
Rail	382	5,512	6,396	12,290
Inland Waterway Transport	26	2	0	27
Logistics	14	217	153	384
ICT	30	0	0	30
TOD	n.k	n.k	n.k	n.k
Institutions	10	9	0	19
Total	2,117	11,865	9,725	23,707

Source: Study Team

3) Estimated Budget Envelope

13.4 In order to determine the government's capacity to fund the listed transport projects, the budget envelope was estimated for both Yangon Region and Greater Yangon (study area) based on the following assumptions:

(i) GRDP of Yangon Region

- 2016: USD17.6 billion
- 2035: USD75.9 billion
- Assumed Growth Rate: 8% / year for 2016–2035

(ii) Share of Greater Yangon to Yangon Region

- 80% in terms of population

(iii) Allocation for the transport sector

- Scenario 1: 6% of GRDP
- Scenario 2: 3% of GRDP

13.5 The estimated budgets for Greater Yangon are USD41 billion for Scenario 1 and USD21 billion for Scenario 2.

Table 13.1.4 Estimated Budget Envelope for Yangon Region and Greater Yangon by Scenario

Item			Yangon Region	Greater Yangon [1] (Study Area)
GRDP		2016	17,607	14,148
		2035 [2]	75,988	60,983
		2017–2035	850,688	683,534
Allocation to Transport Sector (USD million)	Scenario 1: 6% of GRDP	2017–2020 (Short Term)	5,393	4,334
		2021–2025 (Medium Term)	10,387	8,346
		2026–2035 (Long Term)	35,261	28,332
		Total	51,041	41,012
	Scenario 2: 3% of GRDP	2017–2020 (Short Term)	2,697	2,167
		2021–2025 (Medium Term)	5,194	4,173
		2026–2035 (Long Term)	17,630	14,166
		Total	25,521	20,506

Source: Study Team

1) The share of Greater Yangon was assumed to be 80% that of Yangon Region based on population.

2) Assumed average growth rates are 10% in 2016–2025 and 6.2% in 2026–2035 at 2016 prices.

13.2 Funding Opportunities

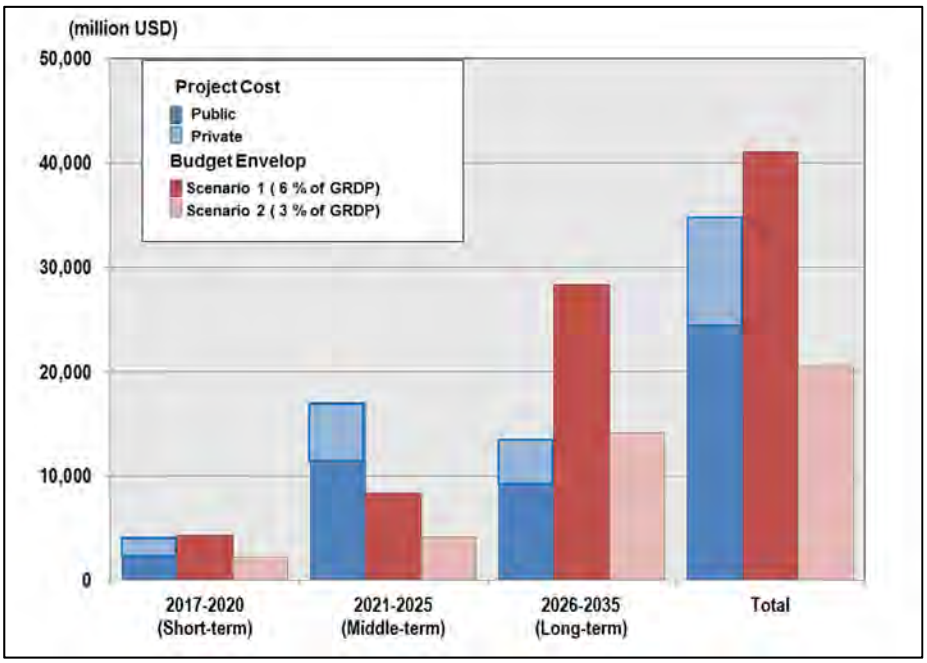
1) Against Budget Envelope

13.6 The project costs were compared with the estimated budget envelope, and the results are as follows:

(i) For the period between 2017 and 2035, the estimated budget envelope under Scenario 1 (6% of GRDP) is more or less equal to the project cost. This implies that Greater Yangon can afford to fund the Master Plan;

(ii) On the other hand, in the short to midterm, the budget envelope will be unable to fund the transport projects.

(iii) Therefore, it is critical to mobilize external funding for the short to the medium term.



Source: Study Team

Figure 13.2.1 Project Costs vs. Budget Envelope

2) Financing Sources

13.7 Even though the aforementioned estimations are indicative values only, it is necessary to look into other public funding sources. Following the user pay principle, the investment capital to develop transport infrastructure should be borne by service users. For example, the idea that railway users should bear the investment cost of urban railway had been suggested by some analysts. However, it is also widely understood that such a financing scheme has not worked or has never been adopted in other countries and cities. Accordingly, different approaches may need to be considered, such as those based on the external economy (benefits) generated by such urban rail projects. Urban rail projects are expected to reduce traffic congestion, improve the environment (air quality, noise reduction, etc.), and increase the value (productivity) of land along railway lines. These benefits can be captured by increasing taxes and fares, and the collected money can be pooled into funds of development of transport infrastructure. The financing sources applied in other cities are as follows. Among them, fuel tax, parking fee and fare setting policy are featured.

(i) Public Transport Fare & Tolls

(ii) Parking Fee

(iii) Vehicle's Acquisition and Registration Fee

(iv) Fuel Tax

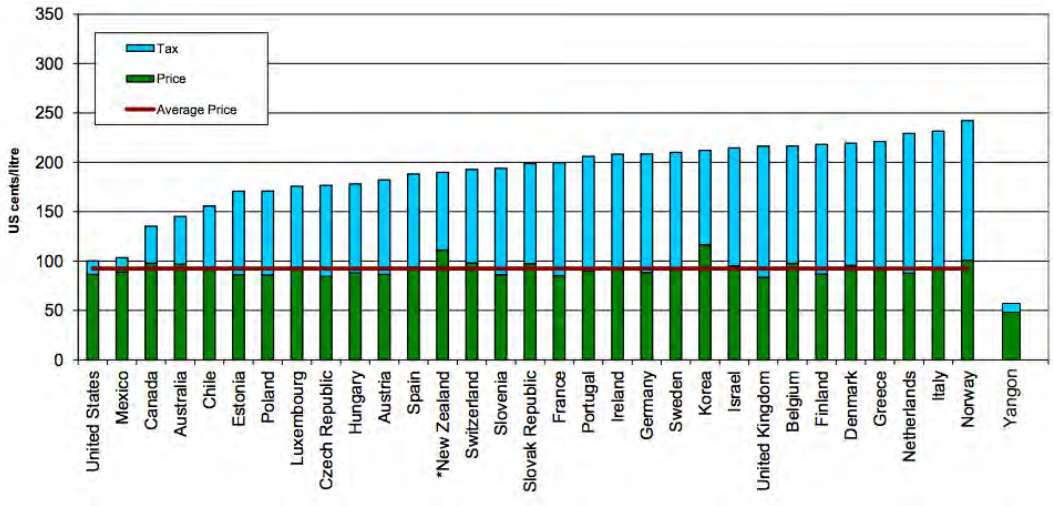
(v) Road Pricing / Area Licensing Scheme

(vi) Value Capture from TOD

(vii) Central Government Transfer

(1) Fuel Taxes

13.8 Increase in fuel taxes for private vehicle users is to shoulder congestion costs. As shown in Figure 13.2.2, the taxation of motor fuel displays a great variability across countries. Asian countries have lower fuel tax rates and Myanmar charges only commercial tax which is 5 % of the price. Raising fuel tax may serve not only the purpose of revenue generation but also internalizing external costs of road transport users.



Source: Worked out by Study Team based on StatsChat(https://www.statschat.org.nz/)

Figure 13.2.2 Petrol Prices and Taxes in OECD Countries (2014) and Yangon (2017)

13.9 The preliminary estimated budget envelope is shown in Table 13.2.1. If the fuel tax is imposed as the same amount of the fuel price, the estimated revenue since 2016 to 2035 is 13.5 billion USD.

Table 13.2.1 Estimated Budget Envelope by Fuel Tax for Greater Yangon

		2016	2035
Estimated Traffic Demand (000 vehicle - km/ Day) 1)		11,625	30,338
Fuel Consumption (000 litter/day) 1)		2,862	5,771
Fuel Price excluding Tax (Kyat / Litter)			619
Tax Revenue by Scenario (million Kyat/day)	Conventional Rate (5 % by VAT): 31 Kyat /Litter	89	179
	Scenario 1: 50 % of Fuel Price: 310 Kyat /Litter	887	1,789
	Scenario 2: 100 % of Fuel Price: 620 Kyat /Litter	1,774	3,578
Revenue Envelope 2016-2035 (billion USD)	Conventional Rate (5 % by VAT): 31 Kyat /Litter		676
	Scenario 1: 50 % of Fuel Price: 310 Kyat /Litter		6,755
	Scenario 2: 100 % of Fuel Price: 620 Kyat /Litter		13,510

Source: Study Team

1) Traffic demand and fuel consumption by M/C, Car, Tai, and Truck are counted.

