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PERFORMANCE OF RAILWAY TRANSPORT IN MYANMAR

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M.DevS-8 (14th Batch)

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PERFORMANCE OF RAILWAY TRANSPORT IN MYANMAR

A Thesis submitted in partial fulfillment of the requirement for the Degree of Master of Development Studies (M.DevS)

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This is to certify that this thesis entitled **"Performance of Railway Transport in Myanmar"** submitted as a partial fulfillment towards the requirements for the degree of Master of Development Studies has been accepted by the Board of Examiners.

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ABSTRACT

This study is mainly focused on performance of Railway transport in Myanmar. Transportation is an important factor for the economic development of Myanmar. As a primary mode of transportation, railway is important not only at the macroeconomic level but also at the microeconomic level. The improvement in availability and capacity of the components in Railway transportation could not catch up with the increasing infrastructure and the performance and productivity improved due to the scarcity of investment funding. This aim of study is to examine the Railway Transport Performance in Myanmar and to analyze the Railway Transportation development in Myanmar. The method of study is descriptive method and secondary data from Ministry of Transportation and Communication. Today, the performance and productivity of the Myanmar rail Network is not upgraded at the pace necessary to keep up with the increase in traffic demand. Myanma Railways runs an impressive number of services, but it is forced to limit speed and cannot ensure on-time performance. MR maximizes the use of its main tracks despite the poor quality of its assets. MR needs to modernize employee skills in all technical fields to operate and maintain new technology, rolling stock, and equipment.

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Performance of Railway Transport in Myanmar

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LIST OF ABBREVIATIONS

ASEAN	the Association of South East Asian Nations
bn	billion
BOT	Build-Operate-Transfer
CO2	Carbon Di Oxide
DMU	Diesel Multiple Unit
EN 15341	the European Standards Maintenance key performance indicator
ERP	Enterprise Resource Planning
FY	Fiscal Year
GDP	Gross Domestic Product
GMS	Greater Mekong Sub-region
HLRs	High Level Requirements
HSE	Health Safety and Environment
IIMM	International Infrastructure Management Manual
IR	Indian Railways
km	Kilometer
KPIs	Key Performance Indicators
LRT	Light Rail Transit
mi	mile
MIS	Management Information System
MK	Myanmar Kyat
MR	Myanma Railways
MRT	Mass Rapid Transit
NAMS	New Zealand Asset Management Steering
Nos	New old stock
PAS 55	Publicly Available Specification was published by the British Standards Institution in 2004 for physical assets
PPM	Public Performance Measure
PSO	Public Service Obligation
SBS	Singapore Bus Service

SMRP	Society for Maintenance & Reliability Professionals
SMRT	Singapore Mass Rapid Transit
UIC	Union International Railways
UN	United Nation
US	United State
YCR	Yangon Circular Railway
YRTA	Yangon Region Transport Authority

Chapter I
Introduction

1.1 Rationale of the Study

The development of transportation systems is embedded within the scale and context in which they take place; from the local to the global and from environmental, historical, technological and economic perspectives. Transportation is a major contributor to the economy and a competitive force in business.

In some circumstances transport investments appear to be a catalyst for economic growth while in others, economic growth puts pressures on existing transport infrastructures and incite additional investments.

Transport markets and related transport infrastructure networks are seen as key drivers in the promotion of a more balanced and sustainable development, particularly by improving accessibility and the opportunities of less developed regions or disadvantaged social groups. At start there are different impacts on the transport providers (transport companies) and the transport users. There are several layers of activity that transportation can valorise, from a suitable location that experiences the development of its accessibility through infrastructure investment to a better usage of existing transport assets through more efficient management.

Because of its intensive use of infrastructures, the transport sector is an important component of the economy and a common tool used for development. This is even more so in a global economy where economic opportunities have been increasingly related to the mobility of people, goods and information. A relation between the quantity and quality of transport infrastructure and the level of economic development is apparent. High density transport infrastructure and highly connected networks are commonly associated with high levels of development.

When transport systems are efficient, they provide economic and social opportunities and benefits that result in positive multipliers effects such as better accessibility to markets, employment and additional investments. When transport

systems are deficient in terms of capacity or reliability, they can have an economic cost such as reduced or missed opportunities and lower quality of life**.**

At the aggregate level, efficient transportation reduces costs in many economic sectors**,** while inefficient transportation increases these costs. In addition, the impacts of transportation are not always intended and can have unforeseen or unintended consequences. For instance, congestion is often an unintended consequence in the provision of free or low cost transport infrastructure to the users. However, congestion is also the indication of a growing economy where capacity and infrastructure have difficulties keeping up with the rising mobility demands. Transport carries an important social and environmental load, which cannot be neglected. Assessing the economic importance of transportation requires a categorization of the types of impacts it conveys.

Due to massive underinvestment and neglect in past governments, Myanmar's infrastructure lags behind its ASEAN neighbour-countries, and hinders access to markets and social services. High transport costs and associated limited access to market and services are among the main causes of poverty and regional inequality. Myanmar need to take out as soon as possible for improving the quality of the transport infrastructure and services for the both private and public sector and need to reduce the economic and social costs of transportation.

Myanmar is one of the members of Union International Railway (UIC). The mission of UIC is to promote the development of rail transport at world level, in order to meet challenges of mobility and sustainable development. And UN also set a vision in transportation sector in order to enhance energy efficiency and reduce air pollution. Railway transportation has lowest level of Carbon Dioxide (CO2) emission compared to other transportations (cars, ships and airplanes).

Better transport is essential to Myanmar's development. After decades of underinvestment, Myanmar's transport infrastructure lags behind other regional countries. Sixty percent of trunk highways and most of the railways need maintenance or rehabilitation

Therefore by using the train, air pollution was minimizes and also large capacity train can be long by adding wagon or carriage and will have a huge capacity; it is possible to handle a large amount of freight transportation and also passengers to one place to another. To get a developed economy, have a safe and low cost transformation for commodities to one economic zone to another and all across the

country and to promote socio-economic development in poor areas, provision for transportation infrastructure should be accelerated to improve the conditions of the poor.

1.2 Objective of the Study

The objectives of the study are to examine the railway transport performance in Myanmar and to analyse the railway transportation development in Myanmar.

1.3 Method of Study

The method of study is descriptive method and secondary data from Ministry of Transportation and Communication, World Bank and Asian Development Bank.

1.4 Scope and Limitation of the Study

The study examined only for Railway Transport sector in Myanmar with secondary data and the study is limited to period 1990 to 2016.

1.5 Organization of the Study

The study is organized into five chapters. Following this introduction Chapter One is rationale of the study, objective, scope and limitation, method and organization of the study. Chapter Two is the Literature review, consists of the importance of infrastructure in transportation and empirical literature review in others countries. Chapter Three is Overview of Railway transportation in Myanmar including historical background of Myanmar railway and Myanma railway overview on assets and staff, Railways' objectives, organization and Railways' Information system. Chapter Four have Railway Performance and Productivity in Myanmar; there were Train Performance, Productivity, Myanma Railway's Management Performance and Financial Performance of Myanma Railway. Chapter Five is the Last Chapter, have findings, conclusion and suggestion of the Thesis.

Chapter II
Literature Review

Economic growth has always been dependents on increasing the capacity and rationality of transport. Transportation has been playing a vital role in the society since the beginning of human history. Transportation can be defined as the movement of people and goods from one location to another, and it is performed by various modes, such as air, rail, road, water, cable, pipeline and space. It covers wide range of tangible and intangible ones, which include infrastructure, vehicle and operations.

Transportation of goods and passengers on rail lines through trains is called rail transport. It occupies an important place in land transport system of country and is the most dependable mode of transport to carry goods and passengers over a long distance. Besides long distance, local transport of passengers is also provided by local trains or metro-rail in some metropolitan cities. Rail transport is available throughout the country except some hilly or mountainous regions. Two types of trains are found, one is passenger train and other is goods train. While passenger trains carry both human beings and a limited quantity of goods, the goods trains are exclusively used for carrying goods from one place to another. These trains are driven by rail engines and they use steam, diesel or electric power to move.

2.1 The Importance of Railways Infrastructure in Transportation

Transport infrastructure is one of the most important factors for a country's progress. One cannot over emphasize the importance of transportation than call it the 'lifeline' of a nation. It has been proven by so many instances how transport infrastructure has added speed and efficiency to a country's progress. Good physical connectivity in the urban and rural areas is essential for economic growth.

The countries high-density rail corridors face severe capacity constraints. There is a definite need for capacity enhancement, up gradation, and creation of new passenger and freight corridors. Other issues plaguing the rail transport are the

differential speeds of trains, inadequate connectivity to ports and mines, inability to carry longer and heavier trains and lower throughput and longer turn-around period. It becomes imperative to locate power-efficient technology in Railway systems that will help tackle this problem as well as ecological concerns.

Railways provides the cheapest and most convenient mode of passenger transport both for long distance and suburban traffic. It has played a significant role in development and growth of industries. It helps in supplying raw materials and other facilities to the factory sites and finished goods to the market. Agriculture also owes its growth to railways to a great extent. Now farmers can sell their agricultural produce to distant places and even sell them in the world market at remunerative prices. Railways is also helpful in removing isolation between cities and countryside and have played a significant role in disseminating innovations and new ideas.

