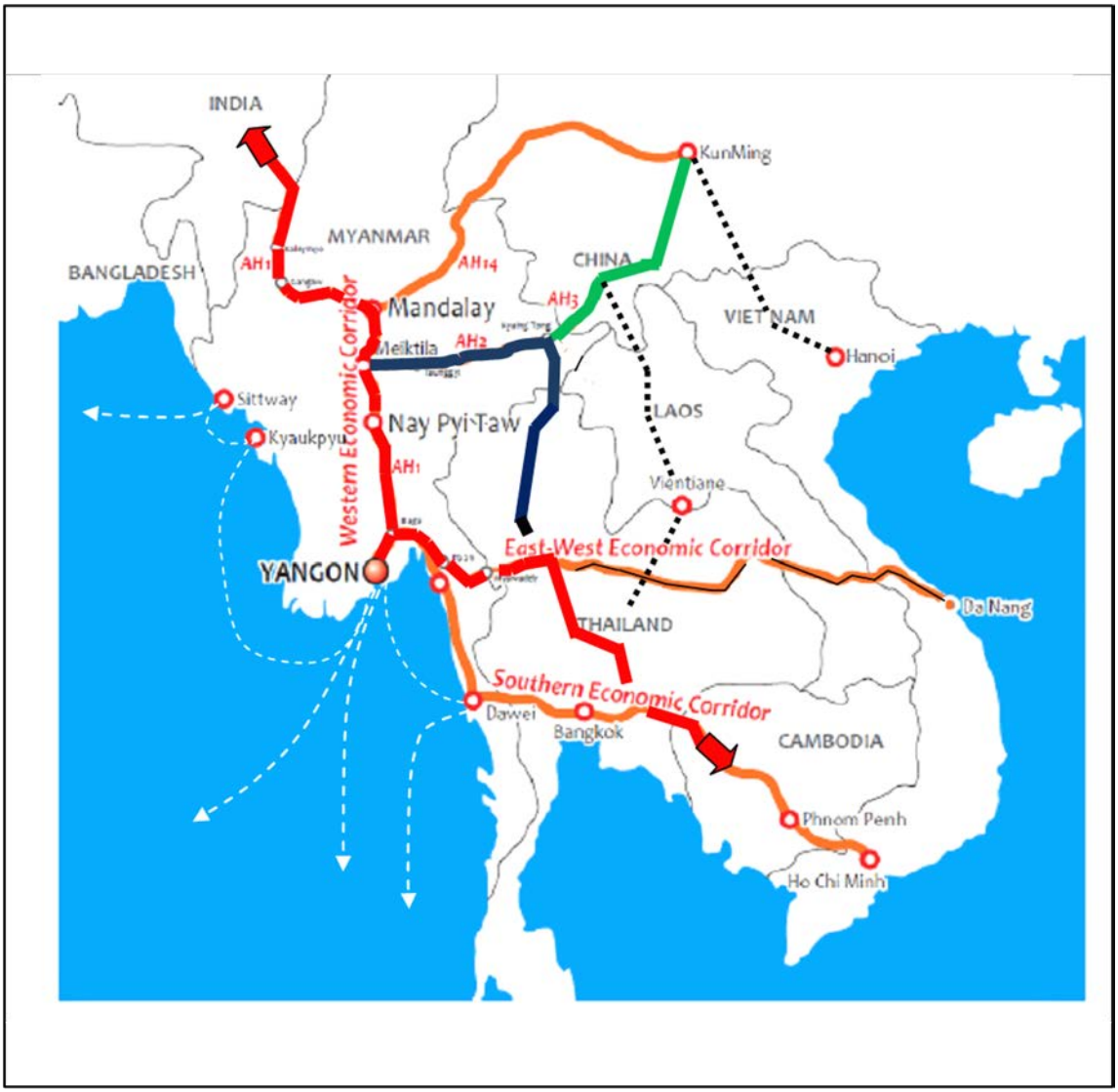
2.3.2 Road Network

(1) Road Network in the Greater Mekong Subregion and Myanmar

1) Asian Highway in Myanmar and Greater Mekong Subregion (GMS)

Greater Yangon is connected with its neighboring GMS countries through the Asian Highways (AH), as shown in Figure 2.3.23. The four routes crossing the national border are designated as parts of the Asian Highway in Myanmar. These four routes also partly overlap with the three economic corridors in GMS, namely, the Western Economic Corridor (AH-1) to Kun Ming in China, the East-West Economic Corridor to Da Nang in Vietnam, and the Southern Economic Corridor to Bangkok and Ho Chi Minh City.



Source: JICA Study Team

Figure 2.3.23: Economic Corridors in GMS to/from Yangon

Table 2.3.13 provides the detailed route information and functions of the Asian Highways in Myanmar.

Table 2.3.13: Asian Highway Routes in Myanmar

Route No.	Origin and Destination in Myanmar	Length (km)	Function
AH-1	Myawadi (Thailand Border) – Thaton – Phayargy – Meiktila – Mandalay – Pale – Gangaw – Kalaymyo – Tamu (Indian Border)	1,554	-Capital Cities Linkage -Industrial/Agricultural Centers -Access to Main Ports
	Phayagy – Bago – Yangon	96	
AH-2	Tacheleik (Thailand Border) – Kyaing Tong – Meiktila	807	-Capital Cities Linkage -Industrial/Agricultural Centers
AH-3	Minela (China Border) – Kyaing Tong	93	-Industrial/Agricultural Centers
AH-14	Musai (China Border) – Larshio – Mandalay	453	-Industrial/Agricultural Centers -Access to Main Ports
	Total (4 Routes)	3,003	

Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan,
Original Source: Asian Highway Database 2005

The present conditions of the Asian Highway in Myanmar (3,003 km in total length) are summarized in Table 2.3.14 below. The sections with two or more lanes of paved road are only 49% of the total, and the sections with one lane of paved or unpaved (gravel/earth) road are 51% (see Table 2.3.14). In addition, almost all sections of main roads paved with asphalt have deteriorated due to the passing of heavy trucks. Therefore, it is necessary to expand one-lane sections, to pave the gravel sections, and to carry out maintenance works of paved roads.

Table 2.3.14: Condition of Asian Highway in Myanmar

Route No.	Total Length (km)	Paved		Unpaved	
		Two lanes or more	One lane	Gravel	Earth
AH-1	1,650	969	467	214	
AH-2	807	50	541	216	
AH-3	93		5	40	48
AH-14	453	453			
Total	3,003	1,472	1,013	470	48
(%)	(100.0%)	(49.0%)	(33.7%)	(15.7%)	(1.6%)

Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan
Original Source: Asian Highway Database 2005

2) Road Network in Myanmar

The total length of intercity roads in Myanmar under the Ministry of Construction (MOC) (Public Works Department) is 39,083 km. The road lengths by surface type are as shown in Table 2.3.15 below. More than 50% of the roads are still unpaved. Figure 2.3.24 shows the road network in the entire country.

Table 2.3.15: Road Length and Surface Type of Intercity Road Network under MOC (2012)

Road Classification	Concrete	Bituminous	Gravel	Metalled	Earth Road	Donkey	Total
Highway	612	11,733	2,441	2,700	1,974	44	19,503
Regional and State Roads	50	5,452	3,300	2,941	6,497	1.340	19,580
Total	661 (1.7%)	17,185 (44.0%)	5,740 (14.7%)	5,642 (14.4%)	8,471 (21.7%)	1,384 (3.5%)	39,083 (100%)

Source: Department of Public Works, MOC

Source: JICA Study Team

Figure 2.3.24: Road Network in Myanmar

The Yangon-Nay Pyi Taw-Mandalay Expressway (520 km) opened in 2009. It has two lanes each for one direction (total of four lanes), and the speed limit is at 100 km/h. At present, heavy trucks are not allowed to use this expressway.

3) Linkage Between the Nationwide Road Network and Greater Yangon

The gateways to the nationwide road network from Greater Yangon are shown in Figure 2.3.25. The main roads located at the gateways are as follows:

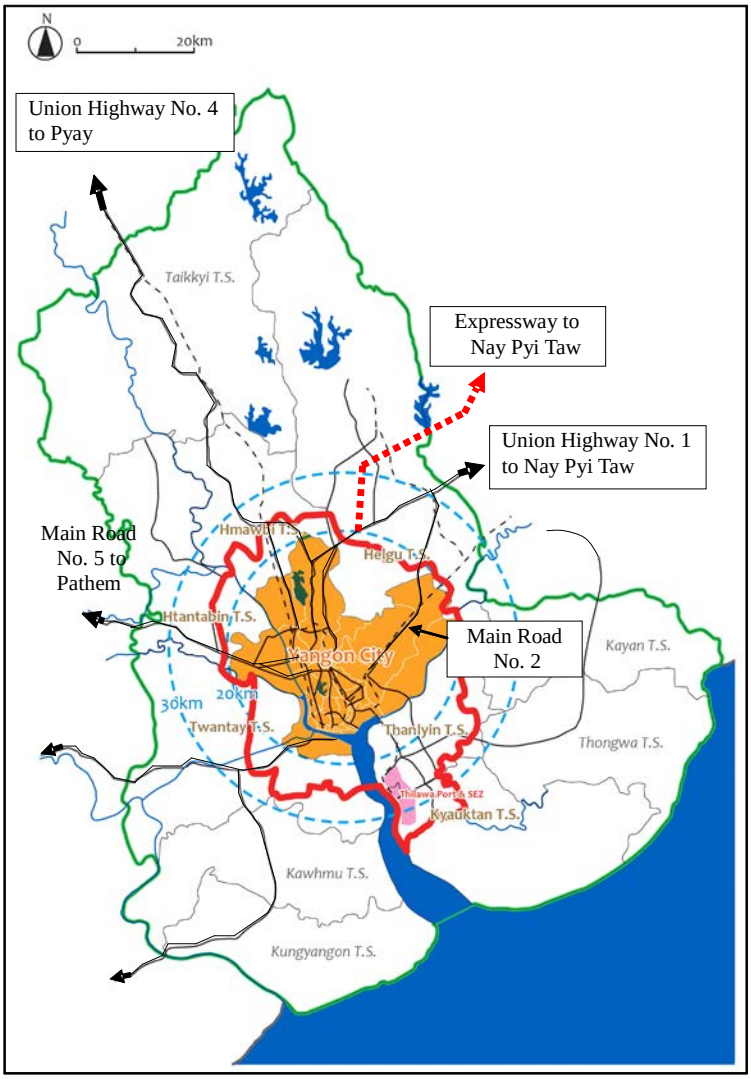
i) Yangon-Mandalay Expressway (to Nay Pyi Taw and Mandalay)

ii) Union Highway No. 1 and No. 2 (to Nay Pyi Taw and Mandalay)

iii) Main Road No. 3 (to Nay Pyi Taw and Mandalay via Union Highway No. 1)

iv) Union Highway No. 4 (to Pyay)

v) Main Road No. 5 (to Pathem in Ayeyarwaddy Region)



Source: JICA Study Team

Figure 2.3.25: Gateways to Nationwide Road Network

Of these gateway roads, Union Highway No. 1 is one of the most important backbone roads which connect Nay Pyi Taw and Mandalay with Greater Yangon.

(2) Road Network in Greater Yangon

Roads are the most dominant mode of urban transportation in Yangon City. Roads cover 95% of all inland passenger traffic (refer to Figure 2.3.25 above).

The history of the road network in Yangon City is intertwined with the history of the city itself and its port activities.

There was an old road network surrounding Shwe Dagon Pagoda which was rebuilt in 1572 and Sule Pagoda. The town was located to the east of Sule Pagoda. The Bago River was silting up off Thanlyin

and sea vessels had difficulty in navigating the reaches opposite the town. Thus, Dagon (renamed to "Yangon" in 1775) became the main port.

After the war with the British in 1852, Dr. William Montgomery, Superintendent Surgeon of the British Troops, made a new city plan with grid-patterned streets based on a road which ran along the port (currently called "Strand Road"). Then, Lieutenant A. Fraser had been assigned the design task based on Dr. Montgomery's plan. The main roads were given names from eminent personnel and the minor roads were numbered. The main roads running parallel from west to east include Strand Road, Merchant Road, Dalhousie (Maha Bandoola) Road, Fraser (Anawrahta) Road, and Montgomery (Bogyoke Aung San) Road.

World War II left great damage to Yangon City, particularly to the road network and its drainage system, and this led to a massive influx of refugees into the city. These people squatted on public land such as on roads and sidewalks.

In order to accommodate the massive population, Yangon City was extended to the west by three 100-feet roads, three 50-feet roads and twenty-two 30-feet roads, and to the east by three 50-feet roads and twenty-two 30-feet roads. The suburbs of Kyimyindaing, Ahlone, Pazundaung, Yegyaw, Myaynigone, Kamayut were incorporated into the town and Voyle Road (U Wisara Road) was added as another northward road to Prome Road (Pyay Road).

1) Current Road Network Hierarchy

Roads are classified into some types by MOC, as shown in Table 2.3.16.

Table 2.3.16: Road Classification

Road Classification	Functions and Design Features	ROW (m)	Cross Section Elements	Speed (km/h)
Expressways	Provide metropolitan and city continuity and unity. Limited access: some channelized grade crossing and signal at major intersection. Parking prohibited.	45-90	3.6 m per lane, 2.4-3.0 m shoulders, 2.4-7.2 m median strip	80
Major Roads	Provide unity through contiguous urban areas. Usually from boundaries for neighborhoods. Minor access control; parking generally prohibited.	30-45	Minimum four lanes; 1.8-4.2 m median strip	56-72
Secondary Roads	Main feeder streets. Signals where needed; stop signs on side streets. Occasionally from boundaries from neighborhoods.	24-30	2@3.6 m or 4@3.6 m traffic lanes; 2@3.0 m parking lanes	56-64
Collector Streets	Main interior streets. Stop sign on side streets.	18-24	2@3.6 m traffic lanes; 2@3.0 m parking lanes	48
Local Streets	Local service streets. Nonconductive to through traffic.	12-18	2@2.7-3.3 m traffic lanes	40
Cul-de-sac	Street open at only one end, with provision for a practical turnaround at the other.	9 (27 m dia. turnaround)		

Source: Regulation of DHSHD, Ministry of Construction, Sep. 2010

Although the Yangon City Development Committee's (YCDC's) classification is based on the road width and number of lanes, the functions of each road are defined as follows:

i) Main Road: Connects major cities and towns with paved type links

ii) Collector Road: Secondary paved roads connecting with cities/towns with main roads

iii) Minor Road: Other roads connecting towns

Major roads in Yangon City are listed in Table 2.3.17 and are illustrated in Figure 2.3.26.

Table 2.3.17: Major Roads in Yangon City

No.	Name of Road	Direction and Number of Lanes	Type of Road Surface
MAIN ROADS (RADIAL UNION HIGHWAY)			
1	No. (1) Main Road	2-way, 6-lanes	Asphalt
2	No. (2) Main Road	2-way, 2-lanes	Asphalt
3	No. (3) Main Road	2-way, 4-lanes	Asphalt
4	No. (4) Main Road	2-way, 4-lanes	Asphalt
5	No. (5) Main Road	2-way, 4-lanes	Asphalt
6	No. (6) Main Road	2-way, 4-lanes	asphalt
COLLECTOR ROADS (NORTH-SOUTH)			
7	Bayint Naung Road	2-way, 6-lanes	Asphalt
8	Kyeemyindang Road	2-way, 6-lanes	Asphalt
9	Upper Kyeemyindang Kanner Road	2-way, 4-lanes	Asphalt
10	Insein Road	2-way, 6-lanes	Asphalt
11	Pyay Road	2-way, 6-lanes	Asphalt
12	U Wisara Road	2-way, 6-lanes with median	Asphalt
13	Thu Damar Road	2-way, 6-lanes	Asphalt
14	Kaba Aye Pagoda Road	2-way, 6-lanes	Asphalt
15	Shwe Dagon Pagoda Road	2-way, 4-lanes	Asphalt
16	Zoological Garden Street	2-way, 6-lanes	Asphalt
17	Thein Byu Road	2-way, 4-lanes	Concrete/Asphalt
18	Waiza Yan Tar Road	2-way, 6-lanes	Asphalt
19	Upper Pazundaung Road	2-way, 4-lanes	Asphalt
20	Lower Pazundaung Road	2-way, 4-lanes	Asphalt
21	Than Thu Mar Street	2-way, 6-lanes	Asphalt
COLLECTOR ROADS (WEST-EAST)			
22	Khayae Pin Road	2-way, 2-lanes	Asphalt
23	Lanthit Road	2-way, 4-lanes	Asphalt
24	Thamaing Buteryone Road	2-way, 4-lanes (2-way, 2 lanes on Baynt Naung Bridge)	Asphalt
25	Kyaik Wine Pagoda Road	2-way, 4-lanes	Asphalt
26	Kabar Aye Pagoda Road	2-way, 4-lanes	Asphalt
27	Parami Road	2-way, 4-lanes	Asphalt
28	Hledan Road	2-way, 6-lanes	Asphalt
29	University Avenue Road	2-way, 4-lanes	Asphalt
30	Dharma Zedi Road	2-way, 6-lanes with median	Asphalt

No.	Name of Road	Direction and Number of Lanes	Type of Road Surface
31	Shwe Gone Dine Road	2-way, 6-lanes	Asphalt
32	Nat Mauk Street	2-way, 6-lanes	Asphalt
33	Ahlone Road	2-way, 6-lanes	Asphalt
34	U Htaung Road	2-way, 4-lanes with median	Asphalt
COLLECTOR ROADS (NORTH-SOUTH inside the CBD)			
35	Phone Gyee Street	2-way, 4-lanes	Asphalt
36	Sule Pagoda Road	2-way, 6-lanes with median	Asphalt
37	Pansodan Street	2-way, 4-lanes	Asphalt
38	Bo Myat Htun Road	2-way, 4-lanes	Asphalt
39	Bo Tha Htaung Payar Road	2-way, 4-lanes	Asphalt
COLLECTOR ROADS (WEST-EAST inside the CBD)			
40	Bogyoke Aung San Road	1-way, 4-lanes	Asphalt
41	Anawrahta Road	1-way, 3-lanes	Asphalt
42	Mahabandoola Road	1-way, 4-lanes	Asphalt
43	Merchant Road	1-way, 3-lanes	Asphalt
44	Strand Road	2-way, 6-lanes	Asphalt

Source: Prepared by JICA Study Team based on information from YCDC

Source: JICA Study Team based on information from YCDC

Figure 2.3.26: Current Road Network in Yangon City

The roads where heavy vehicles are allowed to pass are generally well-maintained with lane marks; however, the pavement of some roads are seriously damaged mainly due to the passing of heavy vehicles. Also, differential settlement was observed on many approach sections of the

structures (bridges/culverts). Crossfalls and clothoid curves were not properly installed at curve sections even on high-speed toll roads (YGN-NPT Expressway).

Table 2.3.18 shows the existing major bridges which cross Hlaing River, Bago River, Pazundaung Creek, and Twante Canal. These bridges are categorized as long span bridges and maintained by MOC.

Table 2.3.18: Major Bridges in Yangon City

Name of Bridge	Name of River/Creek	Type of Bridge (Superstructure)	Length (m)	Width (m)	Number of Lanes	Completion Year
Across Hlaing River						
Bayintnaung Br	Hlaing River	Steel Truss	500	12.8	2-lanes, 2-ways	1994
Aung Zaya Br	Hlaing River	Cable Stayed	1,152	16.0	4-lanes, 2-ways	2000
Shwe Pyi Thar Br	Hlaing River	Steel Truss	1,041	19.7	4-lanes, 2-ways	2001
Across Bago River						
Thanlyin Br	Bago River	Steel Truss	1,822	21.0		1993
Dagon Br	Bago River	PC/RC	1,384	25.6	6-lanes, 2-ways	2007
Across Pazundaung Creek						
Mahabandoola Br	Pazundaung Creek	Cable Stayed	1,110	25.6	6-lanes, 2-ways	2000
Thaketa Br	Pazundaung Creek	Bascule	approx. 285	-	2-lanes, 2-ways	1967
Nga Moe Yeik Br	Nga Moe Yeik Creek	Steel Truss	approx. 290	-	1-lane, 1-way	-
Thuwunna Br	Nga Moe Yeik Creek	PC Box	300	11.8	2-lanes, 2-ways	1985
New Thuwunna Br	Nga Moe Yeik Creek	PC/RC	296	18.3	2-lanes, 2-ways	2007
No.2 Road Br	Nga Moe Yeik Creek	RC	213	25.6	6-lanes, 2-ways	1999
Parami Br	Nga Moe Yeik Creek	RC	202	12.2	2-lanes, 2-ways	1997
Industrial Road Br	Nga Moe Yeik Creek		approx. 200	-	2-lanes, 2-ways	-
Across Twante Canal						
Twante Br	Twante Canal	Suspension	1,088	11.0	2-lanes, 2-ways	2006
Pan Hlaing Br	Pan Hlaing River	PC/RC	591	11.0	2-lanes, 2-ways	2005

Source: JICA Study Team based on information from YCDC

The major deformations observed by the JICA Study Team are the following:

i) Differential settlement on the approach section of bridges (e.g. at Aung Zaya Bridge)

ii) Rust and corrosion on steel truss bridges (e.g. at Bayintnaung Bridge)

iii) Peeling of the painting system (e.g. at Thaketa Bridge)

iv) Opening of finger joint (e.g. at Twante Bridge)

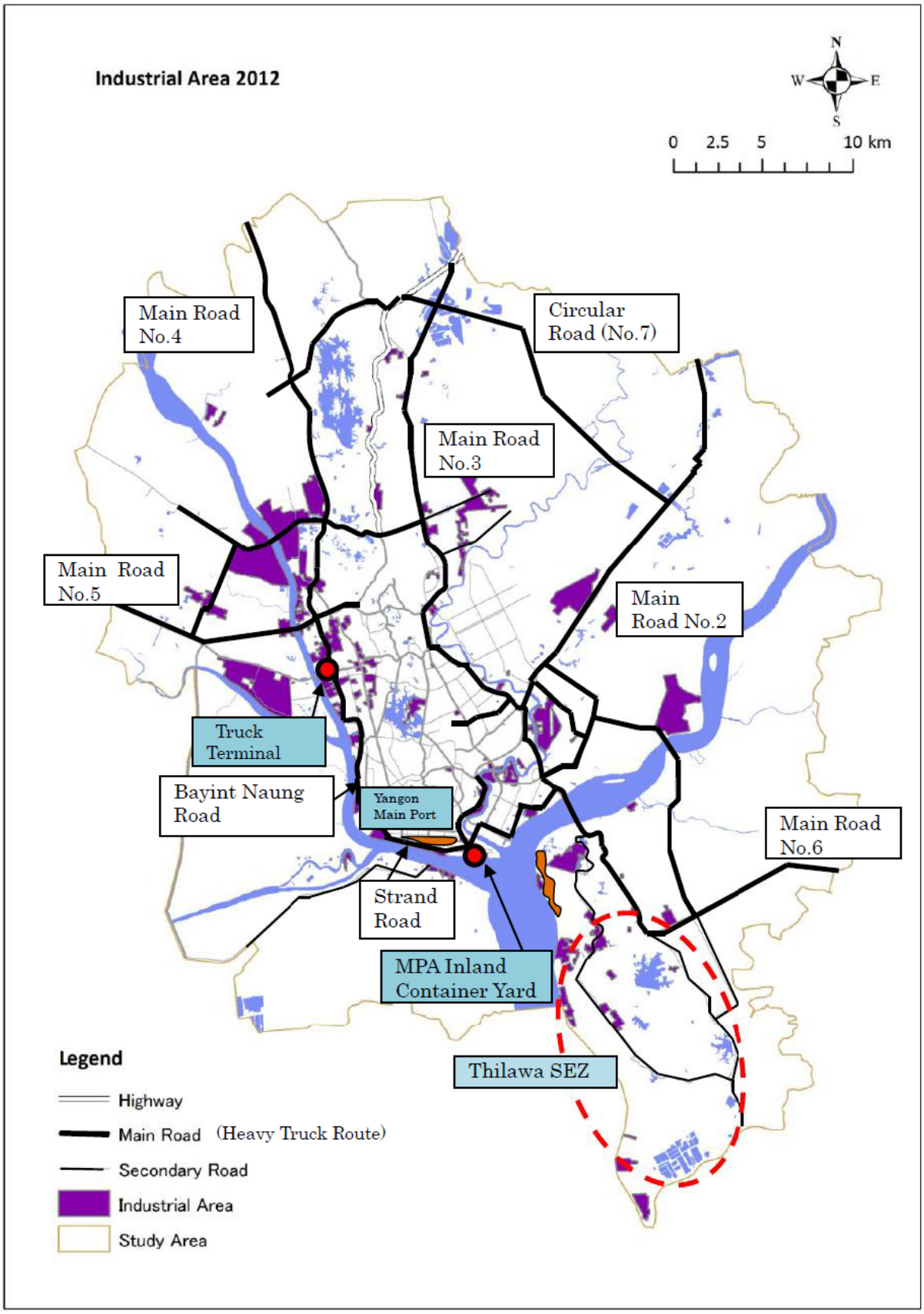
It is recommended to conduct a detailed investigation to check the existing conditions of the bridge structures.

2) Road Network Configuration

At shown in Figure 2.3.27 above, the existing main road network in Greater Yangon has a radial pattern (except the inside of the CBD), and there are no clear circular links connecting through the west and east areas. Rivers and creeks prevent the formulation of easy connections in the west-east direction. In addition, all main radial roads (Nos. 1, 2, 3, and 4) have a common destination toward the CBD, which is located at the south part along the Yangon River. This urban structure and road network configuration are the main reasons for traffic congestion at peak hours in the morning and the afternoon.

3) Connectivity with Port Facilities, Logistic Functions and Industrial Zones

Figure 2.3.27 shows the main roads connecting the ports, logistic facilities and industrial areas.



Source: JICA Study Team (based on information from the Traffic Regulation Control Committee, YCDC)

Figure 2.3.27: Connectivity with Ports, Logistic Facilities and Industrial Areas

Originally, industrial areas were developed along the Hlaing River in the west parts of Yangon City and along the Bazundaung Creek. Industrial zones in the northwest area are connected with the existing Yangon Port by Main Road No. 4, Bayint Naung Road and Strand Road. The Thilawa SEZ is also linked with the CBD by Thanlyin Bridge and Strand Road. There are some industrial zones along Main Road No. 2. Another industrial zone is located near Dagon Bridge. Since the loading limit of the existing Thanlyin Bridge is only 30 tons, many heavy trucks prefer to use Dagon Bridge since its maximum loading is 75 tons.

It should be noted, however, that the existing Main Road No. 2 has only two lanes in the suburbs and it will become difficult to handle the large number of heavy trucks that will be generated from the Thilawa SEZ going and coming to/from the nationwide road network via Union Highway No. 1. Therefore, it is necessary to expand Main Road No. 2 to at least four lanes before the Thilawa SEZ is completed by 2015.

(3) Road Administration

Table 2.3.19 shows the length of roads in Myanmar and the responsible authorities of such roads by type of road surface.

Table 2.3.19: Road Length and Responsible Authorities in Myanmar (km)

Responsible Authorities	Type of Road Surface						Total
	Concrete	Bituminous	Gravel	Metalled	Earth Road	Donkey	
MINISTRY OF CONSTRUCTION (MOC), DEPARTMENT OF PUBLIC WORKS							
Highway	612	11,733	2,441	2,700	1,974	44	19,503
Regional and State Roads	50	5,452	3,300	2,941	6,497	1,340	19,580
Subtotal	**661**	**17,185**	**5,740**	**5,642**	**8,471**	**1,384**	**39,083**
Yangon Region (under MOC)	61	648	127	73	71	-	980
MINISTRY OF PROGRESS OF BORDER AREA AND NATIONAL RACES							
Urban Road	7	4,881	2,216	661	3,509	-	11,273
Village and Border Road	120	4,073	17,042	4,977	55,889	-	82,100
Subtotal	**127**	**8,954**	**19,257**	**5,638**	**59,398**	**-**	**93,373**
YANGON CITY DEVELOPMENT COMMITTEE (YCDC)							
Subtotal	**1,240**	**1,748**	**13**	**455**	**473**	**-**	**3,928**
MANDALAY CITY DEVELOPMENT COMMITTEE							
Subtotal	**11**	**573**	**120**	**-**	**310**	**-**	**1,014**
NAYPYITAW CITY DEVELOPMENT COMMITTEE							
Subtotal	**246**	**129**	**43**	**735**	**1,131**	**-**	**2,284**
ARMY CORPS OF ENGINEER							
Subtotal	**393**	**62**	**605**	**166**	**6,823**	**-**	**8,050**
MINISTRY OF ELECTRIC POWER 1 (MOEP-1)							
Subtotal	**48**	**89**	**542**	**-**	**280**	**-**	**959**
TOTAL	**2,726**	**28,739**	**26,320**	**12,635**	**76,885**	**1,384**	**148,690**

Source: Department of Public Works, MOC, reported in 2012

The roads inside Yangon City, which has 33 townships, are under the responsibility of YCDC, and the roads beyond these 33 townships are maintained by MOC and the Department of Development Affairs (DDA) under the Yangon Regional Government.

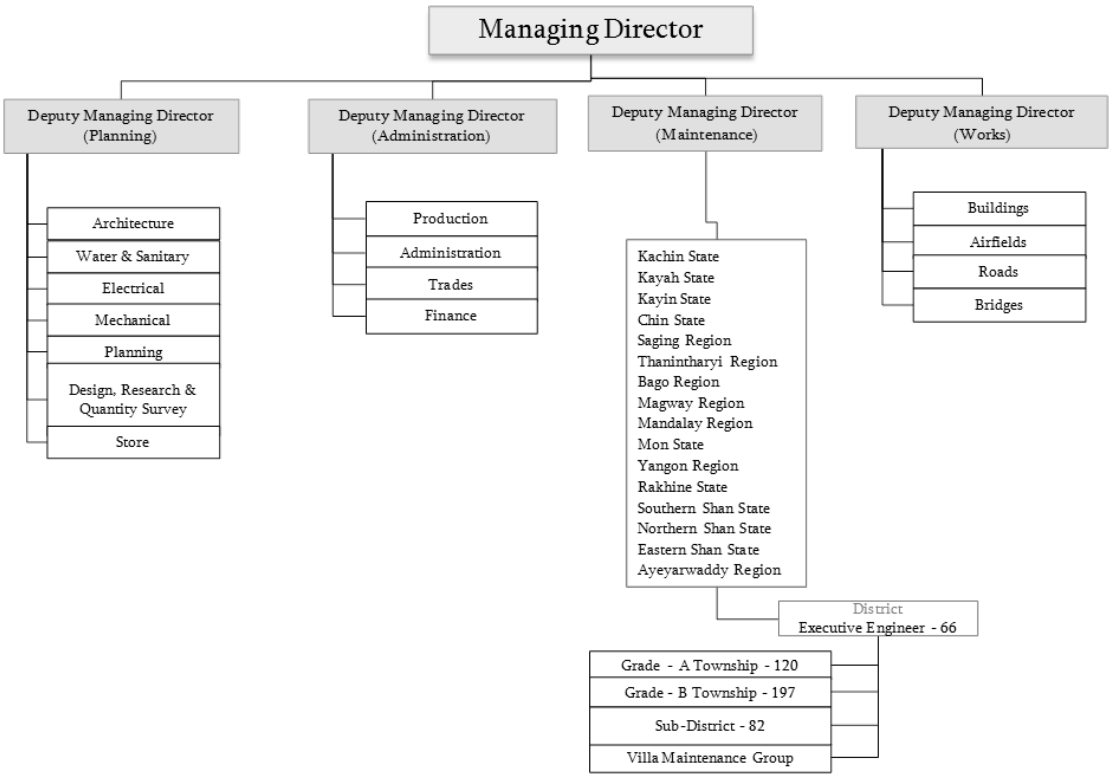
The major bridges across the Yangon River, Bago River and Pazundaung Creek in Yangon City are maintained by MOC, and the bridges across the railway tracks are maintained by Myanmar Railways under the Ministry of Railway Transportation.

1) Ministry of Construction

The Department of Public Works of MOC is responsible for planning, construction, and operation and maintenance of the "union highways" and "regional and state roads" in Myanmar.

The maintenance of the roads, including the union highways in Yangon City (33 townships), is the responsibility of YCDC. The maintenance of major bridges crossing rivers and creeks is still conducted by MOC.

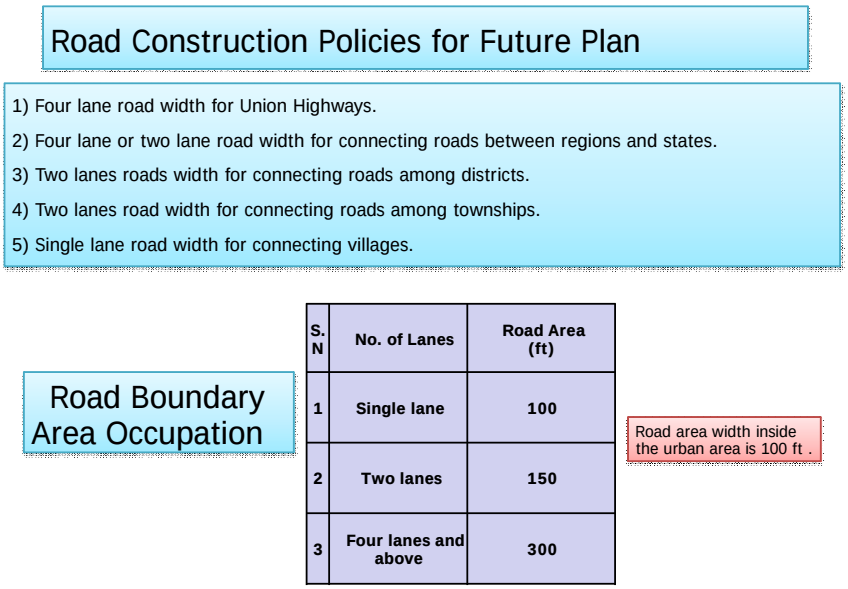
The organization chart of the Department of Public Works is shown in Figure 2.3.28.



Source: Department of Public Works, MOC

Figure 2.3.28: Organization Chart of the Department of Public Works, MOC

Figure 2.3.29 summarizes the road construction policies and future plan by MOC. According to such policies, the target of the improvement of the roads has been set based on the target number of lanes to be simply determined by the type of roads.



Source: Department of Public Works, MOC

Figure 2.3.29: Road Construction Policies for Future Plan of the Department of Public Works, MOC

The target number of lanes shall be technically determined from results of demand forecast based on traffic analysis. Comprehensive traffic data collection shall be urgently required for effective road planning.

2) Yangon City Development Committee (YCDC)

The Engineering Department of Roads and Bridges of YCDC is responsible for the construction and maintenance of roads inside Yangon City (33 townships). Currently, the number of staff in charge of bridges is very minimal, whereas MOC and Myanmar Railways are responsible for most bridges in Yangon City.

(4) Financing for Construction and Maintenance of Roads

1) Public Financing

It was reported by several news media on 3 July 2012 that YCDC is struggling to acquire more financial resources amounting to MMK 70 billion for its annual budget.

For the 2012-2013 fiscal year, YCDC plans to spend around 21% of its budget of MMK 55.52 billion on maintenance and construction of major roads and bridges, according to the statement released by YCDC.

2) Private Financing

The build-operate-transfer (BOT) scheme had been introduced in Myanmar in 1996. The concession period is usually set to 40 years with three times of five-year extensions. According to MOC, the number of registered enterprises is 61 companies, and 29 companies are currently running road operations in Myanmar.

As shown in Table 2.3.20, 15.1% of the total roads under MOC are maintained under BOT scheme.

Table 2.3.20: Road Length under BOT Scheme in Myanmar

No.	State or Region	Road Length under MOC (km)	Road Length under BOT Scheme (km)	Ratio of BOT Scheme
1	Kachin State	3,740.5	486.4	13.0%
2	Kayah State	804.7	0.0	0.0%
3	Kayin State	1,811.3	259.5	14.3%
4	Chin State	1,977.1	0.0	0.0%
5	Sagaing Region	4,322.9	521.8	12.1%
6	Tanintharyi Region	1,363.7	0.0	0.0%
7	Bago Region	2,167.8	744.2	34.3%
8	Magwe Region	3,321.1	592.0	17.8%
9	Mandalay Region	2,514.4	1,165.4	46.3%
10	Mon State	733.7	259.3	35.3%
11	Rakhine State	1,745.1	180.6	10.3%
12	Yangon Region	980.3	428.9	43.8%
13	Shan State	11,052.8	1,021.9	9.2%
14	Ayeyarwaddy Region	2,547.2	235.8	9.3%
Total		**39,082.5**	**5,896.0**	**15.1%**

Source: Department of Public Works, MOC, reported in 2012

In Yangon Region, 43.8% of the roads under MOC are maintained under BOT scheme.

In Yangon City, Asia World Port Management Co., Ltd. is upgrading Strand Road with rigid pavement under a concession agreement with YCDC.

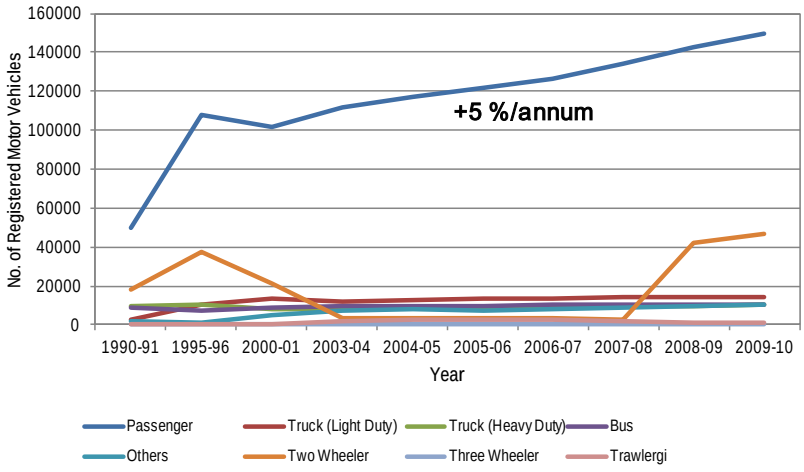
3) External Assistance for Road Sector

No external foreign assistance is currently provided to the road sector in Yangon City.

(5) Traffic Condition

1) Roads

Due to the rapid increase of the number of vehicles, serious traffic congestion is observed on the main roads of Yangon City, especially during the morning and evening peak hours. Even during the daytime, traffic congestion is seen on: 1) roads that are heavily damaged (Strand Road, Kyee Myin Dine Road, Bayint Naung Road, and Upper/Lower Pazundang Road), and 2) roads near schools and shopping centers.



Source: Statistics Yearbook 2010, Central Statistical Organization (Published in 2012)

Figure 2.3.30: Registered Motor Vehicles by Type in Yangon City (1990-2010)

Ordinarily, to establish the future improvement plan of the road network, traffic data such as traffic counts, OD interviews, etc. shall be continuously collected. However, such data are not available in Yangon. The latest traffic survey was conducted in 2004 for three days covering 17 points on the roads under the study of the "Yangon Strategic Development Plan 2020, YCDC, 2006".

A preliminary road capacity analysis has been conducted by the JICA Study Team. Table 2.3.21 shows the results of the analysis showing the required number of lanes of major roads in Yangon City, referring to the results of the abovementioned traffic survey data taken in 2004. The growth ratio of the traffic volume has been referred to the annual growth of registered vehicles from 1990 to 2010 (+5%/annum).

Table 2.3.21: Estimation of Required Number of Lanes of Major Roads

Name of Road	Estimation of Traffic Volume (PCU/h) Upper: Morning Peak Lower: Evening Peak				Capacity per Lane (PCU/lane /h)	Current Number of Lanes per Direction	Required Number of Lanes per Direction Upper: Morning Peak Lower: Evening Peak			
	2012	2020	2025	2030			2012	2020	2025	2030
Insein Road	957	1,415	1,805	2,304	1,287	3 lanes	0.7	1.1	1.4	1.8
	1,028	1,519	1,939	2,475			0.8	1.2	1.5	1.9
Pyay Road	3,524	5,206	6,645	8,480	1,020	3 lanes	3.5	5.1	6.5	8.3
	2,847	4,206	5,369	6,852			2.8	4.1	5.3	6.7
Kabar Aye Pagoda Road	2,656	3,925	5,009	6,393	1,020	3 lanes	2.6	3.8	4.9	6.3
	2,880	4,254	5,430	6,930			2.8	4.2	5.3	6.8
Lower Pazundaung Road	2,105	3,111	3,970	5,067	1,020	2 lanes	2.1	3.0	3.9	5.0
	2,144	3,167	4,042	5,159			2.1	3.1	4.0	5.1
Swe Dagon Pagoda Road	2,569	3,796	4,845	6,183	1,020	2 lanes	2.5	3.7	4.7	6.1
	2,645	3,907	4,987	6,365			2.6	3.8	4.9	6.2
Baintnaung Road	2,819	4,165	5,316	6,784	1,020	3 lanes	2.8	4.1	5.2	6.7
	2,320	3,427	4,374	5,582			2.3	3.4	4.3	5.5
Parami Road	1,501	2,218	2,831	3,613	1,020	2 lanes	1.5	2.2	2.8	3.5
	1,433	2,117	2,702	3,449			1.4	2.1	2.6	3.4

Note: ▓▓▓ indicates "shortage of the number of lanes".

- Traffic volume in each year was calculated based on the traffic counting results by YCDC in 2004 with 5.0% annual growth ratio.
- Capacity per lane was determined referring to the HCM (Base Capacity: 1650 for divided road, 1500 for undivided road) with side friction factors (0.78 for divided road, 0.68 for undivided road).

Source: JICA Study Team based on the Yangon Strategic Development Plan 2020, YCDC (2006)

According to the above analysis, most of the roads are getting congested, and immediate countermeasures shall be required. However, the widening of the existing roads will be quite difficult due to dense housing/properties along the roads. The construction of elevated roads (viaduct/flyover structures) and/or additional roads, such as outer ring roads, may be considered.

1) Bottleneck Points/ Sections

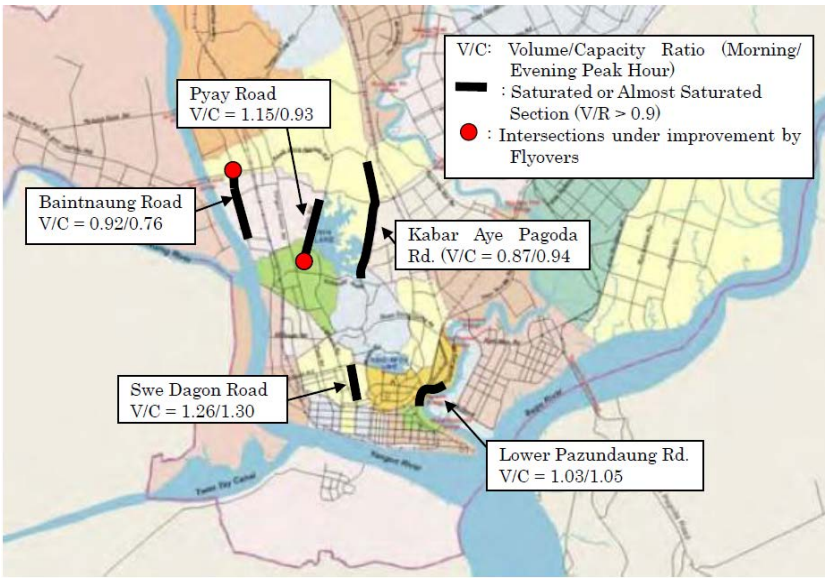
From the estimated traffic volume of 2012 in Table 2.3.21 above, the volume/capacity ratio (V/C) of each road section were calculated to identify the main bottleneck points. Such values are shown in Table 2.3.22 and Figure 2.3.31. A bottleneck point is defined as a road section which has traffic volume during peak hours that exceed or almost reach its capacity.

The main bottleneck points are observed at the entrance of the CBD (Shwe Dagon Pagoda Road with V/C=1.3, and Lower Pazundaung Road with V/C=1.1), and road sections near the inner urban ring zone (Pyay Road, Kabar Aye Pagoda Road, and Baintnaung Road).

Table 2.3.22: V/C of Major Roads (2012)

Name of Road	Traffic Volume (pcu/hr/direction) Upper: Morning Peak Lower: Evening Peak		Capacity per lane (pcu/ Lane/hr)	Current Number of lanes per direction	Volume/ Capacity Ratio (V/C) 2012
	2004	2012			
Insen Road	648	957	1287	3	0.25
	696	1028	1287	3	0.27
Pyay Road	2385	3524	1020	3	1.15
	1927	2847	1020	3	0.93
Kabar Aye Pagoda Rd.	1798	2656	1020	3	0.87
	1949	2880	1020	3	0.94
Lower	1425	2105	1020	2	1.03
Pazundaung Rd.	1451	2144	1020	2	1.05
Swe Dagon	1739	2569	1020	2	1.26
Pagoda Rd.	1790	2645	1020	2	1.30
Baintnaung Rd.	1908	2819	1020	3	0.92
	1570	2320	1020	3	0.76
Parami Rd.	1016	1501	1020	2	0.74
	970	1433	1020	2	0.70

Source: JICA Study Team based on the Yangon Strategic Development Plan 2020, YCDC (2006)



Source: JICA Study Team.