(2) Parking Fees

13.10 Increase in parking fees for road vehicle users is to shoulder the cost of public spaces and facilities. The preliminary estimated budget envelope is shown in Table 13.2.2. Under the assumed number of users of parking facilities and fare setting, the estimated revenue since 2016 to 2035 is 11.6 billion USD, more than 30 % of transport project cost.

Table 13.2.2 Estimated Budget Envelope by Parking Fees for Greater Yangon

Trip Purpose		No. of Trips by Private Car		Assumed % of Car Users Priced Parking Facilities	Fare Assumption	
		2016 (000)	2035 (000)			
At Residence		450	1,685	25%	5,000	per day
at Destinations	To Work	126	470	30%	1,000	per hr * 8 hrs
	Business	141	529	30%	1,000	per hr * 2 hrs
	Private	173	649	30%	1,000	per hr * 2 hrs
Fare Revenue per day (million Kyat)		1,053	3,942	Envelope (2016-2035)	14,300 billion Kyat ≒ 11.6 billion USD	

Source: Study Team

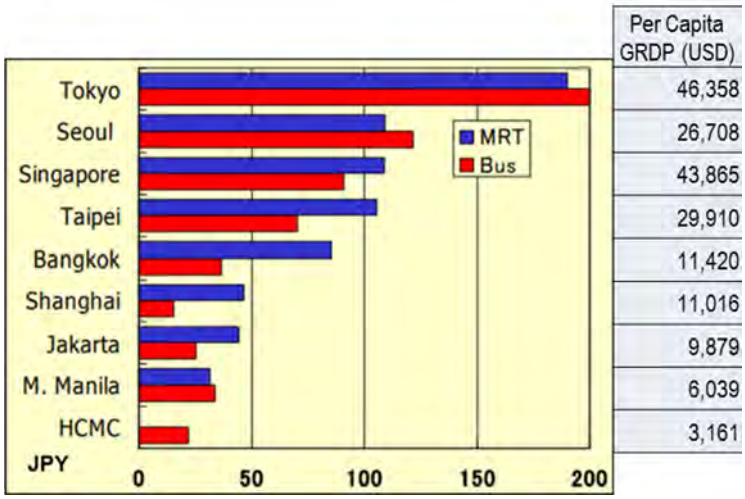
(3) Fare/ Toll Setting Policy

13.11 Profitability is a key issue for urban rail and some transport projects. In Asia's developing cities, public transport fares are very cheap and cause a loss, increasing subsidy and inability to maintain preferred service quality will be inevitable. In some Asian cities demonstrate that operational profitability can be achieved without losing its service quality. Similarly, well-structured fare system for urban public transport options may guarantee higher operating ratio without losing the ridership. The fare elasticity is the key strategy for the rational price for travel.

13.12 It is difficult to change public transport fares once these are decided. "Fare setting beyond populism" is the key to the profitability of transport development projects. Based on the results of a willingness-to-pay survey conducted in the study, the people are willing to pay high fares for good transport services.[1] To illustrate this, the taxis in Yangon can serve as an example. Taxi fares in the city are more than 10 times those of bus, but the number of registered taxis and patronage of the mode has increased significantly. This phenomenon suggests that high fares for urban rail and other transport services can still ensure high ridership and contribute to profitability.

13.13 For fares on urban railway, it should be balanced with fares on conventional modes to ensure competition under different levels of service and operating costs. Figure 13.2.2 shows the public transport fares in Asian mega cities with per capita GRDP. In Metro Manila, the fares on the LRT/MRT are cheaper than those for air-conditioned bus, and rail transport is considered as the mode for low-income groups. On the other hand, urban railway in Bangkok has high fares and attracts high-income passengers.

[1] Other survey results are shown in Technical Report Vol. 1 – Traffic Survey.



Source: Worked out by Study Team based on STREAM study(Fare) and various sources (GRDP)
1) Bus fare is for air−conditioned bus; LRT in Metro Manila and BRT in Jakarta are considered as MRTs.

Figure 13.2.3 Public Transport Fare for a 10-km One-way Trip in Selected Asian Cities, 2007

3) PPP Scheme

13.14 The term public-private partnership (PPP) has been broadly applied to any innovative involvement of the private sector in the design, construction, operation, maintenance, or financing of transport infrastructure. The PPP framework is considered an effective instrument not only to fill up the funding and financing gaps but also to make use of private sector's creativity to increase efficiency of project management and service operation.

13.15 However, the implementation of some PPP projects in other Asian countries has been problematic and private sectors hesitate to engage. If the Governments can make initiatives to better frame PPP contracts, avoid unnecessary transaction costs and provide some degree of capital subsidy to make them commercially viable, private sectors can be attracted by significant PPP investment. As mentioned above, the fare setting to ensure the profitability is a key issue.

13.16 And another most important factor of PPP in urban rail is land development right to be granted to the private sector for generation of ancillary revenue. The experiences of other East Asian Cities show that the performance of PPP urban railway project is sensitive to successful land value capture to finance the development.

13.17 But if the public sector and the regulatory framework of PPP are unstable for public sectors, overcoming private sector hesitation of significant investment for PPP will be difficult. The public sector should enter into selective partnerships with the private sector where risk sharing is clearly defined and allocated.

13.3 Preliminary Evaluation of Projects

1) Economic Evaluation of Selected Projects

(1) Methodology and Assumption

13.18 In general, the economic benefits of transport projects consist of: (i) consumer surplus, namely benefits for rail users, and (ii) producer surplus (increase in net profit of supplier).

(i) **Consumer surplus** can be classified into two, namely travel time cost (TTC) savings and vehicular operating cost (VOC) savings. TTC saving is derived from direct and indirect benefits.

(ii) **Producer surplus** may also be an outcome of a project. The two major transport service providers are the MR (train operator) and bus operators. The shift of passengers from bus to rail will result in a benefit to the latter, and dis-benefit to the former (bus operator). Because of the low marginal cost of railway operation compared to bus, the benefit to the rail producer will be higher. However, for simplicity, the two values can be assumed as equal, resulting in a producer surplus that is zero.

13.19 Non-quantifiable benefits include environmental, social, and economic benefits, as shown in Table 13.3.1.

Table 13.3.1 Categories of Economic Benefits

Type of Benefit	Counted	Not Counted
1. Consumer Surplus: TTC	X	
2. Consumer Surplus: VOC	X	
3. Producer Surplus: Incremental Passenger Revenue		X
4. Enhanced Traffic Safety		X
5. Reduced Air Pollution and Noise		X
6. Increased Land Value		X
7. Job Opportunities		X

Source: Study Team

13.20 The Study Team adopted the following assumptions and standardizations for the sake of simplification and convenience of comparison:

(i) Annual Working Days: 324 days/year.

(ii) Opportunity Cost of Capital: 12%.

(iii) Project Evaluation Period: 40 years, which is equivalent to the maturity period of Japanese ODA loans.

(iv) Project Life Period: For simplicity, the project life is deemed to be equivalent to the project evaluation period; and therefore, no residual or terminal value was considered in the analysis.

(2) VOC and TTC

13.21 As savings in VOC and TTC were selected as the economic benefits of a project, their unit costs were required to estimate the benefits. Unit costs were based on the estimation results in YUTRA Study (2013) which were updated using 2016 prices, as shown in Table 13.3.2.

13.22 The unit VOC by vehicle type was estimated based on an analysis of actual performance data collected from different transport operators and automobile dealers. The following data were used in estimating VOC:

(i) Fuel and lubricant cost;

(ii) Tire cost;

(iii) Repair cost;

(iv) Depreciation cost;

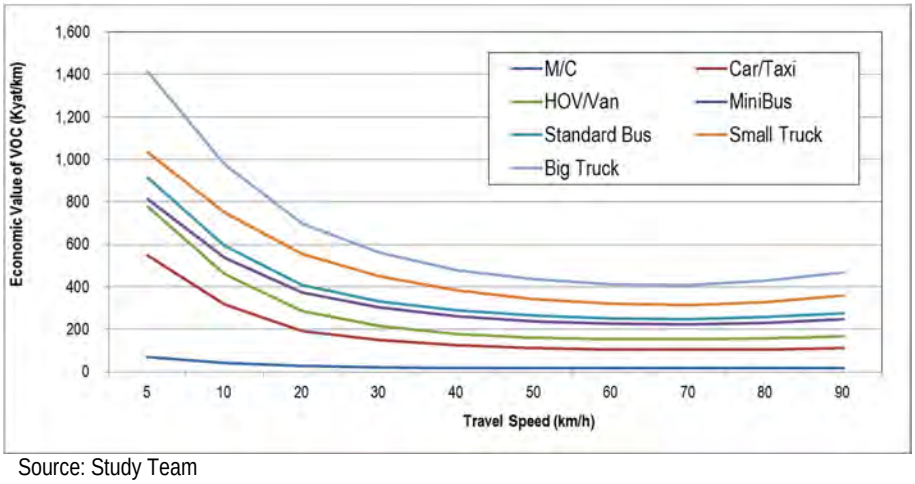
(v) Capital opportunity cost; and

(vi) Crew cost.