Railways is particularly suited to long distance journey and provide a strong medium of national integration. Railways play a vital role in mitigating the sufferings of the people in the event of natural calamities like droughts, floods, famines, earthquakes, etc. These are done by carrying relief and rescue teams and essential items to the affected areas and save people from sufferings and starvation.

Railways also help in facing man-made calamities like social, political, religious disturbances, insurgency, etc. It facilitates easy movement of police, troops, defence equipment, etc. The importance of railways to save the country's freedom and integrity from external aggression has been proved at several occasions. Railways are specially suited to long haulage of bulky materials like coal, petroleum and ores.

Railways is a safe land transport system when compared to other forms of transport. Railway transport is capable of high levels of passenger and cargo utilization and energy efficiency, but is often less flexible and more capital-intensive than road transport, when lower traffic levels are considered.

A large number of problems include late running of trains, lack of passenger facilities including cleanliness at the railway stations, lack of security arrangement on the railways resulting in theft and dacoities, etc. Political pressure and interference is a very big problem which the Myanma Railways is facing with increasing impact. Several projects which are not economically viable have been initiated for political considerations. Some strategies need for development of transportation. For increasing the role of transportation in sustainable development, need to use some strategies for increasing sustainability.

2.1.1 Some Strategies for Transportation Development

An overall transportation strategy includes short-term and long-term goals and initiatives across more than just the logistics department. A sound strategy takes into account inventory planning, vendor compliance, partner collaboration, leveraging the entire transportation network, customer demand, and fully landed product cost, among others.

Since the transportation system come to acquit human needs, the Performance of it should be careful in order to meet these needs, so it should not discriminate between humans and between generations, and great efforts should be done in social justice, with considering of facilities such as policy making in areas receiving costs, service levels, and etc. Sustainable in the transportation sector can help lower median income part of the community to satisfy their transport needs. Expansion of infrastructure in this sector can create new and more employment opportunities and thus the unemployment levels in the community will be reduced. Changes in consumption patterns and habits and social structures of society can affect transport easily.

For increasing the role of transportation in sustainable development, need to use some strategies for increasing sustainability. These strategies include promoting public transportation, demand management, improving road management, pricing policies, vehicle technology improvement, using clean fuels, cultural enhancement, and transportation planning.

Although, there is still no single definition for sustainable transportation to achieve sustainable transportation require knowledge of the effects of transportation on economy, environment, and society. It is clear that transportation is unsustainable, because there are several reasons for this. The principals are

a) the limited nature of petroleum reserves,
b) the excessive number of fatalities and injuries due to motor vehicles,
c) urban sprawl
d) the negative impacts of petroleum-based emissions on air quality, of less importance , but certainly not insignificant,
e) traffic congestion, bordering on gridlock in many cities which are problems related to noise pollution, structural damage due to vibration from motor vehicles, water pollution attributable to runoff from streets and highways, the

loss of wetlands, open spaces, and historic facilities, ocean pollution due to oil spills and secondary impacts (Black, 1997).

Economy and transportation are two members of a body that they can't separate from each other. With careful planning and suitable foresight can increase the economic progress, and impact favourable effects on the economy of community. Transportation and economic factors interact easily with each other; the transport sector is an important component of the economy impacting on development and the welfare of populations.

When transportation systems are efficient, they provide social and economic opportunities and benefits that result in positive multipliers effects such as better accessibility to markets, employment and additional investments. When transportation systems are incomplete in terms of capacity or reliability, they can have an economic cost such as decreased or missed opportunities. Efficient transportation reduces costs, while inefficient transportation increases costs. Transportation also carries an important social and environmental load, which cannot be neglected.

Some strategic decision of Railways was delays, such as what kind of train should be bought and when will it be bought. Thus, this limited the performance and improvement of Railways. Changing Technology can be a huge threat for the railway transport. The rapid improvement in the world of technology might be a disaster for some railway companies are short of capital to follow up the trend of technology. Slowing down of improvement will pay some price to the environment (pollution) and customer (uncomfortable). The technology use by MR’s is still falling behind other country railway system.

Therefore, it is important for them to improve it as soon as possible before it irritates the consumer. Competition in urban areas, there are many other mode of public transport such as taxi and busses. It is a huge competition to stay on top of the others. While in long distance travel competitors such as airlines and busses can be found too. Therefore, in order for MR to have a lead against others, it is important to improve their services in every aspect and also to improve their current technology. Private Transport Since the government is promoting their local made cars.

2.1.2 Performance Measurement

Measuring is a management tool which facilitates and supports efficient and effective decision making. In and of itself, it does not determine performance, but it can facilitate good management.

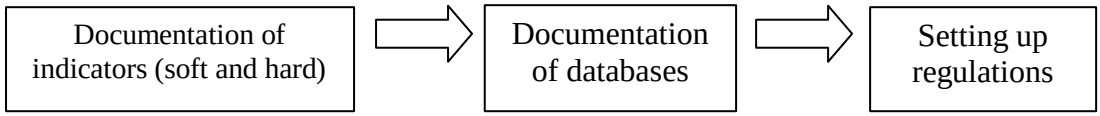
Organizations use indicators in some form or another to measure their performance. The most common indicators are financial; many of these are mandatory by law. Other indicators are technical, organizational, HSE (health safety and environment), etc. There are few agreements on how to categorize indicators. It is up to each organization to decide which standards or frameworks to use. Well known standards for maintenance key performance indicators (KPIs) are the European Standards EN 15341 and SMRP (Society for Maintenance & Reliability Professionals) Best practice metrics. Use of standardized indicators or metrics, such as the indicators from the standard EN 15341 or the SMRP metrics, has the following advantages:

a) Maintenance managers can rely on a single set of standardized indicators supported by a glossary of terms and definitions
b) The use of standardized indicators makes it easier to compare maintenance and reliability performance across borders
c) When a company wants to construct a set of company indicators or scorecard, the development process based on standardized indicators is simplified
d) The standardized indicators can be incorporated in various enterprise resource planning (ERP) systems and reports
e) The standardized indicators can be adopted and/or modified to fit the company's or the branch's special specific requirements
f) The need for discussion and debate on indicator definitions is not required and uncertainties are thus eliminated

Organizations' performance measurement system often grows from the need to measure different processes, thus, the number of databases and indicators grows over time. Some indicators stay while others become obsolete or disappear, but at some point, the amount of information is too large and becomes uncontrollable. The performance measurement system needs to be organized or reorganized, databases and indicators must be documented, regulations set, gaps must be identified, the performance measurement system must be aligned to the business goals and the owners of databases and indicators must be clear.

See Figure 2.1, for high level requirements (HLRs) for organizing a measurement system. Supportive guidelines for asset management in railways can be found in a work by Union International Railways (UIC), as a seven-step procedure based on the following standards and manuals: PAS 55, the asset management standard by British Standards Institute; the International Infrastructure Management Manual (IIMM) by New Zealand Asset Management Steering (NAMS) Group; and the Asset Management Overview by the US Highway Agency.

Figure (2.1): High level requirements for organizing or reorganizing a Performance Measurement system (PM-system)



1. Indicators in use	1. Defining databases	1. Usage of databases and indicators
2. Defining indicators	2. Quality of data	2. Registration of indicator
3. Indicators for benchmarking	3. Usability	3.Ownership
4. Defining scorecards		

Source: SMRP, "SMRP Best Practice Metrics, 2011

It is not possible to measure everything with only quantitative or qualitative methods. Rather a combination of both methods must be used to create a measurement system that is as complete as possible. Qualitative measurement methods are good for measuring soft values, like employee satisfaction, and for checking conformity with quantitative indicators.

2.1.3 The Challenges of Railway Transport

Five challenges facing railways that can help alleviate:

i. Maintenance & Reliability: as more and more passengers use railways, and 24/7 services become increasingly popular, delays and malfunctions on these networks may also increase. Reliable cable protection, serves to reduce the risk of any damage to cables, and the consequent damages associated.

ii. Innovation & New products: as demand for the railways increases, so too does the demand for new technologies and innovative solutions; maximizing efficiency and security, whilst ensuring trains not only run on time, but they run with grace and speed.

iii. Associated Costs: keeping costs down, particularly for the end user, is important for any industry and, although it has no control over many costs associated with the rail industry - such as the rising price of fuel - what we do have control over is keeping any unforeseen damages and malfunctions which may occur due to damaged or broken cables to a minimum, which will in turn lower these costs.

iv. Durability: as demand for freight and passenger trains increases, so too does the physical demand on the railway lines themselves; increasing the need for durable cable protection that can withstand the physical strains of repeated use. All of the products are tested beyond industry standard to ensure that, however high the demand, our applications protect those cables time and time again.

v. Withstanding Extreme Conditions: with the possibilities, capacities, and capabilities of the world's railways so often challenged, so too are the environments these railways can endure; the Gothard Base Tunnel being a perfect example of this. Extreme and interchangeable conditions call for versatile protection that can easily withstand a multitude of extreme temperatures.