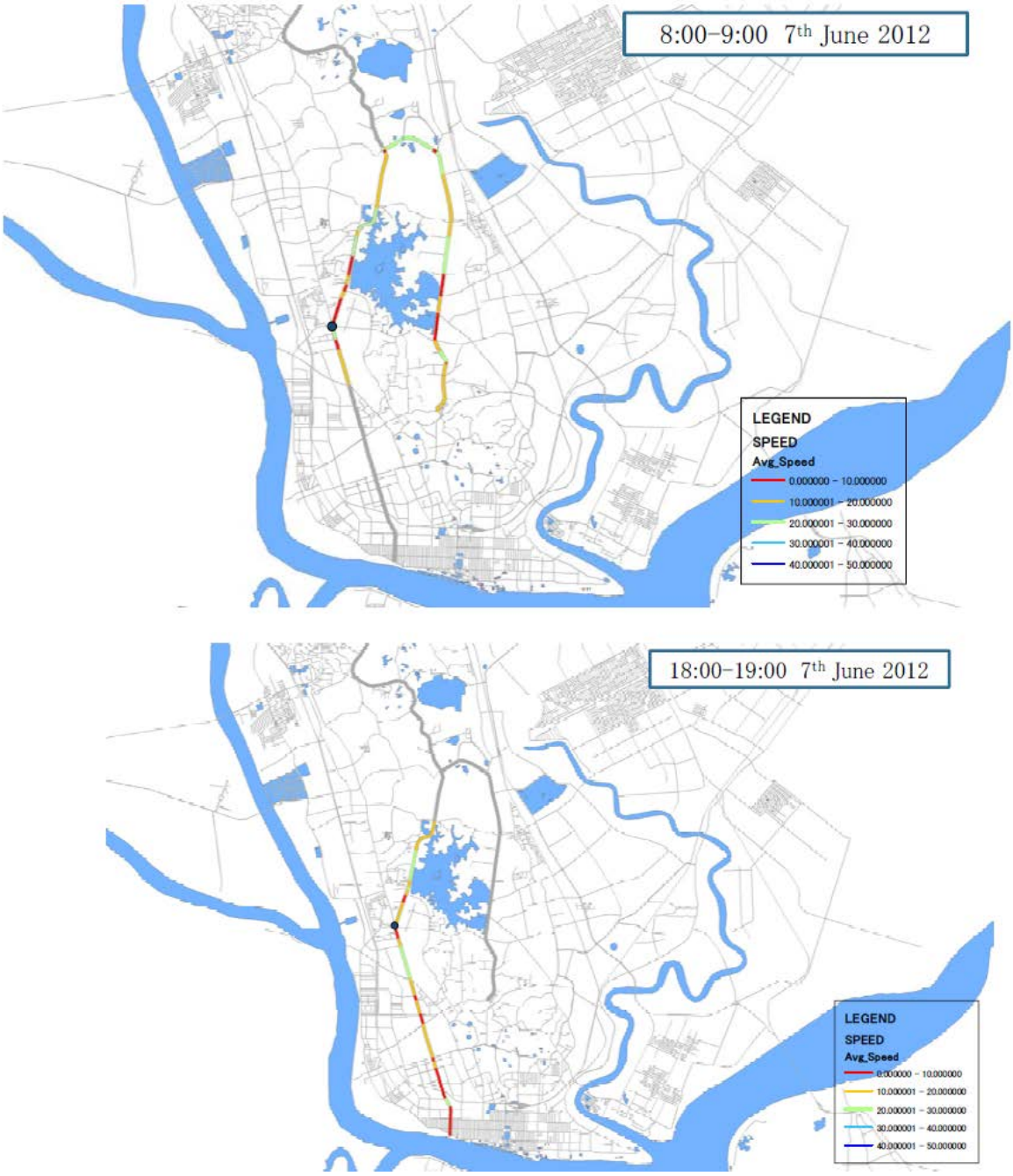
Figure 2.3.31: Bottleneck Points

Although these bottleneck sections are located on main roads with four to six lanes, too many more vehicles than the link capacity are concentrated on these road sections and intersections during peak hours.

2) Travel Speed on Main Roads during Peak Hours

In a different JICA study, travel speed surveys were carried in the morning and evening peak hours along Pyay Road and Kabar Aye Pagoda Road in June 2012. The average speed during morning peak hours at the same bottleneck points analyzed above in terms of V/C was very

slow at less than 10 km/h. The average travel speed in and near the CBD during evening peak hours was also less than 10 km/h.



Source: "Data Collection Survey for Intelligent Transportation System on Yangon, Myanmar" June 2012, JICA

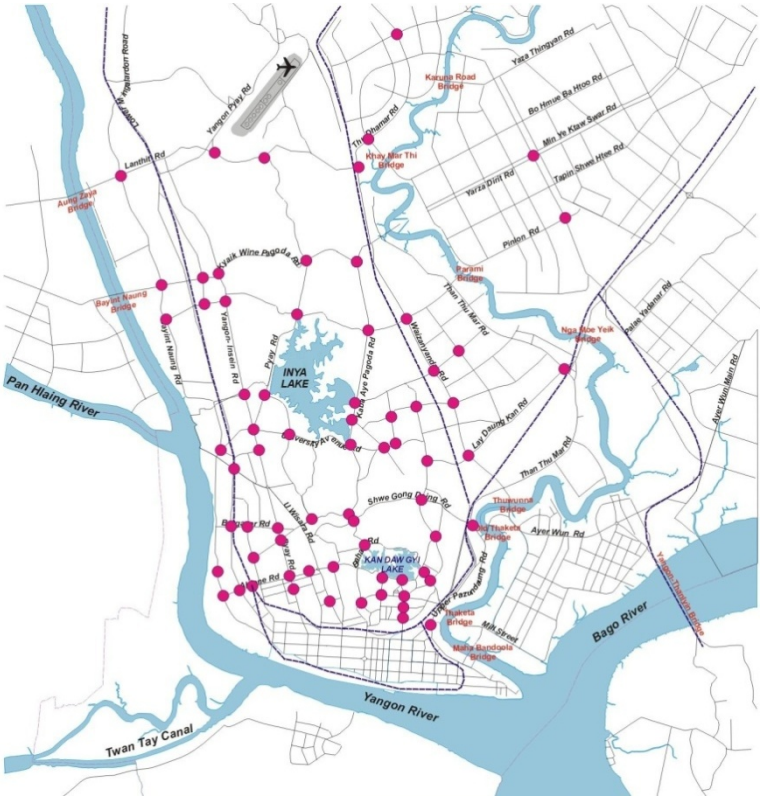
Figure 2.3.32: Average Travel Speed during Peak Hours on Selected Main Roads

2) Intersections

At intersections in Yangon City, traffic congestion was also observed.

The intersections in Yangon City are generally classified into 1) signalized intersections, 2) non-signalized intersection, and 3) roundabouts.

Figure 2.3.33 shows the locations of signalized intersections in Yangon City.



Source: Yangon Strategic Development Plan 2020, YCDC (2006)

Figure 2.3.33: Locations of Existing Signalized Intersections (Outside the CBD)

Regarding intersection configuration, improvements such as adding more lanes will be necessary considering the long queues at intersections.

YCDC is constructing flyovers at seriously congested intersections. Further construction of flyovers may also be considered.

3) Comprehensive Transport Network System which Supports Strategic Urban Development

The UMRT system will play a major role in providing people smooth mobility in the metropolis, while a functional road network system will provide valuable urban space and environment as well as basic infrastructure for urban economic activities. A functional road network will consist of major arterials, and secondary arterials and local distributors, and these functional roads are effectively connected forming a grid pattern or a radial-circumferential pattern and so forth. The current road network system in Yangon forms a grid pattern with north-south major roads; however, a grid patterned road network system is weak, as it is likely to induce bottlenecks because of the traffic demand concentrated on the specific road sections and intersections. On the other hand, a circumferential road has a vital traffic dispersal function which will be required in the future road network system of Yangon so as to promote smooth and efficient urban development. The functional road network system and the UMRT network system are connected effectively and strategically, forming a comprehensive transport network system. In addition, the comprehensive transport network should be linked with international ports and airports in order to contribute to the economic development of Myanmar. In particular, coordination with the Thilawa Port development project in the Yangon port area and a new international airport project should be considered.

(6) Traffic Conditions in the CBD

In the CBD of Yangon, there are 46 signalized intersections at present. The one-way system is adopted to the east-west directions together with the two-way system on the north-south roads. However, due to the many traffic signal intersections and no signal coordination, long waiting times and long queues are often observed at these intersections. These delays and long queues are mainly caused by inappropriate signal operations. Therefore, improvement of signal operations and control will be necessary to realize smooth traffic flows. Advanced signal systems such as Area Traffic Control System (ATCS) will be effective in reducing traffic congestion.

Another traffic issue in the CBD is on-road parking which reduces road capacity. At present, parking on designated road sections in the CBD is illegal and restricted. However, as there is much shortage in parking spaces, strict control or regulations have not been applied to parking on roads even in restricted roads in the CBD. (Parking is permitted in restricted zones if parking fees are paid.) Considering the recent rapid growth of car ownership, comprehensive parking policies including preparation of off-street parking spaces and improvement of public transport services are urgently needed. Figure 2.3.34 shows the current on-road parking restricted roads in the CBD. These restricted zones (roads) had been decided and declared by YCDC in 1995 based on the YCDC Order No. 1/95 and started on 1 September 1995 covering the roads listed below. Restriction of on-road parking is from 8:00 a.m. to 6:00 p.m.

(i) Eastward: Bo Aung Kyaw Street

(ii) Backward: Lan Ma Daw Street

(iii) Northward: Bo Gyoke Aung San Road

(iv) Southward: Kann Narr (Strand) Road

However, it is described in the above declaration that parking is permitted if parking fees are paid (MMK 200/h). Therefore, there is actually no strict restriction taken and still a lot of vehicles park in designated parking restricted zones.

Maha Bandoola Garden Street
(near YCDC)

Parking Restricted Zone
Many vehicles are parking
(Bo Aung Kyaw Street)

Parking Restricted Zone
Congested with parking vehicles
(Bo Aung Kyaw Street)

Parking Restricted Zone
Vehicles are parking in both sides
(Bo Aung Kyaw Street)

Source: JICA Study Team

Figure 2.3.34: Parking Restricted Roads in the CBD

Slow moving vehicles, such as tricycles, are also restricted to enter the following roads in the CBD (YCDC Notification Order No. 1/99, May 1999):

(i) Eastward: Thei Phyu Road

(ii) Southward: Merchant Road

(iii) Westward: Lanmadaw Road

(iv) Northward: Bo Gyoke Aung San Road

The restriction of slow moving vehicles (non-motorized vehicles, including bicycles) to enter the CBD should be continued and maintained in order to maintain smooth traffic flows and prevent traffic accidents.

However, it is also emphasized that the preparation of separate lanes for bicycles, which would enable access to green belts and waterfront facilities in and around the CBD, is recommended from the viewpoint of the environment and comfort to residents' daily lives in Yangon.

(7) Traffic Accidents

1) Number of Accidents

Tables 2.3.23 and 2.3.24 show the past trend of the number of road accidents by vehicle type in Greater Yangon.

The following characteristics are pointed out from these tables:

i) The number of total accidents generally increased from 2008 to 2011 for accidents which resulted in deaths and injuries; although, the numbers slightly decreased in 2010.

ii) Accidents in 2011 recorded the highest number in the past four years (208 died, and 1,830 injured).

iii) Many accidents mainly involved buses and own cars. Particularly, accidents related to buses per 10,000 vehicles shows an extremely high number (i.e., 697.5 in 2011) as compared with other vehicles. The reasons for the high accident rate of buses were due to their operation system to pick up/drop passengers on the road side, fast driving speed, and overloading of passengers.

Table 2.3.23: Past Trend of Road Traffic Accidents

Vehicle Type	No. of Accidents							
	Died				Injured			
	2008	2009	2010	2011	2008	2009	2010	2011
Taxi	5	8	7	12	109	112	96	153
Bus	64	63	71	61	609	778	501	823
Own Car	58	98	65	90	358	597	504	679
Container	19	26	23	35	66	99	91	142
Others	7	11	9	10	43	33	59	33
Total	153	206	175	208	1,185	1,619	1,251	1,830

Source: Traffic Police, Ministry of Home Affairs

Table 2.3.24: Number of Accidents per 10,000 Vehicles

Vehicle Type	No. of Accidents per 10,000 vehicles							
	Died				Injured			
	2008	2009	2010	2011	2008	2009	2010	2011
Taxi	3.59	5.64	4.90	7.44	78.16	79.00	67.26	94.88
Bus	59.53	59.12	63.22	51.69	566.46	730.04	446.09	697.46
Own Car	4.58	7.39	4.60	6.10	28.26	45.03	35.69	45.98
Container	8.05	10.67	8.59	13.02	27.95	40.62	33.98	52.83
Others	7.04	10.70	7.98	8.76	43.25	32.10	52.30	28.90
Total	8.27	10.72	8.55	9.72	64.08	84.29	61.10	85.56

Source: Traffic Police, Ministry of Home Affairs

The numbers of accidents by township in 2011 are summarized in Table 2.3.25.

The highest numbers of accidents were observed in Hlaing Tharyar Township (268) and Mingalardon Township (237). In Mingalardon Township, Main Roads No. 1 and No. 3 run in the north to south direction at the center of the township. Hlaing Tharyar Township is located at the entrance of the busiest road, that is, Main Road No. 4.

In order to eliminate the influence of the area of townships, the number of accidents per square mile was calculated as well. As shown in Table 2.3.25 below, the highest accident density (per square mile) was observed in the CBD with an average of 46.7 per square mile. Other townships with high accident density are Bahan (34.3), Sanchaung (51.0) and Kamaryut (30.4), which are also located in the Inner Urban Ring zone and connected to the CBD via Main Roads No. 1, No. 3 and No. 4.

Table 2.3.25: Number of Accidents by Township (2011)

No.	Township	No.of Accidents			Population	Area	Per	Per
		Death	Injured	Total	(2011)	(s.q.mile)	10,000 pop	s.q. mile
1	Pazuntaung	2	8	10	53,648	0.39	1.86	25.6
2	Botahtaung	2	47	49	49,134	0.96	9.97	51.0
3	Kyauktada		21	21	34,797	0.28	6.04	75.0
4	Lanmadaw	6	21	27	43,137	0.54	6.26	50.0
5	Latha		12	12	34,125	0.31	3.52	38.7
6	Pabedan	1	9	10	37,551	0.28	2.66	35.7
	CBD	**11**	**118**	**129**	**252,392**	**2.76**	**5.11**	**46.7**
7	Dagon	1	41	42	24,492	1.96	17.15	21.4
8	Bahan	11	106	117	100,695	3.41	11.62	34.3
9	Seikkan	2		2	2,241	6.41	8.92	0.3
10	Dawbon	2	25	27	87,284	1.47	3.09	18.4
11	Kyeemyindaing	5	25	30	115,841	4.81	2.59	6.2
12	Mingalar Taung Nyunt	2	37	39	155,767	1.96	2.50	19.9
13	Ahlone	1	20	21	65,510	1.04	3.21	20.2
14	Sanchaung	2	47	49	105,208	0.96	4.66	51.0
15	Tarmwe	2	40	42	191,114	1.71	2.20	24.6
	Inner Urban Ring	**28**	**341**	**369**	**848,152**	**23.73**	**4.35**	**15.5**
16	Dala	n.a.	n.a.	n.a.	181,087	3.90	n.a	n.a
17	Seik gyi Kha Naung To	n.a.	n.a.	n.a.	38,425	2.27	n.a	n.a
	South of CBD				**219,512**	**6.17**		
18	North Okkalapa	5	53	58	333,484	10.32	1.74	5.6
19	South Okkalapa	4	40	44	191,388	3.93	2.30	11.2
20	Thaketa	9	50	59	253,284	4.93	2.33	12.0
	Older Suburbs Zone	**18**	**143**	**161**	**778,156**	**19.18**	**2.07**	**8.4**
21	Hlaing	15	85	100	151,014	5.26	6.62	19.0
22	Kamaryut	1	72	73	87,881	2.40	8.31	30.4
23	Thingangyun	8	99	107	231,621	4.40	4.62	24.3
24	Yankin	2	34	36	125,909	1.94	2.86	18.6
	Outer Ring Zone	**26**	**290**	**316**	**596,425**	**14.00**	**5.30**	**22.6**
25	Insein	13	138	151	311,200	13.52	4.85	11.2
26	Mingalardon	31	206	237	288,858	43.57	8.20	5.4
27	Mayangone	11	139	150	205,403	9.78	7.30	15.3
	Northern Suburbs	**55**	**483**	**538**	**805,461**	66.87	**6.68**	**8.0**
28	South Dagon	13	51	64	370,403	30.55	1.73	2.1
29	North Dagon	6	23	29	221,200	23.27	1.31	1.2
30	East Dagon	11	54	65	145,505	35.15	4.47	1.8
31	Dagon Seikkan	8	42	50	120,161	32.97	4.16	1.5
32	Shwe Pyi Thar	3	46	49	295,993	25.76	1.66	1.9
33	Hlaing Thar Yar	29	239	268	488,768	26.32	5.48	10.2
	New Suburbs Zone	**70**	**455**	**525**	**1,642,030**	**174.02**	**3.20**	**3.0**
	Sub-Total	**208**	**1830**	**2038**	**5,142,128**	**306.73**	**3.96**	**6.6**

Source: Traffic Police, Ministry of Home Affairs

2) Road Markings

Road markings for the center lines and side lanes are done on the main roads and are well-maintained in the CBD and urban areas. However, markings on main roads in the suburbs are not clear, and sometimes such markings are completely gone in the case of minor roads.

3) Driving Manners and Traffic Safety Measures

Drivers' manners are comparatively good in case of passenger cars. However, the problem is that buses, which often occupy one lane to pick up passengers alongside, occasionally stand by for a long time until the bus is full. As explained in the above analysis, the traffic accident rate of buses per 10,000 vehicles is extremely high. It was pointed out also that the pedestrian priority rule is not strictly observed; therefore, crossing roads is often dangerous for pedestrians. In order to reduce the number of accidents, measures such as construction of pedestrian crossing bridges to separate vehicles and pedestrian movements, and establishment of bus bays are necessary in addition to traffic safety education.

(8) Ongoing Projects and Existing Future Plan

1) Roads and Bridges

According to Article 10 of "The Yangon City Development Law (1990)", the Urban Planning Division of YCDC is responsible for urban planning of Yangon City.

YCDC established the "Yangon City Development Concept Plan" in February 2012, which includes the road network in Yangon City. This plan was prepared in reference to the Yangon Structure Plan (Vision 2040) by the Department for Human Settlement and Housing Development (DHSHD) of MOC.

The Yangon City Development Concept Plan proposed the following road-related surveys and projects:

1) Short-term Plan

- Construction of multilevel crossings (flyovers) at congested junctions, and planning of connections to the road network
- Survey for circular express roads

2) Medium-term Plan

- Construction of circular express roads
- Construction of bridges and tunnels that would cross rivers

3) Long-term Plan

- Link the circular express road with the inner city road network
- Construction of access-controlled express roads as multilevel roads

According to YCDC, the proposed road network was not planned based on traffic analysis. Therefore, it was proposed to conduct a survey for circular expressway roads in the short-term plan. However, it was noted that the inner ring road network proposed by DHSHD of MOC was not shown in the plan of YCDC. Besides, the outer ring road proposed by DHSHD has approximately 20-25 km radius, while the outer ring road proposed by YCDC has approximately 12-25 km radius. Such discrepancies need to be adjusted.

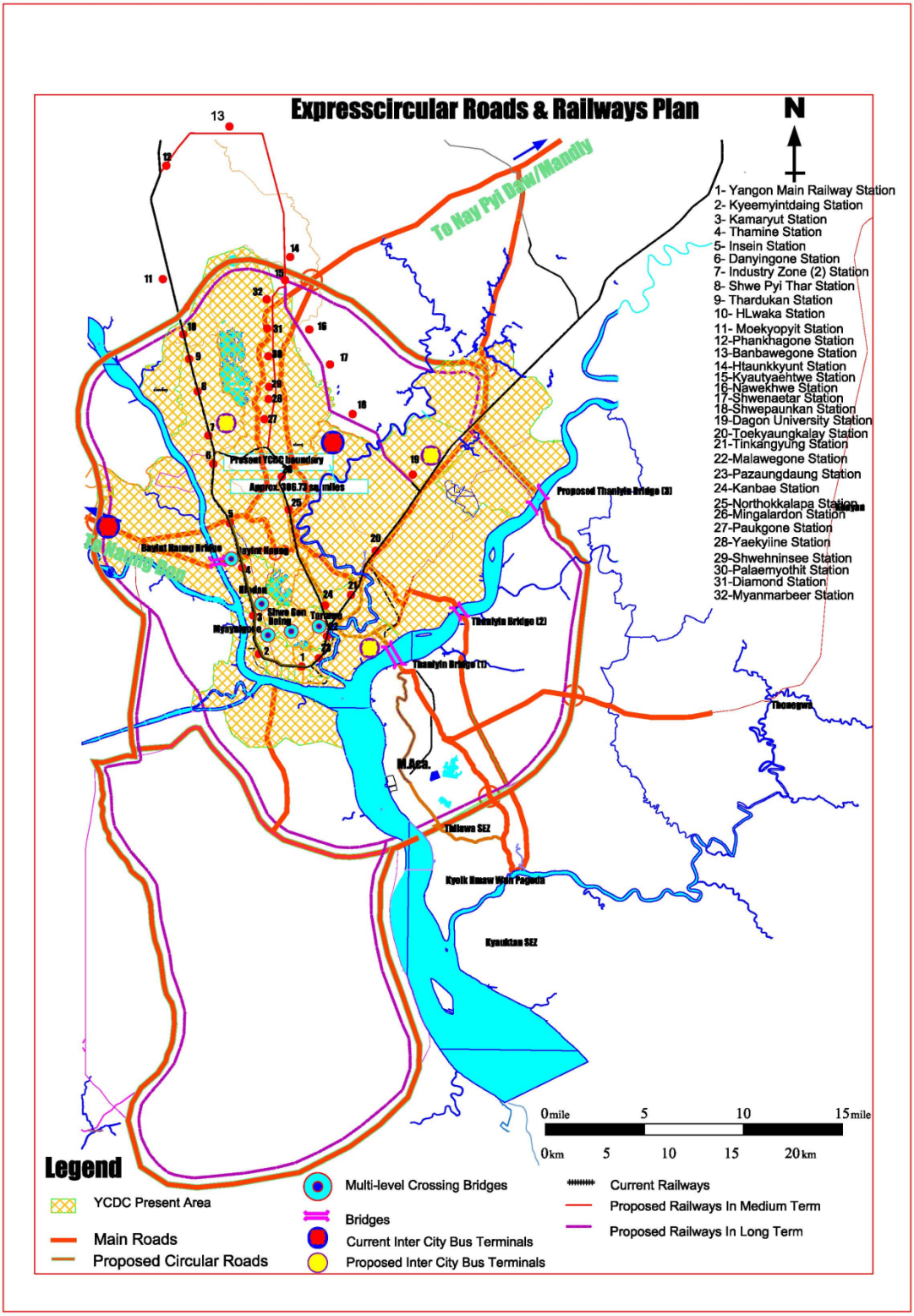
Table 2.3.26 shows comparison of ring roads in other Asian urban cities.

Table 2.3.26: Comparison of Ring Roads in Other Urban Cities

Countries	Expressway Ring Roads	Radius of Ring Roads (approximately)	Population of Cities
Thailand	Bangkok Expressway	R= 2-4 km (Inner Ring) R= 12-25 km (Outer Ring)	8.2 million (2010)
Japan	Tokyo Metro Expressway	R= 3 km (Inner Ring) R= 7-8 km (Outer Ring) R= 15 km (Outer Outer Ring)	13.2 million (2012)
Indonesia	Jakarta Intra Urban Toll Road Jakarta Outer Ring Road Jakarta Outer Outer Ring Road	R= 5 km (Inner Ring) R= 11 km (Outer Ring) R= 15-20 km (Outer Outer Ring)	9.6 million (2010)
Myanmar	Plan by YCDC	R= 12-25 km (Outer Ring)	10 million (estimated for 2040)
	Plan by DHSHD	R= 5-12 km (Inner Ring with six lanes) R= 20-25 km (Outer Ring with eight lanes)	

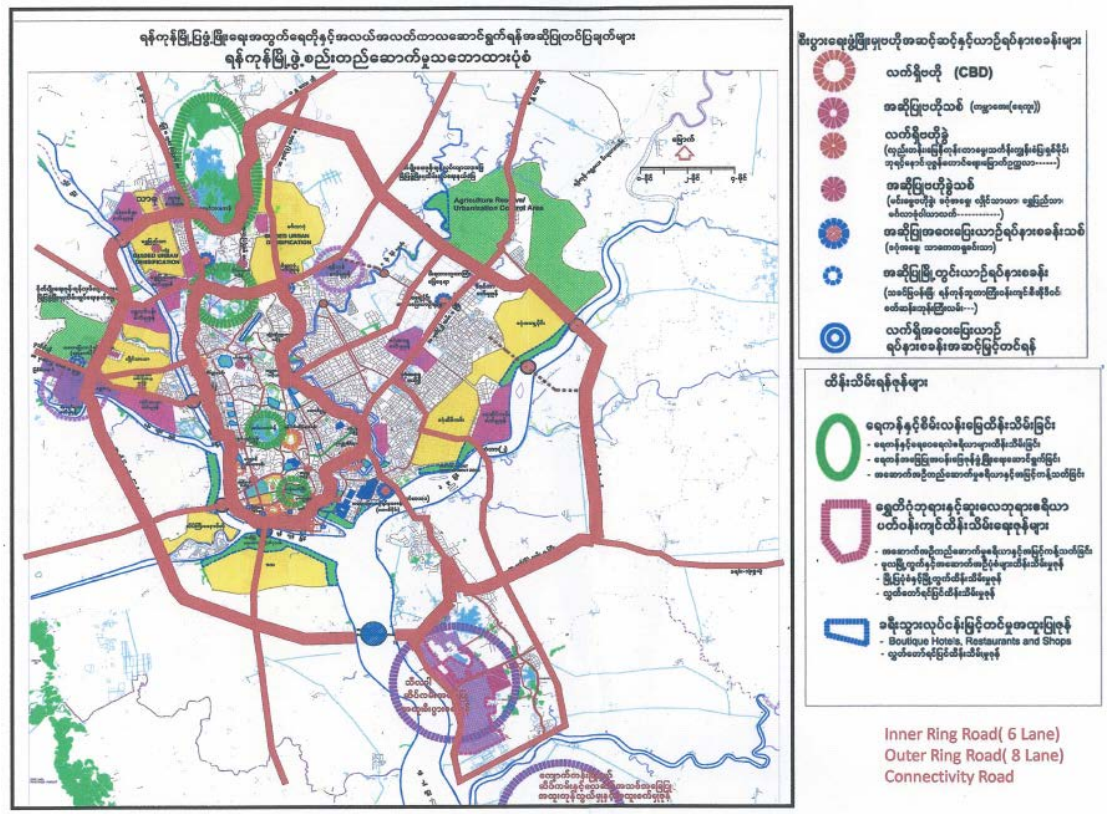
Source: JICA Study Team

The inner ring road may be reconsidered during the survey for circular expressway in the short-term plan.



Source: Yangon City Development Concept, 2012

Figure 2.3.35: Proposed Road Network in 2040 by YCDC



Source: Department of Public Works, MOC

Figure 2.3.36: Proposed Road Network in 2040 by MOC

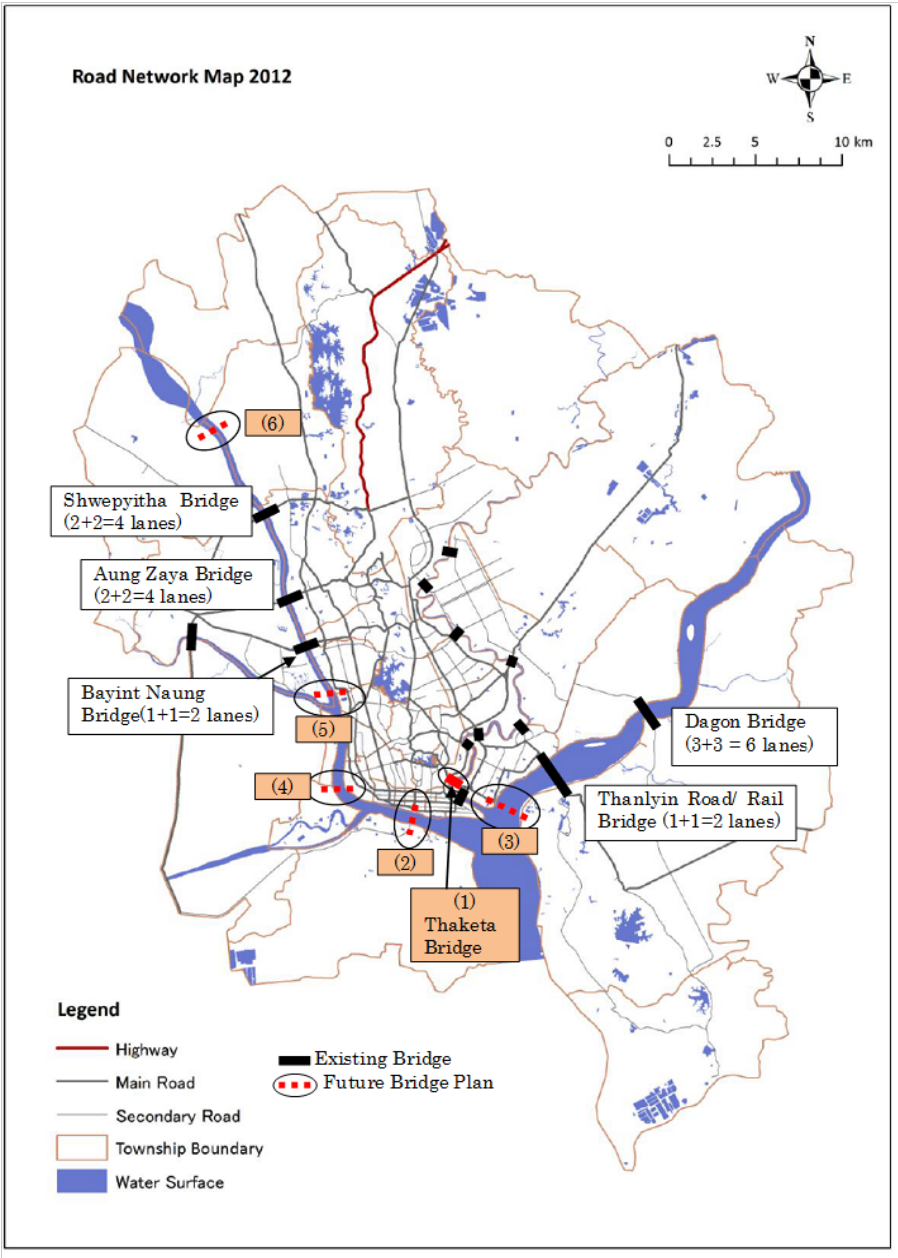
The MOC is planning to construct 18 bridges in Myanmar. Six of these bridges are planned in Yangon City, as listed in Table 2.3.27.

Table 2.3.27: New Bridges Proposed by MOC

No	Project Name	Type of Bridge	Name of Road	Location	Length of Bridge	
					Main Bridge (m)	Approach Bridge (m)
1	New Thaketa Bridge Projcet Across the Pazuntaung creek	Cable-stayed Steel Box PC Box	Thaketa-Dawpone	Pazuntaung/ Dawpone	190	-
					100	50
					110	45
2	Dala Bridge Across Yangon River/	Cable-stayed	Yangon-Dala Twantay- or Yangon Thanlyn	Yangon City		
3	Thaketa No. 2 Bridge across Bago River					
4	Kyimyindine Bridge	PC Box	Kyimyndine Aye Village Road	Kyimindine Yangon City	600	300 x 2
5	Bayintaung Bridge No .2 Across Hlaing River	PC Box or Extradose	Yangon Pathein Road	Insein Yangon City	600	300 x 2
6	Wataya Bridge Across Hlaing River	Suspension	Htantapin-Mhyawbi Road	Mhyawbi Yangon Div	300	200

Source: Department of Public Works, MOC, reported in 2012

Figure 2.3.37 shows the locations of existing and future planned bridges in Greater Yangon.



Note: Numbers in parentheses indicate the new bridges proposed by MOC as listed in Table 2.3.27.
Source: JICA Study Team (Future planned bridges were obtained from MOC)

Figure 2.3.37: Existing and Future Planned New Bridges

Since the existing Thanlyin Bridge crossing over the Bago River is a composite road/railway bridge (1 + 1 = 2 lanes) and the loading limit is set at 30 tons only, most heavy vehicles use Dagon Bridge instead to access the Thilawa SEZ by taking a detour route. The existing Bayint Naung Bridge crossing over the Hlaing River has only two lanes, which are not enough to handle a large number of vehicles from the western industrial areas. Therefore, the existing bridge capacity to cross over the Hlaing River and the Bago River is not sufficient and additional new bridges to strengthen the whole road network are necessary. Thaketa Bridge, which crosses over the Pazundaung Creek, was constructed in 1967 (45 years before); therefore, construction of the new Thaketa Bridge is planned.

2) Intersections

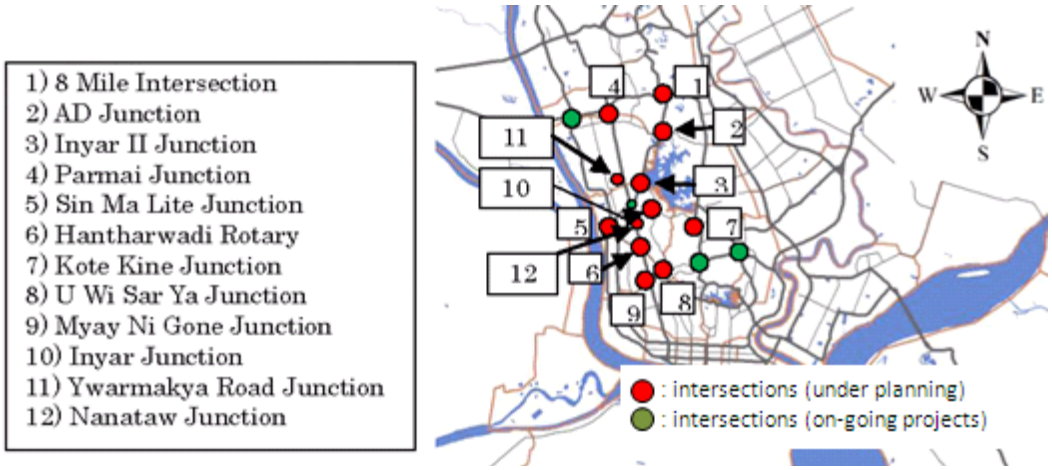
Table 2.3.28 shows the ongoing projects of YCDC for the improvement of intersections.

Table 2.3.28: Ongoing Intersection Projects

No.	Project Name	General Feature	Contractor	Consultant	Project Management Consultant
1	Bayintnaung Flyover Project (under construction)	2nd Layer Bridge L=435m PC-I Girder 3rd Layer Bridge L=736m PC-I Girder	First Myanmar Investment Co.,Ltd. (FMI) (Myanmar)	Asian Engineering Consultants Corp. Lts. (Thailand)	Asian Engineering Consultants Corp. Lts. (Thailand)
2	Hledan Flyover Project (under construction)	Steel-I Girder (30m/40m spans)	Shwe Taung Development Co., Ltd. (Myanmar)	T.Y.Lin International PTE. Ltd. (Singapore) VERTEX Asia Pacific PTE. Ltd. (Singapore)	Tokyu Construction Co., Ltd. (Japan)
3	Swegonedine Flyover Project (under construction)	Steel-Box Girder (41-46m spans)	Capital Development Ltd. (Myanmar)	Asian Engineering Consultants Corp. Lts. (Thailand) PSK Consultant Co., Ltd. (Thailand)	JFE Engineering Corporation (Japan)
4	Tar Mwe Intersection (not yet commenced)	Improvement of Intersection Shape	-	T.Y.Lin International PTE. Ltd. (Singapore) VERTEX Asia Pacific PTE. Ltd. (Singapore)	-

Source: Progress report of each intersection project provided by YCDC

Figure 2.3.38 shows the bottleneck intersections identified by YCDC.



Source: JICA Study Team

Figure 2.3.38: Bottleneck Intersections

Table 2.3.29 presents the outline features of each bottleneck intersection. The intersections marked in yellow are near or on the route of an ongoing project (under construction).

It may be recommended that the location of the intersection for the forward project will be selected among the intersections, except the ones marked in gray in Table 2.3.29 in order to

avoid serious traffic congestion due to the overlapping of construction periods with ongoing flyover construction projects.

Table 2.3.29: Inventory of Bottleneck Intersections

ID	Name of Junction	Shape	No. of Legs	Main Road (Main Traffic Flow)	Secondary Road/Street (Secondary Traffic Flow)
1	8 Mile Junction	Cross	4-legs	Pyay Rd	Kabaaye Pagoda Rd
2	AD Junction	Cross	4-legs	Pyay Rd	Parami Rd
3	Inyar II Junction	T	3-legs	Pyay Rd	Inya Rd
4	Parami Junction	Cross	4-legs	Insein Rd	Parami Rd
5	Sin Ma Lite Junction	Cross	6-legs	Kyee Myindaing Kanner Rd Bayint Naung Rd	Hledan Rd Nar Nattaw St other 2 minor street
6	Hantharwadi Rotary	Roundabout	4(5)-legs	Pyay Rd	Hanthawadi Rd U Wisara Rd (Zawgyi St)
7	Kote Kine Junction	Cross	4-legs	Kabaaye Pagoda Rd	University Avenue Rd
8	U Wisara Junction	Cross	4-legs	U Wisara Rd	Dharma Zedi Rd
9	Myay Ni Gone Junction	Cross	4-legs	Pyay Rd	Dharma Zedi Rd
10	Inyar Junction	Cross	4-legs	Inya Rd	University Avenue Rd
11	Ywar Ma Kyaung Road Junction	T (Cross)	3(4)-legs	Insein Rd	Ywar Ma Kyaung St
12	Nar Nattaw Junction	T	3-legs	Pyay Rd	Nar Nattaw St

Source: JICA Study Team

3) Necessary Data for Traffic Demand Forecast for Future Road Planning

In order to prepare appropriate road planning, future traffic demand forecast is essential. However, there has not been any comprehensive traffic demand forecast covering all transport modes in Yangon. At present, the data available are only the traffic count data at 17 road sections on the main roads, which were obtained in the traffic count survey in 2004 by the Yangon Strategic Development Plan 2020.

In addition to the updating of the above traffic data, the following data are necessary for the traffic demand forecast of all transport modes:

i) Origin-destination matrices by trip purpose and by transport mode based on the person trip survey

ii) Network data of all transport modes necessary for modal split model and traffic assignment simulations

(9) Key Findings and Main Issues to be Addressed for the Road Network

The current peoblems/ issues of road traffic in Greater Yangon are summarized below from both aspects of road infrastructure (hard components) and policy/ institutional framework (soft components).

1) Current Issues of Existing Road Infrastructure

a) Present Conditions of Road Network Configuration and Existing Bridges

As the Greater Yangon area is divided by Yangon River, Bago River, Hlaing River and other rivers and creeks, the development of the transport network is important to connect separated areas. Crossing rivers and creeks is one of the main constraints/obstacles to urban development in the east-west direction, thus, the road network and urban areas have been expanded mainly in the north-south direction. The ring road network system should be developed to connect the areas divided by the rivers; therefore, strengthening the east-west

arterial connection. In relation to this, the existing Thanlyin Bridge crossing over the Bago River is a composite road/railway bridge with one lane for one direction (1 + 1 = 2 lanes) and the loading limit is set at 30 tons only. Therefore, most heavy vehicles use Dagon Bridge instead to access the Thilawa SEZ by taking a detour route. As the vital project of Thilawa SEZ is shedulued to be opened in 2015, augmentation of capacity of the Bago River crossing and access roads to/from the Thilawa SEZ is urgently required. At the same time, the existing Bayint Naung Bridge crossing over the Hlaing River has also only two lanes, which are not enough to handle a large number of vehicles from the western industrial areas. Therefore, the existing bridge capacity to cross over the Hlaing River and the Bago River is not sufficient and additional new bridges to strengthen the whole road network are necessary. In addition, Thaketa Bridge, which crosses over the Pazundaung Creek, was constructed in 1967 (45 years before) and therefore, construction of the new Thaketa Bridge is planned. The Thanlyin Bridge and Bayint Naung Bridge were both constructed about 20 years before. The old bridges and insufficient capacity for crossing rivers are urgent issues.

b) Traffic Jam at Major Intersections and Road Sections

Due to the recent rapid growth of number of cars and due to the traffic concentration to the 4 main north-south roads which are directly connected with CBD, chronic and serious traffic jams have been observed especially in the peak hours at the intersections and road sections on the main north-south roads. Also, occasional traffic jams have been observed at the level crossing points with the railway. The traffic data available now is only the data of morning and evening peak hours at 17 survey points presented in "Yangon Strategic Development Plan, 2020, YCDC. From the estimated traffic volume of 2012 based on the above data, the volume/capacity ratio (V/C) of each road section was calculated to identify the main bottleneck points. A bottleneck point is defined as a road section which has traffic volume during peak hours that exceed or almost reach its capacity.

The main bottleneck points are observed at the entrance of the CBD (Shwe Dagon Pagoda Road with V/C=1.3, and Lower Pazundaung Road with V/C=1.1), and road sections near the inner urban ring zone (Pyay Road, Kabar Aye Pagoda Road, and Baintnaung Road).

As these road sections are located in the areas where road widening is very difficult, construction of flyovers and reconfiguration of intersections are required.

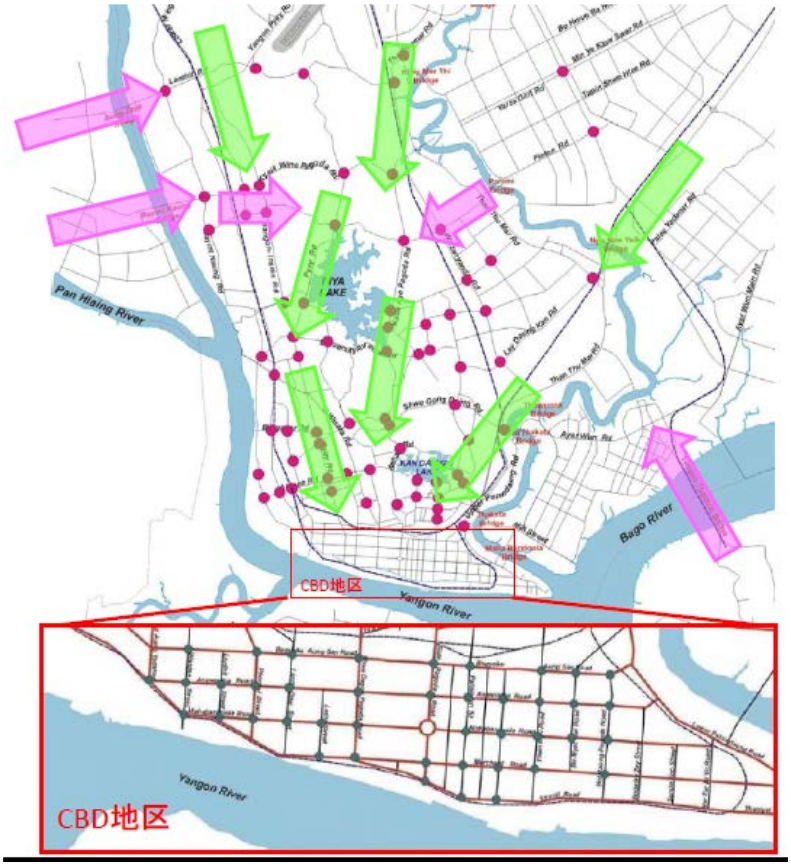
2) Current Issues of Traffic Policy and Institutions

a) Traffic Signal Operation in CBD and in Existing Urban Areas

In the CBD of Yangon, there are 46 signalized intersections at present. The one-way system is adopted to the east-west directions together with the two-way system on the north-south roads. However, due to the recent rapid traffic growth and due to the many traffic signal intersections and no signal coordination, long waiting times and long queues are often observed at these intersections. These delays and long queues are mainly caused by inappropriate signal operations. Therefore, improvement of signal operations and control (such as coordinated traffic signal system) will be necessary to realize smooth traffic flows together with the proper traffic demand management (TDM). Advanced signal systems such as Area Traffic Control System (ATCS) will be effective in reducing traffic congestion. At the same time, establishment of the preliminary traffic control center is required and then to expand its size and technical operational ability steadily.