Table 13.3.2 VOC by Vehicle Type (Economic Price)

Speed (km/h)	M/C	Car/Taxi	HOV/Van	MiniBus	Standard Bus	Small Truck	Big Truck
5	71.2	549.5	778.2	813.6	913.1	1,032.6	1,415.5
10	42.1	316.7	459.5	537.5	593.8	751.1	977.7
20	26.9	193.7	285.9	373.8	408.9	554.5	698.3
30	21.5	149.5	217.2	302.8	331.7	451.4	563.1
40	18.6	126.4	176.9	260.9	288.4	384.4	480.1
50	17.4	112.9	159.1	237.3	264.4	343.5	435.6
60	16.8	106.7	152.9	225.5	251.1	320.7	411.2
70	16.7	104.7	152.6	223.9	248.5	316.2	408.1
80	17.4	106.1	158.2	232.2	257.1	329.7	429.0
90	18.8	110.6	166.9	249.3	275.9	359.7	469.5

Source: Study Team



Source: Study Team

Figure 13.3.1 VOC by Vehicle Type (Economic Price)

13.23 TTC is an important parameter in determining the modal split of passenger traffic and to provide the basis for economic evaluation of a proposed project. The value of passengers' travel time cost was estimated by mode of transport, and the value was assumed to increase at the same growth rate as per-capita GRDP. Unit costs were based on the estimation results in YUTRA Study (2013) which were updated using 2016 prices, as shown in Table 13.3.3.

Table 13.3.3 Value of Time by Travel Mode

(Unit: MMK/h)

Mode	2016	2025	2035
M/C	656	1,140	2,070
Car	1,615	2,802	5,100
Taxi	1,261	2,190	3,984
Bus	811	1,410	2,562

Source: Study Team

(3) Evaluation Results

13.24 Results of the economic analysis for selected priority projects are summarized in the following sections. To compare the economic viability of each project, B/C and EIRR were computed based on the assumptions mentioned in the foregoing sections. Evaluation results reveal that most of the projects are economically feasible, as the threshold of EIRR is 12%.

(i) **Road & Expressway Project:** Roads are fundamental infrastructures in urban areas. They provide space not only for the movement of vehicles and pedestrians but also as places for various socio-economic activities. In this chapter, only the economic benefits were consulted. While results of the evaluation show that all key projects have higher EIRRs than the threshold, the huge development projects showed lower EIRRs and benefit-cost (BC) ratios because they require higher investments, and cost reduction is the key issue. On the other hand, minor projects showed higher economic benefits. For these projects, the difficulties in terms of land adjustment, buildings of affected parties, and institutional arrangements should be carefully discussed.

(ii) **UMRT Project:** Urban rail can be a key driver and catalyst to promote integrated urban development and achieve the desired spatial structure. The development of a high-quality urban rail can also generate tremendous opportunities for TOD when properly designed and can capture the value from those developments. Even the economic benefit from transport cost were consulted, all of selected projects showed high EIRR. Among them, the development of the YCR showed the higher EIRR. The YCR operates in existing urban areas with very high transport demand and it will serve as the main urban transit backbone.

(iii) **BRT Project:** The BRT is proposed to be developed along Kanar Road–Bayint Naung Road (under the urban expressway) and Waizayandar Road (under the IRR urban expressway). Because the investment cost is quite low compared with urban railway development, the project showed quite a high EIRR. Based on the network analysis done in this study, the BRT will play a critical role in areas where the service level of the public transport is limited.

Table 13.3.4 Economic Evaluation Results of Key Projects

Category	Key Projects		EIRR (%)	B/C
Road& Expressway	Inner Ring Road (Eastern axis and Western axis)		17.4	2.0
	Outer Ring Road	East Section	17.9	2.3
		South-West Section	14.5	2.1
		North Section	12.3	1.5
	Bottleneck Removal Programs		38.3	7.1
	Missing Link Development		24.7	2.7
Urban Railway Development Project	Yangon Circular Railway Development (Upgrade & Grade Separation)		36.1	1.7
	Suburban Railway Lines		17.6	1.8
	UMRT Line 1		14.3	1.2
	UMRT Line 2		17.8	1.6
BRT	BRT Line 1 & Line 2		22.2	1.5

Source: Study Team

2) Social & Environmental Evaluation of Projects

(1) Methodology and Assumption

13.25 This section describes the results of the environmental and social evaluation done on the proposed projects. In the master-planning stage, this process aims to forecast the adverse impacts of the projects on their immediate environment and local communities so that mitigation measures and monitoring plans can be prepared at the feasibility study stage.

13.26 In terms of coverage, environmental considerations include common temporary construction effects that were assumed for qualitative evaluation. These include the following:

(i) **Air pollution**
(ii) **Noise and vibration**
(iii) Soil and groundwater
(iv) Fish, wildlife and vegetation
(v) Wetlands and floodplains
(vi) **Greenhouse effect**
(vii) **Energy consumption**

13.27 On the other hand, social considerations studied the following:

(i) **Involuntary resettlement**
(ii) Livelihood
(iii) Cultural sites
(iv) Landscape and visual impact
(v) **Social equity in terms of traffic cost**
(vi) Health and safety
(vii) Recreation areas
(viii) Institutional environment

13.28 Assessing the environmental and social impacts of the projects was conducted using easily available information, which included existing data (e.g., official government statistics, existing project/study findings) and rapid site surveys. Table 13.3.5 elaborates some of the selected criteria in coming up with preliminary findings on the projects' impacts.

Table 13.3.5 Relevant Environmental and Social Indicators for the Projects

Category	Criteria	Indicator	A	B	C	D	E	Weight (%)
		Score	1	3	5	8	10	
Environmental Impact	Air Pollution	Pollutant emission of CO, SO_2, NOx, PM	Significant Increase	Some Increase	Almost no change	Some reduction	Significant reduction	15
	Noise and Vibration	Persons affected by noise and Vibration	CBD / more than 200	Suburban / more than 200	50–200	Less than 50	No influence	10
	Greenhouse Effect	Emission of CO2	Significant Increase	Some Increase	Almost no change	Some reduction	Significant reduction	15
	Energy Consumption	Oil, Petrol and Gas usage	Significant Increase	Some Increase	Almost no change	Some reduction	Significant reduction	10
Social Impact	Social Equity	Charge of traffic cost (public & private mode users)	Significant Increase	Some Increase	Almost no change	Some reduction	Significant reduction	10
	Involuntary Resettlement	Persons to be relocated	CBD / more than 200	Suburban / more than 200	50–200	Less than 50	No influence	40

Source: Study Team

(2) Evaluation Results

13.29 The preliminary results of the environmental evaluation are summarized in Table 13.3.6. The main findings are as follows:

(i) Projects with high social / environmental impact are those in the road, expressway, logistics, and TOD subsectors;

(ii) Road and expressway projects will generate environmental impacts. There is a risk of promoting motorization because of road expansion, as is often pointed out by road development skeptics. Practically, traffic demand in a project area will increase and residents living along the roads will be affected. Some projects which will involve resettlement will require careful discussion with various stakeholders.

(iii) Logistics and TOD projects will also bring about social impacts, i.e., involuntary resettlement. In other Asian countries, this has been the most critical bottleneck in infrastructure projects. To avoid conflict among stakeholders and project delay, an institutional framework for the urban planning sector should be prepared in the early stages of project development.

Table 13.3.6 Preliminary Results of Environmental Impact Evaluation

Sector	Category	Remark		Project			Environmental				Social		Score	Class
		Environmental	Social	Code		Project Name	Air pollution	Noise and vibration	Emission of CO2	Energy Consumption	Traffic cost	Resettlement		
Roads	Minor Improvement/ Maintenance	Some environmental impact can result from increasing traffic.	Traffic cost can be reduced due to mitigation of congestion. Resettlement is not necessary.	R-01		Urban roads and bridges maintenance program	B	B	B	B	D	E	6.3	D
	Rehabilitation			R-02		Rehabilitation program for priority roads and bridges (Hlaw Ga Rd, Hlaing River Rd, Main Rd No.5, No.6, etc.)	B	B	B	B	D	E	6.3	D
	Bottlenecks Removal	Mitigated congestion improved environmental impact.	Reduce traffic cost. No resettlement.	R-03		Program on road improvement of bottlenecks	D	D	D	D	D	E	8.8	E
	Road Development in New Urban Area	Some environmental impact can result from increasing traffic.	Traffic cost can be reduced due to mitigation of congestion. Some resettlement will be necessary for new road construction.	R-04		Road Development in New Urban Area	B	B	B	B	D	B	3.5	B
	Bottlenecks Removal	Mitigated congestion improved environmental impact.	Reduce traffic cost. No resettlement.	R-05		Program on Removal of Bottlenecks for Major Corridors	D	D	D	D	D	E	8.8	E
	Missing Link Development	Increase traffic will have some impact on air quality; traffic noise will be increase in urban area.	Improved accessibility improved traffic cost. Land acquisition for road development.	R-06	1	Program to construct secondary roads in existing urban areas	B	A	D	D	D	B	4.6	B
					2	Program on road widening in urban blocks (5 packages)	B	A	D	D	D	B	4.6	B
	Pedestrian Safety Facility	Pedestrian facility has no environmental impact.	No social impact.	R-07		Pedestrian bridges, pedestrian crossing signals, wide sidewalk, relocation of electric poles, etc.	C	E	C	C	C	E	7.5	D
	Primary Roads Development	Improved accessibility can have positive environmental impact but traffic noise can be increased.	Improved accessibility will reduce traffic cost. Some resettlement will be necessary for ROW.	R-08	1	Construction of new truck route	D	B	D	D	D	B	5.5	C
					2	Wataya Br South Approach	D	B	D	D	D	B	5.5	C
					3	Min Ye Kyaw Swar Rd/Yarzaa Dirit Rd	D	B	D	D	D	B	5.5	C
					4	Kyi Myin Dine Br & ORR connection	D	B	D	D	D	B	5.5	C
					5	Dala Br & ORR connection	D	B	D	D	D	B	5.5	C
					6	Bago River Br -2 and Thanlyin Connection	D	B	D	D	D	B	5.5	C
	New Bridges	Improved accessibility can have positive environmental impact but traffic noise can be increased.	Improved accessibility will reduce traffic cost. Some resettlement will be necessary for ROW.	R-09	1	New Thaketa Bridge	D	B	D	D	D	B	5.5	C
					2	New Bago Bridge	D	B	D	D	D	B	5.5	C
					3	Dala Bridge	D	B	D	D	D	A	4.7	B
					4	Wataya Bridge	D	B	D	D	D	B	5.5	C
					5	Kyi Myin Dine Bridge	D	B	D	D	D	B	5.5	C
					6	Bago River Bridge 2 for Bago or Monkey Point	D	B	D	D	D	B	5.5	C
	Outer Ring Road	Improved accessibility can have positive environmental impact but traffic noise can be increased.	Improved accessibility will reduce traffic cost. .Less resettlement.	R-10	1	East Section (Phase 1)	D	B	D	D	D	D	7.5	D
					2	East Section (Phase 2)	D	B	D	D	D	D	7.5	D
					3	South-West Section	D	B	D	D	D	D	7.5	D
					4	North-West Section	D	B	D	D	D	D	7.5	D
Expressway	Intercity Expressway	Some environmental impact.	Improved traffic flow can reduce traffic cost. Less resettlement.	R-11	1	Yangon – Bago – Hanthawaddy New Airport	B	B	B	B	D	D	5.5	C
					2	Yangon - Pyay	B	B	B	B	D	D	5.5	C