2.1.4 Advantages and Disadvantages of Railways Transport

There are certain advantages and disadvantages of railway transport. The Advantages of Railway Transport are as follows:

a. Safety**:**

Transportation by the means of railway ensures safety for the desired goods because unlike the road transports a train only stops at a desired station instead of the will of the driver. In case of road transports for example, the drivers can at any point of time decide to rest or stop for tea, refreshments, lunch or dinner.

b. Cheap:

Railway transport any day is cheaper as compared to air transport. As a matter of fact, railway transport is even cheaper than road transport because of the reason that goods in bulk quantities are carried from a desired destination to the other. In cases of road transport for instance, less goods as compared to road transport can be carried.

c. Increases Employment:

Railway transport helps people to carry cheap products from a place to another and sell them at high prices. As a result of this, a number of people who are unemployed find a source of their daily bread.

d. Bulk Quantity:

Because railway transportation is cheaper as compared to air and road transport, goods can be carried in bulk quantities as a result of which a lot of time is saved.

e. Public Welfare**:**

It is the largest public undertaking in the country. Railways perform many public utility services. Their charges are based on 'charge what the traffic can bear' principle which helps the poor. In fact, it is national necessity.

f. Administrative Facilities of Government:

Railways provide administrative facilities to the Government. The defense forces and the public servants drive their mobility primarily from the railways.

g. Better Organized:

The rail transport is better organized than any other form of transport. It has fixed routes and schedules. Its service is more certain, uniform and regular as compared to other modes of transport.

h. Employment Opportunities:

The railways provide greater employment opportunities for both skilled and unskilled labor. Over 16 lakh persons are depending upon railways for their livelihood.

Other Advantages:

1) People are able to stretch their legs or walk along the carriage corridor.
2) When the kids start getting bored or irritated, are you able to keep them busy with board games, cards, other games.
3) It's good for the whole family. Grandparents, adults, kids – the whole bunch can travel by train.
4) Sleeping is much more comfortable, with various trains providing blankets and pillows when travelling long distance. Check out the night trains in the European Fast and Furious article.

It is true that as compared to air transport and road transport, rail transport is easier and cheaper but still it has a few disadvantages.

2.1.5 The Disadvantages of Rail Transport are as Follows:

Although railway transport has many advantages, it suffers from certain serious limitations:

a. Loss of Goods*:*

Because goods in bulk quantities are carried chances of goods getting lost are high in case of railway transport as compared to air and road transport.

b. Unsafe for Fragile Items***:***

Railway transportation is particularly unsafe for carrying fragile items like glass because these items can easily break at times when a train halts unexpectedly of when the train is speeding up at times.

c. Late Bookings**:**

Because railway is the cheapest medium of transport, it is hard to find suitable bookings for the transportation of your goods. Railway transport is not suitable in cases of emergency.

d. Unsuitable for Short Distances*:*

Railway transport is unsuitable for carrying goods at shorter distances; road transport is most suitable in this case.

e. Unsuitable for Rural Areas:

Proper railway system is not build up in the Indian villages as a result of which railway transport is unsuitable in the villages of India. Whatever be the disadvantages of railway transport it was, it is and it will always be the safest and the best means for the transportation of goods.

f. Centralized Administration:

Being the public utility service railways has monopoly position and as such there is centralized administration. Local authorities fail to meet the personal requirements of the people as compared to roadways.

g. Slower:

Travelling by train can take longer. Travelling by plane is often considered the fastest way. (Still, some European trains offer you the travel options that take you across Europe faster than a plane)

h. Public Toilets:

Toilets, bathrooms and other public areas on trains can often be dirty or non-functional.

2.2 Empirical Literature Review on Others Countries' Railways Situation

Almost 10,000 billion freight ton-kilometres are travelled around the world. Roughly one quarter of these are travelled in the United States, another quarter in China, and a third in Russia. Of the 3,000bn passenger-kilometres travelled across the world, 1,346bn of these are travelled solely in China. The average Swiss person travels 2,430 km by train each year, almost 500 more than the average Japanese person (the Japanese having the second-highest average kilometres travelled per passenger in the world).

In 2014 there were around 1 million kilometres of railway in the world (a decrease of 3% compared to 2013). Of this, 350,000 km were in Europe and mainly used for passenger service, 370,000 km were in North America and mainly used for freight, and 230,000 km were in Asia and used for both freight and passenger service. In America and Europe, there are many low cost airlines and motorways which compete with rail for passenger traffic, while Asia has seen a large growth in high-speed rail with 257bn p/km representing 72% of total world high-speed rail passenger traffic.

Cambodia has 612 km (380 mi) of 1,000 mm (3 ft 3 $^{3}/_{8}$ in) meter gauge rail network, consisting of two lines originally constructed during the time when the country was part of French Indochina. Due to neglect and damage from civil war during the latter half of the 20th century, the railways were in a dilapidated state and all services had been suspended by 2009. By 2016, freight and limited passenger service was available between Phnom Penh and Sihanouk Ville.

The first railways in Vietnam were established in the 1880s, with construction beginning in 1888. The railway system in Vietnam is owned and operated by the state-owned Vietnam Railways . The principal route, the single track North-South Railway running between Hanoi and Ho Chi Minh City, accounts for 1,726 km (1,072 mi) of the network's total length of 2,600 km (1,600 mi). The national railway network uses mainly meter gauge, although there are several standard gauge and mixed gauge lines in the North of the country.

Bangladesh Railway also known as Bangla Rail is the state owned rail transport agency of Bangladesh. It operates and maintains all railways in the country, and is overseen by the Directorate General of Bangladesh Railway. The Bangladesh Railway is governed by the Ministry of Railways and the Bangladesh Railway

Authority. The Bangladesh Railway system has a total length of 2,855 route km. In 2009, Bangladesh Railway had 34,168 employees. In 2014, Bangladesh Railway carried 65 million passengers and 2.52 million tons of freight. The railway made 8,135 million passenger-kilometres and 677 million tons- kilometres.

Indian Railways is the world's eighth largest employer, with more than 1.308 million employees as of March 2018. As of March 2017, IR's rolling stock consisted of 277,987 freight wagons, 70,937 passenger coaches and 11,452 locomotives. IR owns locomotive and coach-production facilities at several locations in India. It is one of the busiest networks in the world, transporting 8.107 billion passengers and over 1.108 billion tons of freight annually, as of 2017.

Rail transport in Sri Lanka was conceived in the 1850s to develop and unify Sri Lanka. Service began in 1864, with the construction of the Main Line from Colombo to Ambepussa 54 km (34 mi) to the east. During the first half of the 20th century a tram system operated in Colombo, carrying commuters within the city. It is an intercity network connecting major population centres and commuter rail serving Colombo commuters, with most services being run by Sri Lanka Railways, originally known as Ceylon Government Railways, as the nation's railway and primary operator. The railway now moves 300,000 passengers daily on 324 trains between 320 stations across the country. At a peak of 1,900 meters (6,200 ft), Sri Lanka has the most elevated broad-gauge railway in the world.

Laos has no railways but it has one train station at Thanaleng, 4 km north of the Laos-Thailand border. This station has a service from Bangkok by Thai Railways. It’s 20 km east of Vientiane, so as yet there is no Bangkok to Vientiane train service. There is a plan to extend the line to Vientiane, along with a more ambitious plan to build a railway from Vientiane north to the China border, which would form part of the Kunming-Singapore railway line. The railway will start at Boten, and then pass through Luang Prabang and Vang Vieng. This is expected to be completed by 2021. Laos is a country in Asia, which possesses a number of modern transportation systems, including several highways and a number of airports. As a landlocked country, Laos possesses no ports or harbours on the sea, and the difficulty of navigation on the Mekong means that this is also not a significant transport route.

Rail transport in Malaysia comprises heavy rail (including commuter rail), light rapid transit (LRT), mass rapid transit (MRT), monorail, airport rail link and a funicular railway line. A heavy rail is mostly used for intercity passenger and freight

transport as well as some urban public transport, while rapid transits are used for intra-city urban public transport. There are two airport rail link services linking Kuala Lumpur with the Kuala Lumpur International Airport and Subang Airport. The sole monorail line in the country is also used for public transport in Kuala Lumpur, while the only funicular railway line is in Penang. The railway network covers most of the 11 states in Peninsular Malaysia. In East Malaysia, only the state of Sabah has railways. The network is also connected to the Thai railway 1,000 mm (3 ft 3 3⁄8 in) networks in the north. If the Burma Railway is rebuilt, services to Myanmar, India, and China could be initiated.

Chapter III

Overview of Railway Transportation in Myanmar

3.1 Historical Background of Myanmar Railway

The history of Myanmar Railways dates back to the colonial era of Burma. The idea of introducing a Railway transport system in Myanmar germinated in the year 1880. The British rulers planned a railway route between Phitsanoluk in northern Thailand (erstwhile Kingdom of Siam) and Moulmein in Burma. Unfortunately, the idea ended in fiasco for dearth of funds for the project.

The first railway in Myanmar was opened in 1877. That line had 263 km railway line ran between Yangon and Pyay. It was operated by a private company, The Irrawaddy Valley State Railway Company.

The next train line in Myanmar opened in 1884, running 267 km between Yangon and Tuangoo. Again this railway line was built by another new private company, The Sittang Valley State Railway Company. That line was extended to Mandalay in 1889 forming the back bone of the Myanmar's railway infrastructure.

Once the line from Yangon to Mandalay had been completed, branch lines started to be constructed connecting Shwebo in 1891, Katha in 1895, and Myitkyina in 1898. These branch lines were initially run by a third private company, The Mu Valley State Railway Company.