In the existing urban areas near CBD, the main north-south roads (6 lanes: green arrows in the figure below) are directly connected with CBD and collecting the high traffic volume to/from

east-west roads (2-4 lanes: red arrows in the figure below). Although main intersections are already signalized, these existing signals are old-fashioned fixed cycle signals and it is difficult to control effectively the traffic fluctuations in main/ feeder roads. Improvement of existing intersections installing the variable cycle signals without the land acquisition are necessary and introduction of the Area Traffic Control System (ATCS) by the traffic control center is recommended as an immediate effective measure.



Source: JICA Study Tem (base map: from "Yangon Strategic Development Plan, 2020, YCDC, 2006)

Figure 2.3.39: Locations of Main Signalized Intersections and Road Network

b) Countermaeasure for On-Road Parking and Traffic Demand Management

Another traffic issue in the CBD is on-road parking which reduces road capacity. At present, parking on designated road sections in the CBD is illegal and restricted. However, as there is much shortage in parking spaces, strict control or regulations have not been applied to parking on roads even in restricted roads in the CBD. (Parking is permitted in restricted zones if parking fees are paid.) Considering the recent rapid growth of car ownership, comprehensive parking policies such as preparation of off-street parking spaces, public parking facility together with regulation of entering CBD by TDM and improvement of public transport services (including the improvement of the Yangon Central Station as an inter-modal facility) are urgently needed.

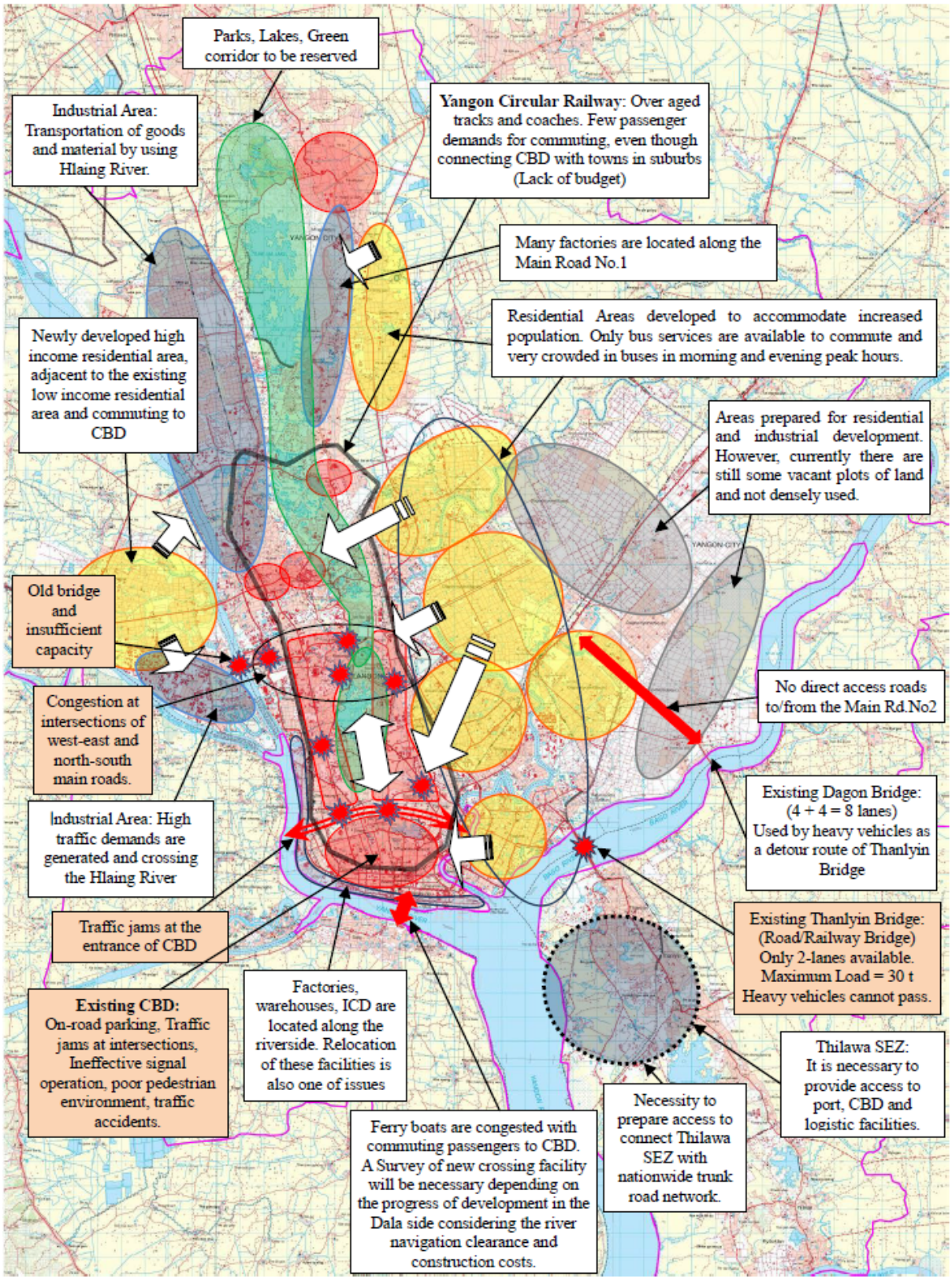
c) Traffic Safety

Drivers' manners are comparatively good in case of passenger cars. However, the problem is that buses, which often occupy one lane to pick up passengers, occasionally stand by for a

long time until the bus is full. Traffic accident rate of buses per 10,000 vehicles is extremely high (51.69 against 9.72 of average of all vehicles in case of fatality, 2011). It was pointed out also that the pedestrian priority rule is not strictly observed; therefore, crossing roads is in dangerous for pedestrians. In order to reduce the number of accidents, measures such as construction of pedestrian crossing bridges in order to separate vehicles and pedestrians movements, and establishment of bus bays are necessary in addition to enforcement of control to the traffic offence/ violation, and education of traffic rules traffic safety.

The current problems and issues in the road sector (including issues related to public transport) are summarized in Figure 2.3.40.

¥



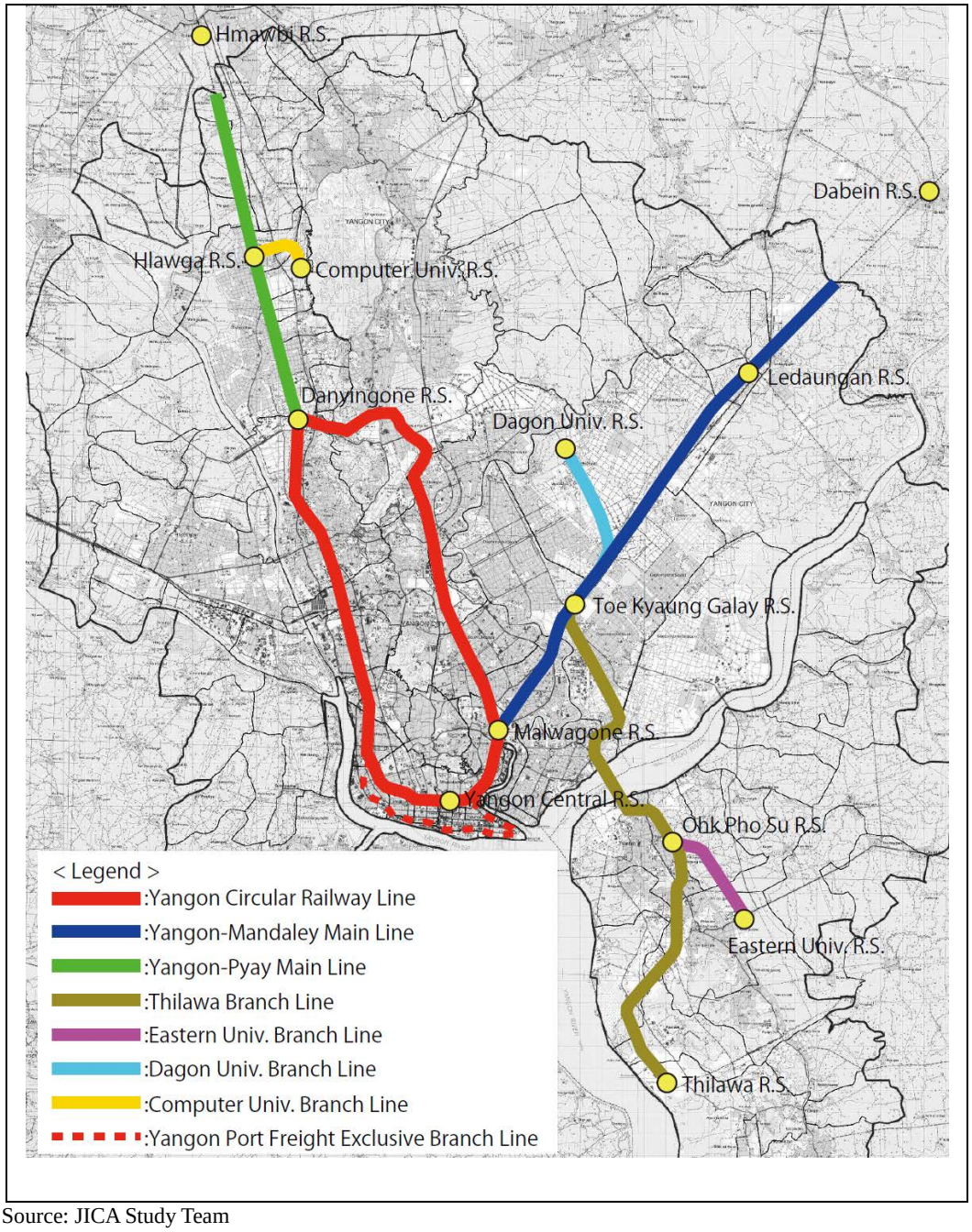
Source: JICA Study Team

Figure 2.3.40: Location Map of Current Issues and Problems of the Transport Sector

2.3.3 Railway

(1) Current Route Network

The current railway network in the Study area is composed of eight lines, which include three main lines and five branch lines (including one exclusive freight line), as shown below.



Source: JICA Study Team

Figure 2.3.41: Current Railway Network in the Planning Area

The features of each line are shown in the table below.

Table 2.3.30: Current Railway Routes in the Planning Area

Route Name	Section	Length (km)	No. of Railway Station (R.S.)	Single track/ Double track	No. of Daily Operated Train	Remarks
Main Line						
Yangon Circular Railway Line	Whole Yangon Circular Railway	47.5 km	38	Double-double Track: (Yangon–Malwagone:3.6km) Double Track: (Remaining Section)	Yangon-Malwagone: 102 Malwagone-Paywatseikkone: 38 Paywatseikkone-Mingaladon: 34 Mingaladon-Danyingone:14 Danyingone-Insein: 54 Insein-Yangon: 79	
Yangon-Mandalay Main Line	Malwagone R.S. – a point between Ledaungan R.S. and Dabein R.S.	28.3 km	6	Double Track	Malwagone-Toe Kyaung Galay: 64 Toegyaunggalay-Ywarthagyi: 16	
Yangon-Pyay Main Line	Danyingone R.S.- Hlawga R.S.- a point between Hlawga R.S. and Hmawbi R.S.	20.1 km (10.5 km +9.6 km)	4	Double Track: (Yangon–Hlawga) Single Track: (Hlawga –Hmawbi)	Danyingone-Hlawkar: 40	
Branch Line						
Thilawa Branch Line	Toe Kyaung Galay R.S. – Ohk Pho Su R.S. – Thilawa R.S.	26.2 km	5	Single Track	Toe Kyaung Galay-Ohk Pho Su: 18 Ohk Pho Su-Thilawa: 4	
Eastern Univ. Branch Line	Ohk Pho Su R.S. – Eastern Univ. R.S.	5.4 km	1	Single Track	12	
Dagon Univ. Branch Line	Toe Kyaung Galay R.S. – Dagon Univ. R.S.	8.0 km	1	Single Track	18	
Computer Univ. Branch Line	Hlawga R.S. – Computer Univ. R.S.	2.9 km	1	Single Track	4	
Yangon Port Freight Exclusive Branch Line	Pazundaung R.S. – Botahtung Freight R.S. – Wadan Freight R.S. - Kyee Myin Daing R.S	9.9 km	2	Single Track	0	No assenger service. Freight train only.
Total		148.3 km (138.4 km for passenger line)	58 (56 for passenger station)		200	No. of R.S. is except Halts. R.S. + Halts =80 (78 for Pax.)

Source: "Traffic Data Yangon Circular Railway 2012 by MR", interview to MR, and Google Earth

At present, Yangon Circular Railway, which runs through the mostly urbanized area of Yangon, is used by two types of commuters; i) relatively low income earners and ii) poor farmers who bring their cultivated products from the northern part of Yangon City to sell in CBD area, according to the ridership survey. It seems that middle class people tend to use bus transport and seldom use railway due to the low frequency, low punctuality, low comfortability, poor feeder service, and slow speed in spite of the low fare.

(2) Historical Background of Railway Network Development

Railway network in Yangon Region had been developed in three stages: 1st Stage was from late 19th century to 1950s, 2nd Stage was from 1960s to 1980s, and 3rd stage was from1988 up to present.

1) 1st Stage: from the late 19th century

In the late 19th century, two trunk lines, namely a part of Yangon-Pyay line and a part of Yangon-Toungoo line, were constructed in Yangon Region (see Figure 2.3.42).

Yangon-Pyay line was constructed in 1877 as the first railway line in the country. The line was constructed for the purpose of transporting rice from Irrawaddy valley to the main port in Yangon. The alignment in Yangon Region passes along the left bank of Yangon River and Hlaing River. This was done to avoid topographical difficulties such as hilly areas, lakes, river crossings, etc.

On the other hand, Yangon-Toungoo line, which is currently a part of Yangon-Mandalay line, was constructed in 1885 from the viewpoint of the strategic importance of accessibility to Upper Myanmar, then a part of another country. The alignment in Yangon Region passes along the right bank of Puzundaung creek and Bago River for the same reason as the alignment of the Yangon-Pyay line.

Initially, both lines were constructed as long distance railway lines. However, these railway lines now plays an important role not only as intercity transport, but also as urban transport modes for the city dwellers in Yangon, especially for low income people.

2) 2nd Stage: from 1910s to 1960

In 1911, a new single track railway line linking Malwagone with Mingalardon was constructed in order to ensure the logistics to/from the Mingalardon area which was the center for the army where many army personnel lived with their family and initially had poor access to CBD and Yangon port. It seems that the alignment was decided in terms of the ease of land acquisition due to the area being undeveloped at the time.

In 1959, the line linking Malwagone with Mingalardon was extended to Danyingone in order to be complete the line as a circular railway, and Yangon Circular Railway was opened. In 1960, the track was doubled, and Yangon Circular Railway was completed (see the middle map of the figure below).

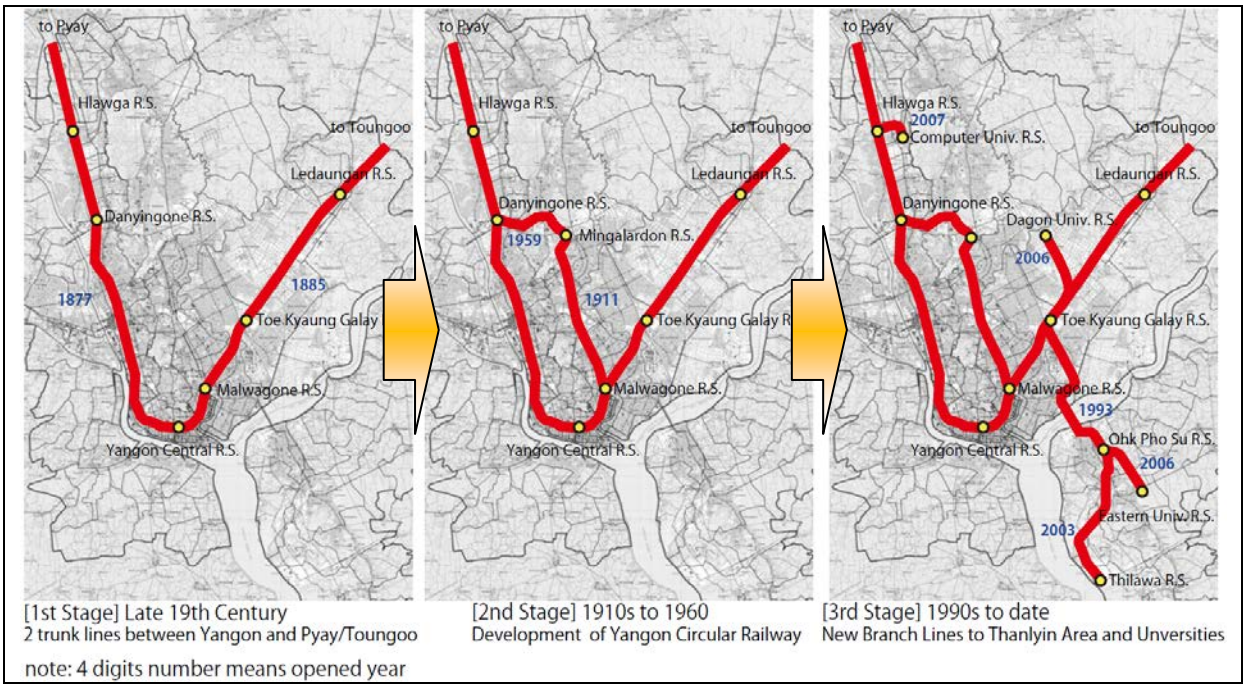
The line was constructed to provide the army with easy access to Insein side along Hlaing River. The alignment was decided for topographical reasons, easy land acquisition, and avoiding Yangon airport land.

3) 3rd Stage: from 1990s to date

After 1988, Myanmar government promoted the construction of new railway lines in the whole country in order to connect developed areas with undeveloped areas (indeed 46% of total 5,844 km was constructed after 1988.).

Regarding Yangon Region, a part of Thilawa Branch line from Toe Kyaung Galay Railway Station (R.S.) to Ohk Pho Su R.S. was connected in 1993 in order to develop Thanlyin area which was separated from the center of Yangon city by Bago River and had many undeveloped areas. After that, the line was extended to Thilawa port in 2003 in order to transport cargo between Thilawa and areas further inland.

In the 21st century, Myanmar government expected that the number of university students will increase for future growth by establishing several universities at the outskirts of Yangon. As a transport mode for the students, Dagon University branch line and Eastern University branch line were constructed in 2006, and Computer University branch line was opened in 2007 (see the right map of figure below).

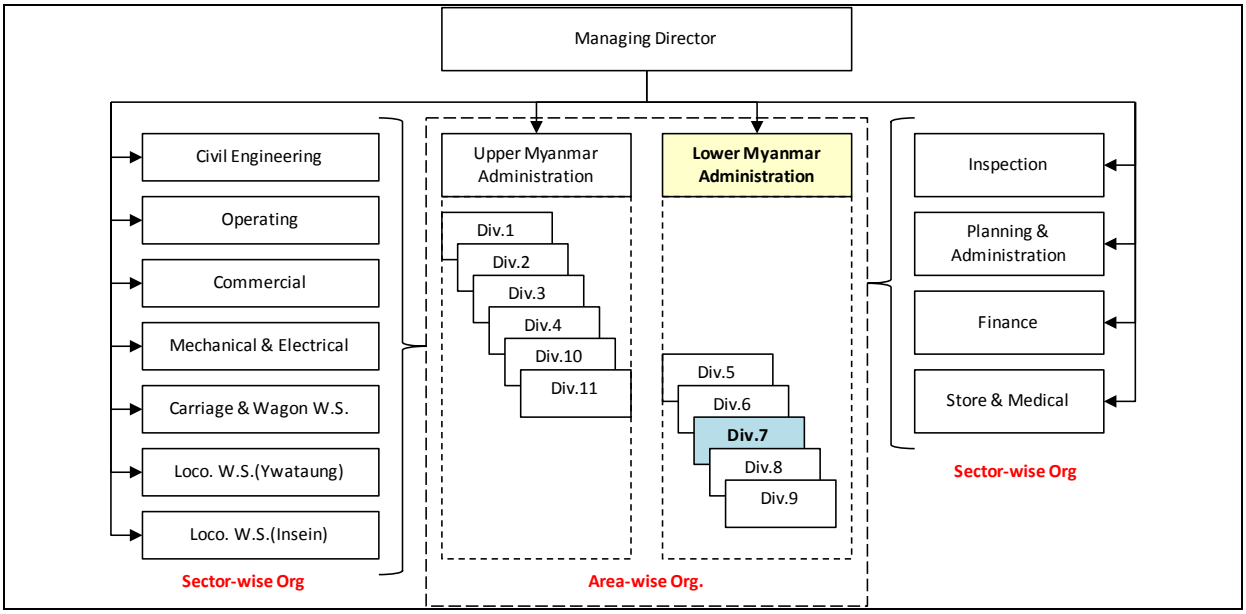


Source: JICA Study Team (prepared based on the information from Fact about Myanma Railways 2011-2012)

Figure 2.3.42: Chronological Chart of Railway Network Development in Yangon Region

(3) Administration and Organization

All railway operations and management in Myanmar is conducted by Myanmar Railways (MR) which is under the umbrella of Ministry of Rail Transportation (MORT). Organizational structure of MR is shown below.

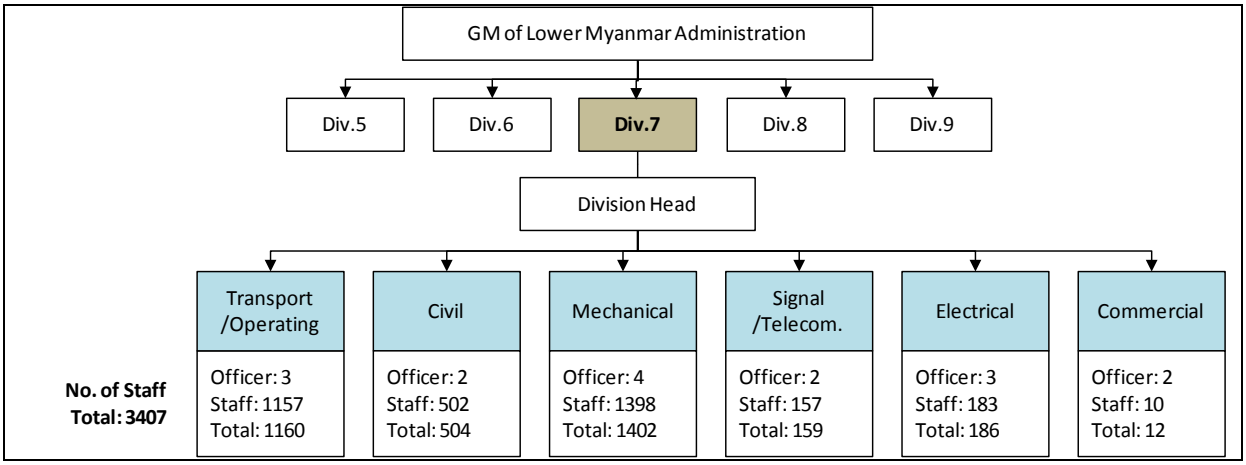


Source: Fact about Myanmar Railways 2011-2012 (partially arranged)

Figure 2.3.43: Organizational Chart of Myanmar Railways

The organization of MR is divided sector-wise and area-wise. In terms of the area-wise aspect, MR has two administrations for Upper Myanmar and Lower Myanmar, which consist of 11 divisions. Regarding the sector-wise aspect, there are 11 sector departments in the headquarters such as Civil Engineering, Operations, etc. and the departments dispatch their staff to regional administrations and divisions. Therefore, the staff which belong to regional administrations and divisions receive instructions and orders from both the general manager of his sector in the headquarters and of his administration.

Division 7 is in charge of Yangon Region. Organizational chart of Division 7 is shown in the figure below.



Source: interview with Head of Div.7 in MR

Figure 2.3.44: Organizational Chart of Division 7

Regarding finance, MORT allocates an annual budget to MR headquarters, and MR headquarters allocates it to the sector's departments in the headquarters. Then, the sector's departments decide which necessary projects will be distributed. Hence, the general manager of Lower Myanmar Administration has no authority to decide the budget allocation.

Financial statement of MR is shown in the table below. The table shows that profitability worsened after 2006 and every year thereafter and the total expense became twice the total revenue in FY2010. Although it has improved in FY2011 as a result of raising the ticket fare, it is expected to require a huge investment continuously for intercity train operations and maintenance, etc. because of the large country and the rapidly expanding railway network. It is an important issue to consider how to develop an appropriate operations and management system for urban railway.

Table 2.3.31: Financial Statement of MR

(unit: million MMK)

Items	FY2006	FY2007	FY2008	FY2009	FY2010	FY2011*
Revenue						
- Passenger	18,510.44	20,433.62	20,541.15	20,204.27	20,639.34	29456.60
- Goods	4,867.70	4,625.82	5,468.90	7,689.97	8,288.01	16,734.19
- Others	1,794.87	2,196.40	2,104.36	2,210.64	4,237.27	4,817.21
Total Revenue	25,173.01	27,255.84	28,114.96	30,104.88	33,164.62	51,008.00
Expense						
- Operation Expenses	37,677.07	43,635.92	52,600.71	58,864.77	66,346.52	68,223.95
- Interest	24.24	27.68	26.50	36.61	61.66	37.92
- Profit & Loss on Foreign Exchange	1.49	-6.98	-8.85	-5.41	-25.22	
Total Expense	37,702.80	43,656.62	52,618.36	58,895.97	66,382.96	68,271.87
Operation Ratio (=Expense/Revenue)	149.68%	160.07%	187.15%	195.64%	200.16%	133.85%

Note: The number for FY2011 is provisional.
Source: Fact about Myanmar Railways 2011-2012, etc.

Financial statement for Yangon Circular Railway and the Suburban Lines is shown in the table below. Official financial statement for Yangon Circular Railway and the Suburban Lines was virtually non-existent because MR's financial management system is fully controlled by MR headquarters, and each office division has no data about expenditures in their jurisdiction area. The following table is prepared by a local private company based on their survey and estimation.

Table 2.3.32: Financial Statement of Yangon Circular Railway and the Suburban Lines (Estimation)

(unit: million MMK)

Items	A month in 2011
Monthly Expenses	
- Salary	27.807
- Engine fuel (65,337 gallons)	196.011
- Maintenance expenses for YCR office, engines, coaches	22.692
- Maintenance for railways	14.900
Total	261.410
Monthly Income	
- Fare box revenue	29.488
- Income from shops / rental fee	13.410
Total	42.898
Income-Expenses	-218.510
Operation Ratio (=Expense/Revenue)	609%

Source: Upgrading of the Yangon Circular Railway Project, Fact about Yangon Circular Railways, 2011

- Privatization of Yangon Circular Railway and the Suburban Lines

Recently, Myanmar government is encouraging the development of the infrastructure through BOT schemes, etc. In line with this policy, MR is trying to proceed with the privatization of the Yangon Circular Railway and the Suburban Lines. The tender for Concession Contract was announced in September 2011 without any closing date and consequently, nine companies submitted their proposal to the management committee (as of August 2012). According to the tender document, i) the concessionaire is responsible for the maintenance of the eastern half of Yangon Circular Railway, Thilawa branch line and three university branch lines and MR will continue to be responsible for the maintenance of the western half of Yangon Circular Railway, Yangon-Mandalay Linen and Yangon-Pyay Line because long distance trains are operated in addition to suburban trains in these sections;ii) train operations system is provided by MR due to the importance of safety in the facility, iii) rolling stocks shall be procured by the concessionaire. Regarding the ownership of infrastructure, MR owns the ground track and concessionaire has elevated track according to MR although the tender document is not mentioned clearly.

According to the interview with MR, there are many issues to be solved and it is quite unclear whether the privatization will be realized successfully and when.

(4) Fare System

The fare table for Yangon Circular Railway and the Suburban Lines is shown below. The fare for two riding tickets was MMK 20 until November 2011. However, it was raised to MMK 100 afterwards.

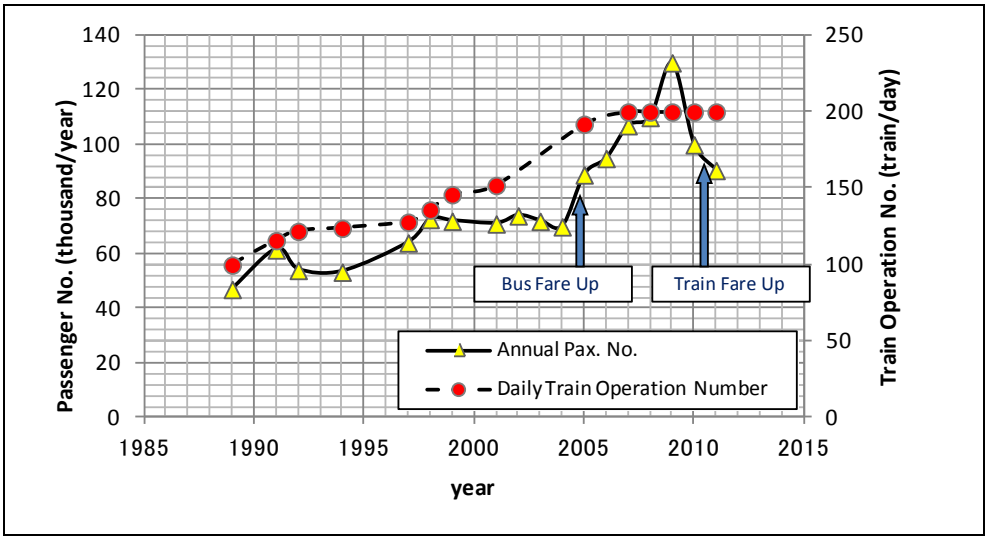
Table 2.3.33: Fare Table of Yangon Circular Railway and the Suburban Lines

Type	Fare (MMK)	Remarks
two riding tickets	100	For foreigner, US$1 per one way.
Monthly ticket	1,700	
Monthly ticket (for Student)	1,150	
Luggage	50	1 bundle,10 viss(=16 kg)
Without ticket (adult)	1,000	As fine
Without ticket (child)	500	As fine
Without ticket (luggage)	150	As fine
Note: 1) 1 riding ticket is not available. 2) Same price regardless of riding length as long as inside Yangon Circular Railway and the Suburban Lines 3) 6 ticket inspection group which consist of 37 ticket inspectors conduct ticket inspection		

Source: Traffic Data Yangon Circular Railway 2012, and MR Presentation Material for Yangon Circular Railway

(5) Transport Volume and Train Operation

The average daily ridership of Yangon Circular Railway and the Suburban Lines in FY2011 is 90,620 passengers./day and the daily number of operated trains in the lines is 200 train/day. The change in the number of annual passengers and daily operated trains by year in Yangon Circular Railway and the Suburban Lines are shown in the figure below. The figure shows that Yangon Circular Railway and the Suburban Lines are used as a means of citizens' transportation and that the number of the users showed an increasing trend as a whole until late 2000s though there is somewhat an increase or decrease within short periods. However, the number of passengers in FY2011 dropped drastically because of implementation of fare increase.



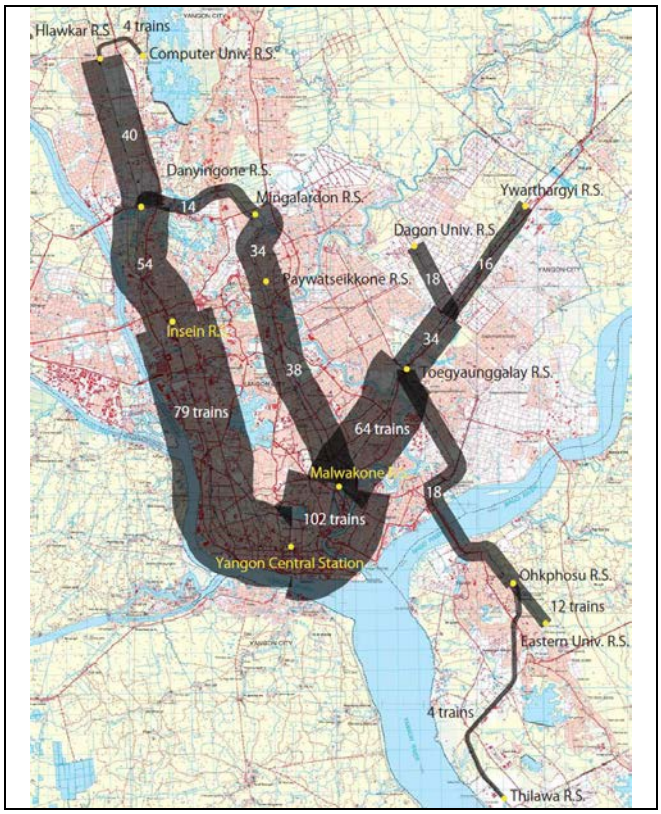
Source: Upgrading of Yangon Circular Railway Project: Facts About Yangon Circular Railways, 2011, Presentation Material by MR, and Traffic Data Yangon Circular Railway, 2012.

Figure 2.3.45: Change in the Number of Passengers and Train Operations of Yangon Circular Railway and the Suburban Lines

The number of operated trains among sections is shown in the figure below. The figure shows that V shaped lines between Danyingone and Toe Kyaung Galay via Yangon Central Station is the most important corridor in Yangon Circular Railway and the Suburban Lines.

The figure also shows that Yangon Circular Railway and the Suburban Lines play an important role as urban transport in Yangon Region as a whole. However, the operational performance and capacity is quite poor due to the deterioration of all infrastructures and lack of proper maintenance. Even the sections in relatively good condition in Yangon Circular Railway, Yangon-Mandalay Main Line and

Yangon-Pyay Main Line in Yangon Region, which are the most maintained line, the maximum speed is approximately 25-30 km/hr, while the other suburban lines are forced to operate at quite slow speeds of 5-10 km/hr due to terrible track conditions. The time it takes to make a round trip of Yangon Circular Railway, which has 47.5 km, is approximately three hours (equivalent to 15 km/hr).



Source: Traffic Data Yangon Circular Railway, and Train Operation Diagram in Yangon Circular Railway and Yangon Suburban Line

Figure 2.3.46: Train Operation Number at Each Section

(6) Geometric Condition

The geometric condition of Yangon Circular Railway and the Suburban Lines is shown in the table below.

Table 2.3.34: Geometric Condition of Yangon Circular Railway and the Suburban Lines

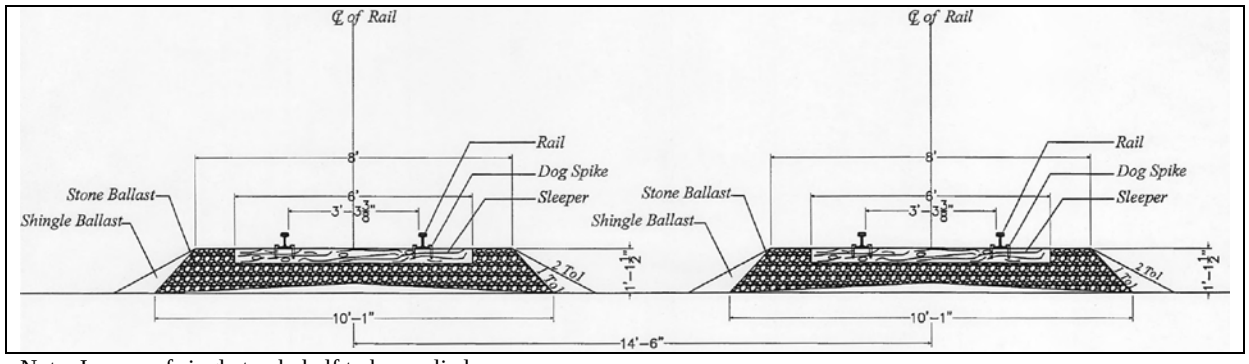
Item	Applied Condition	Remarks
Gauge	Meter Gauge	
Axle Load	12 ton	
Minimum Radius	219 m	Whole MR: 103 m
Maximum Gradient	5 mm/m (exceptional: Thanlyin Br. approah: 10mm/m)	Whole MR: 40 mm/m between Mandalay - Lasio, and Thazi - Shwe Nyaung.
Line interval	Main line to main line: 4.4 m Sidings: 3.8 m	

Source: interview to MR

(7) Track Condition

Typical track cross section of Yangon Circular Railway and the Suburban Lines is shown in the figure below. A 37 kg/m rail with 12 m length, which is quite light and generally only suitable for low grade lines, is used for all lines. Most of the railheads are worn-out due to prolonged use and are recommended to be replaced immediately. The ratio of good sleeper is being increased especially in

Yangon Circular Railway because MR is positively proceeding with the replacement of timber sleepers to PC sleepers which are produced by a PC sleeper plant in Bago. However, in spite of their efforts, the track condition is relatively quite poor because there are no proper ballast spreading, no proper embankment, no proper roadbed quality control and poor drainage system. It causes many derailments and extreme speed restrictions. Especially, embankment and roadbed of four branch lines recently opened after the 1990s are in quite severe condition due to sub-standard work without proper material control and compaction control.



Note: In case of single track, half to be applied.
Source: MR

Figure 2.3.47: Typical Track Cross Section in Yangon Circular Railway and the Suburban Lines

(8) Structure Condition

The list of bridge and crossing structures is shown in the table below. According to visual checks, the different types of bridges are steel girder, RC girder, and RC box culvert. In the case of Computer University branch line, although it is currently a single track, the structures are constructed for double tracks in consideration of future track doubling.

Yangon Circular Railway crosses 47 roads and 22 of them are currently grade-separated flyovers and 25 of them are level crossings at-grade. The grade-separated flyovers are concentrated to the western side of the circle which is the developed area. The remaining level crossings affects the restriction for shortening train operation intervals, because the opening/closing operation is conducted manually and a long closing time is required. The grade separation work (flyover construction) has been implemented through MR's budget and responsibility.

Table 2.3.35: Number of Bridge and Crossing Structures

Line	Bridge	Level Crossing	ROB	FOB
Yangon Circular Railway	42	25	22	33
Yangon-Mandalay Main Line (Yangon Central R.S. – Tongyi R.S.)	29 L>12m:14 L<12m:15	12	6	7
Yangon-Pyay Main Line (Yangon Central R.S. – Taikkyi R.S.)	135	16	-	-
Thilawa Branch Line	14	18	-	-
Eastern Univ. Branch Line	10	-	-	-
Dagon Univ. Branch Line	10	7	-	-
Computer Univ. Branch Line	9	2	-	-
total	239	80	28	40

Note: ROB means Road Flyover, FOB means overpass for pedestrian
Source: Answer to Questionnaire from MR

(9) Signal and Telecommunication System

Automatic Block Color Light Signal is applied for all Yangon Circular Railway, Danyingone R.S.-Hlawga R.S. section on Yangon-Pyay Main Line and Malwagone R.S.-Ywathagyi R.S. section on Yangon-Mandalay Main Line. The first Automatic Block Color Light Signal made in the U.S. by Westinghouse was installed for the 5.6 km section of Yangon Circular Railway in 1950. After that, Automatic Block Color Light Signals made in Germany and Korea was installed incrementally for the remaining sections from 1970 to 2000 . The signaling system applies track circuit as train detection system. However, it is frequently short-circuited due to water retained on the tracks due to bad drainage during the rainy season, and the signal shows red color continuously because of fail-safe system.

Regarding the remaining four lines (Thilawa Branch Line, Eastern University Branch Line, Dagon University Branch Line, and Computer University Line), Paper Token System is applied.

Regarding the signaling system inside main station yard in Yangon Circular Railway, seven stations have Relay Interlocked Color Light Signal and one station has Electromechanical Interlocked Color Light Signal and Semaphore Signal.

In all, six types of telecommunications system are installed in Yangon Circular Railway and the Suburban Lines. All stations have Station Clerk Phone and 15 main stations have some additional systems such as UHF transceiver, VHF transceiver, auto phone, block phone, and P.A. system.

(10) Rolling Stock and the Maintenance System

For Yangon Circular Railway, 21 train sets are operated and in the Suburban Lines, and the train sets divide into two types, diesel locomotive with passenger coach-type and diesel railcar-type (rail bus). Of these, 14 train sets are “locomotive with passenger coach” and these are composed of one locomotive with five or six coaches. Both locomotive and coaches are quite deteriorated due to aging (over 30 years old) and lack of proper maintenance and therefore it is hard to accelerate/decelerate quickly. Seven train sets are “diesel railcar-type” with one or two cars and the diesel railcars are operated not in the Yangon Circular Railway but in the suburban lines. The number of rolling stocks for Yangon Circular Railway and the Suburban Lines is shown in the table below.

Table 2.3.36: Number of Rolling Stock for Yangon Circular Railway and the Suburban Lines

Rolling Stock Type	Number	Remarks
Diesel Locomotive	24	900HP, 1100HP, 1200HP, 1600HP
Passenger Coach	68	
Diesel Railcar	17	Manufactured in Japan

Source: Traffic Data Yangon Circular Railway 2012

All rolling stocks operated in the Yangon Circular Railway and the Suburban Lines have their regular maintenance in Insein Maintenance Shed which is located beside Insein Maintenance Workshop. According to the regulations of Myanmar Railways, the conduct of regular maintenance is divided in eight (8) stages, from M-1 (lightest maintenance) to M-8 (heaviest maintenance). Insein Maintenance Shed can treat between M-1 and M-5, and more heavy maintenance is conducted in Insein Maintenance Workshop.

(11) Key Findings and Main Issues to be Addressed for Railways

1) Poor Railway Network

The number of railway lines is absolutely insufficient judging from the present population (6.5 million) of Yangon and the urban structure (Decentralized Urban Pattern) proposed in the Study. It is required to construct new railway lines, MRTs, and feeder transports such as monorails, LRTs, etc.

2) Unique Budget Allocation System in MR

MR's regional administration/division in charge of Yangon area (Division 7 in Lower Myanmar Administration) has no budget of its own which they can control because the authority for budget allocation is given to MR headquarters only, and it causes an obstruction in establishing Division 7's own development/maintenance plan. It is recommended that the following actions be conducted as countermeasures;

- To prepare a special budget frame for railway infrastructure development for Yangon region;
- To establish new organization in YCDC or YRG for developing urban railways including MRT, monorail, LRT, etc. for Yangon region.

3) Low market share

Railways now play an important role as major transport mode for poor people due to low ticket prices. However, upper class people seldom use railways in spite of the good location and alignment of the railways, and the modal share is merely 3% only (as compared to bus service with 84%). It is recommended that the following actions be conducted as countermeasures:

- To improve railway infrastructure including tracks, signaling/telecom, rolling stocks, stations, etc. in order to improve safety, punctuality, frequency, comfortability, travel time, etc.
- To improve connectivity and accessibility at stations between railways and other transport modes such as buses, taxis, etc.

4) Deteriorated Infrastructures

Track condition is quite poor because: i) relatively light, 37 kg/m rail, which is normally used only for low density lines, is used and in addition the railhead is thoroughly worn out due to long duration of service, ii) the ballast thickness under the sleeper is not enough and it causes accelerated roadbed deterioration, and iii) due to the poor drainage condition, water stays on the tracks during rain and it causes damage to roadbed and contaminates the ballast. Regarding the signaling system, frequent trouble and malfunctions happen due to the age of the system and shortcut circuits caused by water staying on the tracks. Telecommunications system is also old-fashioned such as walkie-talkie, telephone, etc. Regarding rolling stock, all diesel locomotives and coaches are aging and deteriorated due to the poor maintenance. Especially, acceleration/deceleration performance is quite poor due to locomotive traction type and it has a detrimental effect to the train operation frequency. In addition, the stations are not functional as key traffic connecting areas, due to the poor condition of station plaza and poor ticket selling system. Furthermore, low height platform is common, and it takes a long time for boarding/alighting. It is recommended that the following actions be conducted as countermeasures:

- To reconstruct roadbed;
- To install proper drainage system;
- To spread ballast by proper thickness;
- To replace with heavier HH rail;
- To replace with new signaling system;
- To install proper drainage system on tracks and structure;

- To replace new telecommunications system;
- To replace with diesel railcar which has high acceleration/deceleration performance;
- To increase ticket selling counter;
- To improve ticket selling procedure;
- To introduce ticket vending machine;
- To introduce AFC system;
- To introduce pre-paid card or chargeable card system;
- To introduce high platform height.