					3	Yangon - Thilawa	B	B	B	B	D	D	5.5	C
					4	Yangon – Hlegu	B	B	B	B	D	D	5.5	C
					5	Yangon - Pathein	B	B	B	B	D	D	5.5	C
	Urban Expressway	Some environmental impact from increased traffic.	Improved traffic flow can reduce traffic cost. Less resettlement.	R-12	1	North-South Backbone (Western Axis: Insein-CBD-Dala)	B	B	B	D	D	D	6.0	D
					2	North-South Backbone (Eastern Axis: Mindamar-CBD)	B	A	B	D	D	D	5.8	C
					3	Access to Yangon-Mandalay Expressway	B	B	B	D	D	D	6.0	D
					4	Pazundaung Bypass	B	B	B	D	D	D	6.0	D
					5	East-West Smart Tunnel (North)	B	B	B	D	D	D	6.0	D
					6	East-West Smart Tunnel (South)	B	B	B	D	D	D	6.0	D
Public Transport	Bus Transport Modernization	Significant positive environmental impact can achieve from improving bus transport.	Improved bus transport can contribute to modal shift and reduce traffic cost. No resettlement.	P-01	1	Bus Industry Reform/Capacity Building	E	E	E	E	D	E	9.8	E
					2	Bus Route Restructuring	E	E	E	E	D	E	9.8	E
					3	Bus Fleet Renewal/Maintenance	E	E	E	E	D	E	9.8	E
					4	Bus Terminals/Facilities Improvement	E	E	E	E	D	E	9.8	E
					5	Bus Corridor Traffic Management	E	E	E	E	D	E	9.8	E
					6	Bus Transport Sector Management (YRTA)	E	E	E	E	D	E	9.8	E
	BRT Development	Significant positive environmental impact can achieve from improving bus transport.	Improved bus transport can contribute to modal shift and reduce traffic cost. No resettlement.	P-02	1	BRT under North - South Backbone Western (Kannur Rd - Bayint Naung Rd)	E	E	E	E	D	E	9.8	E
					2	BRT under North - South Backbone Eastern (Waizayandar Rd)	E	E	E	E	D	E	9.8	E
Traffic Management and Safety	Road Vehicle Management	No environmental impact.	No social impact.	M-01	1	Improvement of Vehicle Registration System	C	E	C	C	C	E	7.5	D
					2	Development of Vehicle Inspection System	C	E	C	C	C	E	7.5	D
	Traffic Enforcement	No environmental impact.	No social impact.	M-02	1	Establishment of Institutional Framework	C	E	C	C	C	E	7.5	D
					2	Capacity Building of Traffic Enforcers	C	E	C	C	C	E	7.5	D
	Traffic Engineering	Traffic improvement can have some positive environmental impact.	Traffic cost can significantly improved with effective traffic management. No resettlement.	M-03	1	Management of Traffic Control Centre	D	D	D	D	E	E	9.0	E
					2	Expansion of Traffic Signals for Vehicles and Pedestrians	D	D	D	D	E	E	9.0	E
					3	Improvement of Pedestrian Facilities/ Walking Environment	D	D	D	D	E	E	9.0	E
					4	Provision of Signage and Lane Marking	D	D	D	D	E	E	9.0	E
	Traffic Safety Education	No environmental impact.	No social impact.	M-04	1	Preparation of Traffic Rules/Regulations	C	E	C	D	C	E	7.8	D
					2	Traffic Safety Education for School Children	C	E	C	C	C	E	7.5	D
					3	Traffic Safety Campaign for the Public and Communities	C	E	C	C	C	E	7.5	D
	Parking Management	No environmental impact.	No social impact.	M-05	1	Establishment of Parking Regulations and Enforcement	C	E	C	C	C	E	7.5	D
					2	Development of Public Parking Facilities	C	E	C	C	C	E	7.5	D
	Traffic Demand Management	No environmental impact.	Mitigated traffic can reduce traffic cost. No resettlement.	M-06	1	Introduction of Staggered Working/School Time	C	E	C	C	D	E	7.8	D
		Significant positive environmental impact can achieve from expansion of pricing.	Significant traffic cost reduction. No resettlement.		2	Expansion of Pricing (higher parking fee, fuel, vehicle tax)	E	E	E	E	E	E	10	E
		Significant positive environmental impact can achieve from expansion of pricing.	Significant traffic cost reduction. No resettlement.		3	Area Licensing Scheme Control (CBD)	E	E	E	E	E	E	10	E
Urban/ Suburban Rail	Circular Rail	Improved air quality and reduce energy consumption than private vehicles. Generate noise for vicinity area.	Significant traffic cost reduction. No resettlement.	L-01	1	Upgrading of Existing Line and Services	D	A	D	E	E	E	8.5	E
					2	Urgent Service Improvement	D	A	D	E	E	E	8.5	E
		Significant environmental improvement but generate noise in vicinity area.	Significant traffic cost reduction. No resettlement since same ROW.		3	Elevation and Electrification of Circular Rail	E	A	E	E	E	E	9.1	E
					4	Improvement/Development of Access Transport	E	E	E	E	E	E	10	E
	Suburban Commuter Rail	Improved air quality and reduce energy consumption than private vehicles. Generate noise for vicinity area.	Significant traffic cost reduction. Less resettlement is necessary for depot.	L-02	1	Yangon-Mandalay Line	D	B	D	E	E	E	8.7	E
					2	Yangon-Pyay Line	D	B	D	E	E	E	8.7	E
					3	Thilawa Branch Line	D	B	D	E	E	E	8.7	E
					4	Outer Circular Rail Line	D	B	D	E	E	E	8.7	E
					5	Relocation of Depot / Workshop to Suburban Area and Regeneration of MR Land	D	B	D	E	E	C	6.7	D
	New Lines	Significant positive environmental impact except for noises in vicinity area.	Significant traffic cost reduction. Resettlement is necessary for some area.	L-03	1	Development of UMRT Line 1 (North-South)	E	B	E	E	E	B	6.5	D
					2	Development of UMRT Line 2 (East - West)	E	B	E	E	E	B	6.5	D