These three pioneering private companies were short lived, and in 1896 they were nationalized and the track and trains were transferred into the ownership of the state run Burma Railway Company which built more branch lines and finally reaching the sea in 1907.

After the First World War, a line was built between Mawlamying and Ye, at the northern end of the Mergui Archipelago. Burma's last major rail line, from Thazi on the Rangoon-Mandalay line to Kalaw was built between 1914 and 1918. In 1928, the Burma Railway Company was dissolved; the railways were brought directly under government operation and renamed Burma Railways. With return on capital declining, Burma Railways became the country's single largest debt item when the

financial separation of India and Burma took place in 1937. The company's coal and rolling stock were imported from India or Britain.

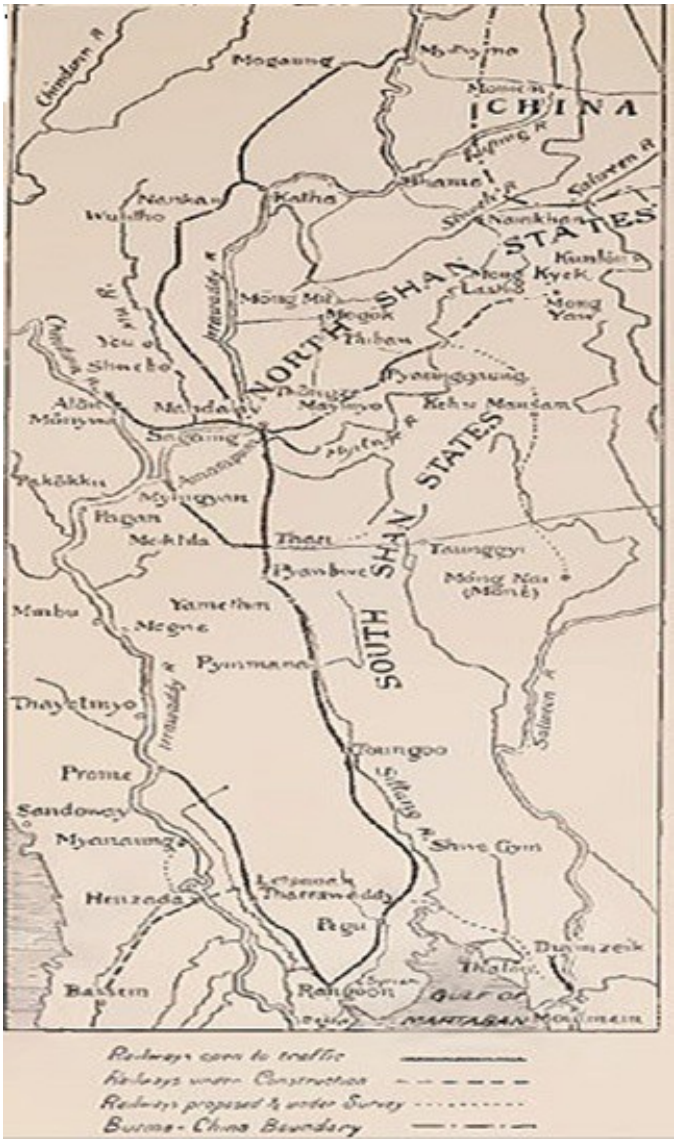
In early 1939, when the Japanese forces gained control over entire South East Asia, they took initiative for building the railway link. Their sole intention was to use the railway as supply line for transporting army and war equipments to the Burmese front with the secret motive of invading India. However, work continued simultaneously at both ends -Thanbyuzyat in Burma and Nong Pladuk in Thailand. Alongside, with the death of poor distressed workers.

During 1942-43, they employed about 60000 people for the job. Alongside, the Burmese Government sent bands of 'Sweat Army' of laborers, originally draftees, to lend hands to construction work. According to a horrifying statistics, around 100,000 Asian laborers perished like worms. During 1942-45 more than 13000 POWs died. However, there was not any end to misery. Consequently, hordes of emaciated plantation workers, mostly of Tamil origin, made a beeline for job at the railway construction sites.

World War II damaged Myanmar’s Railway Network. This golden age of Myanmar’s railway construction came to an abrupt end in 1942 with the invasion by Japanese military forces. The Japanese removed around 500 km of existing track to build railways lines, most notably from Burma to Thailand, rendering about 70% of the existing railway network unusable. See Figure (3.1) is rail network in 1900s.

Post War reconstruction of Myanmar Railways**.** The Japanese military had seriously damaged Burma’s infrastructure, and this in turn led to hardship which some believe fuelled the independence movement in Burma, which gained freedom from British rule in 1948. The new Myanmar authorities then set about rebuilding the country’s rail infrastructure and by 1961 the railway network consisted of 3,020 km of track, nearly the same as had been in place before 1942 (3,313 km).

Figure (3.1): The Burmese Rail Network in 1900s



Source: Internet, History of Myanma railways

The next large phase of railway construction came after the installation of a new the State Law and Order Restoration Council in 1988. Myanmar's new government rulers were real railway enthusiasts, and increased the length of track from 3,162 km in 1988 to 5,068 km in 2000, and the number of train stations from 487 to over 800. In essence over a 12 year period the Myanmar authorities doubled the size of the country's railways infrastructure.

Table (3.1): Improvements for Railways Line (1988-1998)

Sr. No.	Date of Operations	Line (km)	Route	Notes
1	1988	36.3	Thaton-Myaingalay	New
2	1989	34.6	Dabeyin-HleLawin	New
3	1990	21.8	Mandalay Circular Railway modernization	-
4	1992	60.3	Shwenyaung-Yauksauk	-
5		99.8	Tada Oo-Myingyan Lines	including a line to Mandalay International Airport
6	1993	164	Aungban-Loi-kaw	in Kayah State
7	1993	23.4	ChaungOo-Tawkyaungyi	part of the 406.3-km ChaungOo-Pakokku-Kalaymyo line
8		54	Minywa-Pakokku	-
9	1994	11.8	Tada-U-Mandalay International Airport	New
10		55.7	Pakokku-Myaing-Myozoe	-
11	1995	44.2	Myozoe-Zipyar	-
12		44.3	Namsang-MoeNe'	the first section of the eastern extension of the Thazi-Shwenyaung
13		17.2	Dawei-Yephu	part of the 177-kilometre Mawlamyaing-Ye-Dawei line
14	1996	110.8	Gangaw-Natchaung	-
15		11.7	Myitkyina-Nantpaung-Airport	-
16		54.3	Taunggyi-Phamon-Banyin	-
17		145.4	Pyay-Aunglan-Satthwa	an alternative line to Bagan
18	1997	33.5	Shwenyaung-Taunggyi	-
19		141.6	Kaloggyi-Yephu	part of the 177-km Mawlamyaing-Ye-Dawei line
20		83.8	Taungdwingyi-Magwe	-
21		25.7	Ye Oo-KhinOo	-
22	1998	162.22	Ye -Dawei	Line Begins with construction

Source: Myanma Railways

The Table (3.1) showed the improvements for railways line from 1988 to 1998. It including new line, extension and line begin with construction from old line since after World War II.

In 2003, Okkphosu-Thilawa-Deep sea Port line was opened 14.8 km (9Mile). The bridge over the Ye River on the Ye-Dawei line opens on 26 November. In 2004, Hsinbyushin-Chindwin River section of Mandalay-to-Pakokku line was opened with 1.5 km (1 mile). At the same year, the Yangon-Mandalay line is modernized and double-tracked. The Ye-Dawei line opens at 2005. In 2006, the Than win Bridge and Mawlamyine railway station opened, connecting the line on the southern bank of the Thanlwin River with the rest of the country. Construction of the 483-km (300-mile) Kyangin-Pakokku line begins.

The Pyinmana-Myohaung section of the Yangon-Mandalay line is double-tracked in November, 2007 to serve the country's new capital, Naypyidaw. In 2008, Katha-Bhamo line was began constructions of the 153 km (95 mile) on 1st January. Construction of the 63-km (39 mile) Kyangin-Okshippin section of the 515-km (320 mile) Kyangin-Pakokku line begins on 1st March, and construction of the 205km (128-mile) Dawei-Myeik line begins on 6th December. And then Pyawbwe-Phayangarsu section of the Yangon-Taunggyi line (via Thasi) with the 26 km (16mile) opens on 1st December. The 211 km (131 mile) Dawei-Myeik, 375 km (233mile) Namsam-kengtungand, 152 km (94 mile) Pyawbwe-Natmauk-Magway lines were opened in 2009.

In 2010, Katha-Moetagyi section line was opened 27 km (17 mile) on 16th May and Kwan Taung-Ponnagyun-Yotayouk section, project of Minbu- Ann-Sittwe line, was opened 37 km (23 mile) 15th May. Yotayouk-Kyauk Taw section of Minbu-Ann-Sittwe line opened 31 km (19mile) and Pathein(Begayet)-Einme section of Pathein-Einme-Nyaung Htong-Yangon(Hlaingthayar) line opened 33km (21 mile) in 2011. Yawdaw-Natmauk section 35.42 km (57 mile) was opened in 2013 and Moeagyi-Chaungwa-Kyaukkyi 32 km (20 mile) section of Katha-Bamaw line was opened in 2014 and Yangon (Hlaingthayar)-Nyaung Htong-Saekug-Salon line was also opened in that year.