5) Many Level Crossings in Yangon Circular Railway

Yangon Circular Railway has 25 level crossings and it induces traffic jam. In addition, level crossing operation for manually opening/closing a barrier takes a long time, and it impairs the shortening of train operation interval. It is recommended that the following actions be conducted as countermeasures;

- To install automatic operating level crossing system in order to minimize barrier closing time;
- To replace level crossings with flyovers (ROB). The height of ROB shall consider the future electrification requirements.

6) Ineffective train diagram and bottleneck due to mixing long-distance trains with Yangon Circular trains

There is a bottleneck caused by inappropriate track layout between Yangon R.S. and Puzundung R.S. In the section, two tracks for Yangon Circular Railway and long distance Yangon-Mandalay Line are grade crossing, and the number of tracks in this section is reduced. In addition, the section between Yangon R.S. and Danyingone R.S. is used for both Yangon circular trains and long distance trains, and it causes a delay in Yangon circular trains and restrict shortening of train operation interval. It is recommended that the following actions be conducted as countermeasures;

- To increase new tracks along the bottleneck section;
- To improve Yangon station and change the role of each platform for long distance train and Yangon circular train in order to avoid grade crossing of trains;
- To make Danyingone R.S. a terminal for long distance trains to/from Pyay, and the section between Yangon R.S. and Danyingone R.S. will be used as an exclusive line for Yangon Circular trains.

7) Privatization of Yangon Circular Railway and the Suburban Lines

MR proceeds with the privatization of Yangon Circular Railway and the Suburban Lines. The procedure is ongoing and it is unclear when and how privatization will be completed. Therefore, it is recommended to start the railway improvement projects from sections which are not affected by the privatization procedure.

2.3.4 Ports and Logistics

(1) Ports in Greater Yangon

Myanmar is the westernmost country among the ASEAN member countries, and contains the gates of both the East-West Economic Corridor and the Southern Economic Corridor of the Greater Mekong Subregion (GMS). These corridors are being promoted with the aid of international donors including JICA and the Asia Development Bank (ADB). However, the development of Myanmar is still very slow. In the port sector, the acceleration of development of port facilities in conjunction with the corridors is urgently required.

Source: JICA Study Team

Figure 2.3.48: Economic Corridor of GMS

Dawei is the gate of the Southern Economic Corridor, while Mawlamyine is nominated as the gate of the East-West Economic Corridor. However, since Mawlamyine Port is very shallow (at about 4 m depth), Yangon Port may take over as the gate of the East-West Economic Corridor.

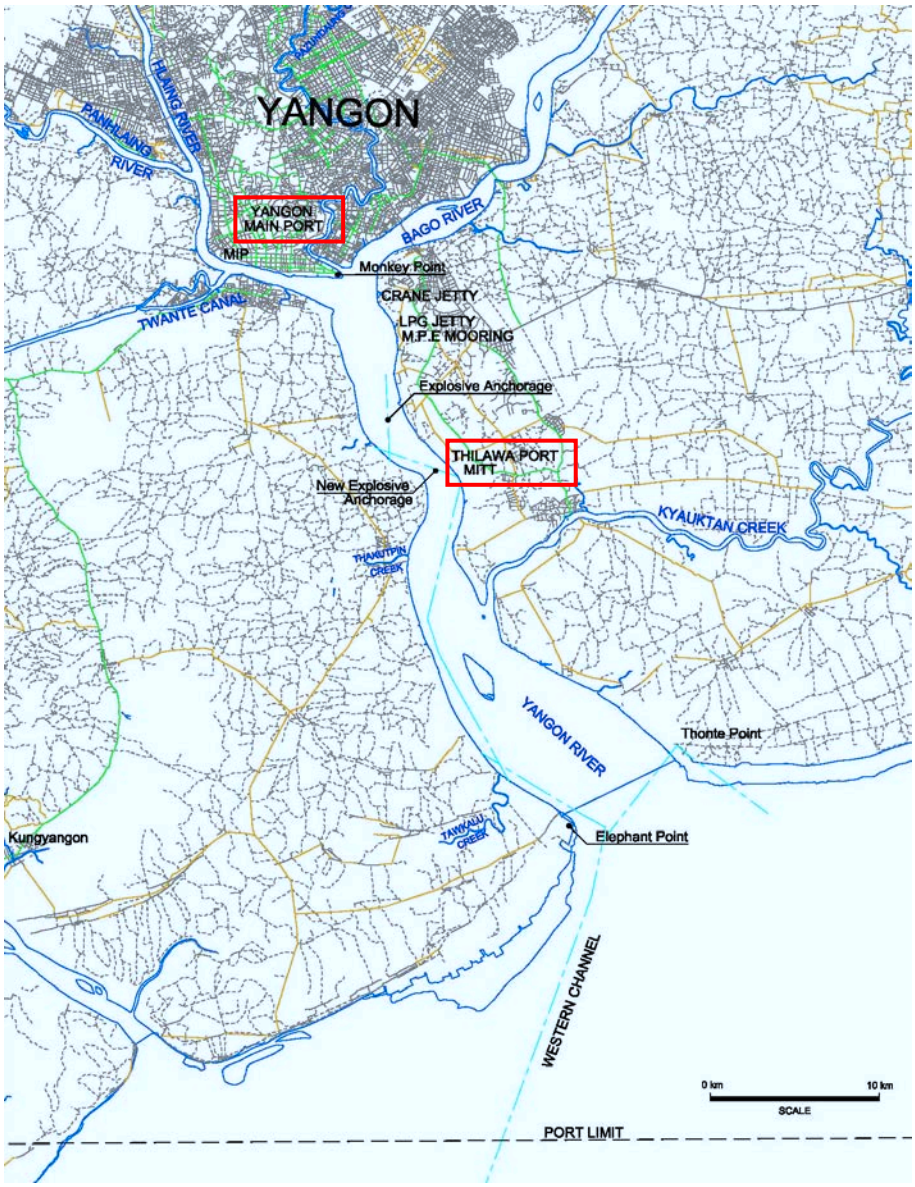
Yangon Port handles about 90% of the total national cargo volume in Myanmar. Yangon Port consists of "Yangon Main Port" in the ex-capital, Yangon City (32 km from the mouth of the river), and "Thilawa Area Port" (middle reach between the mouth of the river and Yangon Main Port).

Yangon Main Port was constructed during the colonial era, and has been developed since then. There are many jetties on the left bank of the Yangon River, which are owned by the Myanmar Port Authority (MPA) and other organizations.

On the other hand, Thilawa Area Port commenced its operations in 1997. The development of the said port, which was aimed at alleviating port congestion expected due to the changing economic system, was implemented since 1988. However, Thilawa Area Port has been virtually inoperative since democratic reforms started in 2011.

At present, the total container handling volume in Myanmar is merely 350,000 TEU. However, the potential for rapid expansion of container handling due to the economic growth is very high.

Yangon Port is managed by MPA, which is affiliated to the Ministry of Transport (MOT). Thanks to the democratic reforms in 2011, the Government of Japan announced that it would resume providing Japanese official development assistance (ODA) loans to Myanmar.



Source: Nippon Koei

Figure 2.3.49: Layout Plan of Yangon Port

(2) Related Government Organizations

Ministries involved in the transportation sector in Myanmar are Ministry of Construction, Ministry of Rail Transport, and Ministry of Transport. Ministry of Construction is in charge of road plan and construction, Ministry of Rail Transport for railway operation and maintenance, and management of land transportation (truck, bus, taxi, and vehicles), Ministry of Transport for management of sea, water, and air transportations.

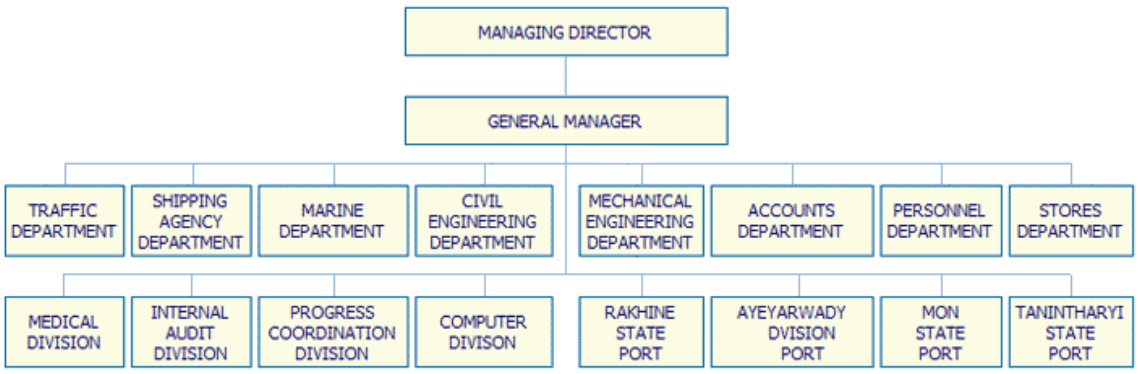
Organizations under MOT：

- Department of Transport
- Department of Civil Aviation
- Department of Marine Administration
- Department of Meteorology and Hydrology

- Directorate of Water Resources and Improvement of River Systems
- Inland Water Transport
- Myanma Airways
- Myanma Port Authority
- Myanma Shipyards
- Myanmar Maritime University
- Myanmar Mercantile Marine Collage

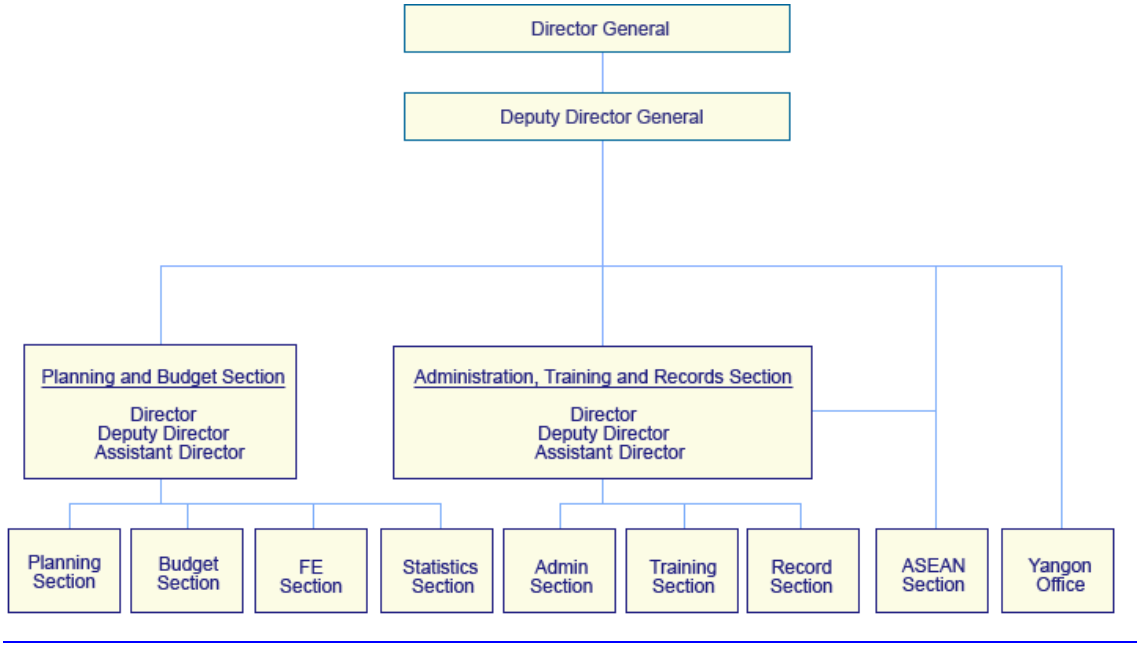
Source: MOT

Figure 2.3.50: MOT Organization



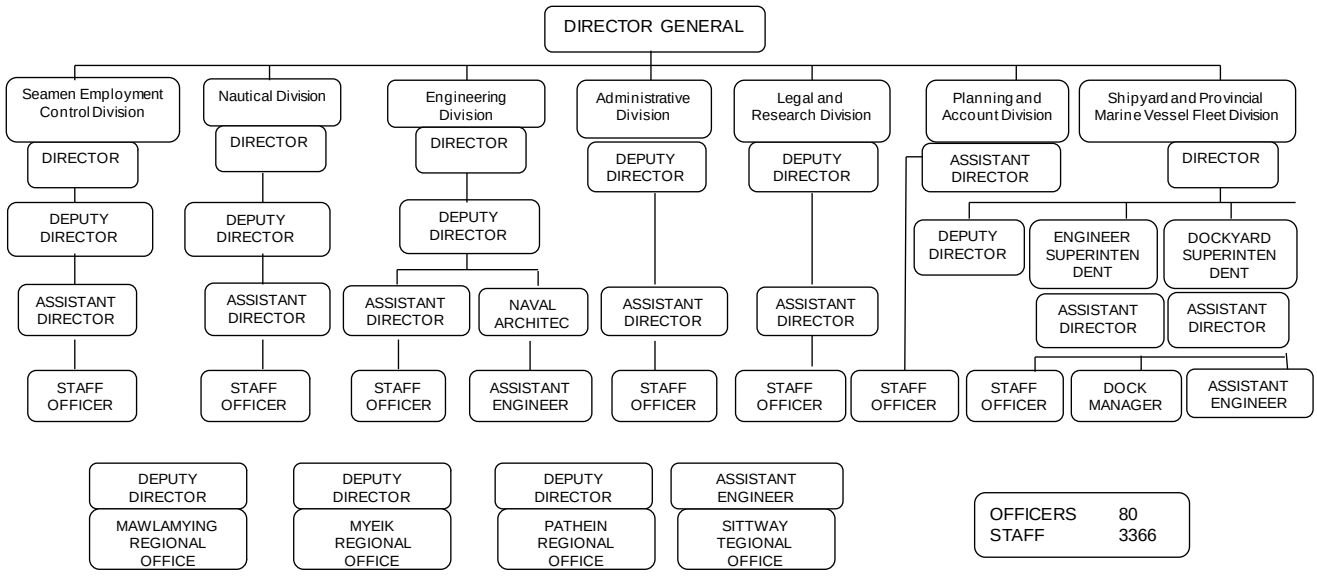
Source: MOT

Figure 2.3.51: Myanma Port Authority (MPA) Organization



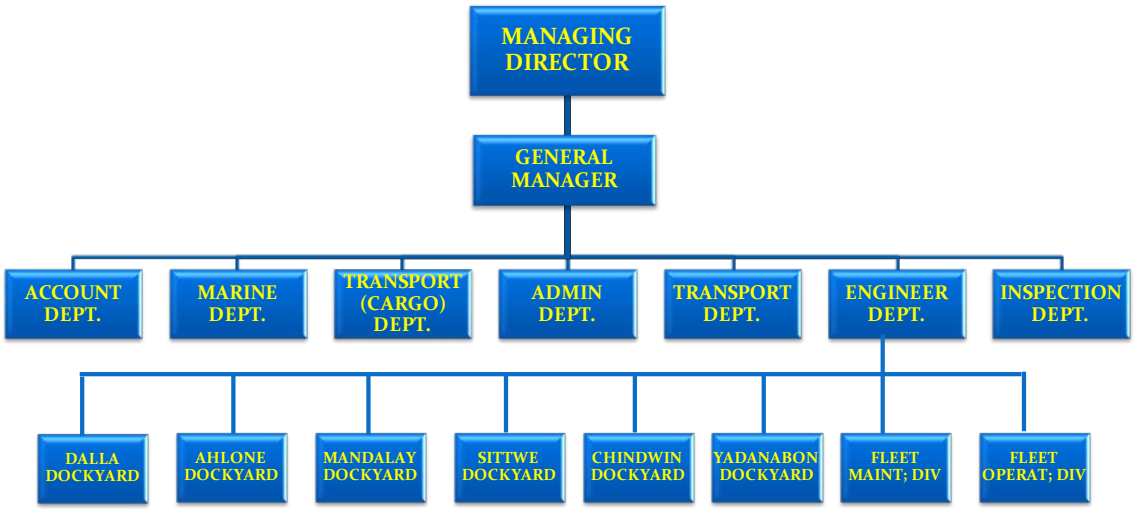
Source: MOT

Figure 2.3.52: Department of Transport Organization



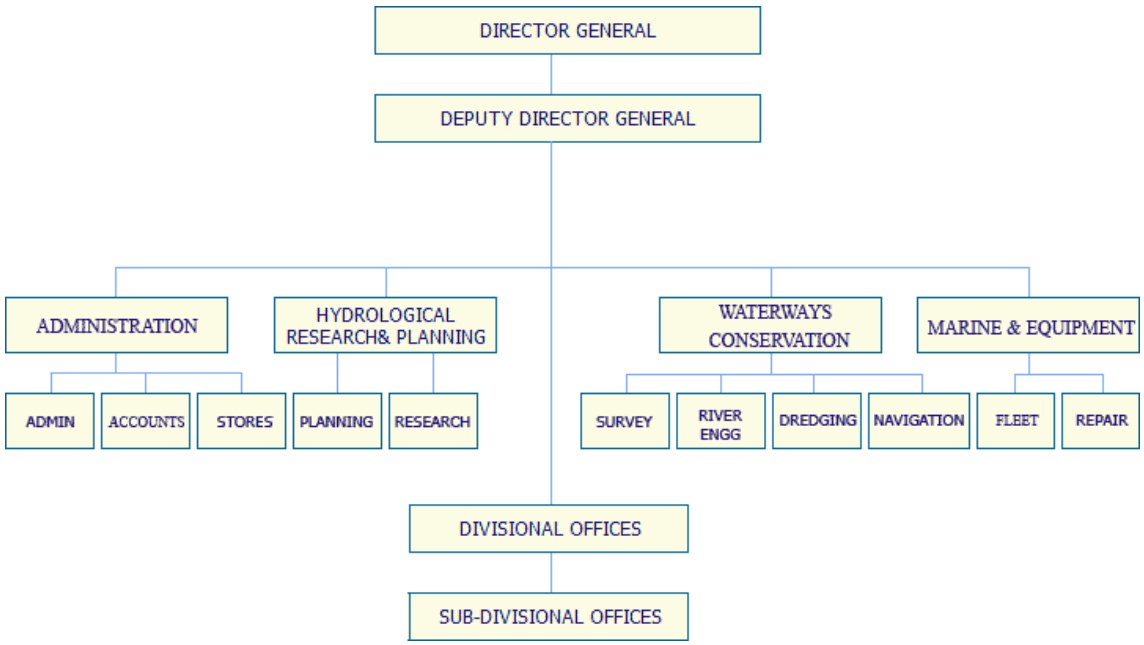
Source: Department of Marine Administration (DMA)

Figure 2.3.53: DMA Organization



Source: Inland Water Transport (IWT)

Figure 2.3.54: IWT Organization



Source: MOT

Figure 2.3.55: Directorate of Water Resources and Improvement of River Systems Organization

(3) Current Conditions of Yangon Main Port

Yangon Main Port is adjacent to Yangon City, which is a place for large-scale consumption. Since there is a shallow area in the ship's navigation approach channel called the "Inner Bar", which is at the confluence of three rivers (the Yangon River, the Bago River, and the Pazyndaung River), the ship entrance to Yangon Main Port is regulated to a maximum size of 15,000 DWT, LOA167 m, or Draft-9 m.

On the left bank of the Yangon River, stretching from Botahtaung Township to Ahlone Township, there are commercial ports, fishing ports, passenger terminals, and shipyards. The BOT project on the widening of Strand Road behind Yangon Main Port commenced in 2011 in partnership with YCDC.

1) International Port

In Yangon Main Port, there are four international ports, namely, the Asia World Port Terminal (AWPT), the Myanmar Industrial Port (MIP), the Sule Pagoda Wharf (SPW), and the Bo Aung Kyaw Wharf (BSW). AWPT, MIP, and BSW mainly handle container cargo, and SPW handles non-container cargo. Particularly, AWPT handles about 70% of container cargo of Yangon Port. As the container handling volume in Yangon Port is increasing, container terminal operators have been planning or implementing the expansion or rehabilitation of the terminal. In Botahtaung Township, there is an inland container depot (ICD) owned by MPA.

During the last five years cargo handling volume in Yangon Port has increased five times, and further increase is expected. In order to meet such increase of cargo volume, the expansion of Yangon Port should be carried out. Currently several existing terminal operators intend to do so through BOT scheme. The Government of Myanmar is also implementing rehabilitation projects of its own port terminals by BOT scheme. International tenders are in progress, and several Japanese companies have shown their interest.

Source: JICA

Figure 2.3.56: Location of International Ports at Yangon Main Port

Table 2.3.37: Existing Conditions of Yangon Main Port

Name of Wharves	Length (m)	Depth (m)	Apron Width (m)	Storage Area		Owner	Type of Cargo	Accommodative Size of Vessel	Year of Commision
				Yard (m2)	Shed (m)				
AWPT No.1	198.0	9.0	30.5	4,363.0	2,675.5	AWPM	Container & GC	15,000	2001
AWPT No.2	156.0	9.0	19.5	3,483.0	1,859.0	AWPM	Container & GC		1997
AWPT No.3	260.0	9.0	30.5	7,928.0	1,859.0	AWPM	Container & GC		2005
AWPT No.4 (Under Construction)									
MIP Wharf	310.0	9.0	18.0	102,385.0	6,140.0	MIP	Container & GC	15,000	2003
Sule Pagoda No.1	137.0	9.0	12.2	6,967.5	5,016.6	MPA	GC	15,000	1941
Sule Pagoda No.2	137.0	9.0	12.2	5,574.0	5,202.4	MPA	GC		
Sule Pagoda No.3	137.0	9.0	12.2	10,683.5	3,855.4	MPA	GC		
Sule Pagoda No.4	137.0	9.0	12.2	3,251.5	6,688.8	MPA	GC		1932
Sule Pagoda No.5	160.0	9.0	15.2	6,038.5	17,595.3	MPA	GC		1962
Sule Pagoda No.6	160.0	9.0	15.2	3,251.5	16,062.4	MPA	GC		
Sule Pagoda No.7	158.5	9.0	15.2	1,042.3	13,098.9	MPA	GC		
Bo Aung Kyaw No.1	137.0	9.0	15.2	48,000.0	4,400.0	LPM	Container & GC	15,000	1941
Bo Aung Kyaw No.2	137.0	9.0	15.2				Container & GC		
Bo Aung Kyaw No.3	183.0	9.0	30.0				Container		1998

Source: MPA

Asia World Port Terminal

Bo Aung Kyaw and Sule Pagoda Wharves

Source: Nippon Koei

Figure 2.3.57: Yangon Main Port

2) Inland Waterway Transport

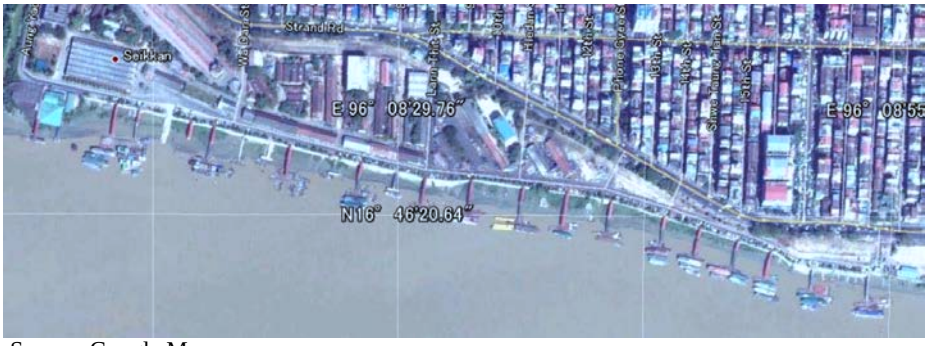
The Ayeyarwaddy (Irrawaddy) River flows from north to south through Myanmar. The Ayeryarwaddy tributaries and other rivers form one of the most utilized inland waterway networks in the world. The Inland Water Transport (IWT), a state-owned transport enterprise under MOT, is the largest operator of inland waterway vessels. The rest of the vessels are operated by other state enterprises or private owners. About 5,000 vessels are officially registered in Myanmar, out of which IWT owns 476 vessels (as of January 2012). IWT engages 71 vessels for passenger and cargo commute in the Delta region. IWT operates 21 routes and the service distance is at 2,526 miles in the Delta division.

In the Delta region, inland waterway is the most important mode of transportation due to the underdevelopment of road and railway transportation. Majority of the population reside near rivers, and are engaged in agriculture. For these low income populations inland waterway transportation is especially important. Agriculture products, such as rice, egg, and fish, construction materials, and consumables are transported between Delta and Yangon.

The Twante Canal is only the canal connecting the Yangon River and the Ayeyarwaddy River. This all the cargo vessels heading for the Delta, and Mandalay and upper Myanmar pass the Twante Canal. In front of the jetties at the Lammadaw Township is the entrance of the Twante Canal.

Due to the large difference of tide level in Yangon, the jetty structure is pontoon type connecting to the bridge. Loading and unloading of cargo are carried out by manual labor. Most of the vessels engaged in inland waterway head for the Delta region. Not far from the Lanmadaw jetties is the Twante Canal, which connects the Yangon River with the Ayeyarwaddy River, and thus the Delta region.

According to the HIS results, only 8% (800 out of 10,045) have used inland waterway transportation. The users are limited to commuters crossing the Yangon River. About half of them (51%) rated "good", 37% rated "satisfactory", and 11% rated "poor" or "bad". It can be concluded that the users were satisfied with the services. However, like other infrastructure sectors, the improvement of safety and usability will be necessary.



Source: Google Map

Figure 2.3.58: Jetties at Lamadow Area

Jetty at Botahtaung Area

Cargo Handling

Source: Nippon Koei

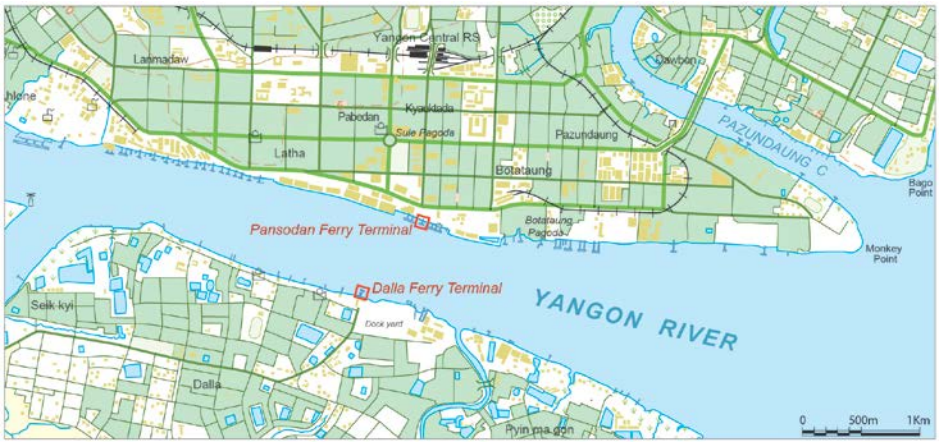
Figure 2.3.59: Cargo Handling for IWT

3) Dala Ferry (Nanthida Jetty)

The other side of the Yangon River is Dala Township, wherein IWT operates passenger ferry boats from Yangon. Such ferry boats transport a total of about 30,000 passengers daily, and are an essential mode of transportation between Yangon and Dala.

Since the existing ferry boats are old and have safety issues, JICA is now implementing the "Preparatory Survey on the Provision of a Ship Crossing the Yangon River", under which the Government of Japan hopes to grant new ferry boat(s) to Myanmar.

In CBD there are four other passenger ferry routes crossing the Yangon River. However, the number of the passenger is very comparing with the Dala route.



Source: Nippon Koei

Figure 2.3.60: Location of Dala Ferry Terminal

4) Existing Shipyards

In Yangon Main Port, there are shipyards owned by Myanmar Shipyards (MS), IWT, and MPA, all of which are affiliated to MOT. IWT owns two large shipyards in Yangon: Dala (established in 1852) and Ahlone (established in 1904). Dala Shipyard, largest in Yangon, has 14 slipways with the land area of 12ha. Repair and new building of ferry boat, barge, tugboat, landing craft, and express boat have been carried out.

5) Fishing Ports

There are fishing ports in the upstream reach of the Yangon River (Hlaing River) and the Pazyndaung Creek. Fishing areas include the Yangon River and the Yangon offshore.

Dala Dockyard

Fishing Port at Hlaing River

Source: Nippon Koei

Figure 2.3.61: Dock Yard and Fishing Port

6) Waterfront Development

Up to now there is only one riverfront restaurant at Nanthida Port. MPA is planning waterfront development of a few locations on the left bank of the Yangon River. In the development plan, shopping centers, restaurants, and parks are to be constructed.

Existing Restaurant in Nanthida Area

Candidate Area for Waterfront Development

Source: Nippon Koei

Figure 2.3.62: Waterfront Development

7) Cyclone Nargis

On 2nd May 2008 Cyclone Nargis stuck Yangon and Bago region, which caused 140,000 causalities and damaged houses for 2.4 million people. Yangon Port also suffered tremendous damages: many pontoon jetties were damaged, and more than 100 vessels were sunken. After the cyclone, MPA and IWT established a disaster prevention plan, which mainly deals with the vessel evacuation plan.

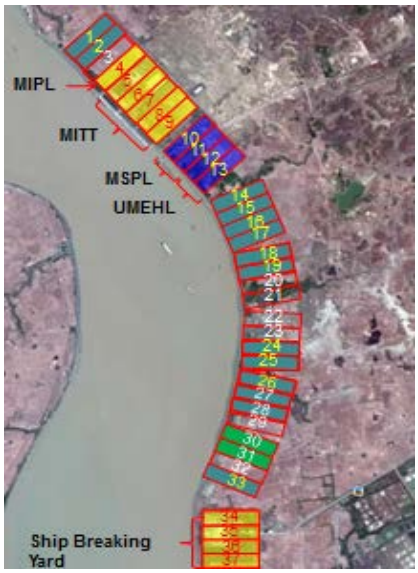
(4) Port in Thilawa Area

Thilawa Area Port has 37 plots (each plot is 200 m wide and 750 m long) owned by MPA. The Ministry of Construction owns 2400 ha of land for the SEZ behind the port area. The impacts to the social environment in these areas would be minimal.

Thilawa Area Port lies halfway between the mouth of the Yangon River and Yangon Main Port. The draft restriction of calling vessels is at -9 m, which is the same as that of Yangon Main Port; however, size restriction is at a maximum of 20,000 DWT (as compared to 15,000 DWT at Yangon Main Port).

1) Current Condition

As of July 2012, operating ports in Thilawa Area Port are Plot No. 4 (Myanmar Integrated Port Limited: MIPL), Plot Nos. 5 to 9 (Myanmar International Terminals Thilawa: MITT), and Plot Nos. 34 to 37 (Ship Breaking Yard: SBY). MIPL was developed by Singaporean funding. MITT was developed and is managed by the Hutchison Group. Though MITT was designed as a container terminal, it handles only a few 10,000 TEUs yearly. Currently, MITT mainly handles timbers and cars.



Source: MITT

Figure 2.3.63: Layout Plan of Thilawa Area Port

2) Future Development Plan

The remaining 27 plots of Thilawa Area Port are under planning, under construction, or not contracted yet. Several oil and gas terminals are planned by private firms in Myanmar. The allocation of the 37 plots, as of March 2012, is depicted in Table 2.3.38.

Table 2.3.38: Allocation of the Three Plots of Thilawa Area

Plots No.	Contents
1-2	Private Companies
3	Remaining
4	Myanmar Integrated Port Limited (MIPL)
5-9	Myanmar International Terminal Thilawa (MITT)
10-11	MPA-SMD Port Limited (MSPL)
12-14	Union of Myanmar Economic Holding Limited (UMEHL)
15-16	Private Companies
17-18	Private Companies
19	Union Solidarity and Development Association (USDA)
20-21	Remaining
22-26	Japan ODA (under planning)
27-28	Private Companies
29-30	Remaining
31-32	Private Company
33	Private Company
34-37	Myanmar Economic Corporation (MEC)

Source: MPA

3) Future Container Terminal Development

Since July 2012, JICA has implemented "The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area" in preparation for a yen loan. The Thilawa Area Port urgent development plan and the Yangon Port master plan are studied under this study. As for Thilawa, a feasibility study for container terminal development including related facilities and equipment is being carried out. This study will establish the division of roles between Yangon Main Port and Thilawa Area Port.

(5) International Trade Trend

Table 2.3.39 summarizes the amounts (in MMK) of the trade items from 2005 to 2011. The amounts of trade have been increasing constantly. The top export items include natural gas, pulse (bean), garment, and teak. Agricultural and forestry products, which contribute to the export, come from the inner or Delta regions. The top import items include refined mineral oil, non-electric machinery and transport equipment, and base metals and manufactures.

The cargo throughput in Myanmar was about 26 million tons in 2011 (Table 2.3.40). International shipping was much more in Myanmar as compared with coastal shipping. The ratio of international shipping to coastal shipping is about 9:1. In the last five years, the volume of international shipping has doubled, whereas the volume of coastal shipping has increased only by 20%. Since 2010, import volume has become larger than export volume in international shipping. Major coastal shipping items include agricultural and fisheries products from local ports to Yangon Port, and daily commodities and durable goods from Yangon Port to local ports.

According to the study results of JICA's "The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area", the maximum container handling capacity after renovation of the current port facilities (such as berth expansion of MIP or containerization of Sule Pagoda Wharf) proposed in the abovementioned JICA survey is 725,000 TEU for Yangon Main Port and 815,000 TEU for MITT in Thilawa Area Port (Table 2.3.41). According to the forecast in the study, the projected demand of containers to be handled in Thilawa will surpass its current capacity in 2016. Thus, the construction of Thilawa Area Port through an ODA loan is highly expected. In the proposed schedule by JICA, the first phase of Thilawa Area Port will be completed at the end of 2015.

Table 2.3.39: Trend of Trade Items

unit : MMK

	2005	2006	2007	2008	2009	2010	2011
Export							
Total Amount	20,647	30,026	35,297	37,028	41,289	49,107	49,288
Natural gas	6,235	11,676	13,938	12,996	15,854	13,947	18,860
Pulse	1,876	3,498	3,463	4,069	5,063	4,450	5,312
Garment	1,586	1,602	1,555	1,594	1,544	2,100	2,685
Teak	1,723	1,750	1,540	1,146	1,172	1,709	1,901
Hardwood	1,027	1,189	1,424	1,066	1,519	1,596	1,674
Fish	544	725	1,059	972	1,053	1,168	1,593
Rice and rice products		18	553	1,112	1,391	1,092	1,439
Raw rubber				122	406	849	707
Prawn	576	608	556	472	346	367	444
Sesame	106	171	209	173	184	251	313
Others	6,973	8,789	11,000	13,306	12,758	21,578	14,360
Import							
Total Amount	11,514	16,835	18,419	24,874	22,837	35,509	48,764
Refined mineral oil	1,561	3,967	2,034	3,192	3,674	7,711	10,404
Non-electric machinery and transport equipment	1,786	2,718	4,162	7,240	4,908	6,661	9,846
Base metals and manufactures	1,164	1,184	1,206	1,818	1,993	3,066	5,112
Electrical machinery and apparatus	646	708	861	949	977	1,928	2,515
Plastic	574	720	857	909	859	1,372	1,684
Artificial and synthetic fabrics	917	1,060	1,169	817	780	1,151	1,371
Edible vegetable oils and other hydrogenerated oils	571	478	1,058	1,610	976	1,122	2,131
Pharmaceutical products	362	555	636	679	798	1,003	1,177
Cement	53	116	153	147	313	775	811
Paper, paperboard and manufacture	296	303	292	392	318	390	531
Rubber manufactures	140	211	287	258	351	338	426
Others	3,443	4,817	5,705	6,863	6,890	9,992	12,757

Source: JETRO website: http://www.jetro.go.jp/world/asia/mm/

Table 2.3.40: Cargo Throughput by Port

unit:ton

		2006	2007	2008	2009	2010	2011
International	Import	5,168,750	5,812,793	5,735,245	9,172,538	11,908,660	14,225,240
	Export	5,146,594	5,541,104	8,122,714	11,146,486	7,146,366	9,059,520
	total	10,315,344	11,353,897	13,857,959	20,319,024	19,055,026	23,284,760
Coastal	Unload	937,622	929,259	814,511	760,640	1,027,881	1,101,651
	Load	1,115,308	1,134,394	1,114,189	1,140,100	1,372,667	1,309,746
	Total	2,052,930	2,063,653	1,928,700	1,900,740	2,400,548	2,411,397
Total		12,368,274	13,417,550	15,786,659	22,219,764	21,455,574	25,696,157

Source: MPA

Table 2.3.41: Container Handling Capacity (Unit: TEU)

	Hteedan Terminal	Ahlone Terminal	MIP Terminal	Bo Aung Kyaw Terminal	Sule Pagoda Terminal	Sum of Yangon Main Port	MITT Terminal	Total
Capacity by current facility	149,000	191,000	131,000	57,000	-	528,000	203,000	731,000
Capacity after renovation	149,000	280,000	189,000	57,000	50,000	725,000	815,000	1,540,000

Source: “The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area”, JICA, 2012

(6) Future Cargo Trend in Yangon Port

According to the study results of JICA's "The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area", the increase of container throughput in Yangon Port (Yangon Main Port and Thilawa Area Port) was estimated for years 2015, 2020 and 2025, as shown in Table 2.3.42 below. Container throughput will double by 2015 from the current 350,000 TEU level (in 2011). After 2015, the throughput will further double every five years or so, assuming that the container throughput is linearly related to the GDP, the forecast of which is 5.3% to 7.7% (low and high cases).

Table 2.3.42: Container Throughput Forecast

(Unit: TEU/year)

Year		2015	2020	2025
Yangon Port	High Case	892,000	1,986,000	4,014,000
	Low Case	852,000	1,700,000	3,064,000
Thilawa SEZ related container		75,000	226,000	392,000

Source: "The Preparatory Survey for the Project for Expansion of Yangon Port in Thilawa Area", JICA, 2012

(7) Logistics Overview in Myanmar

According to the "Statistical Yearbook 2010", cargo transportation (in freight ton-mile) by public sector is as summarized in Table 2.3.43 below. Transportation by private sectors was not included in the figures due to the lack of official survey regarding such.

Table 2.3.43: Cargo Transportation (in Freight ton-mile) by Public Mode

Year	Freight ton-mile			
	Railways	Airways	IWT	Road
1990-1991	306,861	688	325,643	76,841
1995-1996	551,594	482	322,601	147,393
2000-2001	750,040	705	344,381	189,893
2001-2002	720,249	543	355,114	202,790
2002-2003	723,098	435	370,872	212,516
2003-2004	599,480	430	427,155	235,367
2004-2005	544,592	254	453,359	246,974
2005-2006	570,124	294	455,157	271,079
2006-2007	551,073	179	519,983	282,589
2007-2008	535,441	197	581,840	304,252
2008-2009	569,869	163	639,444	314,909
2009-2010	658,252	162	687,207	315,614

Source: Compiled from the "Statistical Yearbook 2010" by the Central Statistics Office

In 2010, the total length of railways was about 5,700 km; the length of waterways under DWIR was at 6,650 km; the average length of flight routes was at 2,303 km; and total length of roads was about 34,400 km. As far as public transportation is concerned, waterways (IWT) and railways are the major modes of transportation. However, the net road transportation, which includes the private sector, will be much higher than the figures indicated in the table above, especially since 2000 as private participations have been increasing.

(8) Current Conditions of Logistics in Yangon (Other Than Port)

1) Water-borne Logistics

River gravels which are being used as concrete material are transported by river barge from around Pyey. Fine sand for concrete material or reclamation fill material is dredged near the Monkey Point in the Yangon River and transported by micro dredgers. Dredged sand is unloaded onshore hydraulically at the concrete batching plant or yard at the sand retailing shops. Many sand shops are located along the Pazundaung Creek in Yangon.

IWT operates passenger and car ferries between Yangon City and the southern and western parts of the Yangon River for people and cars commuting to and from Yangon City. Currently, there are approximately 46 round trips daily for Dala passengers, six for Dala car ferry, ten for Kha Naung To, eight for Sa Por Creek, and two for Seikgyi. The average number of daily passenger is about 30,000 for Dala and 2,000 for Kha Naung To. Kan Gyi Kone village located on the sandbar along the Twante canal (ferry terminal is Kha Naung To) has no bridges, thus the ferry boat is the only mode of the transportation to carry and bring outside the cargos and passengers at their destinations.

2) Truck Cargo In and Out of Yangon

There are more than 30 truck centers in Yangon City. The largest one, Bayint Naung Warehouse, is located near Bayint Naung Bridge on Thamine Butar Yon Road and Bayint Naung Road. There are many small wholesale stores, which mainly deal rice, household goods, cement, or construction materials, in this truck center. Every day, over 1000 trucks, with sizes of over 32 ft long, bring goods in and out the center. The parking spaces are narrow, and congestion in and around the area is apparent.

Bayint Naung Warehouse

Bayint Naung Warehouse (traffic jam)

Source: JICA Study Team

Figure 2.3.64: Bayint Naung Warehouse

The Highway Freight Transportation Services Association (HFTSA) is an association affiliated with the Ministry of Commerce, the Ministry of Construction, and the Regional Government. HFTSA's duties include reporting cargo data (in and out Yangon) to the authorities, and disseminating announcements from the authorities to its members. It is mandatory that truck companies (owners) that own over 4.5 ton cargo trucks going in and out of Yangon join the association. HFTSA has three checkpoints outside Yangon City, namely, No. 1 (Yangon – Bago route), No. 2 (Yangon - Pyae route), and No. 3 (Yangon - Delta route), to check the cargo load of the trucks in all directions.

Table 2.3.44: Weekly Cargo Truck Volumes In and Out of Yangon for Over 4.5 ton Trucks (17-23 Nov. 2012)

(1) Yangon - Bago Route (In and Out of Yangon)

No.	Type of trucks	Yangon In			Yangon Exit			Total Weight of Loads		Total Vehciles
		Vehicles	Ton	Viss	Vehicles	Ton	Viss	Ton	Viss	
1	6 wheels	467	4,203	2,521,800	1,176	10,584	6,350,400	14,787	8,872,200	1,643
2	10 wheels	223	2,453	1,471,800	523	5,753	3,451,800	8,206	4,923,600	746
3	12 wheels	1,036	13,468	8,080,800	1,713	22,269	13,361,400	35,737	21,442,200	2,749
4	22 wheels	142	4,970	2,982,000	247	8,645	5,187,000	13,615	8,169,000	389

(2) Yangon - Pyae Route (Out of Yangon)

No.	Type of Trucks	Vehicles	Ton	Viss
1	6 wheels	533	4797	2878200
2	10 wheels	105	1155	693000
3	12 wheels	313	4069	2441400
4	22 whees	7	245	147000
	Total	958	10266	6159600

(3) Yangon - Delta Route (Out of Yangon)

No.	Types of Trucks	Vehicles	Tons	Viss
1	6 wheels	936	8424	5054400
2	10 wheels	9	99	59400
3	12 wheels	81	1053	631800
4	22 wheels	-	-	-
	Total	1026	9576	5745600

Source: Highway Freight Transportation Services Association

According to the weekly cargo survey by HFTSA shown above, about 70,000 tons of cargos go out Yangon weekly. The Yangon - Bago route, which connect Mandalay and the upper country, is heavily used for cargo transportation. Large trucks such as 22 wheeler trucks are the major size of trucks for this route.

According to HFTSA, there are no private companies allowed to operate truck centers in Yangon, where the goods are collected and long-distance trucks haul the goods to states and provinces. Only Bayint Naung Warehouse is the approved truck center. There are about 30 small truck centers in Yangon. The Bayint Naung Warehouse is located at the busy traffic areas, and existence of this truck center further aggravates the problem on traffic jam. Furthermore, the narrow parking spaces and small streets/roads in the Bayint Naung Warehouse have become unsuitable for the increasing numbers and sizes of the trucks. The relocation and the modernization of the truck centers are inevitable.

In Myanmar, the ratio of Less than Container Load (LCL) container (several consignees share one container box for a certain destination) is rather high. Thus, the demand for the Container Freight Station (CFS) is still high. However, the current Inland Container Depot (ICD) has no CFS or bonded area, thus the LCL cargo consignees need to bring the goods to the CFS at the port terminals for container packing. This results in many movements of small trucks in Yangon. Thus, the new truck center shall contain a bonded area and CFS. When the Study Team visited the Myanmar International Freight Forwarders' Association (MIFFA), they said they expected YCDC to provide the land for the truck terminal at the suburbs, and for private investors to build and operate.