		Some environmental impact.	Some resettlement for ROW.		3	Yangon New Airport Access	B	B	B	B	B	B	3.0	B
Inland Water Transport	Upgrading of Existing Services	Improved water transport will contribute to modal shift and have some positive impact on environment.	Reduced traffic cost and no resettlement.	W-01	1	Fleet Procurement	D	E	D	D	E	E	9.2	E
					2	Facilities Improvement	D	E	D	D	E	E	9.2	E
	Development of New Routes	Improved water transport will contribute to modal shift and have some positive impact on environment.	Reduced traffic cost and no resettlement.	W-02	1	Facilities Development	D	E	D	D	E	E	9.2	E
					2	Fleet Procurement (Passenger)	D	E	D	D	E	E	9.2	E
					3	Fleet Procurement (Freight)	D	E	D	D	E	E	9.2	E
					4	Fleet Procurement (Tourism)	D	E	D	D	E	E	9.2	E
	Improvement of Management System			W-03		Strengthening Organization	C	E	C	C	D	E	7.8	D
Logistics	Upgrading of Existing Facilities	No environmental impact.	Resettlement will be necessary.	F-01	1	Upgrading of Public Wholesale Markets	C	E	C	C	C	B	4.7	B
					2	Upgrading of Traditional Markets	C	E	C	C	C	B	4.7	B
	Relocation and New Development	Increased route length will have some impact on environmental impact.	Less resettlement and increase traffic cost.	F-02	1	Relocation of Existing Port Function to Thilawa Port	B	E	B	B	B	B	3.7	B
					2	Relocation of ICD and Development of New Truck Terminal along ORR	B	E	B	B	B	B	3.7	B
ICT	Expansion of ICT for YRTA	ICT can contribute to mitigation of traffic congestion and can significantly improve environmental impact.	Reduce traffic cost and no resettlement.	C-01	1	Collection and Information of Traffic Data through ICT	C	E	D	D	D	E	8.6	E
					2	Development of Bus Operation/Management Information system	D	E	D	D	D	E	9.0	E
					3	Development of Public Transport User Information System	E	E	E	D	D	E	9.6	E
	Expansion of ICT for Public Transport Operators	ICT can contribute to mitigation of traffic congestion and can significantly improve environmental impact.	Reduce traffic cost and no resettlement.	C-02	1	Introduction of Compatible ICT System among Public Transport Operators	D	E	D	D	D	E	9.0	E
					2a	Provision of ICT Equipment for Public Transport Vehicles	D	E	D	C	D	E	8.7	E
					2b	Provision of wifi & Digital Signage at Terminals	D	E	D	C	D	E	8.7	E
					3	Development of Public Transport User Information System	D	E	D	D	D	E	9.0	E
TOD	TOD on Circular Rail	TOD contribute to modal shift and have positive impact on environment.	Traffic cost can reduce significantly and resettlement is necessary.	T-01	1	Integrated Urban Development at/around the Stations	D	A	D	D	E	A	4.7	B
					2	Development of Integrated New Town for Resettlement and those who need Affordable Housing	D	B	D	D	E	A	4.9	B
					3	Effective Use of the Space under the Viaduct	D	E	D	D	E	A	5.6	C
	TOD on Other Lines	TOD contribute to modal shift and have positive impact on environment.	Traffic cost can reduce significantly and resettlement is necessary.	T-02		Development of Underground Space at Metro Stations	D	E	D	D	E	B	6.4	D
Institutions	Strengthening of YRTA	Improved public transport will contribute to modal shift and result positive environmental impacts.	Significant traffic cost reduction. No resettlement.	I-01	1	Establishment of Legal and Policy Framework	D	E	D	D	E	E	9.2	E
					2	Strengthening of Organization and Staffing	D	E	D	D	E	E	9.2	E
					3	Capacity Building including Study Tour	D	E	D	D	E	E	9.2	E
	Capacity Building of Public Transport Operation	Improved public transport will contribute to modal shift and result positive environmental impacts.	Significant traffic cost reduction. No resettlement.	I-02	1	Development of Training Manuals/Guideline	D	E	D	D	E	E	9.2	E
					2	Conduct of Training	D	E	D	D	E	E	9.2	E
					3	Conduct of Workshops	D	E	D	D	E	E	9.2	E
	ROW Acquisition and Resettlement and TOD Promotion	No environmental impact.	Resettlement or land acquisition will be necessary for land readjustment.	I-03	1	Introduction of "Land Readjustment and Urban Renewal System"	E	E	E	E	E	E	10	E
					2	Development of PPP Guideline on TOD	E	E	E	E	E	E	10	E

Source: Study Team

[1)] A=Less than 3, B=3 to 5, C=5 to 6, D=6 to 8, E=More than 8. A low score (i.e., A and B) means the project has high positive or negative impact, while a high score (i.e., D and E) means low impact.

13.30 For particular project categories, specific environmental / social impacts should be considered and discussed. Some examples are as follows:

(a) **Surface Settlement (for Roads and Urban/Suburban Rail):** This applies particularly to the construction of roads and railway with underground structures, because underground work may cause a deformation of the sills and rocks around excavation areas. Such deformation may in turn trigger sudden collapses, subsidence, and sinking which can damage both the work under construction and nearby structures, particularly when the work is under developed areas. Therefore, the following three elements should be carefully taken into consideration before construction start:

- Excavation techniques;
- Dimension and geometry of the excavation; and
- Type of excavated materials.

(b) **Interaction with Surface Water and Groundwater (for Roads, Urban/Suburban Rail Projects with Underground Structure and Bridge):** This applies particularly to the construction of roads and railway with underground structures and bridges, because excavating tunnels induce draining, leading to a more or less drawdown of the groundwater table. The impacts will be undesirable, such as drying up of springs and/or wells and changes in groundwater, in the flow and quality of thermal waters, and in the hydrogeological balance in the water basin. These phenomena can persist even after the tunnel has been constructed, especially if the final alignment is not completely waterproof.

(c) **Urban Generation (for Urban/Suburban Rail and Public Transport):** Public transport projects can enhance urban generation in the catchment areas of the modes. Sustainable public transport can provide better access to housing areas and other urban services, more transportation options, and lower transportation costs, thereby mitigating the environment impacts.

13.4 Findings on the Projects and Importance of Implementing Organization

1) Findings on the Proposed Projects

(i) **Funding:** In this study, more than a hundred projects in various sectors are proposed and the total project cost was estimated to be USD33 billion. Based on the preliminary assessment by the Study Team, Greater Yangon can afford to fund the Master Plan, but the mobilization of external funding for the short to the medium term would be necessary.

(ii) **Economic Evaluation:** The selected projects showed high EIRRs in terms of construction and O&M costs and benefit of VOC & TTC savings. However, their implementation is fraught with a lot of uncertainties. Discussions regarding land adjustment, buildings to be affected, and complex institutional arrangements should start at the early stages of development.

(iii) **Impacts:** The social and environmental evaluation of the proposed projects shows that of the many social and environmental impacts, resettlement is the most critical. To avoid conflict among stakeholders and project delays, the institutional framework for the urban planning sector should be prepared at the early stages of development.

2) Importance of Institutional Coordination

13.31 As the key considerations in a comprehensive approach to transport planning and development among the sectors have been pointed out, Table 13.4.1 shows the assumed implementation bodies of the proposed projects by category. Transport development projects/ actions involve various agencies and organizations at national and local levels, including the private sector and communities. Especially for road development, the YCDC, MOC, YRG, and private developers have to work together. Coordination among implementation bodies is necessary for smooth implementation of the projects.

Table 13.4.1 Implementation Organization by Project Category

Sector	Category	Implementing Agency
Roads	Minor Improvement/ Maintenance	MOC, YCDC, YRG
	Rehabilitation	MOC, YCDC, YRG
	Bottlenecks Removal	YCDC
	Road Development in New Urban Area	YCDC, Developer
	Missing Link Development	YCDC/ MOC
	Pedestrian Safety Facility	YCDC
	Primary Roads Development	MOC
	New Bridges	MOC
	Outer Ring Road	MOC
Expressway	Intercity Expressway	MOC
	Urban Expressway	MOC / YCDC
Public Transport	Bus Transport Modernization	YRTA
	BRT Development	YRTA
Traffic Management and Safety	Road Vehicle Management	Road Transport Administration, MOC
	Traffic Enforcement	Road Transport Administration, MOC
	Traffic Engineering	YRTA/YCDC
	Traffic Safety Education	Traffic Police / MOTC/ YRTA
	Parking Management	YRTA/YCDC
	Traffic Demand Management	YRTA
Urban/Suburban Rail	Circular Rail	MOTC/MR/YRTA
	Suburban Commuter Rail	MOTC/MR/YRTA
	New Lines	not decided yet
Inland Water Transport	Upgrading of Existing Services	YRTA, Private Company
	Development of New Routes	YRTA, Private Company
	Improvement of Management System	YRTA, Private Company
Logistics	Upgrading of Existing Facilities	YCDC
	Relocation and New Development	MOT
ICT	Expansion of ICT for YRTA	YRTA
	Expansion of ICT for Public Transport Operators	YRTA
TOD	TOD on Circular Rail	n.k
	TOD on Other Lines	n.k
Institutions	Strengthening of YRTA	YRTA
	Capacity Building of Public Transport Operation	YRTA
	ROW Acquisition and Resettlement and TOD Promotion	MOC, MOTC, MR, YCDC , etc.

Source: Study Team

Source: Classified by Study Team

3) Proposed Directions of Policy / Institutional Framework

13.32 To achieve the development goals with limited resources, it is more important to implement integrated, coordinated, and phased actions. And the role of the YRTA is essential to integrate and coordinate the actions of all implementation bodies for a smooth traffic environment in Yangon Region.

13.33 In many urban areas elsewhere, transport authorities are seen as organizations that act for public interest with the primary responsibility for a well-functioning and integrated transport system within their respective jurisdictions. As such, they take the responsibility for the planning, organizing, and financing public transport services.

13.34 As many projects/actions in large, urban areas are interrelated, a sectoral approach or piecemeal solutions are not sustainable. Integration and coordination between transport and urban development is important and requires the YRTA to act as an effective instrument for planning, managing, and regulating the region's multimodal transport systems.

13.35 As well as implementing infrastructure development projects, preparing an overall policy/ institutional framework is necessary, and the YRTA must function as the lead here, supported by other stakeholders. To enhance the implementation of the proposed projects under such an institutional framework, they should be packaged as short-term, strategic programs that the government has to lead (see Chapter 14).