Table (3.2) is showed the improving of railway miles, route miles, railway stations and bridges for railway infrastructure of Myanma Railways from 1988 to 2017. Although total rail miles were 2793.86 miles in 1988-1989, total rail miles 4939 miles were increase in 2016-2017. In 2016-2017 route miles and station were more

increased than 1988-1989. Bridges were 5650 Nos in 1988-1989 and then they were increased 12099 Nos in 2016-2017. By the table, railway infrastructures are improved than previous years.

Table (3.2): Improvement of Railway Infrastructures (1988-2017)

Particulars	1988-89	2002-2003	2016-2017
Rail Miles	2793.86	3897.29	4939
Route Miles	1976.35	2989.12	3798
Stations	487	768	960
Bridges (Nos)	5650	9056	12099

Source: Myanma Railways

Below the figure (3.2) is showed the railway network in Myanmar at 2017. So many improvements of railways line than The Burmese rail network in 1900.

The State Law and Order Restoration Council took over state power on 18th September 1988 and following the change of the Socialist Republic of the Union of Burma to the Union of Myanmar. The name Burma Railways Corporation was changed to Myanma Railways on 1st April, 1989. (Hereinafter referred to as “MR”) The name Union of Myanmar was changed to the Republic of the Union of Myanmar on 30th March 2011, the name of Myanma Railways was not changed.

Figure (3.2): Myanmar Railway Network (2017)

Source: Myanma Railways

3.2 Myanma Railways Overview on Railways Assets

Railways assets were measured how to develop tracks per line, routes per kilometre within one year, condition of signals and telecommunications system and how many possess of Locomotives and rolling stock.

Myanma Railways' (MR) track, rolling stock, and signalling systems are outdated and in critical condition:

a) About half of locomotives, rolling stock, and coaches need to be replaced. Locomotives with high fuel consumption should be replaced or retired.
b) Most tracks were originally designed to very low axle bearing standards, and have not been renewed since. Ballast is absent in many sections. At least 30% of bridges need major repair or replacement.
c) Signalling systems are over 60 years old.

These constraints severely limit MR's efficiency and service quality:

i. limiting operational speed and causing frequent delays and accidents,
ii. limiting line capacity and freight quantity, and
iii. requiring very high fuel consumption and other operational expenses.

MR has a very dedicated staff but is limited in its ability to attract skilled workers and managers onto train them in-house. This is because MR offers low wages and has limited training resources.

MR's capacity to address these challenges is limited by its status as a state-owned enterprise and its complex organizational structure. Myanma Railway also has old fashioned technology. MR's data collection is entirely paper-based. Ticketing, freight way billing, and train recording are not computerized. There are no electronic systems to exchange train information from station to station. All operating and financial data are collected and compiled manually. There are no management information systems (MIS) and no centralized asset databases. Manual compilation of data is tedious, and the lack of automation restricts MR Managers' ability to access timely information and to share information easily.

Myanma Railways runs an impressive number of services, but it is forced to limit speed and cannot ensure on-time performance. MR maximizes the use of its main tracks despite the poor quality of its assets. However, systematic track and rolling stock failures force MR to halve potential speed and constrain reliability to 60% on average. Train derailments and other accidents are very frequent. The accident rate is about 50 times that of a modern rail system. Track condition is a lead

issue. MR's asset productivity is very low. MR's assets are generally underutilized; they must be rehabilitated before they can be used more productively. Staff productivity is low, and there may be scope for downsizing. Compounding the operational constraints, most of MR's network has little traffic and, in many cases, little potential market. Network rationalization would improve productivity.

3.2.1 Tracks

Myanma Railways (MR) has 6,112 route km in 2016(3,798 route miles), of which 705 km (438 miles) are double-tracked between Yangon and Mandalay. About 50% of the routes were constructed during 1988–2010, and another 116 route miles were added since 2011. The total length of tracks (including yards and stations) is 7,948 km (4,939 miles).

Tracks have an axle load capacity of 12.5 tons, which restricts wagon loading (and is not consistent with neighbouring countries that are reconstructing their networks to allow axle loads of 15–20 tons).MR is developing plans to increase axle load capacity to 20 tons to be consistent with other countries in the Greater Mekong Subregion (GMS). MR has been progressively upgrading its rail from 60 pounds to 75 pounds and replacing wooden sleepers with concrete sleepers produced in plants constructed under build–operate–transfer (BOT) arrangements with MR. As of 2014, about 50% of sleepers are concrete.

MR spent about $1,650 per track kilometre on maintenance in FY2014. This is very low by international comparison, which reflects the low standards used by MR. But this should be viewed with caution as track maintenance requirements are a function of the extent of mechanization, traffic volume (gross tonnage), train speed, and geographic conditions.

3.2.2 Signals and Telecommunications

MR's signalling and train control systems are old and life-expired. In some locations, the equipment is over 60 years old. Some of MR's train control systems still utilize electric tubes**.** Some upgrading (conversion to solid state relays and automatic block signalling) has occurred on the Yangon Circular Railway (YCR) and on the Yangon–Mandalay route, utilizing the fibre-optic cable that has been installed along the line. However, the condition of relays, wires, and points is poor throughout the

system; as a result, manual block control is often necessary. There are no computerized control systems.

Telecommunications on the Yangon–Mandalay route has also improved with the installation of a fibre-optic cable. However, these improvements have not yet been extended to other parts of the network that still rely on very high frequency (VHF) radio for train-to-station communications.

3.2.3 Locomotives and Rolling Stock

Much of MR's rolling stock is old and needs replacement or upgrade. The problems are described in the following paragraphs.

The locomotives and rolling stock are old, 56% of diesel locomotives are over 30 years old, 74% of hydraulic locomotives are over 30 years old, 48% of wagons are over 40 years old and 30% of coaches are over 30 years old. Old locomotive units and rail buses breakdown frequently: on average, there are 325 failures per year, or almost 1 failure per day. The overall availability of rolling stock is less than 70%.Because of the age of the units, parts are difficult to obtain as they may no longer be in stock or available. Old locomotives are not fuel-efficient and contribute to MR's increasingly high fuel usage .Old wagons and coaches are basically worn out, and most are unsuitable for rehabilitation.

MR has assessed some options to address the problem of old locomotives, including

a) repowering 30 locomotives (with new engines and modern control systems),
b) purchasing new locomotive units, and
c) developing a plant to manufacture diesel multiple unit (DMU) in Myanmar.

Non standardization of rolling stock requires MR to stock a multiplicity of parts for maintenance and repair. It also affects the scheduling of periodic repair.

i. Locomotives are a mix of Chinese, French, and Indian units.
ii. MR operates four different types of diesel locomotives and five different types of hydraulic locomotives.
iii. There are four different coach bogie types and eight different wagon bogie types.
iv. MR uses two different coupler systems; the systems are incompatible, and as a result trains must be composed based on coupler systems.

3.2.4 Myanma Railways' Information System

MR's data collection is entirely paper-based. Ticketing, freight way billing, and train recording are not computerized. There are no electronic systems to exchange train information from station to station. All operating and financial data are collected and compiled manually. There are no management information systems (MIS) and no centralized asset databases.

Manual compilation of data is tedious, and the lack of automation restricts MR Managers' ability to access timely information and to share information easily.

3.3 Myanma Railways' Objective, Organization and Staff

Myanmar Railway's main objective is passenger to provide safe and smooth transport of goods to support the comprehensive development of the Country. At the same time, human and financial resources driven efficient and the most effective use of the Market to competition in accordance with the economic policy conditions, passengers can compete commercially transporting goods too adequately and effectively for the organization to become a set goal (11) and implemented.

Eleven objectives of Myanma Railways are as follows:

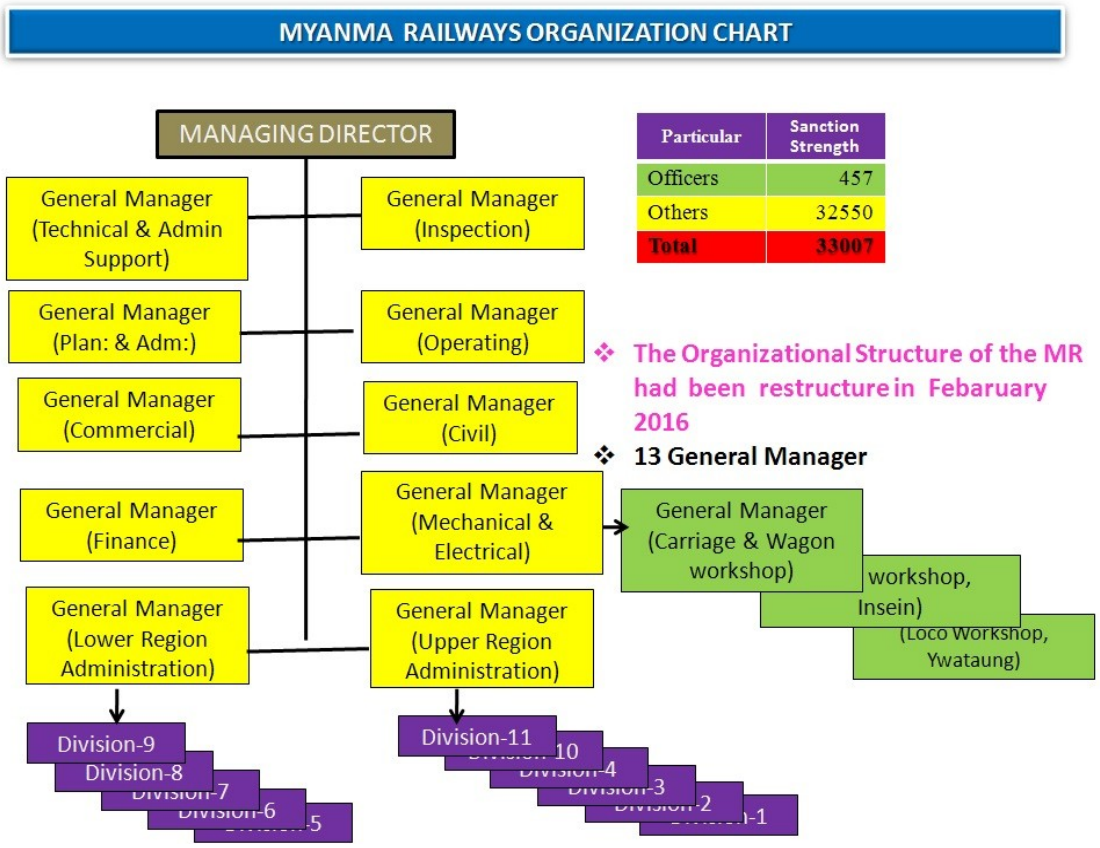
1) To ensure convenience for all passenger and to bring satisfaction to freighters.
2) To keep the number of accidents at a minimum and to ensure total prevention of accidents.
3) To have all trains running on time.
4) To have all railways tracks constructed to require specification and standard in order that they will with stand the stress and strain of constant traffic.
5) To increase income and to keep expensive to a minimum.
6) To promote efficiency in the management of existing staff , facilities and system.
7) To run all railways yards and workshop to fill capacity.
8) To keep locomotive and rolling stocks breakdown to a minimum.
9) To boost the invention and production of machine, accessories and spare parts.
10) To never lose sight of staff privilege and welfare.
11) To eradicate all forms of malpractice.

MR is a state-owned enterprise, not a corporation. Therefore, it takes instructions from the government and is not held to any performance objectives like corporation (or corporatized state-owned company).

Railways that are state-owned enterprises often lose sight of the overall objective of a railway, which is to transport passengers and move freight for customers. Instead, the primary objectives often become meeting government directives and delivering railway inputs, such as track maintenance or equipment repair.

MR's organizational structure is organized by function rather than by line of business. It has possibly too many layers of management. Overall, managers (officers) comprise less than 1.6% of overall staff, but there are also deputy general managers and assistant general managers. As not all officers are trained managers, this structure is particularly bureaucratic and unresponsive in practice.

Figure (3.3): Myanma Railways Organization Chart



Source: Head of Administration, Myanma Railways

MR has One Managing Director and Thirteen General Manager. This organisational structure had been restructuring in February 2016(see in Figure 3.3). The management system is divided into (11) divisions which are grouped into two

regions; these are Lower Region and Upper Region. These regions are managed by two General Manager, lower region includes division 5,6,7,8,9 and upper region includes Division 1,2,3,4,10,11. Three General Manager are also managed major workshops of Myanma railways, these workshop are Myitnge Carriages and wagon workshop, Innsein Locomotives workshop and Ywahtaung Locomotives workshop. Railways officers are average 450 staff and other staffs are over 32000 staff in Myanma Railways.

Chapter IV

Railway Performance and Productivity in Myanmar

In a service industry such as transportation, the performance measurement process starts by defining precisely the services that the organization promises to provide, including the quality or level of service (e.g. timeliness, reliability, etc.) that is to be delivered.

The official measure of punctuality used up till now, known as the public performance measure (PPM), considers trains to be punctual if they are five or 10 minutes after schedule, for short and long-distance trains are respectively, at their destination.

Performance indicators are developed to support infrastructure managers in decision making, Performance indicators for railway infrastructure, with primary focus on the railway track, have been mapped and compared with indicators of European Standards. The listed indicators can be applied to form a performance measurement system for railway infrastructure. Other countries are also indicating for railways performance by railways infrastructure, maintenance, operation, capacity and management and performance measurement. For example, Indian Railways performance indicator has freight and Passenger, development, technology, operating ratio.

Myanma Railways runs an impressive number of services, but it is forced to limit speed and cannot ensure on-time performance. MR maximizes the use of its main tracks despite the poor quality of its assets. However, systematic track and rolling stock failures force MR to halve potential speed and constrain reliability to 60% on average.

Train derailments and other accidents are very frequent. The accident rate is about 50 times that of a modern rail system. Track condition is a lead issue. MR's asset productivity is very low. MR's assets are generally underutilized; they must be rehabilitated before they can be used more productively. Staff productivity is low, and there may be scope for downsizing. Compounding the operational constraints, most of

MR's network has little traffic and, in many cases, little potential market. Network rationalization would improve productivity.

MR revenues cover only half of MR's costs. MR has been making operational deficits since 2006.It is estimated that MR's passenger revenues cover only 66% of operational costs excluding infrastructure (37% of full costs). MR loses money each time it runs a passenger train; with the exception of some express trains. To the contrary, freight revenues cover 120% of operational costs excluding infrastructure (65% of total costs).

There are three main income sources in Myanma Railways; passenger, freight and other incomes earned from out of track business. And Myanma Railways performance indicator has train performance: freight and passenger trains, management performance, financial performance, government investment and productivity.

4.1 Train Performance of Myanma Railways

Myanma Railway operated an average of 419 trains per day in 2017 and 443 trains per day in 2013 which is consistent with its operations since 2009. The intercity passenger trains are 198 in 2013 and 180 trains in 2017. Myanma Railways runs an impressive number of services, but it is forced to limit speed and cannot ensure on-time performance. These trains are operated with outdated train control systems, signalling equipment, and rolling stock. And operating trains per day were decreased in 2017 than 2013. Because of the automobile policy was changed in 2012 and YRTA (Yangon Region Transport Authority) was also changed in 2016. And road transport is more improved than previous year 2013. The numbers of trains by type and daily trains runs are as following Table (4.1).

Table shows that three main types of trains; intercity passenger train, Yangon Circular (suburban) trains and freight trains. In intercity passenger train type, the numbers of express trains are 42 in 2013 and 38 in 2017, the numbers of mail and others are 66 in 2013 and 62 in 2017, the numbers of mixed trains are 62 in 2013 and 56 in 2013 and the numbers of rail bus are 28 in 2013 and 24 in 2017 run per day. And then the numbers of Yangon Circular (suburban) trains are 215 in 2013 and 220 in 2017 per day. Freight Trains are run 30 in 2013 and 19 trains in 2017 per day. Daily trains runs are decreasing in 2017 comparatively with 2013. But Yangon

Circular Railways (YCR) runs are a little increased in 2017. Because operated trains were improved facilities and routes were better than 2013 in YCR.

Table (4.1): Myanma Railways Daily Train Runs in 2013 and 2017

Train Type	No. of Trains per day in 2013 March	No. of Trains per day in 2017 March
Express	42	38
Mail and Others	66	62
Mixed	62	56
Rail Bus	28	24
Intercity Passenger	**198**	**180**
Yangon Circular (Suburban)	215	220
Freight	30	19
Total	**443**	**419**

Source: Myanma Railways (2017).

4.1.1 Yangon Circular Railway

MR operates 220 trains daily on the 29-mile Yangon Circular Railway (YCR) that provides commuter service to Yangon's suburban areas. Services are poor quality and unreliable, especially in the rainy season where tracks may be flooded. Trains are crowded and the average speed is only 10 miles per hour (mph) due to track congestion. The YCR route which takes about three hours to complete its way to see across to section of life in Yangon. The YCR is the cheapest method of transportation in Yangon. Trains are conventional, e.g., locomotives pulling coaches (with the exception of the rail buses acquired in 2015).

4.1.2 Passenger Trains

All passenger trains run with regular schedule. Express trains run from Yangon to Mandalay, Naypyitaw, Pyay, Bagan and Mawlamyaing and from Mandalay to Myitkyina and Bagan. MR also operates express trains in two isolated lines of Pathein-Kyangin and Mawlamyaing-Ye lines. A train on the Yangon to Mandalay route typically comprises eight to nine ordinary coaches, two to five upper coaches, plus a brake van. Sleepers are added on overnight services. On average, there

are 90 persons per coach in ordinary class on the Yangon–Mandalay and Mandalay–Myitkyina trains.

Sometime, replacement cannot be done for the damaged coaches and so the reservation is available for express trains and for upper class of mail trains. Although some express train tickets are sold as reserved, extra tickets than seats have to be issued on demand. Therefore, some express, mail and local trains are usually overcrowded.