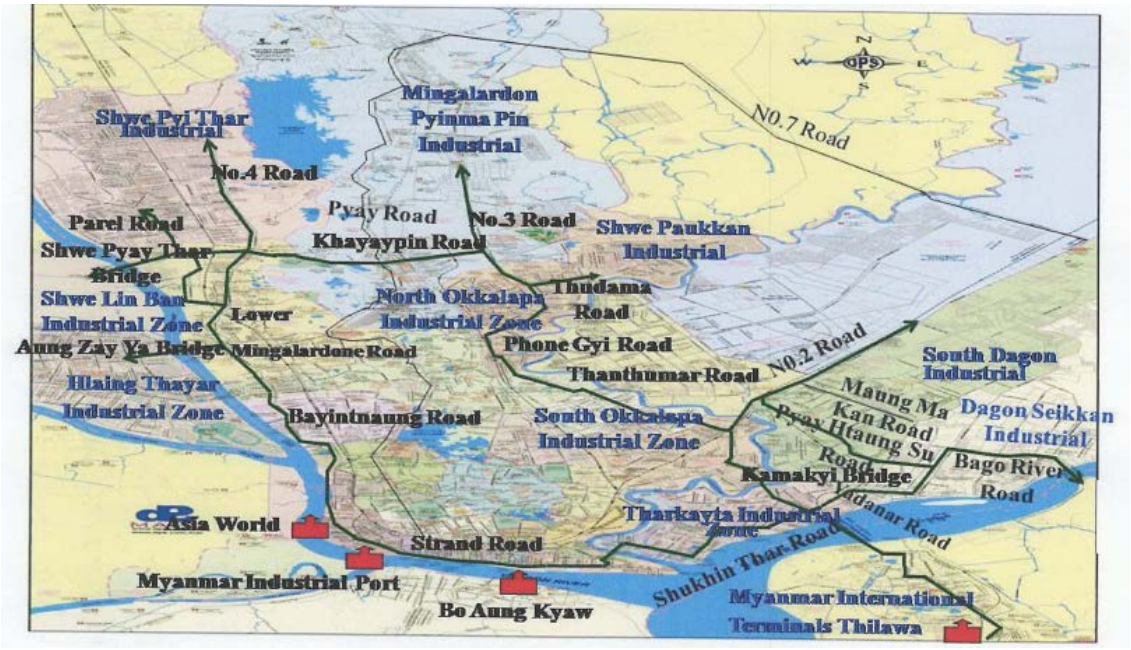
3) Container Cargo

The Myanmar Container Trucks Association (MCTA) is a private association formed by 44 companies or owners of container trucks. According to the association, its members collectively own a total of 827 container trucks, which are about 90% of all existing container trucks in Myanmar.

Most of the loaded containers are transported from container terminals (Bo Aung Kyaw, MIP, Asia World, and MITT) to surrounding industrial zones or downtown areas. Empty containers are transported to ICDs, which have been specially built for empty containers.

There are two Inland Container Depots (ICD) in Botataung Township in Yangon: No.1 ICD (9.75 acre) and No.2 ICD (16.45 acre). They are operated by MPA-Allied Yangon ICD and MEC (Myanmar Economic Corporation), respectively. No.1 ICD has become specialized in storage of empty container due to large supply of empty containers from import activity. Daily movement of the containers is about 400 trucks (in/out), and the average retaining period is 20-25 days, which is rather a long duration. The numbers of the storage container boxes at the No.1 ICD exceed 4000, which is almost the limit of the storage capacity. Recently, the new ICD is open at the Dagon Seikkan Township in Yangon. The demand for ICD will increase constantly as the container throughput increases. Since the volume of loaded container export are much less than import, most of the empty containers are exported without loading.

YCDC and police regulate container truck roads in Yangon. One of the important tasks of MCTA is to enforce traffic regulations to truck drivers. A flow map prepared by MCTA for truck drivers indicates the accessible roads (as of October 2012) in Yangon.



Source: Myanmar Container Trucks Association

Figure 2.3.65: Roads in Yangon Accessible to Container Trucks

4) Movement of Logs (Raw Wood)

The Myanmar Timber Enterprise (MTE) under the Ministry of Environmental Conservation and Forestry is the sole agent in Myanmar in charge of cutting, transporting (to Yangon), and selling of logs (teak and hardwood). Such logs are produced in Mandalay and Sagaing States, and most of them are transported by waterway to Yangon. In Yangon there are 28 log storage yards (eight are owned by MTE) and eight jetties, for unloading and storage, which are mainly along the Yangon River, as shown in Figure 2.3.66. After auction, the logs are transported to factories in Yangon for processing or to ports, such as Sule Pagoda Wharf or MITT, for export. The modes of transportation from the auction places to the export ports are by trailer trucks to port terminals (80%) and barges to ship alongside (20%). About 2.5 million tons of logs, which is about 30% of the total Myanmar export volume, are exported yearly.

One of the causes of traffic jams in Yangon is due to trailer trucks carrying logs that are travelling in every direction as the locations of auctions and export ports are scattered in Yangon. YCDC imposes traffic regulations for these trailer trucks as shown in the map in Figure 2.3.66. It is to be noted that the roads accessible by log trucks and container trucks are the same (as of October 2012).

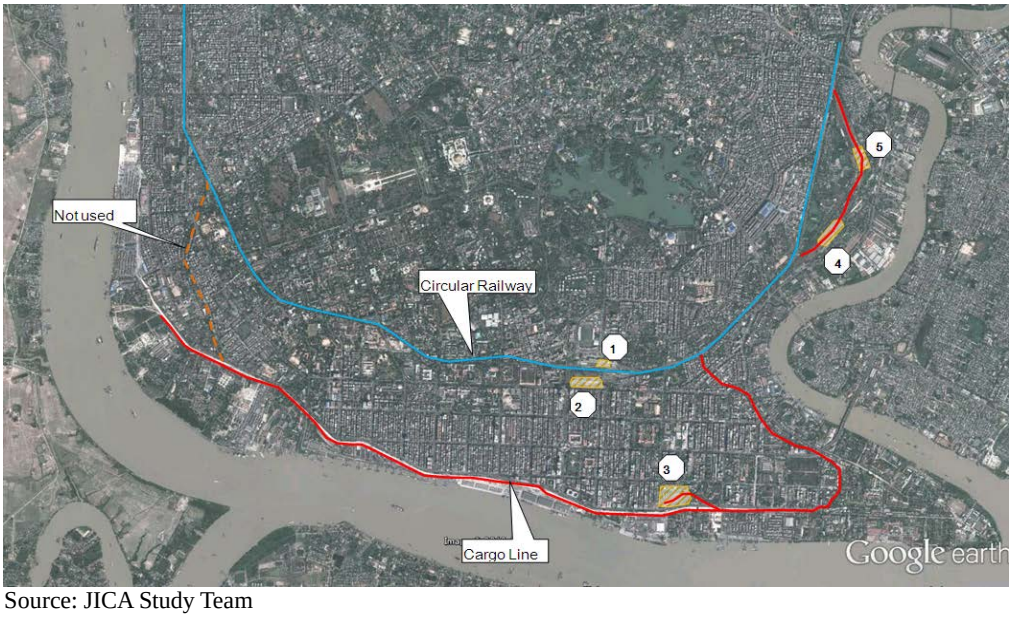
Source: Myanmar Timber Enterprise

Figure 2.3.66: Roads Accessible to Log Trailer Trucks and Locations of Log Storage

5) Railway

The railway cargo line branches off from near the Thein Pyu flyover and ends near Asia World Port Terminal, as indicated in Figure 2.3.67 below. At Botahtaung, another branch goes into Botahtaung Cargo Center. At Bazundang, there is a large cargo base, where the freight bogies are assembled for each destination.

There are five cargo stations in Yangon, namely, (1) Yangon Railway Station Cargo Center No. 1, (2) Yangon Railway Station Cargo Center No. 2, (3) Botahtaung Cargo Center, (4) Sat San Cargo Center, and (5) Ma Hlwa Gone Trains Yard.



Source: JICA Study Team

Figure 2.3.67: Railway Cargo Line and Cargo Stations in Yangon

Yangon Railway Station Cargo Center Nos. 1 and 2 handle goods carried by passenger trains. The cargo handled includes clothes, food products, and medicine. Small trucks (2-4 ton loads) bring or pick up the goods at the cargo stations. The daily tuck visit is merely 15-25 trucks per day for each cargo center.

Yangon Railway Station Cargo Center No. 1

Botahtaung Cargo Center

Sat San Cargo Center

Ma Hlwa Gone Trains Yard (crusher stone storage)

Source: JICA Study Team

Figure 2.3.68: Yangon Cargo Stations

Botathaung Cargo Center, Sat San Cargo Center, and Ma Hlawa Gone Trains Yard handle cargo trains. Botathaung Cargo Center handles only a few cargos. Only about 20 trucks visit Botathaung Cargo Center. Sat San Cargo Center is concentrated in cargo trains headed for Mandalay. At Ma Hlwa Gone Trains Yard, cargo wagons are assembled before leaving for their respective destinations. Also, there are storages for crushed stone, which are brought in from stone quarries near Mawlamyaing. Loading and unloading of cargos are carried out by manual labor, and such task takes time.

Monthly number of cargo trains, not including passenger trains, is summarized in Table 2.3.45.

Table 2.3.45: Monthly Cargo Trains Going Out of Yangon

No	Trains Title / Month	907-UP	805-UP	993-UP	803-UP	507-UP	901-UP	927-UP	913-UP	933-UP	941-UP	921-UP	Remark
		MLK-TG	MLK-PMN	MLK- TZ/ YT	MLK-TZ	MLK-LT	MLK-MH	MLK-MH	MLK-MH	MLK-MKN	MLK-MKN	KMT-MY	
1	January	9	8	4	2	0	16	0	36	6	0	3	
2	February	10	9	4	2	0	13	0	40	9	0	1	
3	March	11	12	5	2	0	15	0	41	10	0	2	
4	April	11	7	5	2	0	20	0	25	6	3	2	
5	May	11	14	4	1	0	13	0	36	9	3	2	
6	June	11	11	5	2	0	15	0	35	6	3	2	
7	July	11	10	5	2	0	13	0	38	7	4	2	
8	August	11	12	4	2	0	15	0	42	4	5	1	
9	September	12	11	7	2	0	12	0	44	5	4	1	
10	October	11	11	8	2	0	17	0	44	8	4	2	
11	November	10	13	7	2	0	14	0	40	6	4	2	
12	December												
	Total	118	118	58	21	0	163	0	421	76	30	20	

Trains going Down From Upper Parts of Myanmar To Yangon

No	Trains Title / Month	908-DN	806-DN	994-DN	804-DN	508-DN	902-DN	928-DN	914-DN	934-DN	942-DN	922-DN	Remark
		TG-MLK	PMN-MLK	TZ/ YT-MLK	TZ-MLK	LT-MLK	MH-MLK	MH-MLK	MH-MLK	MLK-MKN	MKN-MLK	MY-KMT	

Legend

MLK	**Ma Hlwa Gone (Yangoı**
TG	**Taungoo (Bago Divisio**
PMN	**Pyinmana (Naypyidaw)**
TZ	**Thazi (Mandalay Division)**
YT	**Yaw Taw (Mandalay Division)**
HT	**Hlaing Tet (Shan State)**
MH	**Myo Haung (Mandalay Division)**
MKN	**Myitkyina (Kachin State)**
KMD	**Kyi Myin Dai (Yangon Division)**
MY	**Monywa(Sagaing Division)**

Note:

1. **913UP** is Express Train and the Cargo Transportation Price is Higher than Normal Cargo Trains. Total 15 numbers of Buggies in one train.
2. Other ordinary cargo trains are 10 Buggies per train.
3. **805UP** is the Diesel carrier train and its goes to Naypyidaw.
4. Incomming Cargo volume is half of the outgoing Cargo Volume.

Source: Courtesy of the Ma Hlwa Gone Trains Yard office

Train types 931 and 932 are express trains headed for Mandalay (20 hours travel time). Usually, Mandalay express train carries 15 wagons, while the other trains carry ten wagons. Each wagon is loaded with about 30 tons of cargos. Thus, it was estimated that every month about 80,000 tons of cargos go out of Yangon, and about 40,000 tons of cargos come to Yangon by cargo trains. This volume is about one third of the truck transportation system. The trains carrying crushed stones come from Mawlamyaing daily; however, such data were not included in the table.

Currently, the siding rail tracks into the port terminals in Yangon Main Port do not exist and the rail tracks along the Strand Road are not being used. Siding rail into the terminals also will be unnecessary in future due to the following reasons:

- Port terminals in Yangon Main Port are scattered for several kilometers along the Yangon River. Supposing a rail cargo station is constructed in one location in Yangon Main Port, there would need additional truck transportation from the terminals to the rail cargo station.
- The terminal areas in Yangon Port are very narrow, and there will be no place available considering the city development plan in CBD.
- The rail track crosses roads and passes the port terminal gates at several places from Yangon Main Port to the connection point with the Circular Railway. The rail traffic will exacerbate the traffic jam in CBD.

However, the current railway cargo transportation can be improved to increase the cargo volume from Yangon to upper Myanmar and the Mon State, and vise versa by introducing cargo-handling equipment such as forklift, and modern rail maneuvering system. Furthermore, existing cargo stations at the Yangon Station and Botahtaung shall be integrated with the Sat San cargo station as a short-term plan. In a long run, a cargo station combined with other mode of transportation shall be constructed at the suburb in the Greater Yangon.

(9) Policies, Organization, and Legislation

Governing laws in regards to port and logistics are as follows. They are old and appear not to meet the current situations. For example the existing laws do not match with the national policies for foreign investment or privatization.

- The Yangon Ports Act (1905)
- The Myanmar Carriage of Goods by Sea Act (1925)
- The Ports Act (1908)
- The Road Transport and Inland Water Transport Law (1963)
- The Bill of Landing Act (1856)
- The Carriers Act (1865)
- The Maritime Transport Administration Act (1952)
- The Myanmar Merchant Shipping Act (1923)

Furthermore, the laws governing the ship building and inspection were made in about 1900, and have not been revised ever since. Some clauses are obsolete, and cannot be applied. Thus, the review of the laws and regulations will be necessary to improve the safety operations of the ferry services.

Myanmar International Forwarders' Association is tackling the logistic issues in cooperation with The Highway Freight Transportation Services Association and Myanmar Container Trucks Association. According to the hearing, the Association commented on the organization and legislation:

- The current Government organizations are slow to react with the recent change of the country conditions
- At present no licence to become a shipping agent is required. The quality of the service of the logistic industry is a major concern.

Major revisions of the laws and regulations in regard to port and logistic will be necessary.

(10) Key Findings and Main Issues to be Addressed Regarding Ports and Logistics

1) Port Facilities

Most of the port facilities are old and the containerization rate is low, resulting in inefficient cargo handling. Furthermore, since Yangon Main Port is the river port 32km upstream from the river mouth and there are shallow spots in the access channel, ship's waiting time entering Yangon Port is long, which worsen the cargo handling efficiency in Yangon Port. To meet the recent rapid increase in port cargo handling volume, expansion and modernization of the existing port facilities are necessary.

2) Inland Waterway Facilities

The Greater Yangon (Yangon City, Dala, Twantay, and Thilawa) is divided by the Yangon River, the Bago River, and the Twante Canal. The bridges to connect the areas are not sufficient, which resulted in traffic congestion near the bridges. Thus, ferry boat services across the rivers have been developed in the Greater Yangon. Ferry services by large boats are operated by IWT (Inland Waterway Transport). Also there are about 200 small private ferry boats with the passenger capacity up to 24.

The current ferry boats owned by IWT are very old, and slow. They are problematic in safety and punctuality. Thus, the rehabilitation/renewal of the boats, jetties, and the ship yards shall be carried out in order to provide high-mobility ferry services.

Cyclone Nargis stuck the coasts of Myanmar and moved inland across the Ayeyarwady Delta in May 2008, leaving more than 100 ship wrecks blocked the Yangon River and the Twante Canal, which paralyzed the inland waterway transport to the Delta and the upper country until the wrecks had been removed. Learning from this disaster, to maintain the Twante Canal is very important.

3) Old Shipyard Facilities

The facilities of the shipyards where shipbuilding, repair, and inspection of vessels are carried out are generally very old and decrepit. In one shipyard, 100-year old motor winches are still in use. Moving of materials in the shipyard heavily relies on manual labor. Despite its importance, the modernization of the shipyard is very slow.

4) Deep-Sea Port

In neighboring Asian countries, deep-sea ports with depths of around 14 m have already been constructed or are being implemented. In Myanmar, several deep-sea port development projects are now being undertaken in outer sea areas such as in Dawei and Kyaukpyu. On the other hand, Yangon Port restricts its calling vessels to a maximum size of 9 m draft and 15,000 to 20,000 DWT.

Even when the deep-sea ports in Dawei or Kyaukpyu have become operational, Yangon Port will still maintain a significant role in the country's transport system because of its vicinity to the Yangon Metropolitan Area, and it is the hub of the entire river transport system in the country. In addition to this, the planned SEZ nearby Thilawa Area Port will need an efficient port system. Until a deep-sea port (as mentioned in the next paragraph) has been constructed, the existing terminals in Yangon Port shall be expanded to its maximum capacity.

Under such circumstances, the Government of Myanmar has already established its own policy, which includes: to set up a goal for the existing Yangon Port to accommodate a vessel up to 35,000 DWT, and to introduce private companies to investment in terminal facilities in the Yangon Port system. In order to appropriately develop and maintain the channels in the river and the outer sea, careful technical and financial considerations are required. Also, the neighboring two area ports (the existing Yangon Main Port and Thilawa Area Port) should be further developed only after functional demarcation between the ports has been clearly established and the necessary functions of each port are identified. In addition, there is a need to construct a deep-sea port offshore near or around Yangon in the future. In 2012, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) of Japan implemented the "Preliminary Study on National Port Development Plan in Myanmar", in which a preliminary study for new seaport development in the vicinity of the Yangon area will be conducted.

5) Truck Transport Efficiency

Bayint Naung Warehouse, the largest truck center, has become congested due to the rapid increase of cargos and the increase of truck sizes. During lunchtime, all truck drivers leave their vehicles on the lanes in the truck center, thus activities are completely ceased for an hour. Furthermore, traffic jams in roads adjacent to the center will make the access to the center more time consuming.

Since there is a large number of storages of empty containers, most of ICDs have been used as empty container depots, and have not functioned as bonded area. Thus, in order to use the LCL container service, customers need to bring their cargo to the container terminals. This results in many truck movements in Yangon City.

6) Railway Cargo Station Modernization

Though the train cargo stations have sufficient space for cargo handling and for future expansion, most of cargo loading and unloading are being carried out by manual labor. As a result, the total transportation time by rail has increased. Trains take about 20 hours from Yangon to Mandalay, and more time for loading and unloading of cargo.

2.3.5 Water Supply

(1) Legal and Institutional Framework

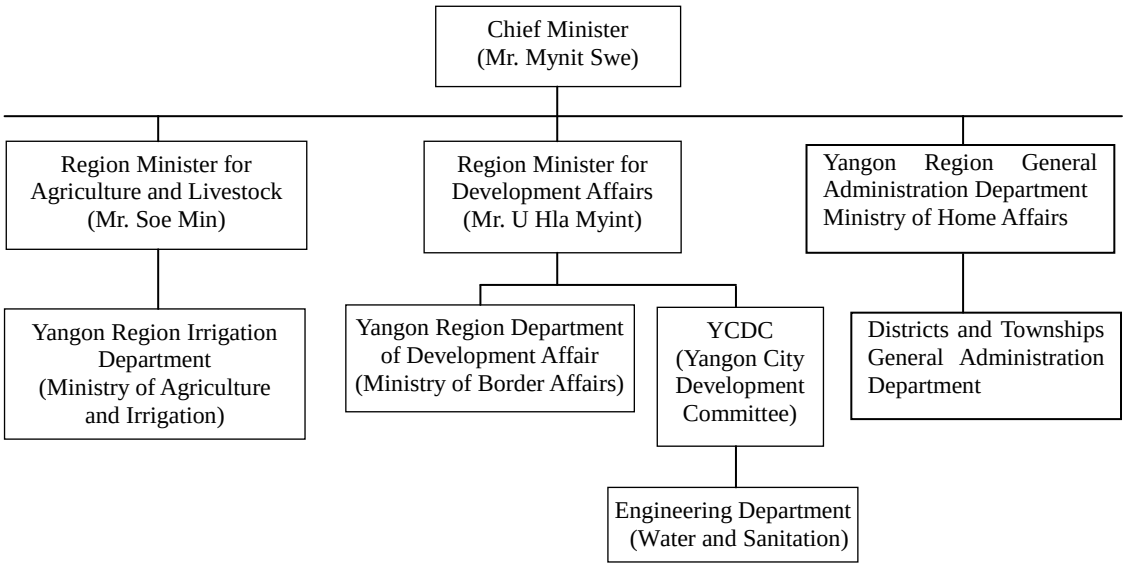
1) Legal Status

The State Law and Order Restoration Council (SLORC) enacted the Yangon City Development Act in 1990 (Act No 11/90) to upgrade the Municipality of Yangon to ministry level. This provided a wide range of duties and responsibilities to YCDC. According to the Act, YCDC is tasked with the management and maintenance of all municipal water works such as the construction or acquisition of new works, prohibition or regulation of the digging or construction of any new wells, tanks, ponds, cisterns and/or fountains. YCDC is also tasked to prevent water pollution within the city, and levy water tax on buildings or lands which are connected with any municipal waterworks.

2) Institutional Setting

The water supply system of Yangon City is managed by the Department of Engineering (Water and Sanitation) of YCDC. On the other hand, water service for six townships outside Yangon City, namely; Kyauktan, Thanlyin, Hlegu, Hmawbi, Htantabin, and Twantay is handled by the Department of Development Affairs (DDA), which is one of Yangon's regional departments.

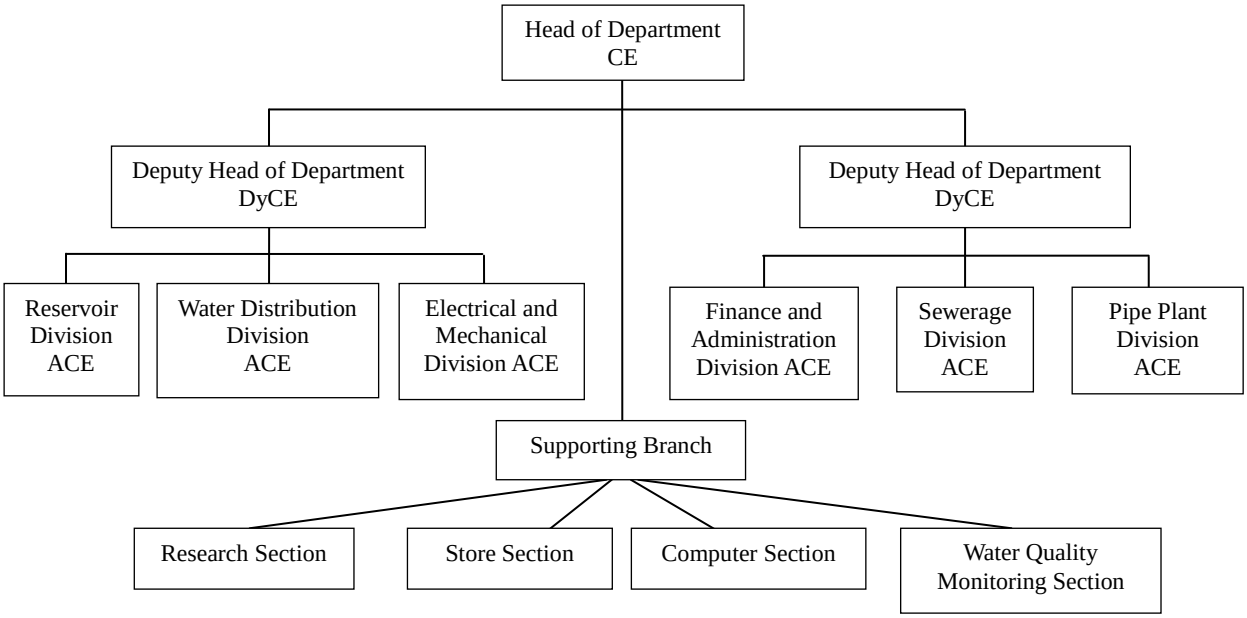
Figure 2.3.69 shows the management body on water supply services.



Source: JICA Study Team

Figure 2.3.69: Management Body on Water Supply

The Engineering Department (Water and Sanitation) is composed of six divisions as shown in Figure 2.3.70.



Source: YCDC, Department of Engineering (Water and Sanitation)

Figure 2.3.70: Organization of Water Supply and Sanitation

1) Reservoir Division (485 staff)

The division is responsible for the operation and maintenance of three reservoirs (Gyobyu, Phugyi and Hlawga) and pumping stations (P/S) (Gyobyu, Phugyi, Hlawga, Nyaunghnapin Water Treatment Plant (WTP) P/S, and Yegu P/S)

2) Water Distribution Division (1,060 staff)

The Division has its main office at city hall, four district offices and 32 township offices. The district office is in charge of tasks such as the acceptance of new connections, repair of minor leaks, complaint-handling, and promotion for new connection. The township office is responsible for the operation and maintenance of tubewells, collection of water tariff and repair of leaks.

3) Electrical and Mechanical Division (86 staff)

Main works of this division is the maintenance of tubewells in South Dagon and Taephyu.

4) Finance and Administrative Division (215 staff)

This division is tasked to undertake tariff collection from government bodies and foreign enterprises, collection of meter charges, payment of salaries, etc.

5) Sewerage Division (139 staff)

This division is responsible for the operation and maintenance of wastewater treatment plants, ejector stations, compressor stations and sewer networks.

6) Pipe Plant Division (136 staff)

This division is in charge of operation of factory producing pre-stressed concrete pipes with diameter of 0.4 m, 0.6 m and 0.9 m. These pipes are used for the Department of Water Supply and Sanitation and are sold to other departments like the Irrigation Department of the Ministry of Agriculture and Irrigation (MOAI).

(2) Water Source Development Plan

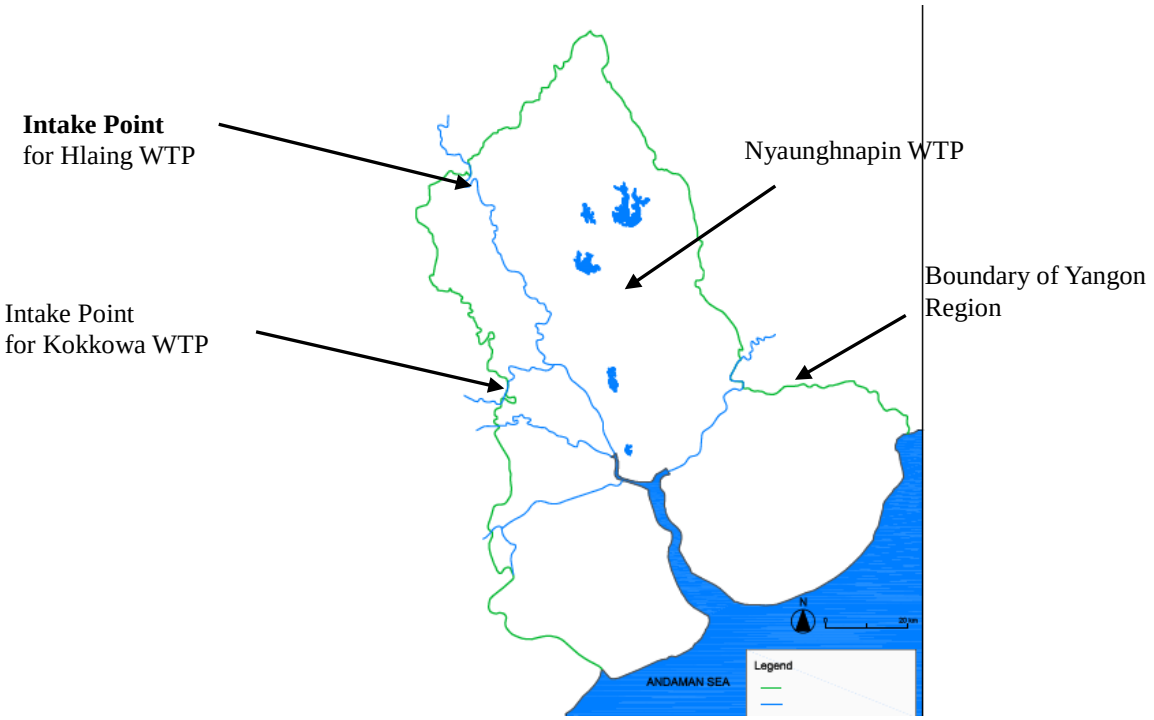
Major water sources of YCDC water supply system include four reservoirs. Out of these four reservoirs, three are owned by YCDC while one reservoir (Nga Moeyeik Reservoir) is managed by MOAI. YCDC obtains water from the Nga Moeyeik reservoir in accordance with the water rights from MOAI. The current water right is 45MGD (20,500 m^3/d). YCDC gets information from MOAI unofficially, in order to form a higher limitation of water rights from the 135 MGD (addition of 90 MGD) Nga Moeyeik Reservoir..

YCDC has a water source and development plan and a WTP construction plan as shown in Table 2.3.46. The locations of these WTPs are indicated in Figure 2.3.71.

Table 2.3.46: Water Source Development Plan

Name	Quantity (MGD)	Capacity (m^3/d)	Remarks	Status
Nga Moeyeik Phase 2 (Nyaunghnapin WTP)	45	205,000		Under construction
Nga Moeyeik Phase 3	45	205,000	With WTP	Under preparation
Kokkowa WTP phase 1	45	205,000		Not yet implemented
Kokkowa WTP phase 2	45	205,000		Not yet implemented
Hlaing WTP	90	409,000		Not yet implemented
Total	270	1,229,000		

Source: Revised Yangon Conceptual Plan



Source: JICA Study Team based on the data from the revised Yangon Conceptual Plan

Figure 2.3.71: Locations of Proposed WTPs

(3) Financial Aspect

1) Water Tariff

Water tariff is categorized into two portions which are local currency and foreign currency. Focusing on the tariff for commercial and foreign businesses is about seven times (0.88/0.13) as high as the tariff of local businesses as shown in Table 2.3.47 and Table 2.3.48.

Table 2.3.47: Water Tariff System (in MMK)

No.	Category	Meter Rate (MMK/m^3)	Flat Rate (MMK/month)
1.	Government Institution ● Departmental, officers and staffs ● Housing factories, workshops	 55 77	Variable, price upon the daily water usage is estimated by water rate.
2.	Public ● Household ・ High rise building, individual house with compounds, residences ・ Individual house and apartment ● Commercial ・ Construction industry ・ Commercial	 88 88 110 110 (US$0.13)	 3,000 1,800 309.6 MMK/m^2 (Price upon the water usage is estimated by 28.8 MMK/sq-ft)

Source**:** YCDC, Department of Engineering (Water Supply and Sanitation)

Table 2.3.48: Water Rate System (in US$)

No.	Category	Meter Rate (US$ / m^3)	Flat Rate (US$ / month)
1.	Hotels, motels, inns (investment in foreign currency)	0.88	US$0.5 /guest /day
2.	Industries, workshops, markets and condominiums	0.88	Price upon the daily water usage is estimated by water rate.
3.	Rent of household (including individual house with compounds, residences, apartments, high rise buildings)	0.44	25

Source: YCDC, Department of Water Supply and Sanitation

Water tariff of YCDC seems to be lower if compared to that of other cities in Asia as shown in Table 2.3.49.

Table 2.3.49: Domestic Water Tariff in Other Asian Countries

Country	City	Water Tariff per Cubic Meter	Remarks
Thailand	Bangkok	Baht 8.5 (US$0.27)	0-30 m^3/month, FY2008
Sri Lanka	Colombo	SL Re 15 (US$0.12)	11-15 m^3 / month, FY2008
India	Jamshedpur	RS 5.0 (US$0.10)	0-30 m^3, FY2008
Malaysia	Kuala Lumpur	RM 0.57 (US$0.19)	0-20 m^3, FY2006
China	Shenzhen	CNY 2.3 (US$0.36)	0-22 m^3, FY2011
Singapore	Singapore	S$1 .17 (US$0.95)	0-40 m^3, FY2010
Myanmar	Yangon	MMK 88 (US$0.10)	FY 2012

Source: Good Practices in Urban Water Management, ADB Conversion rate; JICA HP October 2012)

2) Financial Status

The financial status of the Department of Water Supply and Sanitation is shown in Table 2.3.50 and Table 2.3.51. Revenue from the private sector accounts for about 70% of the department's total revenue. Expenditure for electricity is the largest (40%), and salaries account for 17% in 2011-2012.

Table 2.3.50: Current Revenue of the Department of Water Supply and Sanitation in the Past Three Years

100,000 MMK

Account Title	2009-2010	2010-2011	2011-2012
Current Revenue (Cost received from services)			
Water Charges for Government	11175.07	1094.89	1089.13
Water Charges for private	30683.90	32510.03	33003.89
Water Connection	1223.17	1391.80	1857.42
Sale of Water Meter	389.47	264.72	161.88
Rental of Shops and Sites	334.54	353.23	443.21
Plumber Licenses Fees	7.12	6.40	13.44
Charges for Toll Road (Nga Moeyeik Dam)	0.08	0.12	
Other Revenue	520.62	234.34	791.18
TOTAL	44,333.97	45,708.53	47,090.15

Source: YCDC, Department of Water Supply and Sanitation

Table 2.3.51: Current Expenditure of the Department of Water Supply and Sanitation in the Past Three Years

Account Title	2009-2010	2010-2011	2011-2012
Salary and Costs Local Travelling	**5,470.76**	**7,251.58**	**7,408.06**
Material Cost, Labor Charges and Service	**25,868.09**	**26,019.66**	**31,904.77**
・ Labor Charges	2881.15	4011.86	3932.02
・ Rental & Production Fees	1.26	2.02	5.00
・ Transportation	64.79	38.20	54.86
・ Office utensil	7.32	20.60	20.00
・ Petrol & Lubricant	557.81	1192.39	995.50
・ Stamp & Telecommunication	74.87	9.54	24.10
・ Electricity Charges	17302.87	14039.78	18323.09
・ Periodical			0.50
・ Uniform			10.00
・ Operating Material	4548.83	6272.41	8000.00
・ Printing & Publishing	429.19	432.86	539.70
Maintenance & Repair	**2,324.22**	**3,549.52**	**5,362.48**
Entertainment Charges			**1.99**
TOTAL	33,663.07	36,820.76	44,677.30

Source: YCDC, Department of Water Supply and Sanitation

3) Financial Flow and Budget Allocation System

The department's financial flow and budget allocation system are as follows:

Step 1. Water tariff is collected by the township officer

Step 2. Collected tariff is transferred to the Department of Budget and Account of YCDC. The collected tariff is regarded as YCDC's revenue not the Department of Water Supply and Sanitation.

Step 3. The collected tariff is transferred to Yangon Regional Government.

On the other hand, budget allocation procedure is:

Step 1. Twenty departments of YCDC make budgetary requests to the YCDC mayor. The mayor submits the budgetary request to Yangon's regional chief minister.

Step 2. Yangon's regional chief minister decides the budgetary allocation discussing it to the Regional Ministry of Finance and Revenue.

Step 3. Budget allocation of YCDC is decided through a discussion among the mayor, secretary, seven committee members and the Department of Budget and Account.

4) Issues and problems on finance

Although the operational balance is positive, the actual balance considering repayment for the capital cost may be negative. Therefore, the actual financial statement including repayment of

capital cost is required to evaluate/raise the existing water tariff level. Moreover, YCDC has no jurisdiction to handle the revenue from the operation of water supply services. An independent account system is preferable for the Department of Water Supply and Sanitation to clarify the responsibility of the department and to promote the ownership of the water supply system.

(4) Water Supply System in Yangon City

1) Service Level

Service coverage of the YCDC water supply system is 42% in 2010. The remaining 58% of people obtain water from private wells and other water sources like ponds and rain. On the other hand, the water supply amount of the YCDC system accounts for 58% as estimated by YCDC.

2) Fundamentals of Existing Water Supply System

The fundamentals of the existing water supply system are shown in Table 2.3.52.

Table 2.3.52: Fundamentals of the YCDC Water Supply System

Item	unit	Year 2010
(1) Administrative Population	person	4,728,063
(2) Population Served	person	1,971,560
(3) Service Coverage =(2)/(1)	%	41.7
(4) Daily Average Water Consumption (Domestic)	m^3/d	209,188
(5) Unit Water Consumption =(4)/(2)	Lpcd	106.1
(6) Daily Average Water Consumption (Commercial and Industrial)	m^3/d	29,658
(7) Daily Average Water Consumption (Institutional)	m^3/d	53,197
(8) Total = (4)+(6)+(7)	m^3/d	292,043
(9) Daily Supply Amount	m^3/d	635,636
(10) Non-revenue Water = (9)-(8)	m^3/d	343,593
(11) Revenue Water Rate = (8)/(9)	%	45.9
(12) Non-revenue Water Rate = (10)/(9)	%	54.1

Source: The Study on the Improvement of Water Supply and Wastewater Treatment in Yangon (2012, METI, Japan)

3) System Configuration

Existing water supply systems consists of two systems; the main system and the Dala independent water supply system using tubewells. The Dala system is a very small system having a number of service connections of 1,630. In contrast, the main system has 252,020 service connections. A schematic configuration of existing water supply system is shown in Figure 2.3.72.

4) Major Facility of YCDC Water Supply System

Location of major facilities of the existing water supply system is shown in Figure 2.3.73. After completion of the Master Plan (2002), Nyaunghnapin WTP (2005), South Dagon WTPs (2008 and 2009) and Thaephyu WTP (2009) were constructed to expand the service area.

1) Reservoirs

Table 2.3.53 shows the features of existing reservoirs which are the main sources of the YCDC water supply system.

Table 2.3.53: Features of Existing Reservoirs

Item	Gyobyu	Phugyi	Hlawga	Nga Moeyeik	Total
Year completed	1940	1973	1904	1995	-
Catchment area（km^2）	32.9	70.6	27.1	414	-
Effective capacity (million m^3)	38	91	48	207	-
Intake amount	27 MGD (123,000 m^3/d)	54 MGD (245,000 m^3/d)	14 MGD (64,000 m^3/d)	45 MGD (204,000 m^3/d)	140 MGD (635,000 m^3/d)

Source: JICA Study Team based on the data from the Irrigation Department

2) Other Facilities

The features of other facilities such as the production well pumping station, WTP, service reservoir and service connection are shown below:

- Tubewells

At present, 414 tubewells are in operation. The total drawn amount is estimated at 20 MGD (91,000 m^3/d). Table 2.3.54 shows the number of tubewells by district by casing diameter.

Table 2.3.54: Number of Tubewells by District by Casing Diameter

No	Name of District	2" ø	4"ø	6"ø	8"ø	10"ø	12"ø	Total
1	South District	-	6	30	22	4	5	67
2	North District	-	25	13	28	6	2	75
3	West District	-	1	26	101	20	4	152
4	East District	2	39	32	40	6	1	120
	Total	2	71	101	293	36	12	414

Source: YCDC Department of Water Supply and Sanitation

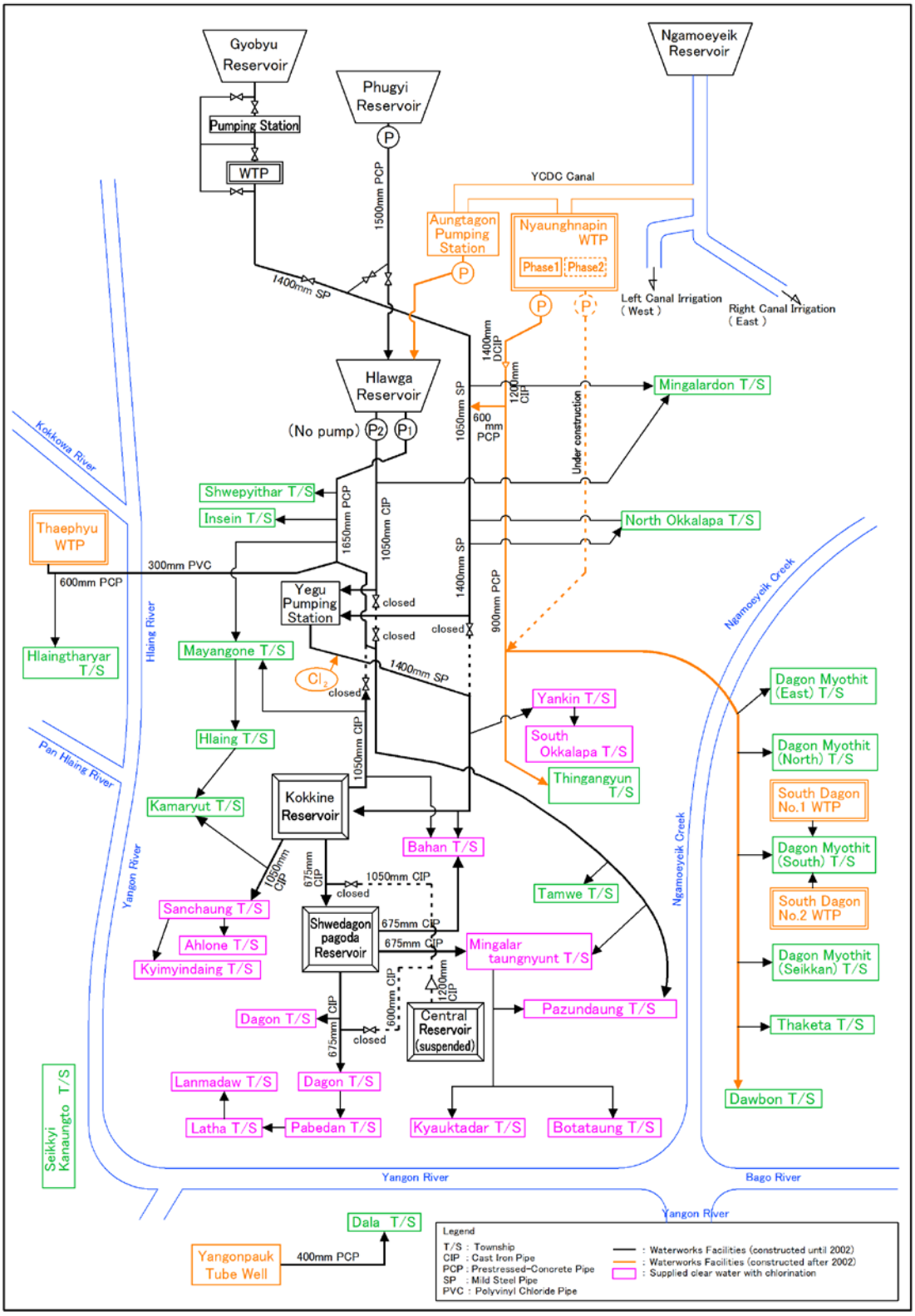
- WTP, Pumping Station, Service Reservoir

Table 2.3.55 shows the outline of WTPs, pumping stations, distribution reservoirs as well as the number of service connections of the YCDC water supply system.