14 CONCLUSION AND RECOMMENDATIONS

14.1 Conclusion

14.1 Yangon has been growing rapidly and will continue to grow further long into the future. Urban populations will increase both due to natural growth and migration from other places in the country for employment, higher education, new business ventures, and other opportunities. People's income will increase and lifestyles will continue to change as the economy grows and the market strengthens its international linkages. By 2035, it was estimated that Yangon would have already grown to become a city with a population of more than 7 million. It is even expected to grow further thereafter, transforming it into a significant city-region or a mega city with a population of 10 million.

14.2 At the same time, urban transport in Yangon has rapidly worsened. Congestion takes place on many sections along major roads and in many areas of the city center throughout the day, but especially during morning and afternoon peak hours, although measures to improve bus services and signalize major intersections have somewhat eased the situation.

14.3 It was estimated that in 2016 the total transport cost, comprising vehicle operating cost and passenger time cost, of both private and public transport amounted to MMK24.3 billion (USD19.7 million) each day. It was also estimated that if no significant transport infrastructure is developed, this figure would increase to MMK170.2 billion (USD137.9 million) by 2035, by which time the entire network would be in a gridlock.

14.4 In order to meet the large transport demand while promoting the planned spatial structure, investments in transport infrastructure and services must expand and accelerate. However, it should be noted that urban transport is an integrated system, comprising various types of infrastructure (such as roads, rail, and waterway transport), passenger and goods services, and their management. While the transport network in the proposed urban transport master plan only shows road and rail infrastructure, operating and managing available infrastructure are equally important. Hence, the main components of the proposed master plan are as follows:

(i) **Urban Roads:** Comprising (i) maintenance/ minor improvement, (ii) rehabilitation, (iii) removal of bottlenecks, (iv) removal of missing links, (v) flyover and underpass construction, (vi) development of secondary road packages, (vii) improvement of walking environment, (viii) development of primary roads, (ix) construction of bridges, and (x) development of an outer ring road.

(ii) **Expressways:** Covering both suburban expressways (partially elevated toll road) and urban expressways (elevated toll road) as an integrated network.

(iii) **Public Transport:** Comprising (i) bus transport modernization, including bus industry reform, bus operator capacity building, bus route rationalization, bus fleet renewal / maintenance, bus terminals / facilities improvement, bus corridor traffic management, bus transport sector management by the YRTA; and (ii) BRT development.

(iv) **Traffic Management and Safety:** Comprising (i) road vehicle management (registration, inspection); (ii) traffic enforcement, (iii) traffic engineering including management of a traffic control center and improvement of intersections; (iv) traffic safety including accident database, enforcement, education, and post-accident measures; (v) parking management, (vi) control of vehicle traffic, boarding / alighting of bus passengers, and illegal parking; (vi) traffic demand management, including staggered working/ school time and road / area pricing.

(v) **Urban / Suburban Rails:** Comprising (i) upgrading and grade separation of circular rail; (ii) improvement of suburban commuter lines, including the Yangon–Mandalay Line, Yangon–Pyay Line, Thilawa branch, and other branch lines to universities; (iii) development of new

lines, i.e., Line 1 (north–south metro line), Line 2 (east–west metro line), and Line 3 (east–west metro line).

(vi) **Inland Water Transport:** Comprising (i) upgrading of existing facilities / services and (ii) development of new routes.

(vii) **Logistics Facilities:** Comprising (i) upgrading of existing facilities, such as wholesale and traditional markets; (ii) transfer of existing port's function to Thilawa; and (iii) relocation of ICD; and development of new truck terminal along the outer ring road.

(viii) **Information and Communication Technology (ICT):** Comprising (i) expansion of ICT for urban transport management, (ii) expansion of ICT for public transport operators and users.

(ix) **TOD:** Comprising (i) development of intermodal / access facilities and TOD at/ around stations of the circular rail and other rail lines, (ii) integration of the circular rail with the development of new towns to serve families to be resettled and provide affordable housing; (iii) development of publicly owned lands integrated with urban rail, (iv) establishment of an institutional framework for TOD based on private sector participation.

(x) **Institutions:** Comprising (i) strengthening of the YRTA, including the establishment of legal and policy frameworks on urban transport, strengthening of the organization and staffing, and capacity building to include study tours; (ii) development of PPP guidelines on urban transport development and TOD; and (iii) capacity development for urban transport operators.

14.5 The total investment cost of the proposed urban transport master plan up to 2035 was roughly estimated to be nearly USD 34.66 billion, of which USD 23.7 billion is the cost to government based on the assumption that 30% of the cost could be mobilized from private sector investments and various user charges such as bus fares, expressway toll, and others. The funding requirement by the government was further estimated by term as shown in Table 14.1.1

Table 14.1.1 Estimated Cost to Government

Item	Cost to Government				Total Cost
	Short Term (–2020)	Medium Term (2021–2025)	Long Term (2026–2035)	Subtotal	
USD million	2,117	11,865	9,725	23,707	34,656
%	8.9	50.0	41.0	100	-

Source: Study Team

14.6 The budget envelope or capacity to mobilize funds by both the public and the private sector was estimated for the study area based on the following assumptions:

(i) The GRDP of Yangon Region for 2016–2035 was estimated by assuming an 8% growth annually;

(ii) The share of the study area in the GRDP mentioned above is approximately 80% based on population; and

(iii) Two scenarios on the allocation of the GRDP to the transport sector were assumed, i.e., 6% and 3%.

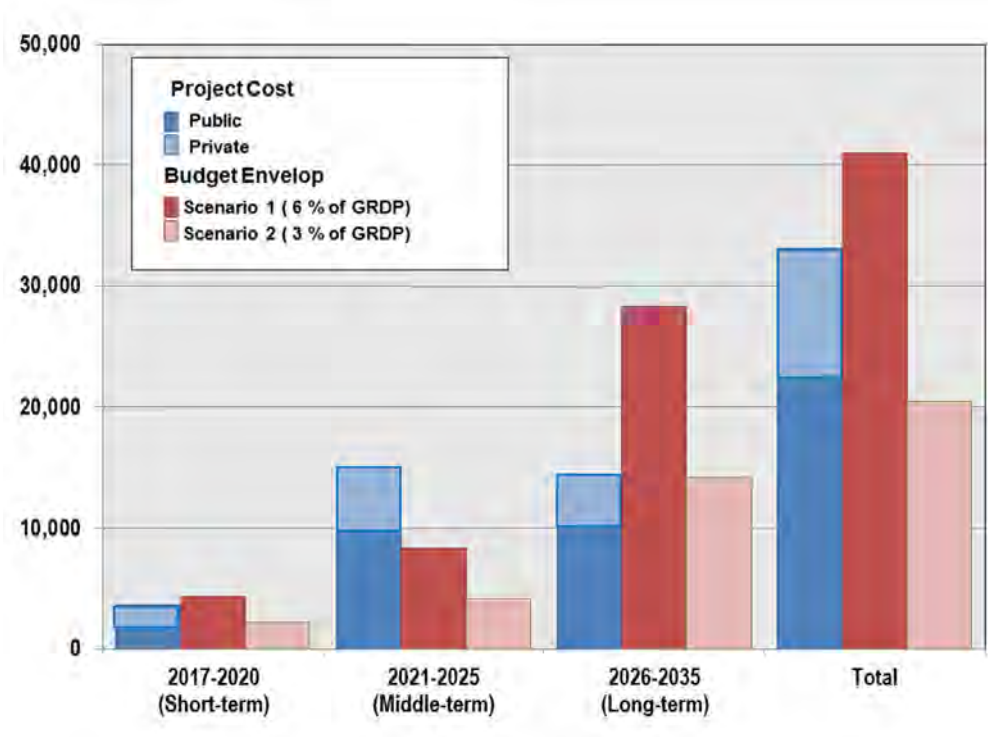
14.7 The estimated budget envelope available for the study area for the period 2016–2035 is approximately USD41 billion and USD21 billion for the high and low scenarios, respectively.

14.8 Project costs were then compared with the estimated budget envelope which indicate the following:

(i) For the total period between 2017 and 2035, the estimated budget envelope under Scenario 1 (6% of GRDP) is more or less equal to the project cost. This implies that Greater Yangon can afford to fund the Master Plan;

(ii) On the other hand, for the short to the medium term, the budget envelope will be insufficient; and

(iii) It is critical to mobilize external funding for the short to the medium term.



Source: Study Team

Figure 14.1.1 Project Costs vs. Budget Envelope

14.9 The preliminary economic evaluation of the proposed transport master plan was conducted by comparing the total plan cost estimated in economic cost and direct benefits including savings in vehicle operating costs and passenger time costs. The estimated EIRR is quite high due to the increasing cost of congestion.

14.10 When the proposed master plan is implemented the impacts on social and natural environment are also expected to be significant. These are briefly as follows:

(i) Average transport cost per person trip will decrease to MMK1,517 as compared with MMK4,421 under the Do Nothing Case in 2035; and

(ii) Air quality will also improve and contribute to a reduction in GHG emissions.

14.2 Recommendations

1) Overall

14.11 While the proposed master plan up to 2035 would help improve the transport situation in the future Yangon, implementing the plan would be critical. If improvements will not be done in a timely manner to address the increasing demand every year, long-term solutions would not be accepted by society. Therefore, in light of the master plan's envisioned scenario for 2035, the proposed projects are further packaged as short-term strategic programs that the government has to lead.