Table (4.2): Number of Intercity Trains Operated by Myanma Railways (2017)

Route	Express	Mail	Local	Rail Bus	Total
Yangon-Mandalay	6	4	8	8	26
Yangon-Naypyitaw	4	-	-	-	4
Mandalay-Myitkyina	8	4	12	-	24
Yangon-Bagan-Pakokku	4	2	-	2	8
Pathein-Hinthada-Kyangin	-	10	4	-	14
Bagan-Mandalay	2	-	-	-	2
Yangon-Mawlammyine-Dawei	8	2	4	-	14
Others	6	34	34	14	88
Total	38	56	62	24	180

Note: Not all trains operate the full length of the route.
Source: Myanma Railways (2017).

MR operated 180 intercity passenger trains per day in 2017. Intercity trains are both conventional and rail buses. As noted earlier, intercity passenger train fares are cheaper than highway buses, but slower and much less comfortable (Table 4.2). Many local trains are operated as mixed train carrying a few freight wagons in main and branch lines. Table (4.2) indicates that total type of trains run in each route. 26 total trains run in Yangon-Mandalay route with 6 express trains, 4 mail trains, 8 local trains and 8 rail buses. In Yangon-Naypyitaw route has only express

trains run 4 trains. In Patnein-Hinthada-Kyangin route not have express trains only mail and local train. Totally local trains are run more than others type of train.

The average speed of intercity trains is low, and travel by train generally takes much longer than by bus (Table 4.3). The main exception is the link between Mandalay and Myitkyina, where roads are not well developed. The low speed is due to the track condition and to the practice of many nonexpress services stopping at many, if not all, stations. Table shows the average speed of passenger trains in main corridors; express trains is take 14.5 hours with average speed 42 kph and mail trains is take 25 hours with average speed 24 kph for 383 mileages at Yangon- Mandalay route.

Table (4.3): Average Speed of Passenger Trains in Main Corridors

Train	Type	Mileage	Hours	Average Speed (kph)	Sanction Speed (kph)
Yangon- Mandalay	Express	383	14.5	42	68
	Mail	-	25.0	24	-
Mandalay-Myitkyina	Express	340	19.0	29	40
	Mail	-	26.5	21	-
	Local	-	30.0	18	-

kph = kilometres per hour.
Source: Myanma Railways. (2017)

Poor punctuality is another issue. The reasons for poor punctuality vary according to the train operation, but generally they are attributable to

a) locomotive failures,
b) brake failures,
c) track caution orders,
d) wagon (wheel) failures,
e) delays at crossings,
f) delays at stations due to signalling failures, and on the congested Mandalay-Myitkyina section, a delayed train delays all other trains.

In general, about 60% of MR intercity trains' arrival time and departure time schedule are shown in (Table 4.4). MR has set a target of 80%. Many express trains meet it, but not the local trains and mail trains. Table show the on-time performance of trains as of 2013 to 2018. Up and down are the names of MR's intercity trains. Delay of train is significant for express trains travelling more than a short distance.

Table (4.4): On-Time Performance of Trains (as of 2013)

Train	Target (%)	Achievement (%)	Difference	Train	Target (%)	Achievement (%)	Difference
1 Up	70	61	-9	2 Dn	70	80	10
3 Up	80	19	-61	4 Dn	80	80	0
5 Up	80	19	-61	6 Dn	80	80	0
11 Up	80	64	-16	12 Dn	80	77	-3
33 Up	80	23	-57	34 Dn	80	7	-73
37 Up	80	24	-56	38 Dn	80	3	-77
55 Up	80	61	-19	56 Dn	80	32	-48
57 Up	80	13	-67	58 Dn	80	77	-3
119 Up	80	93	13	120 Dn	80	90	10
41 Up	70	22	-48	42 Dn	70	26	-44
47 Up	70	12	-58	48 Dn	70	4	-66
131 Up	70	93	23	132 Dn	70	90	20
135 Up	70	48	-22	135 Dn	70	35	-35
117 Up	70	97	27	117 Dn	70	93	23
123 Up	70	81	11	124 Dn	70	81	11
M-14	70	93	23	R-46	70	87	17
23 Up	70	93	23	24 Dn	70	90	20
115 Up	70	100	30	116 Dn	70	100	30

Dn = Down, Source: Myanma Railways (2017).

4.1.3 Freight Trains

MR freight trains are short (often less than 20 wagons) and transport 500–600 net tons of freight on average. On the Yangon–Mandalay and Mandalay–Myitkyina services, freight trains are usually powered by two locomotive units. Yangon–Mandalay express freight trains are about 1,200 gross tons. On most other routes, freight is carried in mixed passenger and freight trains, and trains are usually powered by one unit.

There are two kinds of freight trains, fast freight trains and ordinary freight trains on main route where most freight trains serve for medium and long distance. Only ordinary freight trains run in branch lines. Numbers of freight trains are decreasing as a result of shortages of the number of locomotives in service. Unit trains are operated for timber, rice, fuel, cement and ballast.

Freight traffic management is complicated by several problems:

a) a high system-wide empty return ratio (no backhaul on most of MR's shipments),
b) long train (and wagon or coach) turnaround due to low average train speed (average turnaround per wagon is 7.5 days),
c) low equipment availability,
d) different coupler systems, and
e) manual loading and unloading.

Train speed is constrained overall by the poor quality of train control and signalling systems and by the age of rolling stock. The speed of express trains is generally higher because there is no loading and unloading at stations, as is the case with ordinary and local freight trains.

Train speed on Mandalay–Myitkyina is severely restricted by physical track capacity. MR operates more than 30 trains (including passenger trains) per day on this section, which has a single track in poor condition (minimal ballast and poor platform) and no passing loops. Block signalling is also old (circa 1949) and unreliable.

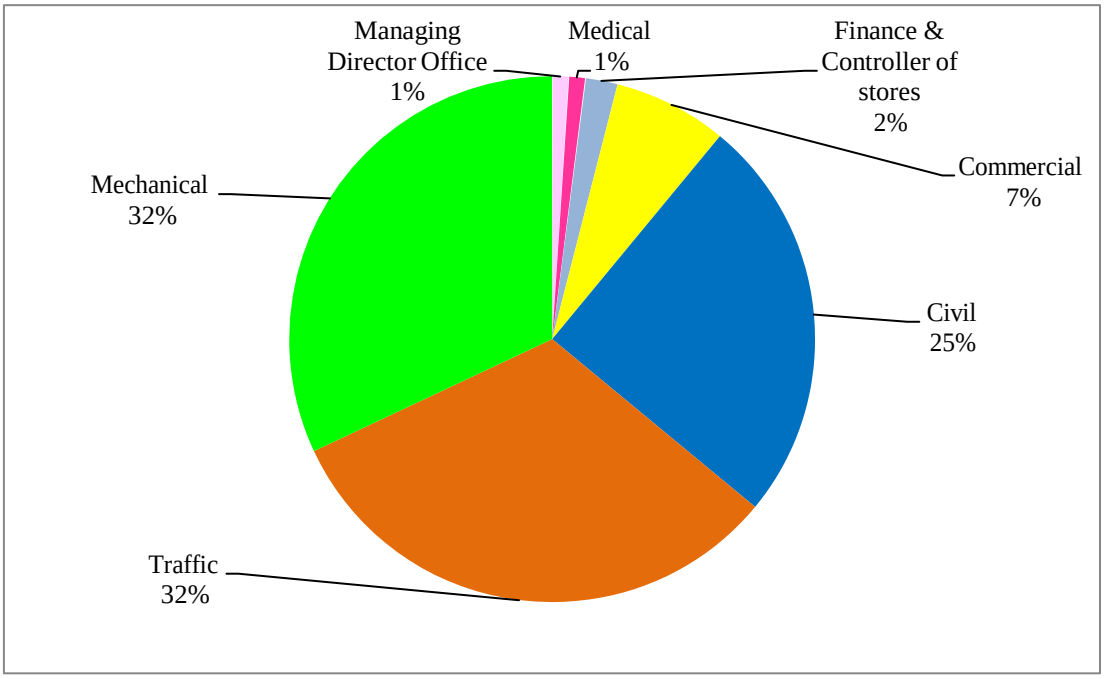
4.2 Myanma Railway's Management and Staff Performance

The government's excessive involvement in MR management hampers strategic and business management. The Ministry of Transport and Communications (Ministry of Railway Transportation until April 2016) is practically responsible for any budgeting, planning, procurement, staff, and services decision. During the year 2016 and 2017, deviations from previously approved budgets and plans require new approvals. This process stifles initiative and slows down decisions, not least because the ministry allocates few staff to meet this important responsibility. Also, in practice, political motivations have prevailed over business needs (e.g., to invest into new lines rather than maintain the trunk network).

MR management is complacent. MR Managers are accustomed to responding to the government's wishes and to being told what to do rather than managing the company and innovating. There has been a lack of management focus on building the railway business, which includes marketing, customer service, and introducing systems to aid in the management of assets and operations.

MR has over 20,000 staff. This is less than the sanctioned level of 32,000; but given the current traffic levels, MR employs more people than most railways of a comparable size. It may be possible with modernization of management systems, upgrading of rolling stock and equipment, and mechanization of track maintenance—to reduce the number of employees over time. However, given the large potential markets available to MR, it may not be necessary to reduce staff as long as productivity is improved (Figure 4.1).