Table 2.3.55: Outline of Major Facilities

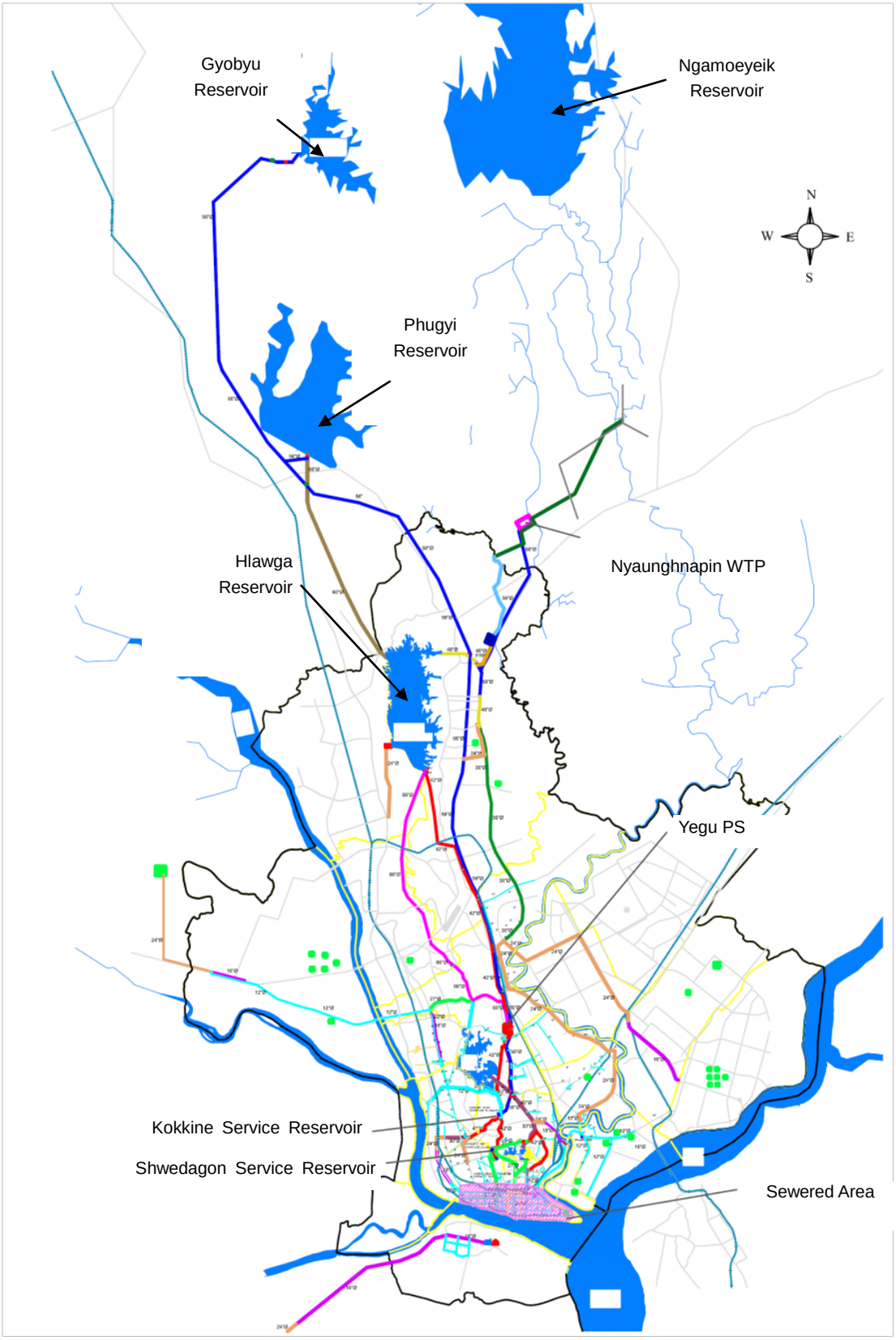
Items	Features	Year Constructed	Remarks
WTP (Gyobyu)	Q=27 MGD, Process: sedimentation +micro-strainer	1940	
Transmission PS (Gyobyu)	3,310 m^3/hr x 3set (including 1 standby set)	1,962/1982	Only operational below certain water levels of the reservoir
Transmission PS (Phugyi)	5,610 m^3/hr x 3set (including 1 standby set)	1988	
Hlawga PS No.1	4,980 m^3/hr x 4set (including 2 standby sets)	1988	
Hlawga PS No.2		1904	Pump uninstalled
Yegu Water Storage	V=3,400 m^3	1,906	RC
Yegu PS	5,610 m^3/hr x 3set (including 1 standby sit)	1990, 2008	
WTP (Nyaunghnapin)	Q=45 MGD, Process: sedimentation + rapid sand filter	2005	Phase2 will operate 2013 Jan (additional 45MGD)
Aungtagon PS	Q=45MGD	2010	
South Dagon No.1 WTP	Q=1.0 MGD, Process: aeration + sedimentation + rapid sand filter	2008	To treat groundwater
South Dagon No.2 WTP	Q=1.0 MGD, Process: aeration + sedimentation + rapid sand filter	2009	To treat groundwater
Distribution Reservoir (Kokkine)	V=90,900 m^3 HWL 42.7 m	1926	
Distribution Reservoir (Shwedagon)	V=4,500 m^3 HWL 40.2 m	1904	
Distribution Reservoir (Central)	V=45,0000m^3 HWL 40.2 m	1965	
No. of Service Connection (East)	85,926		Total of District
No. of Service Connection (West)	53,814		Total of District
No. of Service Connection (North)	77,582		Total of District
No. of Service Connections (South)	36,328		"
Total (Service connection)	Frat rate: 65,076 Metered rate, 186,069 Free: 2,505 } **253,650**		Total of 4 Districts

Source: JICA Study Team based on Department of Water Supply and Sanitation, YCDC



Source: The Study on the Improvement of Water Supply and Wastewater Treatment in Yangon (2012, METI, Japan)

Figure 2.3.72: Schematic Configuration of Existing Water Supply System



Source: Study Report on Fact Finding Survey March 2012, JICA

Figure 2.3.73: Major Facilities of the YCDC Water Supply System

(5) Present Water Demand

Present water consumption by the YCDC system is 292,043 m^3/d. Based on Table 2.3.52, the unserved population of the YCDC water supply system is 2,756,503 (4,728,063-1,971,560). If the unit water consumption is at 106 L/d (Table 2.3.52) neglecting non-domestic use, the total consumption amount is estimated at 584,323 m^3/d (2,756,503x0.106+292,043). Therefore, about 0.6 million m^3/d is considered as the potential water demand on a consumption basis. On the other hand, the potential supply amount varies per assumption of the non-revenue water (NRW) ratio as follows:

- Assumption-1 NRW 50 % 0.6 million/(1-0.5)= 1.2 million/d
- Assumption-2 NRW 30 % 0.6 million/(1-0.3)= 0.86 million/d

From the above estimation, 0.9-1.2 million/d may be the potential water demand of the whole of Yangon City in terms of supply amount. Hence, when YCDC develops or expands the service area, YCDC should consider the reduction of NRW as well.

(6) Water Supply Service Outside of Yangon City

Out of six townships included partially in the Study area, Kyauktan and Thanlyin townships have a public water supply system covering a part of each township. This means that the other four townships: Hlegu, Hmawbi, Htantabin and Twantay, has no water supply system. People from these townships get water by themselves in private wells, ponds, rain water, etc. For example, people from the Twantay township get their water from nine ponds and 1,236 private wells (dug well: 320, tubewell: 916). The features of the public water supply system of the two townships are shown in Table 2.3.56.

Table 2.3.56: Features of Water Supply System in Neighboring Townships

Items	Kyauktan	Thanlyin
Water source	Reservoir	Tubewell
No. of systems	1	3
No. of service connection	1436	97 (42+19+36)
Population in 2011	123,565	204,486
Service Coverage	6 % (assuming 5.0 per SC)	0.2 % (assuming 5.0 per SC)
No. of service tank	15 (communal tank)	3 elevated tanks (V= 50 m^3)
Water Tariff	2500 MMK/month	1000 MMK/month

Source: JICA Study Team based on the interview to engineer of Township Office

Construction, and operation and maintenance (O&M) cost for the water supply system is burdened by township development committee offices having no subsidy from upper organizations. The township development committee offices gain water tariff and tax then expend it on the O&M of the system.

(7) Water Supply System in the Industrial Zone and Port at Thilawa

1) Current Conditions

There are two water supply systems for special purpose such as the Thilawa Special Economic Zone (hereinafter Thilawa SEZ) and Thilawa Port in the Study area. The features of the two water supply systems are shown in Table 2.3.57.

Table 2.3.57: Features of Water Supply System in Industrial Zone and Port in Thilawa

Items	Thilawa SEZ	Thilawa Port
Water Source	Bantwekone Reservoir (Kyauktan TS)	Thilawa Reservoir (Thanlyin TS)
Intake	3 submersible pumps	2 submersible pumps
Distribution System	Gravity system using ground reservoir, pump and elevated tank	Gravity system using ground reservoir, pump and elevated tank
Elevated tank	300 m^3	100 m^3
Water Tariff	300 MMK/m^3	0.8 US$/$m^3$
Operation Body	Ministry of Industry	Ministry of Construction

Source: JICA Study Team for Preparatory Survey on Thilawa SEZ Infrastructure Development

2) Issues for Development in the Future

It is essential to secure a new water source for the opening of Thilawa SEZ in 2015. The water demand and planned facilities to be prepared in the given target year are shown in Table 2.3.58 below.

Table 2.3.58: Water Demand and Planned Facilities in Thilawa SEZ

Target Year	Water Demand (m^3/day)	Facilities to be Prepared
2015	3,000	● Zamani reservoir improvement ● Tube well development ● Conveyance pipeline to class A (L=5.6km) ● Zamani water purification plant (5,250m^3/day)
2018	42,000	● Langunbyn reservoir and canal improvement ● Langunbyn water purification plant, phase 1 (52,500m^3/day) ● Water transmission pipeline to class A (L=51 km)

Source: JICA Study Team for Preparatory Survey on Thilawa SEZ Infrastructure Development

Regarding the existing water resources of Thilawa, there are three reservoirs which were constructed by MOC-DHSHD. The total intake water volume available from these three reservoirs is 28,445 m^3/day. This includes water supply to Thilawa Port, ships and around townships, but does not include water supply to Thilawa SEZ. In the last meeting between the Irrigation Department of MOAI and the JICA Study Team for Thilawa SEZ, the Irrigation Department stated to provide water supply of 3,000 m^3/day to Thilawa SEZ.

In addition, a sustainable water source like large rivers and its tributaries is needed in order to meet the required water volume of 42,000 m^3/day in 2018. The Langunbyn Reservoir, which is located in Bago Region, 60 km away from Thilawa SEZ, has surplus water of 42,000 m^3/day. The Irrigation Department plans to provide the said surplus water for SEZ.

When MOC-DHSHD discussed with YCDC in 2007, YCDC agreed to supply water to the Thilawa SEZ. However, YCDC cancelled its decision in January 2012 because satellite towns located in eastern Yangon has higher priority of water supply. In this regard, it would be difficult for Thilawa SEZ to get enough water from YCDC.

(8) Key Findings and Main Issues for Water Supply

1) Capacity of YCDC

The Water Supply and Sanitation Department of YCDC has a certain level of capability for implementing the project because they have been operating water supply and sewerage systems for over 100 years. However, modernization of the water supply and sewerage systems has been delayed due to the long economic sanction to Myanmar.

- Although the Department of Water Supply and Sanitation of YCDC has been managing water supply and sewerage systems, the modernization of organization, technology and equipment are much delayed.
- As experience on construction works of large WTP is limited, the capability for planning and designing of WTP seems to be at a low level. There are no design criteria for WTPs as well as specific sections for planning/designing.
- Water quality management is insufficient in terms of organizational structure and equipment analysis.

2) Low Service Coverage

Present service coverage by the water supply system of YCDC is only approximately 50%. Moreover, the water demand has been rapidly increasing due to urbanization and population growth of Yangon City. Therefore, additional water source needs to be developed immediately.

3) High Water Wastage

Non-revenue Water (NRW) rate in Yangon City is very high (approximately 50%). Therefore, NRW is to be reduced to make up for the potential water demand.

4) Unsuitable Water Quality to Drink

The ratio of chlorinated water volume over supplied water volume is only 25%. Actually, it is reported that bacteria was detected from all tap water samples.

5) Aged Facilities

All pump stations in reservoirs and main transmission pipes have already aged and beyond its life span.

6) Low Water Tariff

Compared with other countries, the water tariff of YCDC for domestic users is too cheap. For example, the water tariff of YCDC is US$0.10 per 1.0 m^3 while on the other hand, the water tariff of Bangkok and Kuala Lumpur are US$0.27 and US$0.19, respectively. Therefore, user awareness on water savings is low. Also, this water tariff level could not cover the investment cost of the construction of facilities.

7) Improper Distribution System

- The total volume of existing distribution reservoirs are approximately three hours of daily supply. This volume is small from a standpoint of appropriate design.
- There are no distribution blocks despite the large service area. It is necessary to install separation valves to make distribution blocks, considering the height of distribution tanks and the network system.
- There is no flow meter to grasp actual distribution volume. Also, water meter coverage is approximately 70%. Therefore, it is difficult to estimate the actual water balance.

2.3.6 Sewerage and Drainage

(1) Overview

YCDC manages both water supply and sewerage service within a same organizational unit and furthermore, there is no separate sewerage tariff. The sewerage service area is limited within CBD areas and the treatment volume is limited to 500,000 gallon a day (2,300m^3/ day). Therefore there is no significant financial implication from the current sewerage operations. The sections related to sewerage service have a total of 139 staff members, which are comprised of 30 employees in the compressor section, 41 in the sewerage maintenance-west, 39 in the sewerage maintenance-east, and 29 in the wastewater treatment plant.

Existing sewerage system is employed only in the CBD area. The collection system of this sewerage system was developed in 1888 with its sewerage area being expanded in 1929. Then, its wastewater treatment plant (WWTP) was completed in January 2005. Collected wastewater have been previously disposed to the Yangon River until December 2004

The people living outside the sewerage area employ on-site disposal systems like the septic tank system. However, these systems have no exclusive sludge treatment plant. Removed sludge is disposed to the existing WWTP.

(2) Sewerage

1) YCDC Sewerage System

The existing YCDC sewerage system consists of a sewer main (L=10.8 km, Dia 0.3-0.9m), 40 ejector stations, two air compressor stations and a WWTP. The service area covers the whole area of six townships, with partial area of two townships. However, only black water (toilet wastewater) is treated while grey water is disposed to drainage ditches without treatment.

a) Features of WWTP

Features of the WWTP are summarized below:

- Lot Area : 22,500 m^2
- Treatment capacity : 14,775 m^3/day (Current inflow volume: 2,300 m^3/day)
- Design served population : 300,000
- Design water quality (BOD influent 600 mg/l, effluent 20 mg/l)
- Treatment method : Activated Sludge
- Sludge treatment process :

  Thickening - Aerobic Digestion - Dewatering - Disposal to WWTP Lot Area

Alignment of the existing sewer network and location of WWTP is shown in Figure 2.3.74.

b) Estimated Expenditure of Sewerage Operation

Due to lack of accounting separation between water supply and sewerage, an estimated expenditure for sewerage operations is shown in below. The largest part of the budget is used for maintenance of sewers and treatment plant. The overall budget is estimated at MMK 314 million, comprising 7% of the total budget for water and sewerage division.

Table 2.3.59: Estimated Expenditure of Sewerage Operation

Item		Quantity (Unit)	Cost (MMK million)
Manpower	Regular Staff	42 (Persons)	35
	Labor	97 (Persons)	58
Power		511 (MWh)	18
Maintenance		(per year)	192
Others		-	11
Total Estimated Sum			314

Source: JICA Study Team for Project for the Improvement of Water Supply, Sewerage in Yangon City

2) Onsite Disposal System

1) Type of Onsite Disposal System

The present onsite disposal system is categorized into five types, enumerated below, according to the previous study "Yangon Infrastructure and Environment Services, Pre-feasibility Study Yangon City and Regional Development Project August 1993" (hereinafter called as the Pre-feasibility Study).

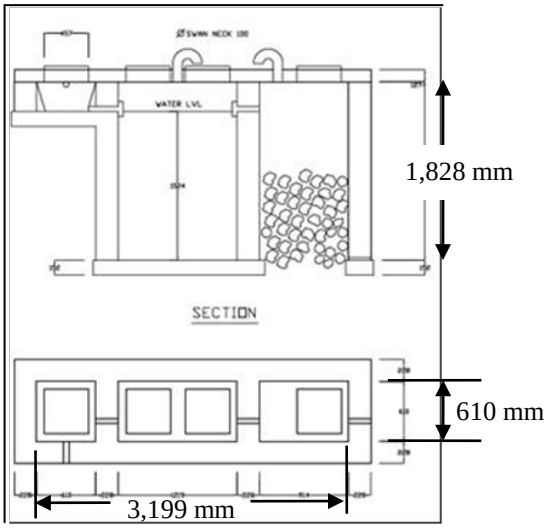
- Septic tank system (common and individual)
- Pour flush system
- Fly proof (chute type)
- Unsanitary latrine
- No latrine

According to the Pre-feasibility Study, the coverage ratio of the septic tank system was 18%. YCDC approves the plumbing and disposal system by septic tank for building constructions. There were actually 662 permits that have been issued in 2011 by YCDC for the construction of septic tanks. Similarly, the construction of 400 septic tanks was approved in January to August 2012. According to the HIS, about 40% of households have septic tanks.

A drawing sample of a household septic tank approved by a YCDC licensed plumber is shown in Figure 2.3.75.

Source: JICA Study Team based on the data from the Department of Water Supply and Sanitation, YCDC

Figure 2.3.74: Existing Sewer Network Plan



Source: Department of Water Supply and Sanitation, YCDC

Figure 2.3.75: Sample Drawing of Septic Tank Approved by YCDC Licensed Plumber

2) Sludge Removal and Sludge Treatment

Vacuum car service for de-sludging septic tanks is provided on demand. Vacuum cars owned by the Department of Motor Transport and Workshop of YCDC carry removed sludge to the WWTP. There is no desludge services by any private contractor at present. The department currently has 33 vacuum cars (1.8 m^3 -10 cars and 5.4 m^3 - 23 cars).

The frequency of vacuum car-running is 36-46 times a day. Actual recordss on the number of vacuum car-running are shown in Table 2.3.60.

Table 2.3.60: Frequency of Vacuum Car-Running by Month (time/month)

Year 2012	Vacuum car (1.8 m^3)	Vacuum car (5.4 m^3)	Total (times)
January	591	588	1,179
February	606	542	1,148
March	617	637	1,254
April	534	531	1,065
May	742	554	1,296
June	675	594	1,296
July	546	582	1,128

Source: YCDC Department of Water Supply and Sanitation, YCDC

Service charge for desludging varies by township and by the size of vacuum car. This service is provided in the YCDC area and its neighbor townships. There is no difference between YCDC townships and not-YCDC townships because the category for the service charges is set considering distance from YCDC. However, no service is provided for the Seikgyikhanaungto Township, despite being within Yangon City due to accessibility difficulties.

Those charges are paid fully by person who ask YCDC to desludge from the septic tank.

Service charge system is shown in Table 2.3.61.

Table 2.3.61: Charging System for Desludging Service

Distance Category	Vacuum Car (1.8 m^3)	Vacuum Car (5.4 m^3)
Category 1 (3 TS)	5.0 gallon x gasoline unit price +MMK 3,500	6.5 gallon x gasoline unit price +MMK 11,000
Category 2 (6 TS)	4.0 gallon x gasoline unit price +MMK 3,000	5.0 gallon x gasoline unit price +MMK 8,500
Category 3 (11TS)	2.5 gallon x gasoline unit price +MMK 2,500	3.0 gallon x gasoline unit price +MMK 6,5000
Category 4 (9 TS)	2.0 gallon x gasoline unit price +MMK 2,000	2.5 gallon x gasoline unit price +MMK 4,500
Category 5 (10TS)	1.5 gallon x gasoline unit price +MMK 2,000	2.0 gallon x gasoline unit price +MMK 4,000

Source: Department of Motor Transport and Workshop of YCDC,

(3) Drainage

1) Overview

Stormwater in Greater Yangon flows into six rivers/canals, namely; Yangon River, Bago River, Hlaing River, Nga Moeyeik Creek (Pazundaung River), Pan Hlaing River and Twante Canal. The six rivers flow through 47 drainage channels as shown in Figure 2.3.76. The list of channels is also shown in Table 2.3.62. Aside from that the channels, 14 outlets to the Yangon River are installed in the CBD area.

The Department of Roads and Bridges, YCDC is in charge of maintenance/improvement works of drainage channels within Yangon City. Other streams are being handled by the DDA of Yangon regional government.

As shown in Figure 2.3.76, the area surrounded by the Hlaing River and Nga Moeyeik Creek has favorable slope for drainage except in some low-lying areas. However, townships that are newly included in the administrative area of Yangon City such as Dala, Dagon, and Shwe Pyi Thar have low and flat topography. Neighboring townships of Yangon City that are included in Greater Yangon, namely; Thanlyin, Hlegu, Htantabin and Twantay also have low and flat topography. Hence, these areas basically have drainage problems.

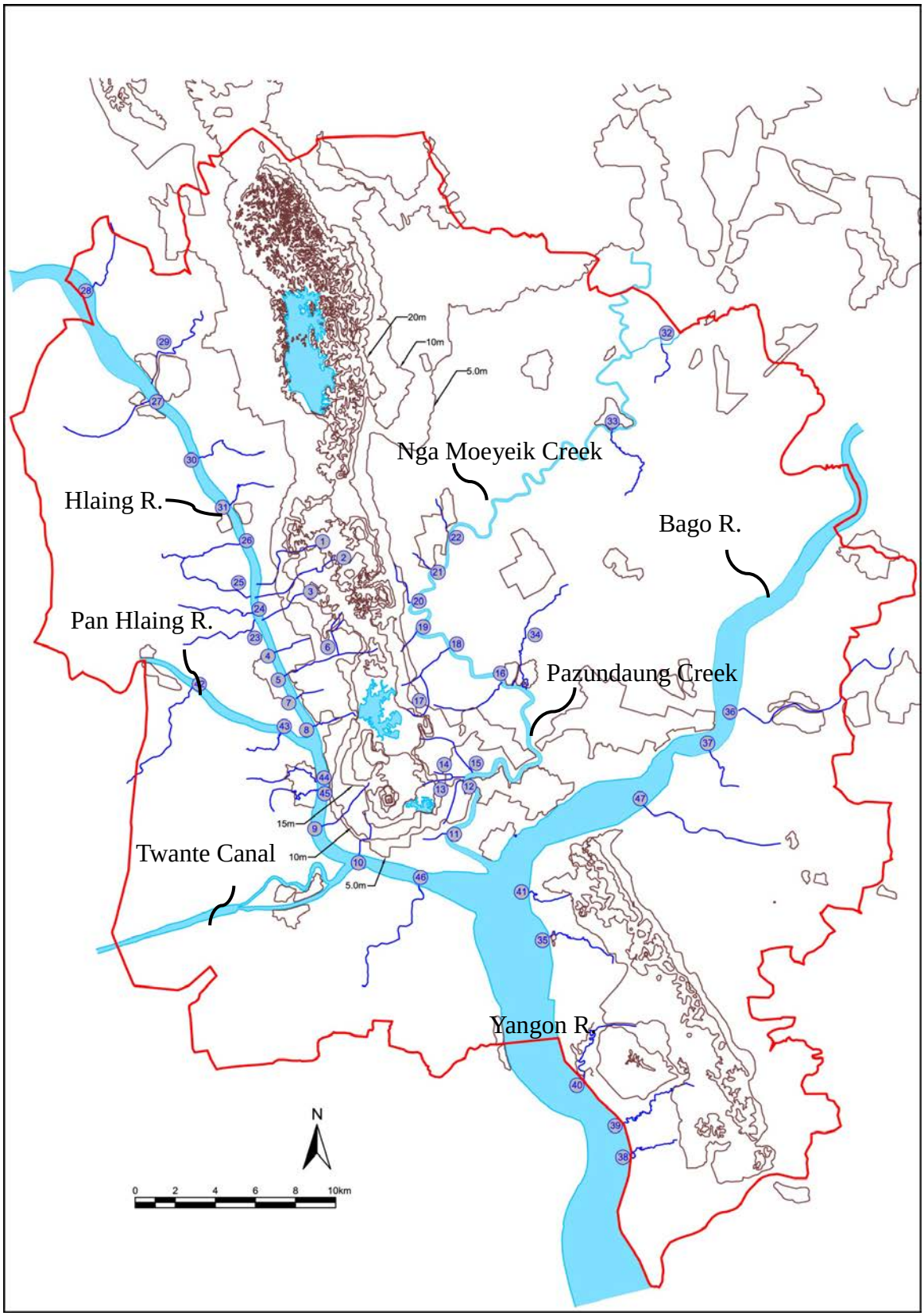
Although habitual flood occurs in some areas, the people do not seem to consider this as a problem because flood usually disappears a few hours later. Also, flood depth is normally less than a knee in height.

Reflecting in the given situation above, the priority for drainage improvement seems very low. Furthermore, there is no specific section for drainage works in YCDC and its neighboring townships.

Table 2.3.62: Rivers, Main Streams and Drainage Channels in Greater Yangon

No.	Name	Administrative Body	No.	Name	Administrative Body
1	Ywa ma C	YCDC	24	Sula kan C	YCDC
2	Ka thwe C	YCDC	25	Shwe lin ban C	YCDC
3	Pauk taw C	YCDC	26	Ka sin C	YCDC
4	Yoe gyi C	YCDC	27	Htain hna pin C	YCDC
5	Tha maing C	YCDC	28	Dun ta be C	DDA
6	Aung theik di C	YCDC	29	Hmaw bi C	DDA
7	Pa dauk C	YCDC	30	Lat that Y C	YCDC
8	Kamayut C	YCDC	31	Tagu gyan C	YCDC
9	Kwin C	YCDC	32	Ok po C	YCDC
10	Ywa thit C	YCDC	33	Hte Tan C	YCDC
11	Thebyu C	YCDC	34	To gyaung ga lay C	YCDC
12	Aung mingalar myopat C	YCDC	35	Seik gyi C	DDA
13	Moemaka C	YCDC	36	Pagan Daung C	DDA
14	Nat C	YCDC	37	Taw thun C	DDA
15	Kunitpinlain C	YCDC	38	Pa lan C	DDA
16	Kyaikasan C	YCDC	39	Shwe byauk C	DDA
17	Semyaung C	YCDC	40	Ayun zok C	DDA
18	Yeipauk-kyi C	YCDC	41	Bo gyok C	DDA
19	Zwezon C	YCDC	42	Tama ta kaw C	YCDC
20	Shwehle C	YCDC	43	Weta C	YCDC
21	Thunandar C	YCDC	44	Kon ywa C	YCDC
22	Danityoe C	YCDC	45	Alat C	YCDC
23	Thaung gyi C	YCDC	46	Ta ma aung C	YCDC
			47	Baw C	DDA
	Yangon River	MOAI		Pazungdaung Creek/ Nga Moeyeik Creek	MOAI
	Bago River	MOAI		Twante Canal	MOAI
	Hlaign River	MOAI		Pan Hlaing River	MOAI

Source: JICA Study Team based on the interview to an engineer of the Department of Roads and Bridges,



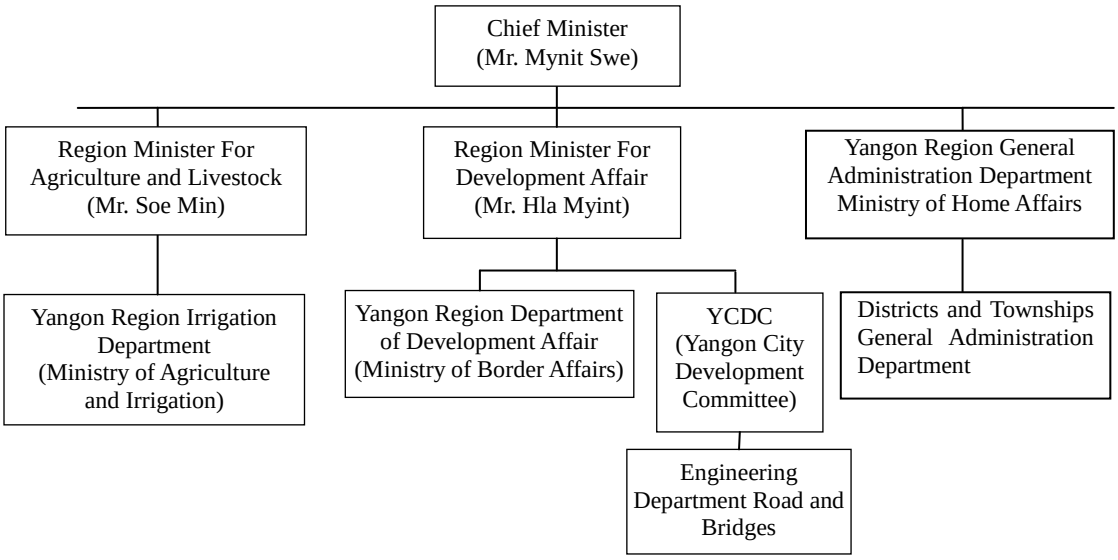
Source: JICA Study Team

Figure 2.3.76: Main Streams and Drainage Channels in the Planning Area

2) Institution

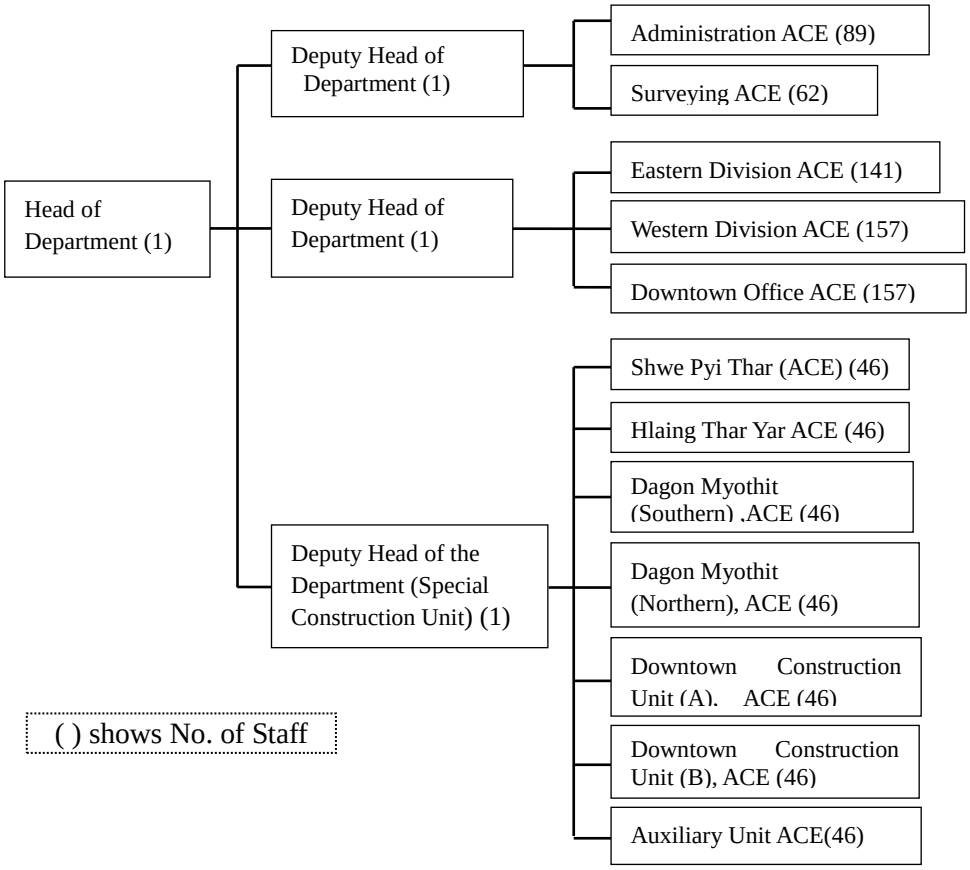
YCDC has been carrying out drainage works based on The City of Rangoon Municipal Act (1922). The responsible department of YCDC for drainage works is the Department of Engineering (Roads and Bridges). On the other hand, water service for six townships outside Yangon City, namely; Kyaktan, Thanlyin, Hlegu. Hmawbi, Htantabin, and Twantay are being handled by the Department of Development Affairs (DDA) which is one of Yangon's regional departments.

Figure 2.3.77 shows the management body on drainage. However, the net number for drainage work is uncertain because there is no specific section on drainage work



Source: JICA Study Team

Figure 2.3.77: Management Body on Drainage



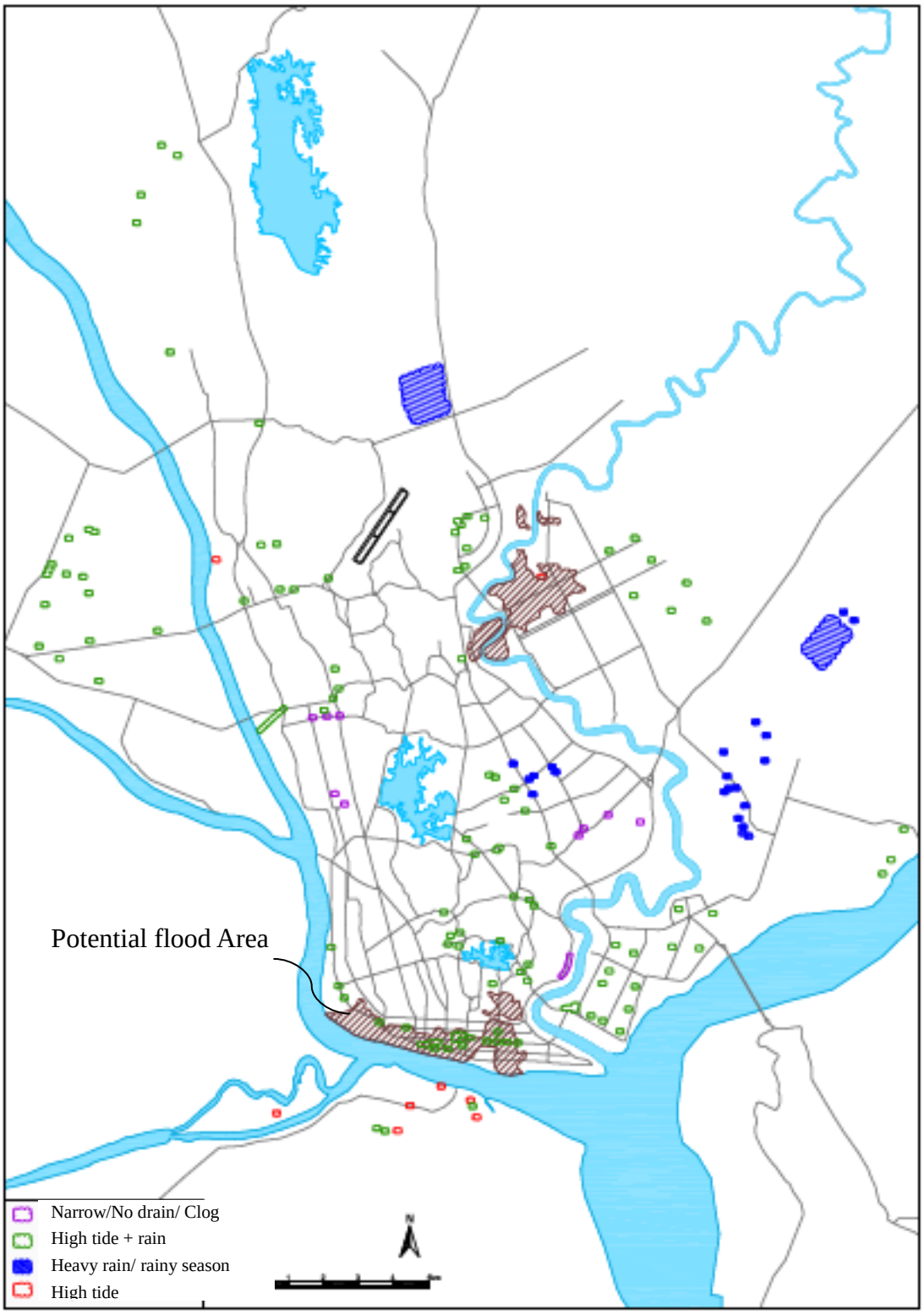
Source: JICA Study Team based on the data from Department of Roads and Bridges, YCDC

Figure 2.3.78: Organizational Chart of Engineering Department (Road & Bridge)

3) Flood Area

There are many reasons for the flooding in Yangon City. According to data collected from township offices in 2012, the reasons are categorized into four: 1) Insufficient size, clogging or no drain, 2) Flood occurrence during high tide and heavy rain, 3) Flood occurs every rainy season (i.e. part of Mingalardon township; north of the airport), 4) Flood occurs every high tide (i.e. near Bayint Naung Bridge)

Figure 2.3.79 shows flood areas by reason reported in 33 township offices of Yangon City. The figure also indicates potential flood areas based on rough altitude less than 3.5 m but these potential areas should be reviewed by actual spot elevation survey and further study.



No data outside Yangon City
Source: JICA Study Team based on the data from township offices and interview to residents

Figure 2.3.79: Flood Areas in Yangon City

4) Relevant Study on Urban Drainage

Relevant studies on urban drainage are listed below:

1) Pre-feasibility Study

In 1982, as part of its participation in the United Nations International Drinking Water Supply and Sanitation Decade, 1981-1990, the government laid down guidelines and targets for the water supply and sanitation sector. To achieve the targets, the city authority and the Government of Myanmar launched the Yangon City and Regional Development Project (MYA/85/016).

This pre-feasibility study is one of the activities of the Project Yangon City and Regional Development Project (MYA/85/016). The study was implemented by the Department of Human Settlements and Housing Development (DHSHD) with the cooperation of the United Nations Development Program (UNDP) and the United Nations Centre for Human Settlements.

2) Study on Drainage System of Mingalar Taung Nyunt Area, Fukken Co., LTD November 2002

Fukken Co., Ltd. dispatched a study mission to YCDC in 1996 using financial assistance from the Engineering Firms Association (ECFA) of Japan. The mission found that the Mingalar Taung Nyunt area of Yangon City is being distressed by inundation every time there is heavy rainfall occurrence. To solve this inundation problem in the Mingalar Taung Nyunt area, Fukken Co., Ltd. Company conducted a preliminary study.

3) Existing Drainage System of Yangon City, Mr. Aung Swe, January 2004

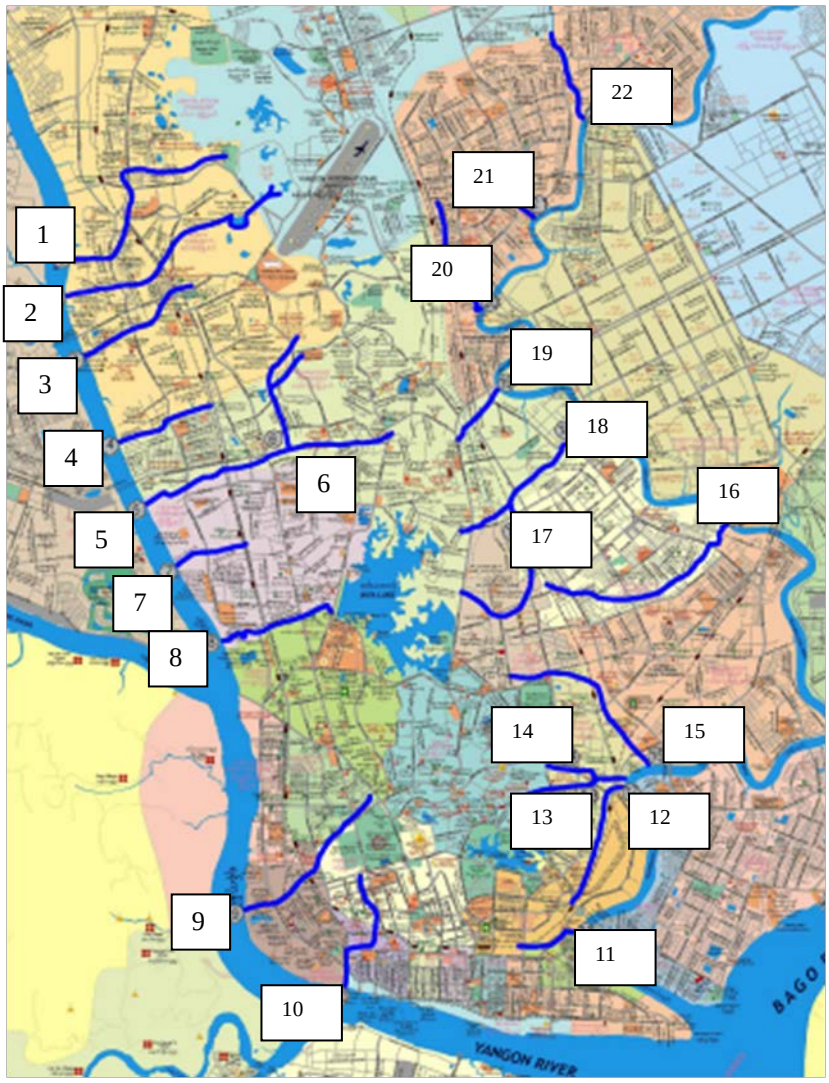
Mr. Aung Swe prepared the report while being employed as an advisor of drainage works for the Department of Road and Bridges, YCDC for three year and half.

5) Current Conditions of Drainage Channel

1) Major Drainage Channel and Outlet

In the past study, 22 drainage channels are listed as passing through densely populated areas. Actually, these 22 drainage channels are regarded as combined sewer (refer to Figure 2.3.80). This is because sullages from households are being disposed to these channels without any treatment.

Figure 2.3.81 shows the location of 14 outlets from the CBD area.



Source: Report "Existing Drainage System of Yangon City"

Figure 2.3.80: Major Drainage Channels in Yangon

Source: JICA Study Team based on the data from the drawing of the Pre- feasibility (Mya/85/016)

Figure 2.3.81: Major Outlet Channels to Yangon River

2) Problems on Existing Drain System

There is no separate section under the Department of Roads and Bridges to carry out drainage programs. This institutional weakness may incur delay in the improvement of existing drainage channels. Major problems of existing channels are:

1) Habitual flood in some areas, 2) Large portions of earth drain with no side-slope protection, 3) Only few tidal gates and dikes are existing which protect lowland areas, 4) Presence of a huge amount of sediments with silt and soil, 5) Presence of illegal settlers in some sections, 6) Several utilities inside ditches such as water pipes or electrical lines which interfere the flow, 7) Side slopes are being used as an open dumping site, and 8) Bottleneck at road and railway crossing.

Some problematic conditions are shown in the photographs below.

Outlet from CBD (G-8) Pansodan Jetty

Water drains to the Yangon River, despite having no rainfall. Water looks sully or grey water.

Shwehle Chaung Drainage Channel (No.20)

A lot of sediments (silt and soil) are found. Flow capacity is decreasing due to sediments.

Kathwe Chaung Channel (No.2) No clearance

Floating solid wastes are accumulated at bridges due to insufficient clearance between the bridge beam and water surface.

Upper Pazundaung Road

Flood occurs during high tide due to the absence of flood protection gates

Figure 2.3.82: Photos of Problematic Conditions

6) Drainage Activities Outside of Yangon City

For townships outside of Yangon City, the township development committee office is undertaking operation and maintenance of secondary drainage channels. According to interviews with township engineers, cleaning and maintenance works are being conducted during rainy season only. Each township development committee office only provides budget for works such as water supply service. Annual budget for cleaning drainage channels/ditches varies from MMK 700 thousand in the Kyauktan Township to MMK 2.8 million in the Hmawbi Township.

(4) Key Findings and Main Issues for Sewerage and Drainage

1) Low Service Coverage

Service coverage in the existing sewerage system is merely less than 10% and the existing water streams passing through densely populated areas are heavily polluted. YCDC needs to improve the service coverage of the sewerage system.

2) Inadequate On-site Disposal System

On-site disposal system using pour flush type toilets without septic tank is still widely used in Yangon City. This system should be replaced with a septic tank system. Moreover, no exclusive sludge treatment plant exists in Yangon City. Removed sludge from septic tanks are disposed to the existing WWTP. Such disposal may result to problems in the operation of the WWTP. Hence, several sludge treatment plants should be provided as soon as possible.

3) Institutional Weakness on Drainage Works

The Department of Roads and Bridges of YCDC is responsible for the drainage works in Yangon City. However, the number of staff specialized for drainage works is very limited and the maintenance and improvement works of existing drainage channels is often delayed. Institutional restructuring might be required such as strengthening the number of staffs for drainage works.

4) Aged Collection System

The existing sewerage collection system was constructed about 120 years ago. This system is expected to be restructured.

2.3.7 Power Supply

(1) Organizations for Power Supply in Myanmar

1) Ministry of Electric Power (MOEP)

MOEP of Myanmar was established in 1997; however in 2006, it was divided into two ministries, namely, the Ministry of Electric Power 1 (MOEP-1) for hydropower stations, and the Ministry of Electric Power 2 (MOEP-2) for power transmission, thermal power station and distribution system. On 5th September 2012, MOEP-1 and MOEP-2 were merged to form again a new MOEP; however, this new organization has not yet been established completely (as of November 2012).

The organization and main works in each department of the former MOEP-1 and MOEP-2 are shown in Table 2.3.63. Among these departments, the Myanmar Electric Power Enterprise (MEPE), with its head office in Nay Pyi Taw, and the Yangon City Electricity Supply Board (YESB), with its head office in Yangon, are involved directly with the electric power supply system in the Yangon Division including the Yangon City area. Their main functions are as follows:

The main works of MEPE are the followings:

- Planning and operations and maintenance of power transmission systems in the whole of Myanmar
- Operations and maintenance of 230 kV substations and gas turbine power stations in Yangon

Meanwhile, the main work of YESB is the planning, and operations and maintenance of power distribution systems in Yangon

The Department of Electric Power (DEP), with its office in Nay Pyi Taw, is responsible for the planning of electric power supply and power stations, not including hydropower stations.