14.12 Recommendations for effective implementation include the following:

(a) **Packaging of Proposed Individual Projects into Programs to avoid Haphazard Development:** In this study, nine (9) strategic programs are recommended as follows:

(i) Removal of bottlenecks on major corridors and the CBD;

(ii) Bus modernization;

(iii) Traffic management and safety improvement;

(iv) Construction of missing links;

(v) Development of the urban rail network;

(vi) Development of the urban expressway network;

(vii) Development of inland waterway transport;

(viii) Transit-oriented development; and

(ix) Strengthening of the YRTA.

(b) **Implementation of Short-term Actions to Promote Long-term Projects:** Large infrastructure projects, especially urban rails, require equally large investments and lengthy implementation periods. It is thus recommended that an alternative to the conventional implementation sequence of "FS-DD-ROW acquisition-Construction" be introduced and integrated urban planning, as well as development of institutions and processes, as conceptually explained in Table 14.2.1.

(c) **Closer Integration with Urban Development Strategies:** As the impact of transport on socio-economic activities, land use, environment and public funding is so large, the transport plan needs to be integrated into urban development strategies, such as the provision of affordable housing, relocation of poor families from high hazard risk areas, and development of new towns and subcenters. High-density commercial complex development must undergo a detailed assessment of the traffic impact they will create to avoid or minimize such negative impact on local circulation. Households and commercial facilities must also have adequate parking spaces.

(d) **Development of Transport as an Integrated Network and System:** Urban transport in Yangon is composed of various modes to which high-standard new modes, such as urban rail, elevated expressways and modern bus, will be added. These modes must function as an integrated and coordinated system to ensure seamless and safe movement of people at affordable costs. For this, it is necessary to strengthen the function and capacity of the YRTA as the sole administrative body in charge of planning and management of the urban transport system in Yangon.

Table 14.2.1 Alternative Steps for Urban Rail Development

Step	Action	Purpose
1	Conduct of FS on the Entire Network or Priority Route	• To verify feasibility of the project • To determine ROW necessary for rail structure, stations, intermodal facilities • To identify potential areas for TOD
2	Integration with Urban Plan	• To designate rail routes and ROW in statutory urban plan • To formulate detailed land use/ urban plan for the influence area of urban rails for enforcement/ control/ guidance of land use/ urban development
3	Land Acquisition / Resettlement	• To commence acquisition of rail ROW • To introduce land adjustment for wider area of improvement including railway ROW and TOD-potential area • To incorporate resettlement as a concept of TOD
4	Initial Development	• To introduce quality bus service or BRT along planned rail routes while land acquisition is carried out • To encourage commercial development in/ around the stations without encroaching on necessary space for intermodal facilities
5	Conduct of D/D for the Routes with Acquired ROW	• DD must include TOD plan to involve potential private investments for value capture.
6	Construction	• When the rail is opened, initial TOD is also completed or on-going.

2) Programmatic Approach to Strategic Projects

(1) Removal of Bottlenecks on Major Corridors and in CBD

14.13 This program intends to provide smooth and safe traffic on major traffic corridors and in the CBD. The projects included in this program are maintenance/minor improvement/rehabilitation of roads and removal of specific bottlenecks, and related traffic management and improvement measures.

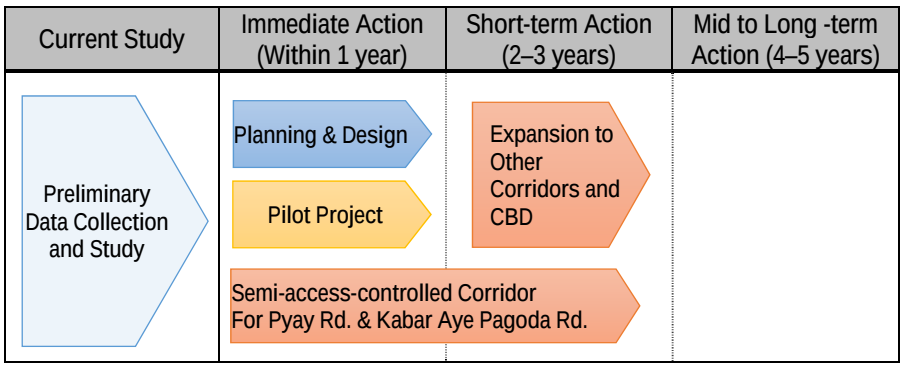


Figure 14.2.1 Roadmap for Bottleneck Removal

(2) Bus Modernization

14.14 This program comprises the following projects: (i) bus route redesign, (ii) bus industry re-structuring, (iii) bus fleet renewal and expansion, (iv) bus support infrastructure, (v) bus corridor traffic management, and (vi) bus sector management and regulation by YRTA. The estimated cost of this program is USD350 million, of which about USD52 million is the government's share in the equity of five public bus companies, spread over 5 years.

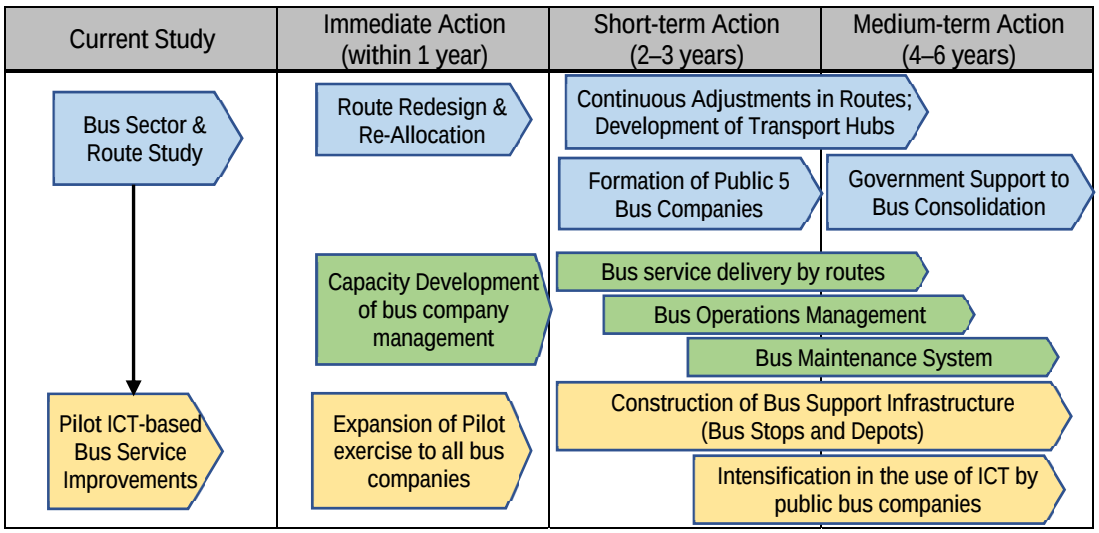


Figure 14.2.2 Roadmap for Bus Modernization

(3) Traffic Management and Safety Improvement

14.15 This program includes such components as (i) road vehicle management, (ii) traffic enforcement, (iii) traffic engineering, (iv) traffic safety education, (v) parking management, (vi) traffic control, and (vii) traffic demand management. The estimated cost of the program is approximately USD245 million (cost to Government is USD198 million).

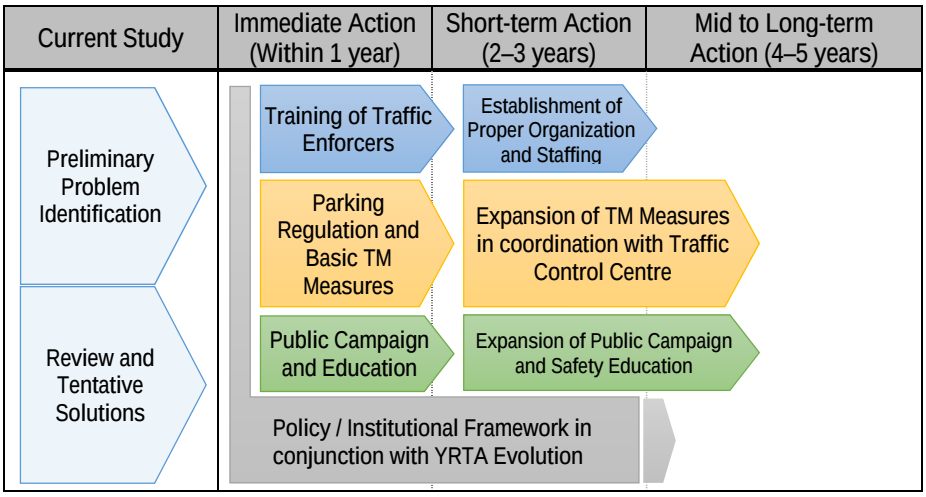


Figure 14.2.3 Roadmap for Traffic Management and Safety Improvement

(4) Construction of Missing Links

14.16 This program intends to strengthen overall road network and accessibility in large urban blocks by widening or constructing secondary roads through new approaches widely practiced in Japan. This program comprises (i) road widening and new construction in large-scale urban blocks (5 packages), and (ii) ROW acquisition and resettlement through the introduction of land readjustment. The estimated cost is approximately USD500 million (cost to Government is USD250 million).