Table 2.3.63: Organization of the Former MOEP-1 and MOEP-2

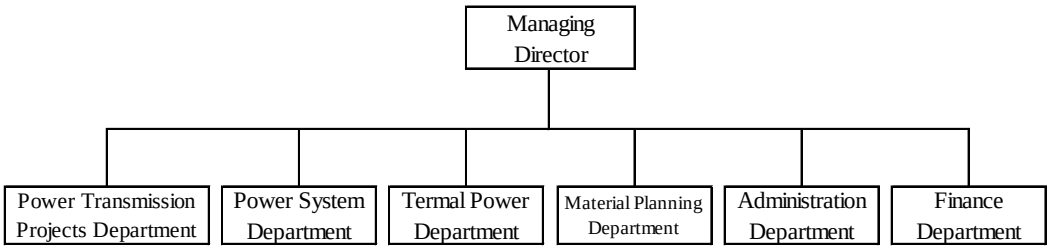
Name of Department		Items of main work
MOEP1: Ministry of Electric Power 1	DHPP: Department of Hydro Power Planning	・Development plan of hydro power stations ・Administration for all MOEP1
	DHPI: Department of Hydro Power Implementation	・Construction of hydro power stations ・Procurement of equipment and machinery ・Maintenance of hydro power stations
	HPGE: Hydro Power Generation Corporation	・Operation of hydro power stations ・Operation of Tee Gyit coal fired steam turbine power station
MOEP2: Ministry of Electric Power 2	DEP: Department of Electric Power	・Planning basic electrical policies ・Coordination with all related ministries or departments ・Planning electrical system (with MEPE)
	MEPE: Myanmar Electric Power Enterprise	・Operation of electrical transmission system ・Construction and operation of gas turbine power stations ・All electrical operating system
	YESB: Yangon City Electricity Supply Board	・Electrical supply for Yangon city area ・Electrical distribution (33kV and below) ・Construction and operation of 66/33kV substations ・Tariff collection
	ESE: Electricity Supply Enterprise	・Electrical supply for the area except Yangon city ・Electrical distribution (below 33kV) ・Construction and operation of 66/33kV substations ・Tariff collection

Notes: Colored portions show departments which are involved directly with the development of power in the Yangon City area.
Source: Report of power supply in world countries (Japan Electric Power Information Center, Inc.) 2010

2) MEPE

The organization of MEPE consists of four technical departments and two administration departments, as shown in Figure 2.3.83.

The number of staff of MEPE is approximately 4500, which includes 450 management class staff (as of March 2012).



Source : MEPE

Figure 2.3.83: Organization of MEPE

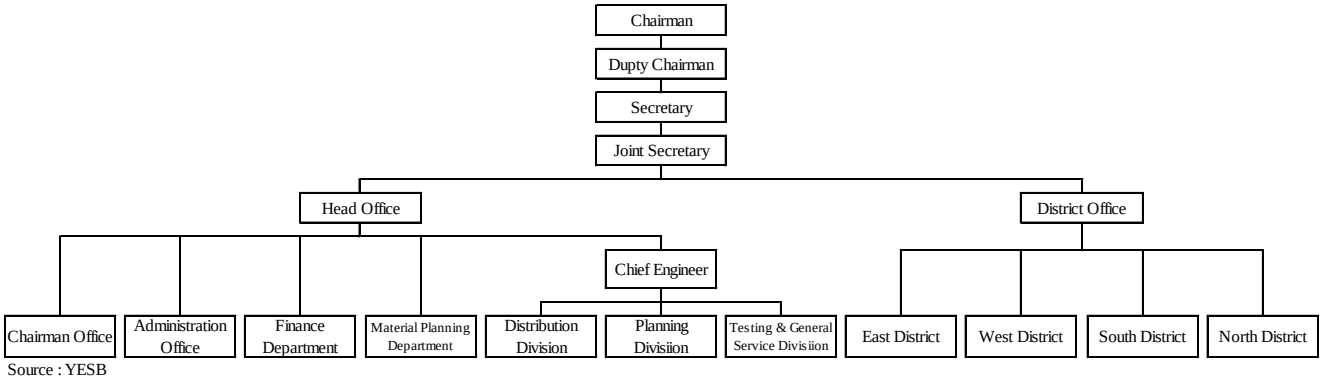
3) YESB

The organization of YESB consists of four technical departments, two administrative departments, and the chairman's office under the head office. Furthermore, YESB has four district offices which carry out operations and maintenance in the east, west, south and north areas of Yangon.

The organization of YESB is shown in Figure 2.3.84. The number of staff of YESB is approximately 4800 including 25% vacant positions (as of March 2012).

Also, YESB carries out the distribution of electric power to townships, as shown in Table 2.3.64.

These townships are mostly located in the Yangon Division.



Source : YESB

Figure 2.3.84: Organization of YESB

Table 2.3.64: Townships Supplied with Electric Power by YESB (Yangon Area)

District Office of YESB	East District	West District	South District	North District
Township Covered by the District Office	● Pazundaung	● Kyauktada	● Thanlyin	● Insein
	● Thingangyun	● Pabedan	● Kyauktan	● Mingalardon
	● South Okkalapa	● Latha	● Dala	● Shwe Pyi Thar
	● North Okkalapa	● Lanmadaw	● Twantay	● Hlaing Tharyar
	● Dawbon	● Ahlone	Kha Yan	● Hlegu
	● Thaketa	● Sanchaung	● Seikgyikhanaungto	● Hmawbi
	● Tarmwe	● Kamaryut	Kon Chan Kone	Htauk Kyunt
	● Mingalar Taung Nyunt	● Kyee Myin Daing	Thone Gwa	Tike Gyi
	● Botahtaung	● Hlaing	Kawmu	Phaung Gyi
	● East Dagon	● Mayangone	Lat Khoke Kone	Oakkan
	● South Dagon	● Bahan	Kyaik Htaw	● Htantabin
	● North Dagon	● Dagon	Ko Koe Kyun	Darpain
	● Dagon Seikkan	● Seikkan	Tadar	
	Shwe Pauk Kan			
	● Yankin			

Notes: The townships marked with ● are 39 townships included in Greater Yangon
Source: YESB

3) Ministry of Energy (MOE)

MOE is in charge of development and import/export of petro and natural gas, and production in the domestic market.

Fuel for the gas turbine power stations operated by MEPE is provided by one office under MOE.

(2) Current Situation of the Power Sector in Myanmar

1) Transmission and Distribution Lines

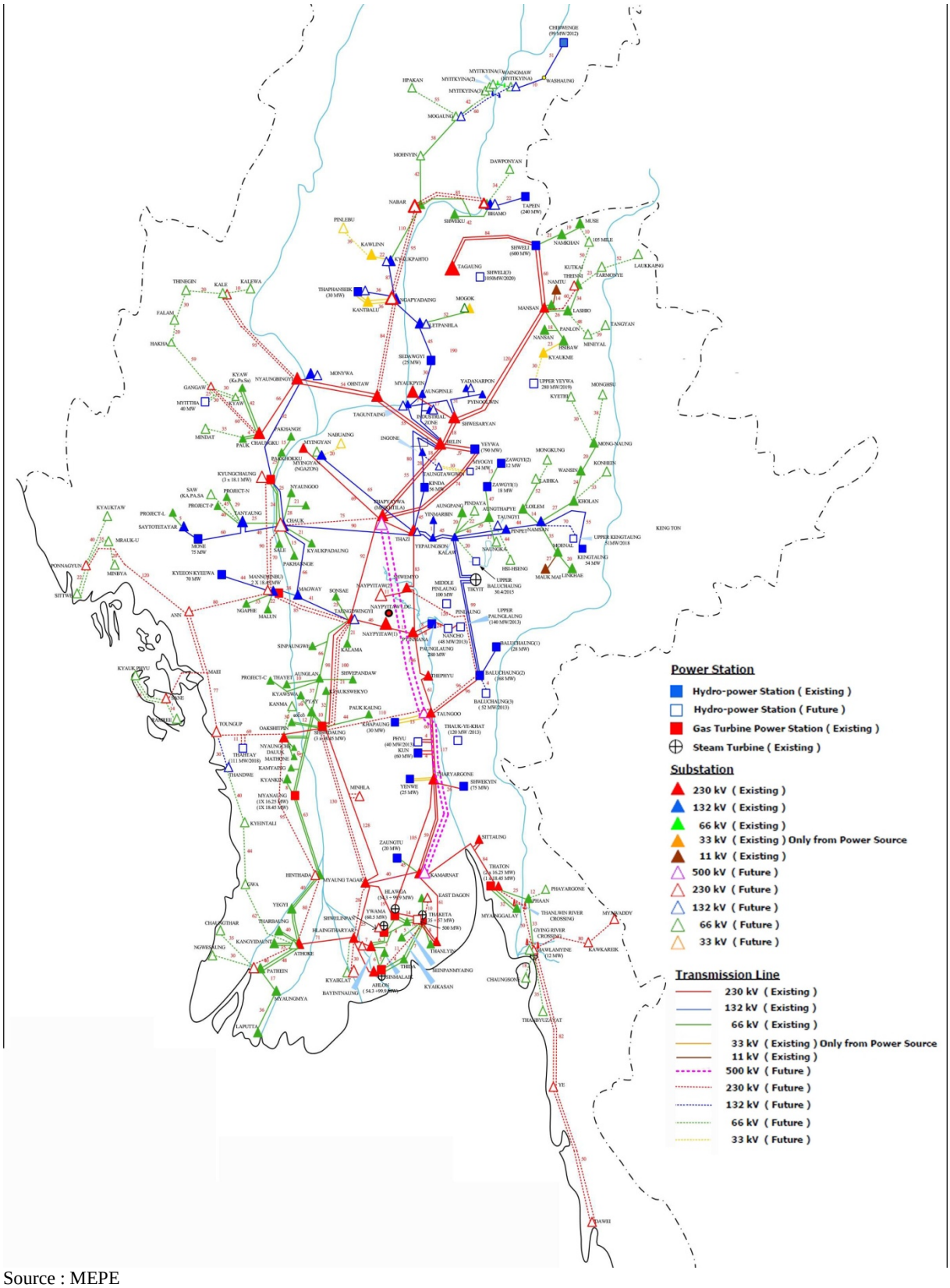
The voltage levels of transmission and distribution lines in Myanmar are as follows:

- MEPE : 500 kV (future plan), 230 kV, 132 kV and 66 kV
- YESB : 66 kV, 33 kV (to be abolished in the future), 11 kV, 6.6 kV (to be abolished in the future) and 0.415-0.24 kV

The distribution lines with voltage levels of 33 kV and 6.6 kV will be upgraded to higher voltage levels in order to decrease transmission loss in the future.

Hydropower stations are located mostly in the northern areas of Myanmar, and are producing electricity to the Yangon City area, which is a large consumer of electricity.

The capacity of the existing transmission lines for the above is insufficient, therefore, MEPE has a plan to construct the 500 kV transmission line as shown in Figure 2.3.85 (pink colored dotted line).



Source : MEPE

Figure 2.3.85: Route Map of Transmission Lines in Myanmar (Existing and Future Plans, as of July 2012)

2) Power Supply

Hydropower stations produce 72% of the total generation in Myanmar; however, the decrease of power generation in the dry season (March to June) due to shortage of water is one of the major problems in electric power supply. Furthermore, the small available capacity of power stations is also one of the major problems. Power stations in Myanmar are listed in Table 2.3.66 (as of 24 September 2012).

1) General Description of Power Stations in Myanmar (as of 24 September 2012)

i) Total installed capacity of all power stations: 3,015MW

ii) Total available capacity of all power stations: 1,632MW

iii) Total available capacity/Total installed capacity: 54%

The current causes for the small actual capacity in power stations are as follows:

- Trouble of generating facility or lack of spare parts
- Small capacity for producing natural gas, and decreasing calorific value of natural gas due to changing gas field from inland to offshore. (Calorific value of inland gas field : 900 BTU/FT^3, Offshore gas field : 650 BTU/FT^3)
- Some decrepit power stations (some hydropower stations were constructed over 40 years ago)

iv) Composition of power stations:
The power stations in Myanmar consist of hydropower, gas turbine, steam turbine in combined cycle system and steam turbine fired by coal. The percentages of generation for each type of power station are as follows:

Hydropower: 72.3%, gas turbine: 18.2%, steam turbine in combined cycle system: 5.5%, and steam turbine fired by coal: 4.0%.

Four combined cycle gas turbine power stations are under operation in the Yangon City area for base load, and producing electricity of 31% of total demand in the entire Yangon Division.

2) Description of Power Stations in the Yangon City Area

i) Total installed capacity: 470.7 MW

ii) Total available capacity: 235.5 MW

iii) Manufacturers of equipment and installed year of the four gas turbine power stations are shown in Table 2.3.65.

Table 2.3.65: Manufacturer and Installation Year of Gas Turbine Power Station in Yangon

Name of Power Station	Gas Turbine Generator		Waste Heat Boiler	Steam Turbine Generator	
	Manufacturer (Installed Year)	Installed Capacity, x Units	Manufacturer (Installed Year)	Manufacturer (Installed Year)	Installed Capacity x Units
Hlawgar	Alsthom (1995)	33.3MW x 3 units	Kawasaki (1999)	ABB (1999)	54.3MW x 1 unit
Ywama	John Brown (1980)	18.45MW x 2 units	-	-	-
	Hitachi (1995)	24MW x 1 unit	Babcock-Hitachi (1997)	Shin Nippon, Meiden (1997)	9.4MW x 1 unit
Ahlone	Alsthom (1995)	33.3MW x 3 units	Kawasaki (1999)	ABB (1999)	54.3MW x 1 unit
Thaketa	Hitachi (1990)	19MW x 3 units	Kawasaki (1994)	Fuji (1994)	35MW x 1 unit

Source: JICA Study Team based on data collected during site investigation

Table 2.3.66: Power Stations in Myanmar and Current Situation of Power Generation (as of 24th September 2012)

Hydro Power Generation

No	Name of Power Station	Installed Year	Specification of generator			Available Capacity MW	Available Capa./Total installed Capa.
			Installed Capacity MW	Generator No	Total MW		
Total (MOEP-1)					2180	1308.1	60.0%
1	PaungLaung	2005	70	4	280	131.0	46.8%
2	Belucaung No-1	1992	14	2	28	14.0	50.0%
3	Belucaung No-2	1960, 1974	28	6	168	101.0	60.1%
4	Ye Ywar	2010	197.5	4	790	589.0	74.6%
5	Shwe Lei	2008	100	3	300	178.0	59.3%
6	Mone Chaung	2004	25	3	75	60.4	80.5%
7	King Tar	1985	28	2	56	35.0	62.5%
8	Tapanseik	2002	10	3	30	16.0	53.3%
9	Ka Paung	2008	15	2	30	-	-
10	Se Taw Gyi	1989	12.5	2	25	14.0	56.0%
11	Ye New	2007	12.5	2	25	17.0	68.2%
12	Zaung Too	2000	10	2	20	16.5	82.5%
13	Zaw Gyi (1)	1995	6	3	18	17.6	97.8%
14	Zaw Gyi (2)	1998	6	2	12	10.0	83.3%
15	Kyain Taung	2008	18	3	54	35.6	66.0%
16	Shwe Kyin	2011	18.75	4	75	35.3	47.1%
17	Tar Pein (1)	2011	60	1	60	-	-
18	Kon	2012	20	3	60	19.5	32.5%
19	Kyi Ohn Kyi Wa	2012	37	2	74	18.1	24.5%

Gas Turbine Power Generation

No	Name of Power Station	Installed Year	Specification of generator			Available Capacity MW	Available Capa./Total installed Capa.
			Installed Capacity MW	Generator No	Total MW		
Total (MOEP-2)				25	549.9	271.8	49.4%
1	Kaun Caung	1974	18.1	3	54.3	11.0	20.3%
2	Man	1980	18.45	2	36.9	-	-
3	Shwe Taung	1983	18.45	3	55.35	14.5	26.2%
4	Myan Aung	1984	17.35	2	34.7	11.5	33.1%
5	Thahton	1985	18.45	1	18.45	-	-
		1985	16.25	2	32.5	24.0	73.8%
6	Hlawgar	1995	33.3	3	99.9	69.4	69.5%
7	Ywama	1980	18.45	2	36.9	31.0	84.0%
		1995	24	1	24	-	-
8	Ahlon	1995	33.3	3	99.9	63.4	63.5%
9	Thakhata	1990	19	3	57	47.0	82.5%

Steam Turbine Power Generation

No	Name of Power Station	Installed Year	Specification of generator			Available Capacity MW	Available Capa./Total installed Capa.
			Installed Capacity MW	Generator No	Total MW		
Total (Electric-2)				6	165.0	28.3	17.2%
1	Hlawgar	1999	54.3	1	54.3	-	-
2	Ywama	1997	9.4	1	9.4	-	-
3	Ahlon	1999	54.3	1	54.3	24.7	45.5%
4	Tharketa	1994	35	1	35.0	-	-
5	Maw La Myaing	1984	6	2	12.0	3.6	30.0%

Steam Turbine Generation by Coal Fired Boiler

No	Name of Power Station	Installed Year	Specification of generator			Available Capacity MW	Available Capa./Total installed Capa.
			Installed Capacity MW	Generator No	Total MW		
Total (MOEP-2)				2	120	23.3	19.4%
1	Tee Gyit	2005	60	2	120.00	23.3	19.4%

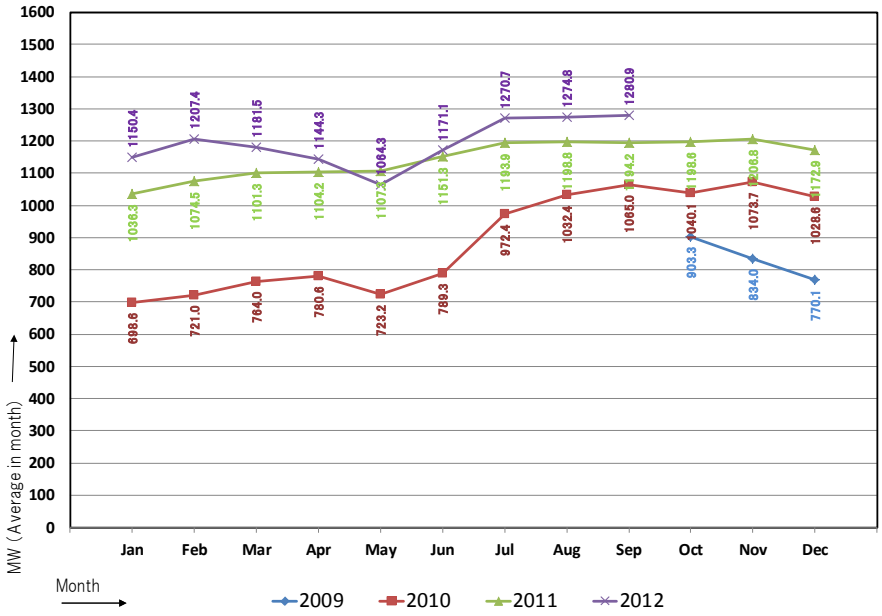
1. Generated fully power from Power Station to Transmmision line 3014.9 MW
2. Actual Power Supply from Power Station to Transmmision line 1631.5 MW
3. Total Available Capacity/Total Installed Capacity 54.1%]

Notes : Colored portions show power stations in Yangon City (Installed capacity :470.7MW, Available capacity: 253.3MW)
Source : MEPE

3) Demand for Electricity

The demand for electricity in Myanmar is approximately 1,850 MW, but the total actual generation is approximately 1,622 MW (24 September 2012). Accordingly, shortage in electricity supply is about 230 MW. Also, in the dry season of March to June, hydropower generation decreases further due to shortage of water. Fluctuation of electrical supply to the whole of Myanmar through the past three years is shown in Figure 2.3.86.

Also, the total generation of power stations in the whole of Myanmar power station by monthly and yearly bases for the past three years is shown in Table 2.3.67.



Source: MEPE

Figure 2.3.86: Generation of Power Station in Myanmar through the Past Three Years (Monthly Average)

Table 2.3.67: Total Generation of Whole Myanmar Power Station in Monthly and Yearly Basis (Past Three Years)

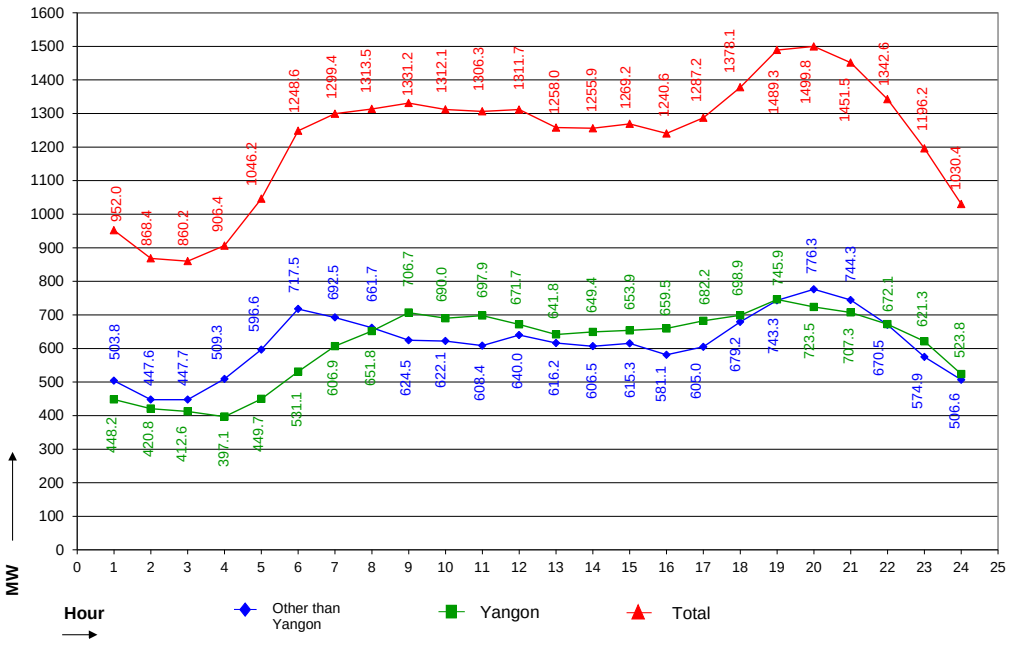
(Unit: GWh)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2009										672.1	600.5	572.9	
2010	519.8	484.5	568.4	562.0	538.0	568.3	723.4	768.1	766.8	773.8	773.1	765.3	7,811.5
2011	771.0	722.0	819.3	795.0	823.8	828.9	888.3	891.9	859.9	861.9	868.9	872.7	10,003.6
2012	855.9	840.4	879.0	823.9	791.8	843.2	945.4	917.9					

Source: MEPE

Under these conditions, MEPE and YESB are forced to make scheduled electricity stoppages or some limitation of periodical inspection/maintenance.

The electricity consumption of the Yangon City area is approximately 50% of that of the whole of Myanmar. The fluctuation of electricity supply in one day in the Yangon City area and other areas is shown in Figure 2.3.87.



Source: MEPE

Figure 2.3.87: Electricity Supply in One Day for the Yangon Area and Others Area (As of 12 March 2012)

Gas turbine power stations basically serve the base load, while hydropower stations are operating for the base load as well as for the peak cut. The generation of gas turbine power stations is approximately 20% of the total generation at peak load.

Electricity supply for the Yangon City area has been increasing yearly at an average rate of 10%/year in the last five years, and the future electricity demand by economic growth was forecasted to increase by 15%/year in average according to YESB. However, YESB's forecast does not include electricity supply for Thilawa SEZ or other new urban developments in the future. The electricity supply for the Yangon City area in the past five years is shown in Figure 2.3.88.

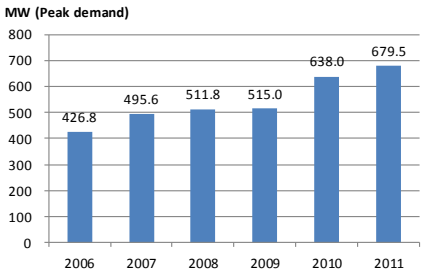
[Data regarding the electricl supply network in Yangon City area]

i) Max. electricity supply:
Approx. 750 MW (2012 forecast)

ii) No. of households connected to public electricity supply:
838,000 households (2010-2011)

iii) Total electricity supply in 2011:
Approx. 2,893 GWh

iv) Method of cabling:
Underground (center of the city), or overhead (suburbs)



Source: YESB

Figure 2.3.88: Electrical supply for Yangon Area

4) Loss of Electricity in Transmission and Distribution

The loss of electricity in transmission and distribution was approximately 25% in 2012, which is a high level as compared with other countries. Frequent loss of electricity is one of the most important issues needed to be solved urgently. The major causes for loss of electricity are as follows:

1) Technical Loss

- Overloading of transmission and distribution lines. The size of existing transmission and distribution lines is very small compared to the actual load of electricity to be transferred as most of the existing transmission and distribution lines were constructed 30 to 40 years ago.
- Operation voltage of electrical distribution is not fair. On-load-tap changers are not equipped mostly to the existing transformer, and adjusting voltage cannot be done automatically for actual demand.

2) Non-Technical Loss

- Illegal connections
- Electricity consumption meters do not function fairly due to big voltage drops.

(3) Current Conditions of Existing Facility

The facilities in 230 kV substations are over 50 years old and mostly deteriorated. Therefore, such old facilities are now being replaced or upgraded.

The oldest gas turbine generating facilities that include a generator of 18.45MW x 2 units in Ywama Power Station was constructed in 1980, and has been deteriorated. These gas turbine generators are almost reaching the end of their useful life.

Pictures of the principle deteriorated facilities are shown in Figure 2.3.89.

18.45MW Gas turbine power facility in Ywama PS

Distribution panel in Hluttaw SS

33/6.6kV Transformer in Hluttaw SS

GIS in 230kV Hlawgar SS

Source: JICA Study Team

Figure 2.3.89: Deteriorated Facilities in Power Stations and Substations

(4) Summary of Current Situations and Analysis of the Power Sector

A summary of the current situations and analysis of the power sector in the Yangon City area is provided in Table 2.3.68.

Table 2.3.68: Summary of Current Situations and Analysis of the Power Sector in Yangon City

No.	Current Situation	Analysis	Regulatory Framework
1	Shortage of electricity supply	・ Shortage of 230 MW for electricity supply (at Sep. 2012) ・ Less output of hydropower stations in the dry season ・ Scheduled stoppage of electricity supply ・ Limitation of periodical inspection/maintenance ・ Decrepit facilities ・ No electricity supply capacity for future demand including for Thilawa SEZ, etc.	・ Development of new power stations ・ Rehabilitation of deteriorated power stations
2	Huge loss of electricity in transmission and distribution systems	・ Decrepit facilities ・ Low voltage and small capacity of transmission and distribution ・ Small capacity of substation ・ Illegal connection for non-technical loss ・ No functioning of consumption meter due to big voltage drop	・ Replacement of decrepit transmission and distribution lines with higher capacity ones ・ Replacement of decrepit substations with upgraded ones ・ Checking of illegal connections
3	Huge fluctuation of voltage in distribution systems	・ Decrepit facilities ・ Difficult situation in controlling voltage in the central control center (load dispatch center) or substation, due to malfunctioning meters ・ No on-load-tap changer equipped on existing transformers, and difficult to make proper voltage control Actual voltage : 11 kV line→9 kV(-18%) 230 V line→190 V~50 V (-17%~-78%)	・ Replacement of decrepit facilities ・ Transformer equipped with on-load-tap changer
4	Necessity of improvement of technical levels of YESB and MEPE	・ YESB: Technical level for planning, and for operations and maintenance of distribution systems ・ MEPE: Technical level for control of electrical systems in the whole of Myanmar	・ Development of organization and technical level
5	Shortage of natural gas for fuel of gas turbine	・ Changed gas field from inland gas field to offshore gas field which produce gas of low calorific value	・ Development of new procurement of gas ・ Plan of new development of offshore gas field in the M6 area, which will produce gas from 2016
6	Stoppage of electricity supply	・ Decrepit facilities ・ Insufficient maintenance and inspection ・ Interference of distribution lines with trees especially in windy or rainy days	・ Replacement of decrepit facilities ・ Sufficient maintenance and inspection works ・ Cutting of trees
7	Best mix of various generating systems	・ Less output of hydropower stations in the dry season	・ Power supply from thermal power station in the dry season ・ Renewable energy as supplemental energy source

Source: JICA Study Team

(5) Key Findings and Main Issues to be Addressed Regarding Power Supply

1) Lack of Power Supply

Under the current situations of electricity supply shortage in the Yangon City area, it is a very important and urgent issue to solve the shortage of power supply capacity with consideration of the increasing electricity demands in the future. The rehabilitation of existing and deteriorated power stations, and the development of new hydropower and gas turbine power stations, shall be the main solutions for such shortage. The forecasting of the increase of electricity demands in the future shall include the demands for urban, suburban, industrial development and Thilawa SEZ.

2) Power Losses in Transmission/Distribution

The problems of high loss of existing transmission/distribution systems and large fluctuations of voltage in existing distribution systems shall be solved with the upgrading or replacement of concerned facilities.

3) Fluctuation of Voltage

The existing electricity supply systems are significantly old and the fluctuation of voltage often occurs. The replacement or upgrading of such system is urgently required.

4) Improvement of Reliability of Transmission/Distribution Systems

Automatic control, remote monitoring/operation and also double circuit transmission is necessary.

5) Shortage of Fuel for Combined Cycle Power Station

The capacity of gas supply for the combined cycle power station is small. Development of a new gas supply source is urgently required.

6) Long Distance between Yangon and Hydropower Stations

The generation cost of a hydropower station is lower than a thermal power station; however, the construction cost of transmission lines is high. Therefore, it is also necessary to study the construction of a fossil fuel power station near a high power consuming area.

7) Stoppage of Electricity Supply

Solving the problems resulting to the stoppage of electricity supply is also urgently required in order to improve the reliability of electricity supply.

2.3.8 Solid Waste Management

(1) Outline of Solid Waste Management of Yangon City

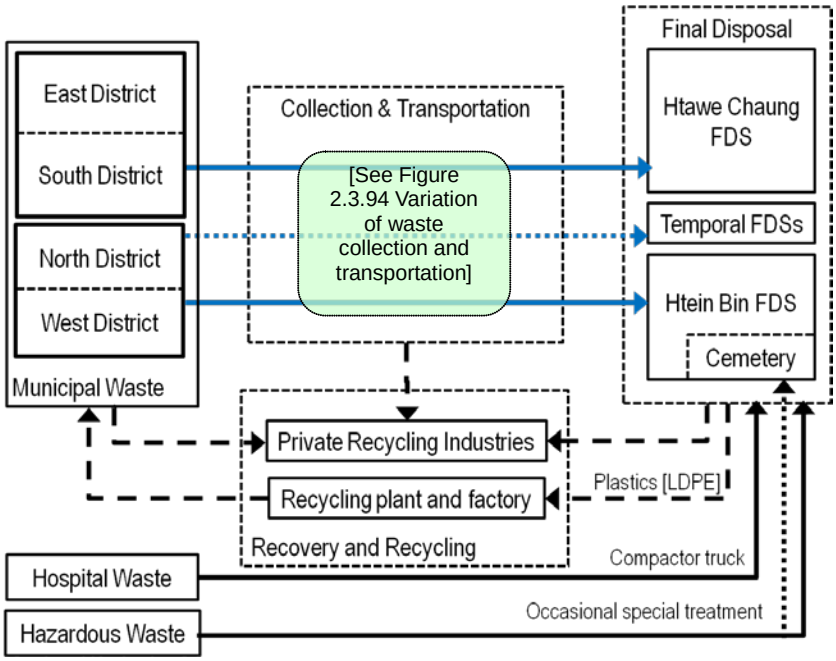
Solid waste in Yangon City is generated by waste generators such as residents, business owners, and retailers, and is collected by the Pollution Control and Cleansing Department (PCCD) of Yangon City Development Committee. It is then transported to final disposal sites (FDSs) operated as open dump sites. Even though the PCCD has made significant efforts to lessen the volume of solid wastes, waste littering and illegal waste disposal are observed in the city.

Equipment for waste collection consists of push carts (hand cart), trucks (flat body), and arm-roll trucks. Waste storage bins placed along the streets consist of temporary waste storage tanks (made of bricks or bamboo), iron containers and plastic waste bins. Iron containers are hauled by the arm-roll trucks to the final disposal site. Many types of trucks transport the collected waste to final disposal sites as well. At the final disposal site, wastes are disposed of in the manner that does not protect the environment known as open dumping. While the final disposal sites are the biggest infrastructure of solid waste management (SWM) in Yangon, the existing facilities are not provided with facilities necessary for final disposal of solid wastes in a sanitary manner.

Part of the recyclables is picked up by individuals and parties of informal (private) sectors from solid waste stream at stages of generation to final disposal. Little part of plastic (low density polyethylene [LDPE]) bags are picked up at the two main final disposal sites operated by PCCD and delivered to the PCCD recycling plant and a private factory for producing recycled commodities such as plastic bags.

Infectious waste generated in governmental hospitals, polyclinics and private clinics are collected by compactor trucks of PCCD allocated for these wastes and burnt at crematory furnace. Some wastes regarded as generated hazardous wastes are treated by the PCCD occasionally.

The flow of solid waste from generation to final disposal is illustrated in Figure 2.3.90.



Source: JICA Study Team based on information from PCCD of YCDC

Figure 2.3.90: Flow of Solid Waste Management in Yangon City

(2) Law and Regulation

Laws and regulations for SWM have not been well-developed in Myanmar while Yangon City has a by-law which only mentions basic requirements on cleansing and pollution control. YCDC is now preparing the draft of amendment of the by-law. The legal framework for SWM should be prepared or updated to improve the situation of SWM.

On the national level, the Environment Conservation Law has just been promulgated in year 2012. Myanmar is still making her way in an initial stage of promoting environmental conservation and enhancing its management aspects. The Ministry of Environmental Conservation and Forestry (MOECF) is preparing environmental conservation rules for execution of the law. This law stipulates the following regarding SWM:

(i) The ministry assigned for environmental conservation that is currently MOECF to give proper and necessary advices to concerned government departments and organizations, private organizations and persons (Article 17)

(ii) The ministry is to prescribe hazardous materials from industry, agriculture, mining etc. (Article 7)

(iii) The entity or the person running a business or a factory in industrial zones, in special economic zones or of any industry approved by the ministry shall contribute financially or give material assistance in environmental conservation activities like waste management and purification. (Article 16)

At the Yangon Regional Level, there have not been any laws and regulations yet. The City Development Committees Law states that “cleansing” is one of the responsibilities of the committee. The roles of these organizations for other components of SWM other than cleansing are not given in the legislation.

At the city level, the by-laws named Pollution Control and Cleansing Law (Order No. 10/99) for managing solid waste, issued about 13 years ago, gives basic responsibilities and restrictions of YCDC, business owners and people in the city. It is to be updated for reflecting the present situation and issues. For example, PCCD has been initiating recycling activities, classifying waste into dry and wet etc. The concept of 3Rs is not dealt with in the by-laws although PCCD has been aware of its significance and trying to promote it. While classification of hazardous and infectious wastes is one of basic aspect to avoid serious problem which may be caused by the nature of these wastes, this is not described in the by-laws. Besides, it is recommended to separate the by-laws for management of cemetery while it is to be dealt with as different works from SWM as well as pollution control in principle.

(3) Organization

The PCCD of YCDC is in charge of SWM in YCDC administrative boundary. The PCCD also takes care of the cemeteries in the city. The organizational structure is shown in Figure 2.3.91. The PCCD is divided into two sub-departments which take care of East/South and North/West. Two deputy heads of departments supervise five sections, including each of two districts, pollution control, one final disposal site and one common section (administration and garage for vehicles) respectively. There are four district offices, main garage office (maintenance workshop for vehicles) and 33 township offices under PCCD. Actual waste collection works are being implemented at 33 township offices of PCCD by waste collection vehicles and collection workers allocated.

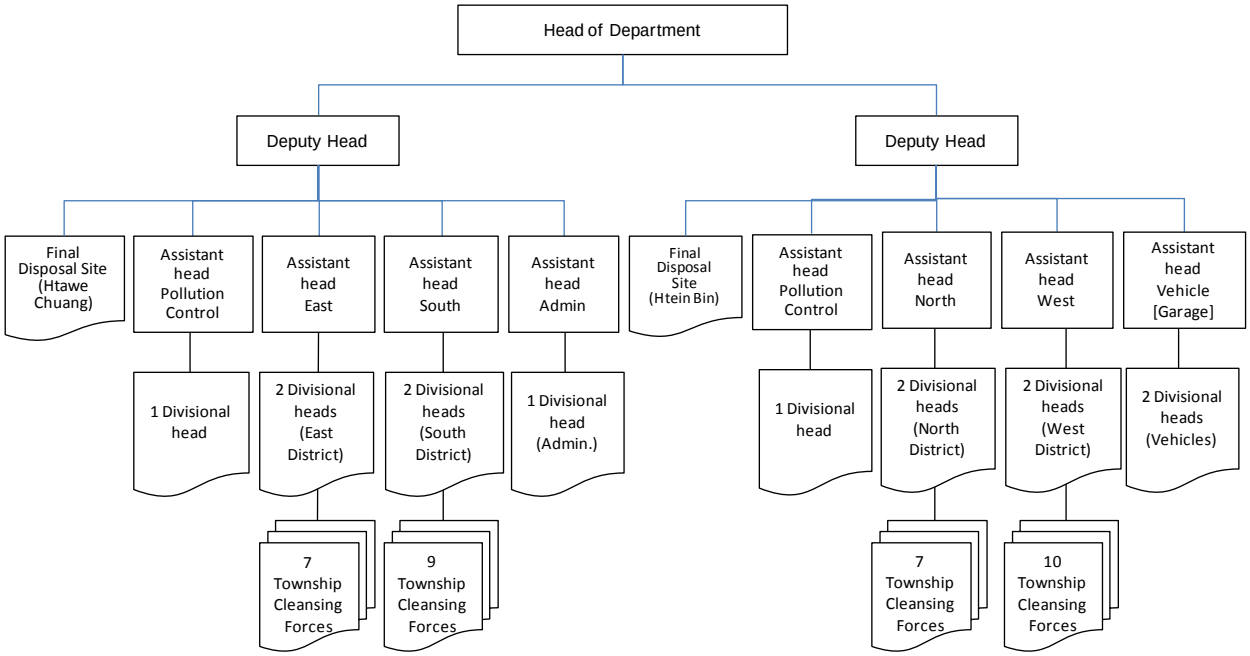
The distribution of personnel to sections and districts of PCCD is shown in Table 2.3.69. The total number of personnel counts for about 4,500. The number of labors includes those of road sweepers and waste collectors at every township, which account for about 3,000 personnel.

There is no regular training program for personnel. The transfer of knowledge and experience necessary for ordinary works are carried out at the work place in the manner of on-the-job training.

Table 2.3.69: Personnel of PCCD

	Main Office	Pollution Control	East district	West district	North district	South district	Main Garage [workshop]	Final disposal sites	Total
Officer	8	7	4	4	5	4	3	2	37
Staff	37	98	170	209	214	222	72	45	1,067
Labor	-	23	667	984	716	887	110	81	3,468
Total	45	128	841	1,197	935	1113	185	128	4,572

Source: PCCD, YCDC



Source: PCCD, YCDC

Figure 2.3.91: Organizational Chart of PCCD

(4) Future Plans

1) Plan for Integrated Solid Waste Management

There are no approved and confirmed master plans for solid waste management intended for Yangon City. When the YCDC discussed the Yangon Concept Plan 2040, reportedly the plan is focused mainly on facility development and not to cover the overall improvement plan. Soft measures for waste generation to final disposal such as policy, economic instruments and capacity development were not discussed in depth.

2) Plan for Facility Development

Candidate sites of future SWM facilities are given in the Yangon Concept Plan 2040, which are proposed without detailed calculation of necessary capacity of facilities and with consideration of land availability owned by YCDC only. It is recognized that these sites have been discussed at the conceptual stage in PCCD. The YCDC considers transfer stations, Waste to Energy (WTE) plants, landfill sites, composting facilities, Compressed Bio Methane (CBM) facilities and an upgrade of waste collection equipment which loads wastes by mechanical device. The candidate sites are shown in Table 2.3.70.

The PCCD seems to expect interests by foreign as well as local investors to facility developments, as the usage of several sites has been verbally approved by the Mayor for future SWM facilities. Actually, there have been approaches to YCDC from some investors as well as governmental institution of foreign countries such as Thailand, South Korea and European countries. The total number of interested parties counted to 38 (as of November 2012). None of them has been realized yet and some of them are still under discussion.

Table 2.3.70: Future Sites for Waste Facility (Township, Final Disposal and Incineration WTE)

Name	Township/District	Area [ha]	Present Condition
FDS			
Hlaw Gar	Mingalardon / North	40	
Mingalardon	Mingalardon / North	7	Extension of the existing temporal FDS
Maso	East Dagon/ East	75	
Kyi Su	Dagon Sekkikan/ East	100	
Dagon Myo Thit	North Dagon/ East	100	
Dala	Dala/ South	240	There are three candidate sites in Dala township. The area in total of three sites counts for 600 acre. One of three sites is an extension of the existing site.
Township or WTE plant			
Hlaing Tharyar	Hlaing Tharyar/ West	8	Site for township or incineration plant applied to the Mayor for use of SWM facility in August 2012.
Ale Yea	Thaketa/ South	20	Closed FDS
Htantabin	Htantabin/ North	61	Current FDS
Htawe Chaung	Htawe Chaung/ East	60	Current FDS

Source: PCCD of YCDC

(5) Generation of Solid Waste

1) Waste Generation Rate and Waste Composition

The generation rate of domestic waste is 0.396 kg/day/person according to a survey conducted in January 2012. The PCCD has conducted the waste generation surveys five times in the last 12 years (see Table 2.3.71). The survey results show fluctuation of generation rates. The rates ranged from 0.267 kg/day/person to 0.396 kg/day/person.

In the surveys, generated and stored solid waste was sampled from households in all of 33 townships, which counted for more than 7% of people in the city. The waste was stored in one day at each household before sampling.

Table 2.3.71: Waste Generation Rate in Yangon City

2001-2002	2003-2004	2006-2007	2010-2011	2011-2012
0.395	0.312	0.287	0.267	0.396

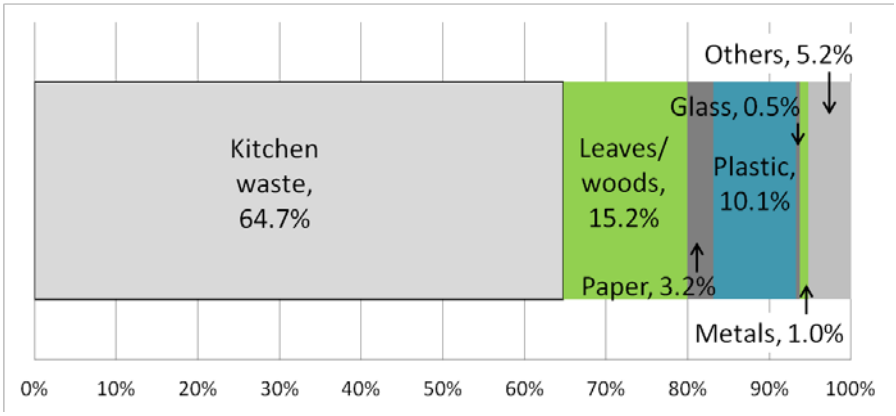
Unit: kg/person/day
Source: PCCD, YCDC

The ratio of kitchen waste in solid waste reaches 65%-weight in composition of solid waste generated in Yangon City according to a survey conducted in January 2012 (see Figure 2.3.92). Green leaves and woods which are also organic materials follow leftover in ratio at weight base. The ratio of materials which are often recognized as recyclables such as metals including steel, tins, and glass is very small. Among them, plastics occupy a relatively big portion, which counts for about 10%.

2) Waste Amount

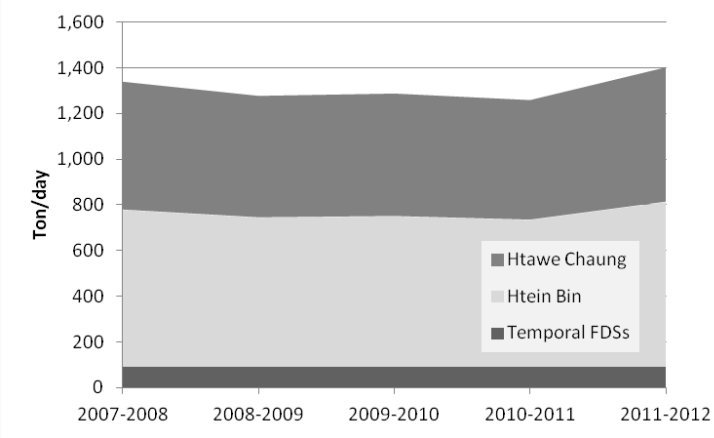
The amounts of solid waste disposed of at FDSs in the last five years are about 1,250-1,400 ton/day in Yangon City (see Figure 2.3.93). While the amount was on a declining trend from 2007 to 2010, it has increased from 2010 to 2011. According to the monthly record of waste amount, the largest figure is observed in April, which is the month of New Year in the country and the second largest is in October or November, which is the religious holiday season.

The YCDC estimated the generation amount of solid waste in the entire city as 1,690 ton/day based on the 4.3 million population and waste generation rate per capita surveyed in January 2012.



Source: Prepared by JICA Study Team based on data from PCCD of YCDC

Figure 2.3.92: Physical Composition of Solid Waste



Note: It is assumed that waste amount hauled to temporary FDSs is constant.
Source: Calculated by JICA Study Team based on yearly data from PCCD of YCDC

Figure 2.3.93: Collected Waste Amount of Solid Waste in Yangon City

(6) Solid Waste Collection and Transportation

1) Waste Collection and Transportation System

The waste collection system in Yangon City is a combination of primary waste collection method, waste temporary storage and secondary waste collection (waste transportation). The variations in the waste collection system are shown in Figure 2.3.94.

The PCCD personnel collects solid waste directly from waste generation sources such as households, shops and businesses using push carts or trucks. This collection work is carried

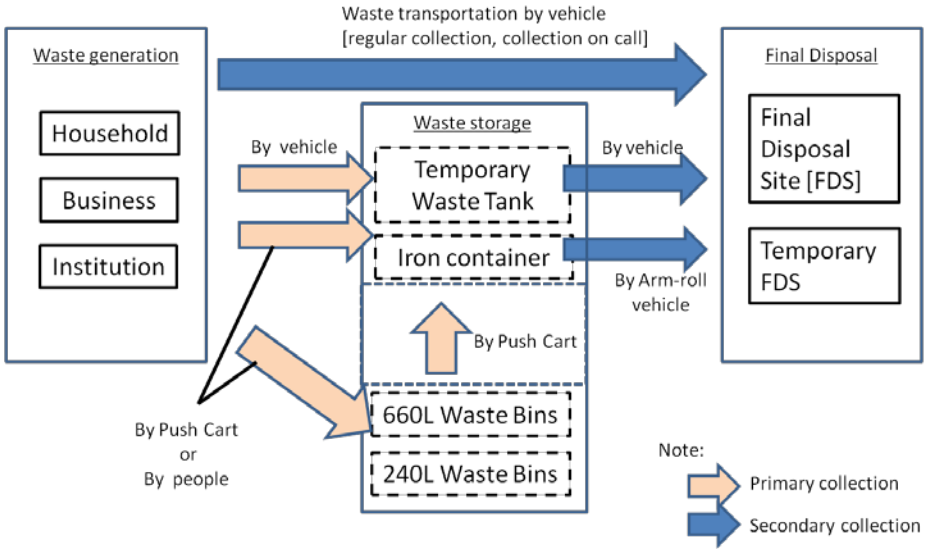
out from 6:00 am to 10:00 am. To inform people of on-going waste collection, collection workers ring a bell. Wastes loaded on push carts and trucks are transported to temporary waste tanks or steel containers with a 25 m^3 loading capacity. These waste storage facilities are constructed or placed along main streets in the townships. In some cases, wastes loaded on trucks are transported to a final disposal site directly instead of via these storage facilities. The wastes deposited in temporary waste tanks are loaded to waste trucks manually. This is a very time consuming work which takes 0.5-2 hrs for every tank. Especially, solid wastes without packing into a plastic bag force workers to transfer waste by using bamboo baskets while those in plastic bags can be loaded on the truck directly.

Waste generators can also discharge solid wastes to plastic bins (capacity: 660L, 240L) and then placed at the corner of the street and also to temporary waste tanks or steel containers. Wastes stored at the waste bins are picked up and transported to temporary waste tank or steel containers again by PCCD personnel.

People are instructed to bring their waste to these bins and storage tanks from 6:00pm to 11:00pm in time for the secondary collection, which normally started at around 6:00pm. Sometimes wastes may overflow from the bins and storage tanks exposing waste and emitting smell from waste. Such occurrence may give bad impressions of SWM to people. This problem must be addressed and may require immediate improvements.

After the secondary collection, wastes are transported to the final disposal sites. Waste transportation is not always carried out immediately after the secondary collection, leaving the fully-loaded trucks parked along the street even in the daytime. Wastes kept in the trucks cause bad smell and give bad impressions to people.

In addition to the regular waste collection and transportation operation, there is another type of collection, so-called “on call”. Waste generators make a phone call for waste collection to a township office or a district office. A PCCD truck goes and collects waste directly from large amount waste generators such as industries, embassies, and institutions.



Source: Prepared by JICA Study Team based on information from PCCD of YCDC

Figure 2.3.94: Combination of Waste Collection and Transportation in Yangon City

2) Facility and Equipment for Waste Collection and Transportation

The facility and equipment are allocated to every township and district offices of PCCD for waste collection and transportation. Waste vehicles and steel containers are normally placed or

parked on the street since township offices do not have enough space for them. This may impair smooth traffic in the street especially during the peak hours. The lists of facility, equipment and vehicles for waste collection and transportation are shown in Table 2.3.72 and Table 2.3.73.

Push carts are common in Myanmar for carrying things, and they are used for primary waste collection and street cleaning. Temporary waste tank, steel container, and waste bins are used as waste storage on streets. Temporary waste tanks are designed and constructed by PCCD or townships with materials made from bricks or bamboo with various sizes or dimensions. Steel containers are manufactured at the main garage of the PCCD. It takes 7-10 days to make one container. Imported waste bins have been purchased and placed on the street from June 2012 in order to improve the capacity of waste storage and quality of service to people by shortening the distance to discharging places.

Waste collection vehicles are classified into seven types which have different loading capacity while there are 16 categories at the registration of the main garage of vehicle section of PCCD. It includes the arm roll vehicles which carry steel containers, trucks with flat body (2-5.5 ton of loading capacity) and tractors. Most of vehicles are very old and require frequent repairs while PCCD has procured new trucks in the last three years. In 2012, four second-hand compactor trucks were donated by a Japanese company.

Table 2.3.72: Number of Equipment and Facility for Waste Collection

District	Temporary waste tank		Steel container	Push cart			Waste bins	
	Brick	Bamboo		Bell Ringing	Street Collection	Total	660L	240L
1 East	135	131	5	55	151	206	38	269
2 West	40	3	6	99	240	339	251	387
3 South	140	29	2	155	174	329	118	553
4 North	239	88	2	78	134	212	64	216
Total	558	251	15	387	699	1,086	471	1,425

Source: PCCD, YCDC (August 2012)

Table 2.3.73: Number of Vehicles for Waste Collection

District	12 Whls Arm-roll	10 Whls arm-roll	10 Whls (Ordinary)	10 Whls POWER PLUS	10 Whls Dump Truck	Dump truck [Korea]	CNG dump truck	Dump truck [Japan]		CHINA Box Car	Farm truck	Trollergy (AMT)	TE 21	FAW/Aeolus/Isuzu	Tractor	Compactor for Hospital/Clinical	ToTAL
Loading capacity [ton]	10	10	5.5	5.5	5.5	3.8	3	4	2	2	2.5	2	3.8	3.8		2	
East District	**1**	**1**	**1**	**0**	**1**	**2**	**9**	**3**	**0**	**0**	**20**	**2**	**3**	**5**	**0**	**3**	**51**
West District	**4**	**1**	**0**	**0**	**1**	**5**	**14**	**10**	**1**	**2**	**13**	**3**	**1**	**6**	**0**	**3**	**64**
South District	**3**	**0**	**0**	**0**	**0**	**2**	**12**	**4**	**0**	**1**	**27**	**2**	**2**	**4**	**2**	**3**	**62**
North District	**3**	**1**			**1**	**3**	**13**	**8**		**1**	**19**	**4**		**6**	**4**	**3**	**66**
Thiri Market	1																1
Vehicle Dept:	2	1	1	6			7	4	2	16	9	2	1	4			55
Total TSP/District	**14**	**4**	**2**	**6**	**3**	**12**	**55**	**29**	**3**	**20**	**88**	**13**	**7**	**25**	**6**	**12**	**299**

Source: PCCD, YCDC [August 2012]

3) Waste Segregation at Generation Source

Waste segregation at the source has been launched since April 2012. The PCCD requires waste generators to separate solid waste into the pre-determined two categories of wet or dry. They also have to put the segregated wastes into plastic (LDPE) bags with a designated color when they discharge them. However, this trial was suspended in July 2012 due to the difficulty and shortage of supply of plastic bags. It has been resumed after the preparation or manufacture of plastic bags in the beginning of September 2012 in all townships for all types of waste generators.

The wastes which are placed in the two designated colored plastic bags are collected together and transported to the final disposal site. As of September 2012, however, proper segregation at generation source is not carried out yet. Only a certain portion of waste is put into the designated colored plastic bags as instructed by the PCCD. Discharging the solid wastes placed in a plastic bag may result in shortening the time for waste loading from temporary waste tanks to trucks because workers do not need to transfer the wastes and loading it on to trucks by using bamboo baskets. As observed in September 2012, materials recovery and utilization might not be easy without substantial improvements of segregation at source and infrastructure such as material recovery facilities (MRF).

4) Maintenance of Equipment

Major maintenance works of vehicles such as overhauling of engines and gear boxes, are carried out by PCCD in their workshop located at the main garage. There are 16 groups of vehicle maintenance composed of six crews for engine, three crews for wiring, and seven crews for body repair. They have managed almost all the maintenance and repair works for vehicles while they outsourced repairs of some latest vehicles with electronic mechanism and programming. In addition to repairing, steel containers and portable public toilets are being manufactured in the main garage. The main garage records the logs of maintenance and repair works done for every vehicles. Minor maintenances of vehicles such as lubrication, change oil, changing of filters and simple replacement of parts are managed by every township office under the control and management of the district offices.

(7) Final Disposal

1) Final Disposal Sites of YCDC

There are two main final disposal sites (FDSs) operated by PCCD. One is Htantabin FDS and the other one is Htawe Chaung FDS. These two FDSs are open and receive wastes for 24 hrs/day. Table 2.3.74 outlines the existing FDSs in Yangon City. The location of final disposal sites and candidate sites are shown in Figure 2.3.95.

The township offices of PCCD supervise and operate several temporary final disposal sites located far from the two large FDS or physically separated by Yangon River. The area in front of Damyingone Train Station which had been a low land buried with solid waste is still used for dumping of wastes from the market nearby.

Table 2.3.74: Existing Final Disposal Site

Name	Township/District	Area [ha]	Planned Service Period	Present Condition
Disposal site				
Htantabin	Hlaing Tharyar/ West	61	2002-2021	28 ha has been occupied with disposed waste
Htawe Chaung	North Dagon/ East	60	2004-2015	19 ha has been occupied with disposed waste
Temporal site				
Shwe Pyi Thar [Kyun Chaung]	Shwe Pyi Thar/ West	1	1998-2015	There are two separate sites are which are in operation within the area, intended for rainy and dry seasons.
Mingalardon	Mingalardon / North	1	2003-2012	Fence is set along the main road. A candidate site for future landfill.
Seikgyikhanaungto	Seikgyikhanaungto / South	0.1	1962- ?	
Dala	Dala/ South	1	1950-?	A candidate site for future landfill.
Damyingone Train Station, Vegetable Market	Shwe Pyi Thar / North	5	2009-2012	Dumping is accepted for land reclamation. No fence at the site. This site is used in dry season.

Source: PCCD, YCDC

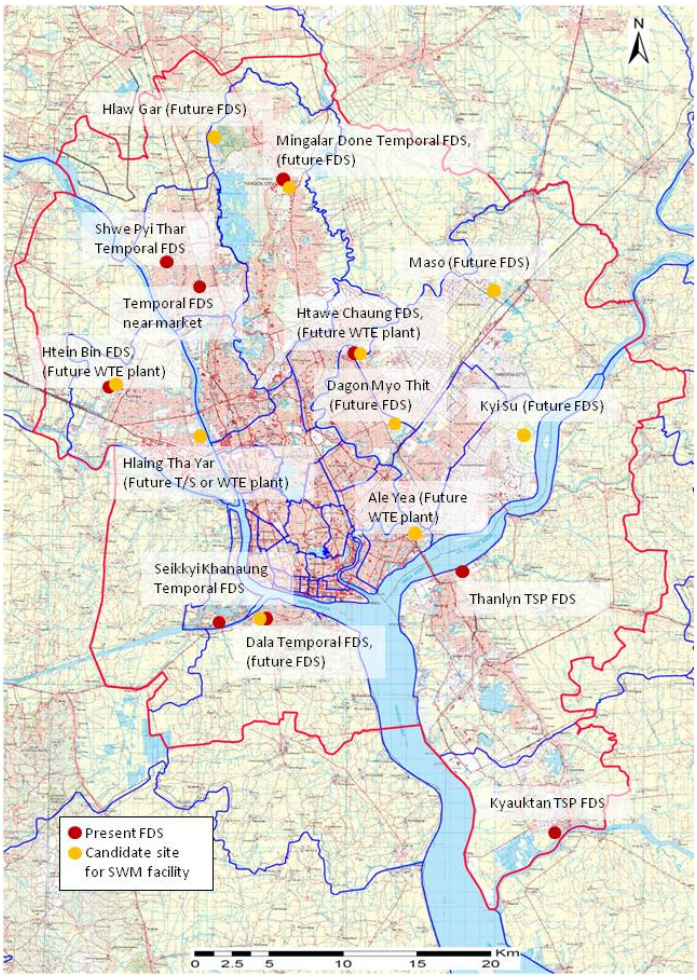
2) Operation of Final Disposal Sites

All FDSs are currently operated as open dumping sites. They contributed some negative environmental impacts on the environment such as water contamination due to untreated leachate, emission of air contaminants to atmosphere due to open burning of solid waste, bad smell from uncovered waste and its decomposition, and breeding of pests like flies.

No soil covering on the dumped waste, collection/treatment of leachate, nor control of landfill gas have been carried out, while pushing of the dumped waste by heavy equipment, record of waste transfer trips at the check point are done at two FDSs. For lighting, solar panels are installed in the two FDSs while the light reach only a limited area of FDSs in Htantabin FDS and Htawe Chaung FDS.

3) Equipment for Final Disposal

Bulldozers, excavators and tractors are used for landfill operation at the two main FDSs as shown in Table 2.3.75. PCCD has rented one



Source: Prepared by JST based on information from PCCD

Figure 2.3.95: Location of the Existing Sites and Candidate Sites for SWM Facilities

additional bulldozer at the Htantabin FDS. Minor maintenance works are carried out at the FDSs. Other maintenance and repair works, which require expertise such as mechanical and electrical ones, are requested from the Engineering Department of YCDC with certain amount of payment.

For waste collection vehicles, at the check points of two large FDSs, drivers and helpers wash these equipment and check also the operating conditions.

Table 2.3.75: Equipment for Landfill Operation

	Bulldozer (type, owner)	Excavator	Tractor
Htantabin FDS	1 (D6, YCDC), 1 (D4, rental)	1	3
Htawe Chaung FDS	1 (D7, YCDC)	1	3

Source: PCCD, YCDC

4) Illegal Dumping and Closed Disposal Sites

Small-scale waste dumping is commonly found in the city, especially at road shoulders, streams and drains on the outskirts of the populated area. It is also observed that there are vacant lands near to final disposal sites. The filling of lower lands with solid wastes has been regarded as land reclamation in Yangon City. This is still accepted and practiced in Yangon City. Temporary final disposal sites in remote townships and the one located near the vegetable market have considered this type of activity.

There are a lot of closed disposal sites in the city as well. Presently, outer surface of most old disposal sites are covered with vegetation and dumped wastes are not seen directly although proper measures for closure were not carried out.

(8) 3R Activities

1) 3R Initiation by PCCD, YCDC

The PCCD has been operating a recycling plant located at the district office (west) in Ahlone Township since year 2005. PCCD had started operation of a pilot plant for recycling in year 2001, which was then relocated and expanded to the present scale in year 2005. From the recovered High Density PolyEthylene (HDPE) and LDPE, the plant produces dust bins for public space, colored plastic bags including those for infectious waste, sharps and domestic wastes. Although it is used to produce PVC pipes from waste PVC pipes, it was stopped due to the high cost of production.

Presentations for public enhancement, including dissemination of the 3R concept, have been implemented twice a week mostly for students in the west and north districts. The subjects explained in the presentations include not only SWM but also pollution control and climate changes.

Also, PCCD conducted a pilot project for composting in year 2007 for the utilization of organic wastes. It was discontinued due to unavailability of a market for products.

2) Material Recovery by Informal Sector

Recyclable materials such as plastics, card boards, scraps, glass bottles, cans and others are often collected over the city through the initiative of private sectors which are not controlled by YCDC, while recycling shops who buy recyclables from both individuals and business establishments are registered by YCDC. The recycling shops with varying sizes are spreading in the city (See Table 2.3.76). The prices of recyclable materials are controlled by the whole

sale market in Yangon City where the recycling shops sell the collected materials to buyers. According to data published by the PCCD, the amount dealt with at the wholesale market is 84.2 ton/day in 2009 and 85.8 ton/day in early 2012.

Table 2.3.76: Number of Recycling Shops Registered to YCDC

East district	West district	South district	North district	Total
40	37	50	48	175

Source: PCCD, YCDC

Materials recovery activities are done at FDSs as well. About 150 and 50 waste pickers reside nearby the Htantabin FDS and Htawe Chaung FDS, respectively.

3) Recycling Industry

Recycling factories are private industries doing their businesses under the market principles since these industries are not a subject for promotion by the government at this moment.

Some types of materials such as paper are recycled by private factories in Yangon City. While the recovered scrap metals are used to be melted and recycled in one township of YCDC. Melting of the scrap metal was prohibited due to its high electricity consumption and air pollution and these kinds of businesses have been relocated to Myuang Tagar Industrial Zone located at outside of Yangon City. Nevertheless, there are still a number of small factories doing some processing of the recycled crude steel in the township.

As mentioned above, the recycling of plastic has been initiated by PCCD. Since June 2012, one private company is recycling plastic bags under close coordination between the YCDC and the association of plastic industries. They produced plastic bags in different colors like blue and green, which are to be used for waste collection, are to be sold to YCDC at a fixed price. According to the private company, they do not have profit nor deficit from this plastic bag recycling.

(9) Financial Aspect

1) SWM Service Fee

The YCDC incurs a “cleansing fee” on households, business entities, hotels and clinics. The fees are shown in Table 2.3.77, which vary according to the sizes of business, types of facilities and other conditions. It charges waste collections upon request (on-call collection) as well. The fee for an “on-call” collection is MMK 30,000/trip for a governmental institution and MMK 35,000/trip for a private generator.

The PCCD personnel in charge visits waste generators who are to pay the cleansing fee and collects it. It is said, however, that the collection rate of cleansing fee is about 20-50%. This year, PCCD is trying to raise the fee collection rate.

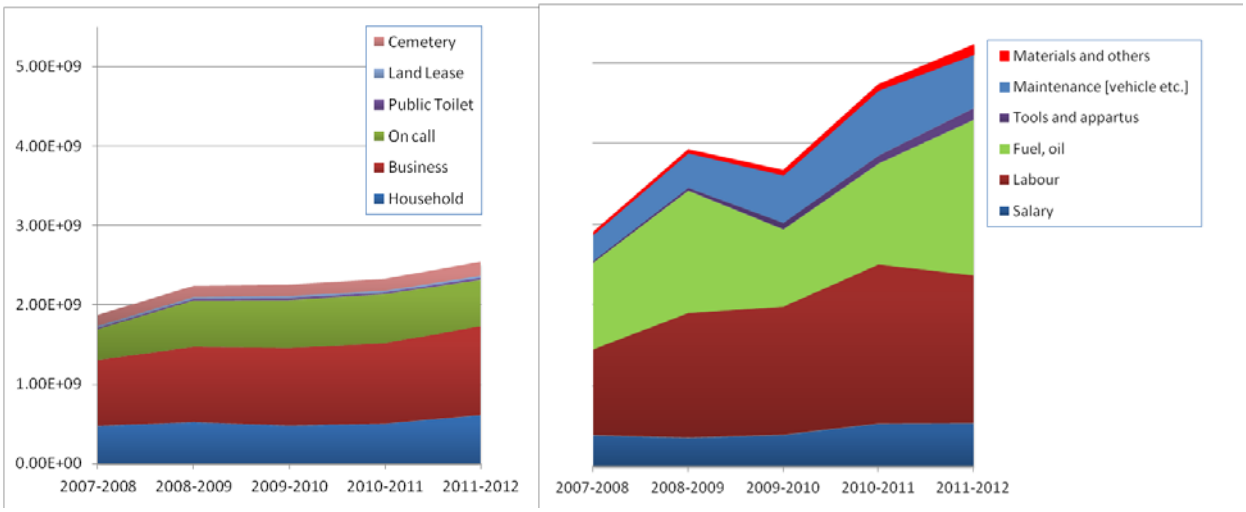
Table 2.3.77: Monthly Cleansing Fee Imposed by YCDC

Household [CBD]	Household [Sub-urban Township]	Household [Satellite Township]	Commercial Entity	Hotel	Hotel [Foreign Investment]	Guest House Inn	Clinics
600	450	300	500 - 400,000	10,000	US$67-300	6500 -250,000	1,200 - 19,500

Unit: MMK/month if not specified.
Source: PCCD, YCDC

2) Revenue and Expense of PCCD

The record reflected on the balance sheet of revenues and expenses of the PCCD is apparently negative, as shown in Figure 2.3.96. The amount of deficit is supplemented by YCDC. The cost for SWM must affect the budget of YCDC because the deficit has increased in the last five years, except from 2008/09 to 2009/10. The increase of expenditures overwhelmed the amount of revenue. It is seen that costs of labor and vehicle operation/maintenance (fuel/oil and maintenance [vehicle etc.]) are the two heavy factors of expenditures and the main source of the increase in costs.



[Revenue (MMK)] [Expenditure (MMK)]

Source: Prepared by JICA Study Team based on information from PCCD of YCDC

Figure 2.3.96: Revenue and Expenditure of PCCD

(10) Solid Waste Management in Periphery Townships

Solid wastes generated in wards of townships located outside of YCDC are collected by township development groups. In some townships, waste collection services are not provided to all the wards. People outside of the service area by the development group dispose of their wastes by themselves like in rural villages.

The sanitary section is in charge of the waste collection except in Kyauktan Township. Waste is collected and transported to their FDS in 6-7 days/week. FDSs are very small compared to those in Yangon City and are operated in an open dumping practice, too. Heavy equipment is seldom used at FDSs. Table 2.3.78 summarizes SWM in these TSP Townships.

Table 2.3.78: SWM of Periphery Townships Outside Yangon City

Township	Dept in charge of SWM	Waste Collection Amount [t/d]	Equipment [Vehicles, Machinery]	Collection Area	Area of Present Disposal Site [ha]
Kyauktan	Sanitary Sect. of Administration Dept	5	Truck 1, push cart 2	6 of 9 wards	2.0
Thanlyin	Sanitary Dept.	7	Truck 4, push cart 6, waste tank 19, waste bin 110, excavator 1	All wards	1.6
Hlegu	Sanitary Dept.	6	Truck 2, push cart 3, excavator 1, portable bin 10	All wards & 1 biggest village	1.6
Hmawbi	Sanitary Dept.	4	Truck 2, push cart	All wards	3.6
Htantabin	Sanitary Dept.	1	Truck 1, push cart 2	3 of 5 wards	0.6
Twantay	Sanitary Dept.	4.5	Truck 2, push cart 2	All wards	1.2

Source: Prepared by JICA Study Team based on interview to townships

(11) Hazardous and Infectious Waste Management

The infectious waste generated in hospitals in Yangon City is separately collected by PCCD's compactor trucks and incinerated at the furnace equipped in the cemetery located at the nearby Htantabin FDS. The furnace of Htantabin Crematorium is used for infectious wastes every afternoon after completion of funerals.

As for management of disposed hazardous materials, the PCCD has treated and disposed of waste which are recognized and classified as hazardous wastes like the expired medicines, residual paints and mercury. In most cases, these materials are sealed into concrete containers or encapsulated and placed into a protected deep trench. Table 2.3.79 summarizes the record of disposal of hazardous waste by the PCCD. Since hazardous wastes have not been regulated by legislation in Myanmar, responsibility of treatment and disposal as well as method for treatment is not clear.

Table 2.3.79: Record of Disposal of Hazardous Waste by YCDC

	Year	Kind of Waste	Disposed Ton	Method
1	2005	Expired Medicine	4.55	Deep Well
2	2006	Expired Medicine	2.27	Deep Well
3	2007	Paint Residue	2	Deep Well
		Melamine Milk Powder	88	Incinerated
4	2008	Expired Medicine	36.85	Deep Well
5	2009	Paint Residue	18.02	Deep Well
		Expired Medicine	15.21	Deep Well
6	2010	Expired Medicine	18.7	Deep Well
7	2011	Damaged Sulfur	150	Deep Tank
		Paint Residue	2.2	Deep Well
		Expired Medicine	14.9	Deep Well
		Total	352.7	
		Average	50	ton/yr
			0.14	ton/day

Source: PCCD, YCDC

(12) Key Findings and Main Issues to be Addressed for Solid Waste Management

1) Lack of Detailed Planning of SWM

Although the YCDC made a lot of efforts for SWM, there are neither short-term nor long-term plans for SWM, including waste collection/transportation, final disposal and intermediate treatment based on quantitative prediction and analysis. Without such plans, it is impossible to develop appropriate capacity and function of infrastructure for the city. While YCDC has selected candidate sites for SWM facilities, capacity of these sites has not been examined in terms of required function and social and environmental appropriateness.

2) Inefficient Waste Collection System

The situation of waste collection can be improved to keep the condition of the city more sanitary as YCDC intends. Current method of waste collection is heavily dependent on human workforces, which results in time-consuming and insufficient waste removal from the living environment. As YCDC envisages, interactions of mechanical method may contribute to shorten the time of waste collection and waste remaining in the populated area.

3) Old Equipment for Waste Collection and Transportation

Most of the vehicles for waste collection and transportation are very old, some even more than 20 years old, and frequently require repair and maintenance. It is necessary to replace these units for efficient and stable performances in collecting wastes. Even the brake lights and direction indicator lights necessary for safe traffic are not equipped in these old vehicles. The replacement of parts and repair of old vehicles will contribute to the increase in the maintenance cost and reduces operation hours. Although PCCD has invested in new vehicles in the last few years, old vehicles still occupy a main part in the fleet.

4) Improper Final Disposal

All final disposal sites are operated as open dump sites, which gives negative environmental impact on water environment, atmosphere, global warming and cause unsanitary conditions. Leachate from dumped waste to the sites flows out and permeates into the ground without any treatment. Sanitary final disposal site must be developed as basic infrastructure for the city so that waste can be disposed of in a sanitary way.

5) Unclear Enforcement of Hazardous/Infectious Waste Management

YCDC treated and disposed of some of hazardous waste materials when necessity arises, while the responsibility of hazardous waste management is not defined in the by-laws that is only regulation related with SWM in Yangon City. The definition of hazardous waste is not clear. The hazardous waste as well as industrial waste is to be managed under the waste generators' responsibility following the polluter pay principle which is stipulated at the Environmental Conservation Law..

6) Weakness of SWM Legislation

While the YCDC manages the solid waste according to their by-laws, the present legislation of SWM on the national, regional as well as YCDC level is very weak. The vision and goal of SWM are not defined and unclear. It is difficult to improve the present situation of SWM without setting a clear target of what needs to be attained. YCDC is to develop a regulation which covers all aspects of SWM including the promotion of the 3R concept, development of sound material recovery cycle society so that the city would be a model in the country.

7) Improper Cost Recovery from Beneficiary

The YCDC recognizes the collection rate of waste service fee from households is very low so that there is a substantial deficit between income and expenditure for SWM. An appropriate cost recovery scheme should be enhanced for improvement of the financial situation of SWM as well as promoting fair cost-sharing system among beneficiaries. The YCDC is required to provide satisfactory service so that beneficiary does not hesitate to bear the cost of the service.

2.3.9 Telecommunications

Telecommunications is an important and integrated part of the sound economic growth for an affluent society. Telecommunications in Myanmar and in Yangon lags behind the time due to the political instability and shortage of modern technology. Improvement and enhancement of telecommunications such as strengthening network capacity and its reliability accelerates social and economic growing. The present condition is analyzed in order to proceed to the desired telecommunications development for Myanmar and Yangon.

(1) Facility Conditions

Conditions of telecommunication facilities in Myanmar and Yangon are as follows.

1) Fixed Telephone

The numbers of users of fixed telephones were pegged at around 1,077,084 in Myanmar (2009). The penetration rate in Myanmar is only 2.24%, which is very low compared to other Asian countries. The number of fixed telephone users in Yangon City was 499,914 (2009) (Table 2.3.80).

Table 2.3.80: Number of Fixed Telephone Users

	2003	2004	2005	2006	2007	2008	2009
Myanmar	372,317	434,182	500,396	594,475	716,349	846,705	1,077,084
Yangon	191,734	228,654	269,333	351,068	384,451	419,268	499,914
Others	180,583	205,528	231,063	279,407	331,898	427,437	577,170
Penetration(%)	0.70	0.80	1.17	1.25	1.51	1.77	2.24

Source: Statistical Yearbook 2010.Myanmar

Fixed telephone penetration rate of Myanmar, according to the ITU Data, is lower than other countries like Cambodia and Laos, which is second to the lowest after Bangladesh (Table 2.3.81).

Table 2.3.81: Fixed Telephone Penetration Ratio (2010)

Country	Bangladesh	Myanmar	Laos	Cambodia	Mongol
Penetration (%)	0.61	1.26	1.66	2.54	7.01

Source: ITU

The local digital exchange that had been introduced before is still operational. The digital exchange room is running fine with air conditioning as well (Figure 2.3.97).

Source: JICA Study Team

Figure 2.3.97: Local Digital Exchange

Manual exchanges are still working all over the country. Before the economic sanctions, the equipment for telecommunications are being manufactured in Germany and Japan. However, the equipment made in China was introduced to Myanmar at the onset of the economic sanction era. The digital exchanges were the product of Shanghai-Bell in two offices that could be investigated. The number of nationwide local exchange is shown in Table 2.3.82.

Table 2.3.82: Number of Local Exchanges

	2003	2004	2005	2006	2007	2008	2009
Auto Exchange	139	163	199	227	251	291	362
Manual Exchange	648	676	660	659	634	600	557

Source: Statistical Yearbook 2010.Myanmar

A new fixed telephone will be opened within one or two days (but the worst is one week) after an application has been filed. Thus, the line number management, numbering management work, and line-open order work are done properly.

2) Public Telephone

Throughout the city, there are a number of fixed public telephone sets in a stall, which a civilian can use by paying a telephone fee to the person in the stall (Figure 2.3.98). Since there is no coin in Myanmar, there are no automatic coin-operated public telephones. There are automatic public telephones by prepaid card in the office handling international call, telegram and telex. Automatic public telephone is not being used most of the time.

Source: JICA Study Team

Figure 2.3.98: Public Phone and Automatic Public Phone

3) Mobile Phone

There are about 580,000 mobile phone units in the whole Myanmar in year 2009, of which about 300,000 mobile phone units are in Yangon, and the mobile phone penetration rate is about 1.2% for the nation, about 6% for Yangon. In recent years, mobile phones are increasing remarkably. The number of mobile phone by area and method is shown in Table 2.3.83.

Table 2.3.83: Number of Mobile Phone

	2003	2004	2005	2006	2007	2008	2009
Total	48,741	92,007	128,700	196,049	287,707	399,830	579,909
Yangon	39,416	72,560	103,144	143,240	185,338	211,432	297,940
Others	9,325	19,447	25,556	52,809	102,369	188,398	281,969
Cellular	8,441	21,524	22,764	23,256	23,879	26,662	26,832
CDMA	11,964	12,041	12,083	12,090	12,153	73,312	198,990
GSM	28,336	58,442	93,853	160,703	251,675	299,856	353,087

Source: Statistical Yearbook 2010.Myanmar

4) Internet

The number of internet users in Myanmar has reached 471,994 in year 2009 (Table 2.3.84). The huge numbers of internet users are in Yangon, Nay Pyi Taw and Mandalay.

Table 2.3.84: Number of Internet Users

	2003	2004	2005	2006	2007	2008	2009
Myanmar	10,338	9,255	67,000#	77,424#	106,674#	451,734	471,994

#: Include e-mail users
Source: Statistical Yearbook 2010.Myanmar

There are three Internet Service Providers (ISP); Myanmar Posts and Telecommunications (MPT), YadanarponTeleport and MOD. Yadanarpon Teleport is a subsidiary of MPT. Yadanarpon Teleport offers ADSL. Fortune Company and E-lite Company offer Fiber line(FTTB) via Yadanarpon Teleport ISP.

MPT offers Dial up line, ADSL line, Fiber line, E1 line and MPT satellite line. Fiber line (FTTB) is offered to government only. Most subscriber's number of internet are using via mobile phones. The subscriber's numbers of internet of MPT are shown in Table 2.3.85.

Table 2.3.85: The Internet Subscriber's Number of MPT

Description	Subscriber	Description	Subscriber
Fiber Line (FTTB)	152	GSM	166,376
MPT Satellite terminal	782	3G	30,613
E1 Line	80	CDMA	65,802
ADSL Line	4615		
Dial up Line	2308		

Source: MPT

RED LINK which is subordinate to YadanarponTeleport is carried out by the wireless WiMAX service. Only RED LINK is providing the WiMAX service in Yangon.

5) Line Facility

Primary cables are buried underground and connected with secondary cables in a cabinet located on the sidewalk. Secondary cables are routed overhead. Some of the cabinets are very weak due to poor workability inside and was constructed in bad condition (Figure 2.3.99). In addition, the closure has been placed on the road beside a cabinet.

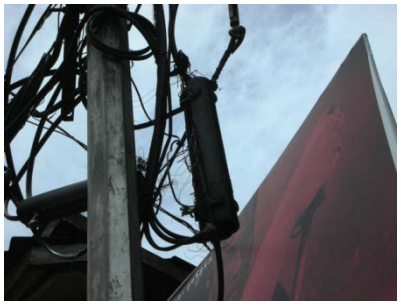
Source: JICA Study Team

Figure 2.3.99: Inside of Cabinet and Closure on Road

There are cases when the building are constructed almost continuously or parallel along the city street, the aerial cable are wired using the walls of the building and when the telephone poles must be raised above than the previous installation, then such wiring has been taken off again causing double work.

The telephone pole is cylindrical in form with almost 0.20 m diameter at the bottom and with 6 m height or length, made of iron plate (Figure 2.3.100). There is an octagonal pole and a cylindrical form made of concrete pole. Some poles are a little bit bended, or have specially designed voided holes or the lattice pole. Cables coming from underground bare on telephone poles base often have a problem with the maintenance. It is also not sealed terminal closure, which allows the ingress of rainwater, and is one of the causes of failure. There are many problems in various construction stages in Myanmar.





Source: JICA Study Team

Figure 2.3.100: Telephone Pole and Cable

6) OFC (Optical Fiber Cable)

Although OFCs are used as a junction cable between the telephone offices, these seem to be borrowed from other companies rather than their own OFC.

MPT laid out OFCs between Yangon and Mandalay currently by a self-funded scheme.

In Yangon, FTTB (Fiber to The Building) service has been performed in some areas.

7) International Line

International lines of Myanmar are the submarine cable (SEAMEWE-3), satellite communications (Intelsat satellite and Thaicom satellite), and terrestrial OFC line (China and Thailand). The capacity of SEAMEWE-3 and OFC line (China and Thai) is shown in Table 2.3.86. Demand for international telecommunications and internet traffic is rapidly increasing since the recent political stability and boom for foreign investment. An increase of international line capacity needs to be done as soon as possible. It is necessary to construct the new transmission facilities and line in domestic side at the same time.

Table 2.3.86: International Line Capacity

Description		Capacity
Submarine Cable SEAMEWE-3	East	8xSTM1, 2xSTM16
	West	5xSTM1, 1xSTM4
China OFC		2xSTM1, 1xSTM16
Thai OFC		3xSTM1, 1xSTM4, 1xSTM16

Source: MPT

8) Domestic Satellite Line

Domestic Broad Band communication is serviced by using Thaicom 4 and Thaicom 5 Satellites. Ayawaddy Bank seems to have done the ATM service on this line (Figure 2.3.101).

Source: JICA Study Team

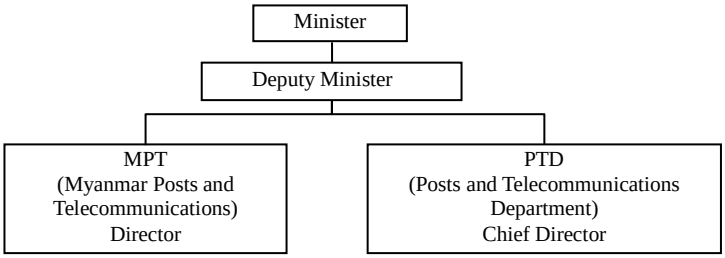
Figure 2.3.101: Domestic Broad Band Communication Service

In addition, the national telephone communication is connected by VSAT (Very Small Aperture Terminal) using Thaicom1 Satellite. Although satellites are used for the international and domestic communications in this way, satellite lease fee is expensive, which is a drawback.

(2) Governing Body for Telecommunications

The Ministry of Communications, Posts and Telegraphs (MCPT) has been changed into the Ministry of Communications and Information Technology (MCIT) on the 9th of November 2012. MCIT has two lower organizations, i.e., Myanmar Posts and Telecommunications (MPT), and Posts and Telecommunications Department (PTD). MPT has a monopoly on telephone, telegram, mobile phone and postal services in Myanmar. PTD regulates telecommunications and broadcasting.

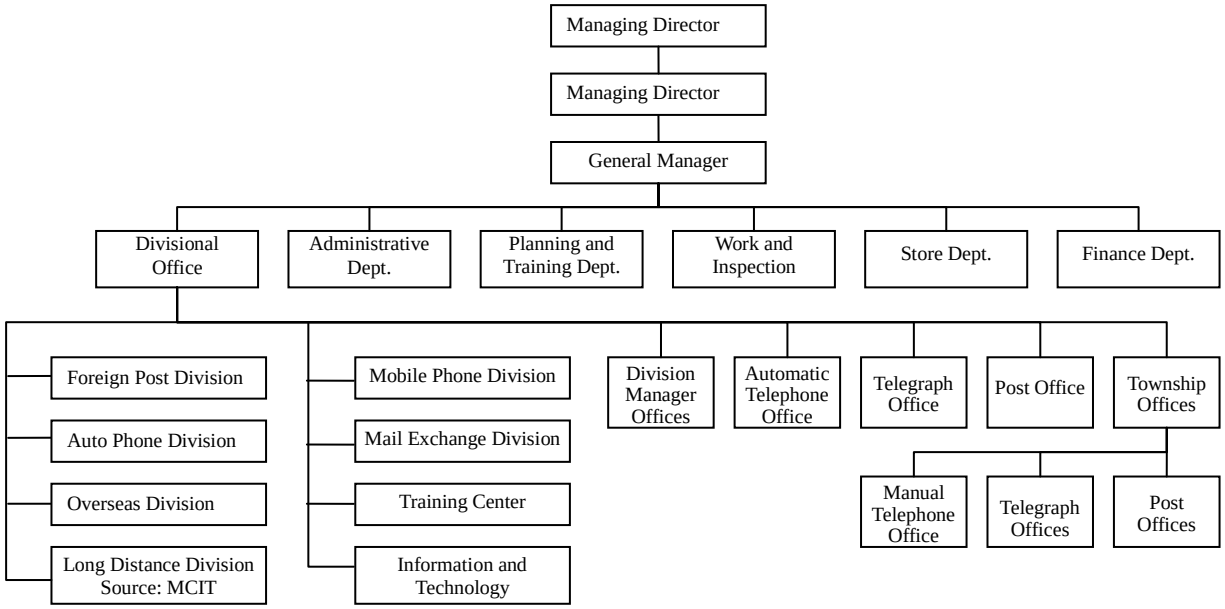
The MCIT organization is shown in Figure 2.3.102.



Source: MCIT

Figure 2.3.102: MCIT Organization

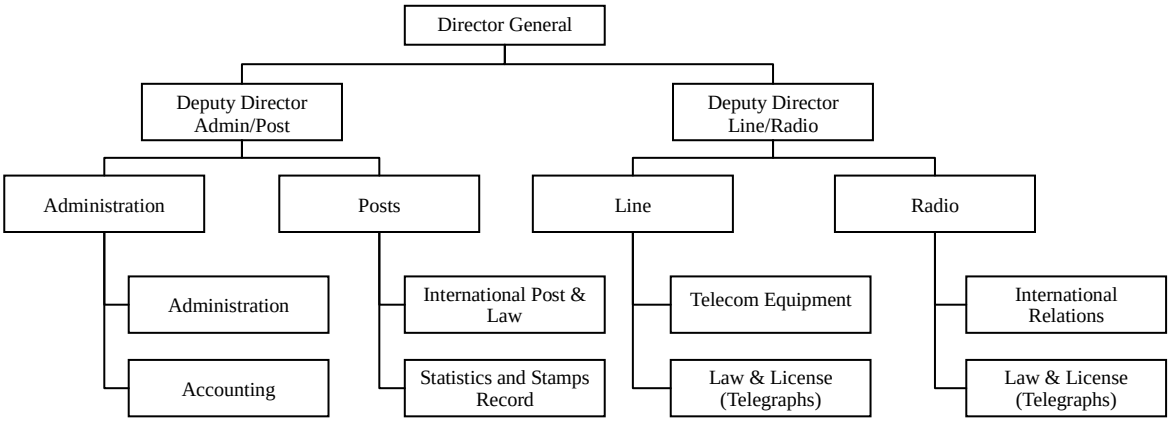
The MPT organization is shown in Figure 2.3.103, which is a subordinate organization to MCIT.



Source: MCIT

Figure 2.3.103: MPT Organization

The organization of PTD is shown in Figure 2.3.104.



Source: MCIT

Figure 2.3.104: PTD Organization

There are two telecommunications carrier, MPT and Yadanarpon Teleport. The government of Myanmar has a privatization plan for the telecommunications carriers. Two more telecommunications carriers will be permitted not later than March 2013.

(3) Telecommunication Fee

The initial cost and telecommunication charges in each system are as follows.

1) Fixed Telephone

1) Initial cost

Initial cost of a fixed telephone was MMK 4.0 million (about US$4,700) before, it is currently at MMK 650,000 (about US$760). It is still expensive for the general public, so it takes time to penetrate.

2) Domestic Call Charges

Call charges within the same State or Division is MMK 50 per minute (about US$ 0.06). Call charges across the Division or State is MMK 100 per minute (about US$0.12).

3) International Calling Rate

International calling rate is US$0.9 per minute to almost all countries, but some countries are different, for example US$1.5 per minute to North Korea and US$1.9 per minute to New Zealand. However, international call tariff is unknown. International call fee to Japan via international exchange operator is US$2 per minute.

2) Mobile phone

1) Initial Cost

The initial cost of GSM is MMK 210,000 (about US$247).

2) Mobile Phone Handset Prices

Mobile phone handset price is from MMK 30,000 (about US$35) to MMK 100,000 (about US$118) in Yangon.

3) Domestic Call Charges

Call charges within the same state or division is MMK 50 per minute (about US$0.06). Call charges across the division or state is MMK 100 per minute about (US$0.12).

3) WiMAX (Internet)

WiMAX fee of RED LINK is shown in Table 2.3.87.

Table 2.3.87: WiMAX Fee (RED LINK)

Plan	Silver	Gold	Gold+	Platinum	Platinum+
Monthly Fee(US$)	30	55	55++	90	90++
MIR*	512Kbps	1Mbps	1Mbps	2Mbps	2Mbps
Usage Quota	3GB	6GB	6GB	12GB	12GB
Additional Charge(US$)	-	-	0.01/MB	-	0.009/MB
(Max Charge=)	-	-	200US$		180US$

*: Maximum Information Rate

It is difficult to penetrate WiMAX to the general public, for the sake of US$30 of a minimum monthly fee and a few number of PC holders.

(4) Key findings and Main Issues to be addressed

In recent years, the fixed-telephone telecommunications has been greatly changed to mobile phone and the internet telecommunications. To catch up on the new telecommunications network (Next Generation Network: NGN), it takes longer times and huge costs. Since telecommunication is a network, not only Yangon, but also the entire Myanmar, must be considered. It is necessary to prepare Myanmar and Yangon Telecommunications Development Master Plan. The main issues of the Master Plan are as follows:

1) Increase of capacity of the international communication line

The traffic of international communication line should be increased enormously, because of the massive use of the internet. Satellite line, submarine cable line and terrestrial OFC line are used for international connections of Myanmar. The cost of installing a satellite line is very high and submarine cable line is difficult to increase in a short period, so terrestrial OFC line to Thailand should be increased as soon as possible. Transmission facilities for submarine cable lines must be increased at the same time.

2) Install more internet facilities

There are only three Internet Service Providers (ISPs) in Yangon and only one ISP services WiMAX. New ISPs should be permitted and internet facilities have to be prepared in order to improve the internet services.

3) Construction of NGN

Next Generation Network (NGN) is a new telecommunications network by the use of internet protocol technology. Construction of OFC is the main work to establish the NGN. OFC will be constructed from the telecommunication building to the home, curb and building to be serviced telecommunications by high speed and large capacity transmission.

The above-mentioned sub-items 1) and 2) are urgent matters on the Yangon telecommunications condition.