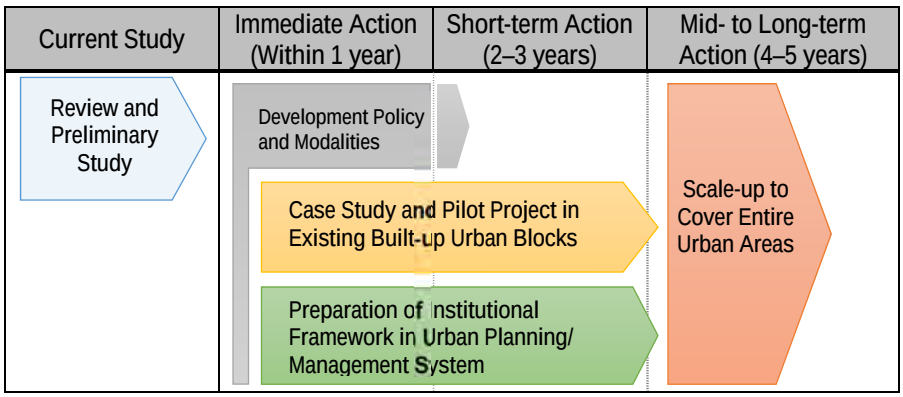


Figure 14.2.4 Roadmap for the Construction of Missing Links

(5) Development of the Urban Rail Network

14.17 This program intends to provide the people with congestion-free, high-quality public transport services in integration with feeder services and TOD. The roadmap of the program is shown below.

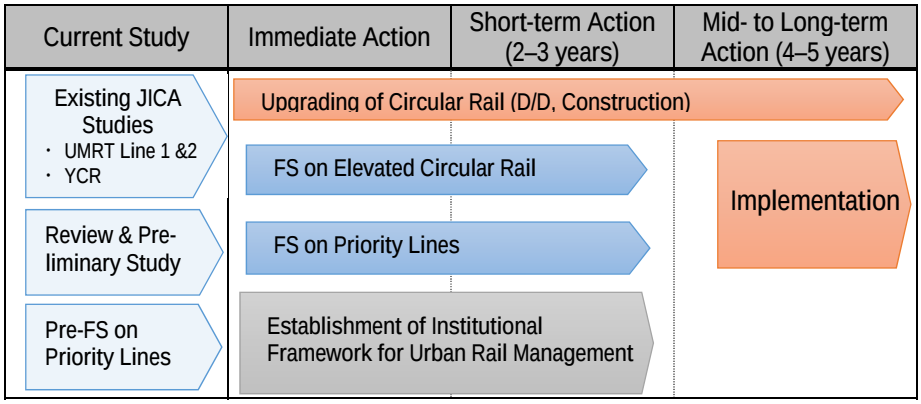


Figure 14.2.5 Roadmap for Urban Rail Network Development

(6) Development of the Urban Expressway Network

14.18 This program intends to provide high-level, high-capacity channels for private and public transport including (i) urban expressways including north–south backbone (western axis: Insein–CBD–Dala), north–south backbone (eastern axis: Mindama–CBD), access to Yangon–Mandalay Expressway, and Pazundaung bypass, east–west smart tunnel (north and south sections), and (ii) BRT development including Kanar Road–Bayint Naung Road (under an urban expressway), and Waizayandar Road (under an urban expressway).

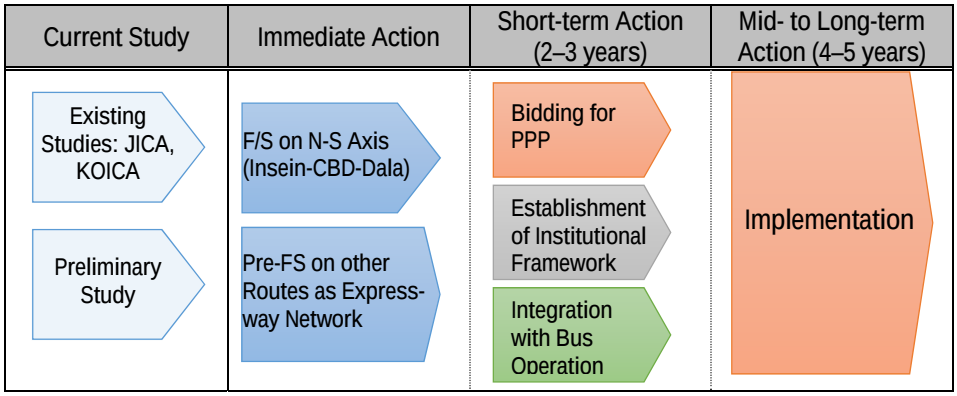


Figure 14.2.6 Roadmap for Urban Expressway Development

(7) Development of Inland Waterway Transport

14.19 This program intends to meet urban transport needs along waterfront areas and comprises (i) upgrading of existing services including fleet procurement and facilities improvement and (ii) development of new routes including fleet procurement and facilities improvement.

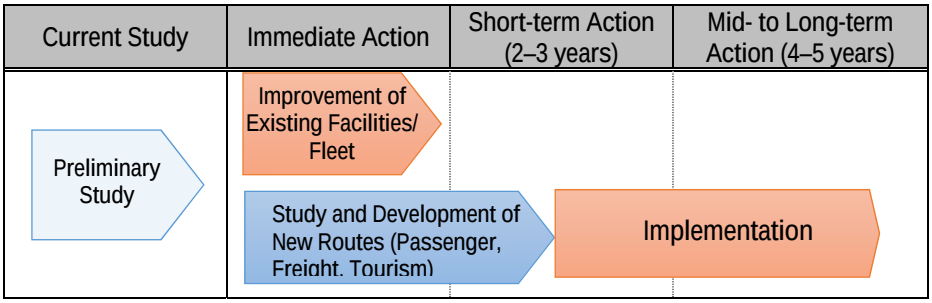


Figure 14.2.7 Roadmap for Inland Waterway Transport Development

(8) Transit-oriented Development

14.20 This program intends to promote transit-based compact urban area, local economic development and value capture, including (i) TOD for the Yangon Circular Rail including integrated urban development in/around the stations, improvement of access to/from the stations, especially in areas within walking distance to stations, development of integrated new towns for resettlement and those who need affordable housing, effective use of space under viaducts and integrated development of publicly owned lands, and (ii) TOD on other lines including integrated development with suburban centers and development of underground space at metro stations.

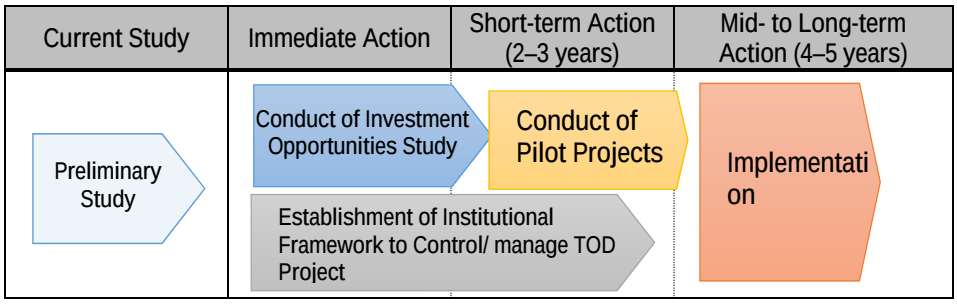


Figure 14.2.8 Roadmap for Transit Oriented Development

(9) Strengthening of the YRTA

14.21 This program seeks to transform the newly organized YRTA into an effective instrument for planning, managing, and regulating the region's multimodal transport system. This package includes (i) mobilization of YRTA and formulation of legal and policy framework; (ii) staffing and capacity building via study tours, attendance in specialized training courses, and hands-on exercises; and (iii) expansion of functions to include construction of bus support infrastructure, and coordination of other transport modes (railways, IWT); and TOD planning and promotion. The estimated cost of the program is approximately USD19 million, most of which will be expenses on personnel compensation and external training.

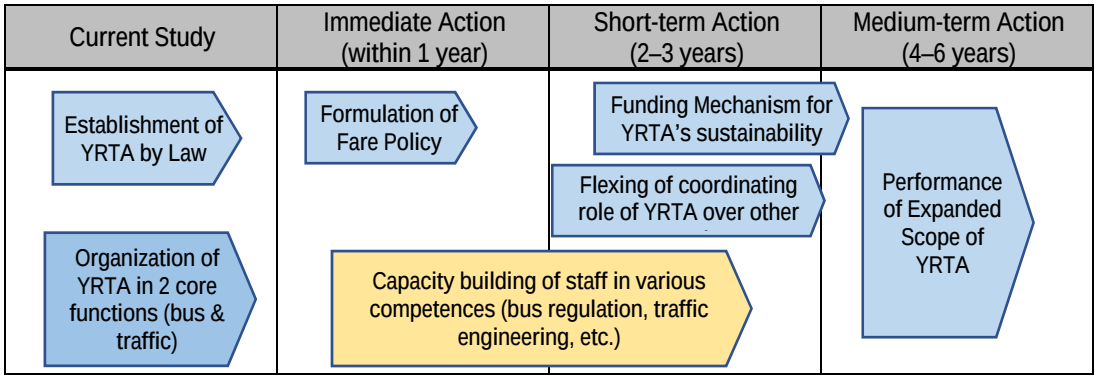


Figure 14.2.9 Roadmap for YRTA Strengthening