Figure (4.1): Myanma Railways Employees by Department



Source: Myanma Railways (2016-2017)

Above the Figure (4.1) is showed the participation of employees by department in Myanma Railways. In Civil department have 25% of employees and Mechanical department being contain 32% of total employees of Myanma Railways. The employees of Traffic department have 32% and Commercial department have 7%. Others department are Managing Director office, Medical department and Finance and controller of store, these are 1% and 2% only involve of Myanma Railways department.

4.3 Financial Performance

The increasing level of expenditure is not sustainable. MR had a working ratio (i.e., cash costs excluding depreciation compared to cash revenues) of 140% in FY 2014. If computing depreciation at replacement value, it is operating ratio may be 180% or higher. Modern railways have much lower operating ratios (75%–100%). Freight revenues do not cover all capital costs, but are close to covering all above rail costs, so that a private operator may be able to invest (Table 4.5).

Table (4.5): Analysis of Freight Cost Coverage Ratio, FY2014 (MK per ton-km)

Items	All costs	Above Rail Costs
Fixed Costs	6.8	0
Variable Costs	24.9	24.9
Capital Costs	14.9	10.4
Total Costs	**46.6**	**35.3**
Average revenues	30.5	30.5
Revenues in % of direct costs (fixed + variable)	96	122
Revenues in % of total costs	65	86

Source: Asian Development Bank (2014).

Table (4.6): Analysis of Passenger Cost Coverage Ratio, FY2014 (MK per ton-km)

Items	All costs	Above Rail Costs
Fixed Costs	4.4	0
Variable Costs	14.5	14.5
Capital Costs	7.3	4.6
Total Costs	**26.2**	**19.1**
Average revenues	9.7	9.7
Revenues in % of direct costs	51	67
Revenues in % of total costs	37	51

Source: Asian Development Bank (2014).

Freight revenues do not cover all capital costs. Freight revenues do not cover all capital costs, but are close to covering all above rail costs, so that a private operator may be able to invest.

In contrast, passenger services only cover 67% of their direct above rail costs, and only 37% of total costs (Table 4.6).

Raising fares price and tariffs cannot help reduce MR's high operating ratio. MR has little scope to increase tariffs and fares, given the large increases since 2010–2011 and MR's lack of competitiveness with buses and trucks.

The focus will need to be on

a) rationalizing services,
b) significantly reducing operating expenses and
c) eliminating financial burdens.

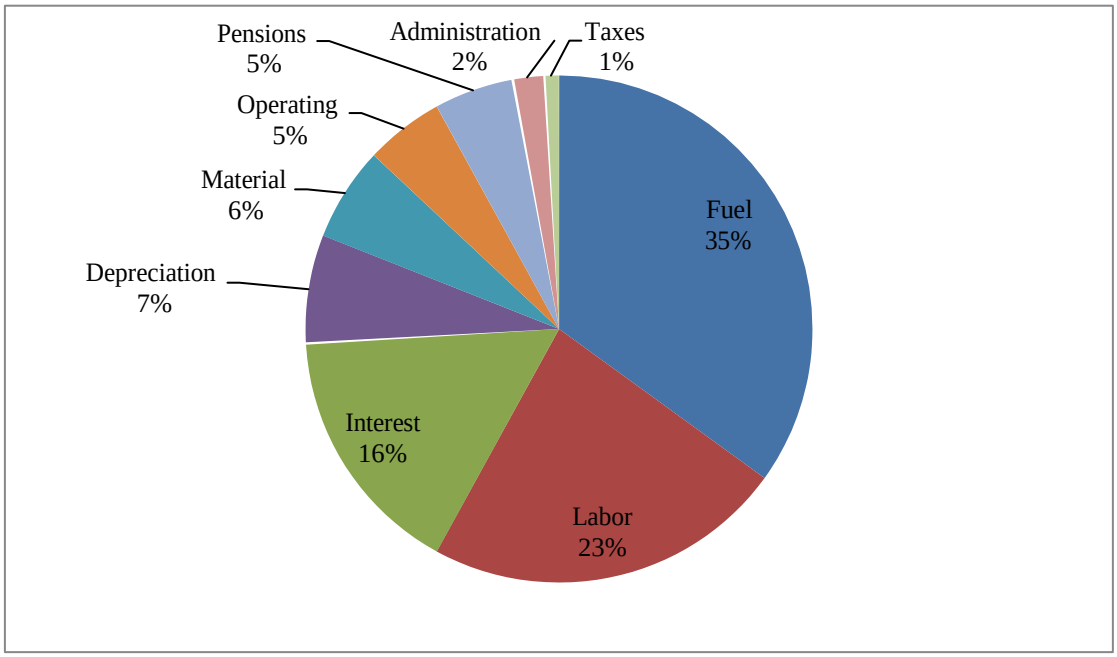
About 40% of MR's costs is attributable to fuel and materials used by the Mechanical Department. Replacing or repowering many of MR's old (and not fuel-efficient) locomotives and standardization of rolling stock could significantly reduce operating costs. Similarly, MR incurs significant expenses to keep old wagons and coaches in running order.

MR operates many light density lines and services. As noted in the section on productivity, 64% of MR's route network (tertiary and quaternary lines) generates only 13% of MR's traffic. Cost reductions could be achieved by reducing or stopping services on part of these lines. Beyond this, a detailed analysis shows that express trains cover about their direct operating costs, but that mail and local trains cover just half of them. MR could rationalize its supply considering the extent to which each service covers direct operating costs.

Below the Figure (4.2) and (4.3) are shown cost reductions could also be achieved by eliminating MR's responsibility for historic pensions for the provision of medical, and welfare services to employees. These two items account for MK12 billion or 11% of MR's operating expenses in FY 2013. A part of welfare costs is reportedly bonuses paid to staff on a standard basis, which should be considered as salaries and unlikely to lead to cost reductions. Figure (4.2) is showed Myanma Railways expenses by category in 2013-2014. Fuel expenses are more than other category. Figure (4.3) is also showed Myanma Railways Expenses by Department in 2013-2014. Mechanical department is most expense than others. Because MR incurs

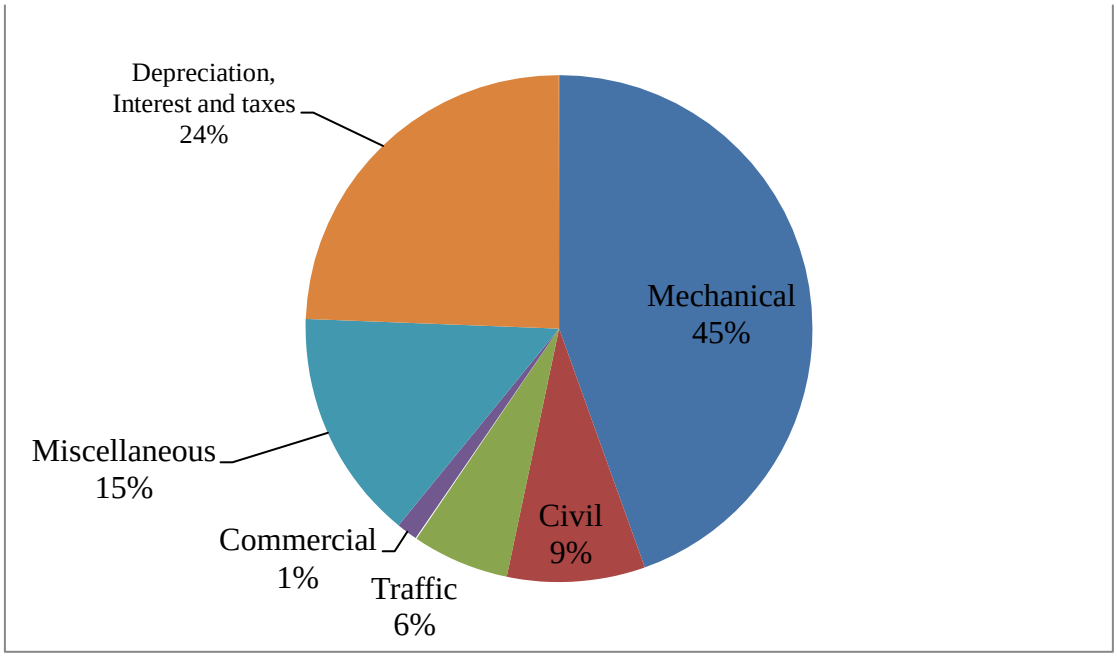
significant expenses to keep old wagons and coaches in running order. Maintenance cost is many others.

Figure (4.2): Myanma Railways Expenses by Category, (2013-2014)



Source: Myanma Railways (2013-2014)

Figure (4.3): Myanma Railways Expenses by Department, (2013-2014)



Source: Myanma Railways (2013-2014)

4.4 Productivity

The classic productivity definition is “a way to measure efficiency.” In an economic context, productivity is how to measure the output that comes from units of input. But what is productivity, and how do they calculate it in their daily lives? It’s easy to produce theories and examples based on abstract units of work or numbers of plants, but their life isn’t a managed supply chain. The productivity of transportation indicator has asset, infrastructure, transport service provider and the viability of every infrastructure project.

Another way to look at transportation productivity is to examine what users pay for transportation. This can be seen as an economic measure of the value of transportation. For passenger transportation, the unit of output is passenger-miles, and average revenue per passenger-mile is the measure of what travellers pay. For freight transportation, the unit of output is ton-miles, and average freight revenue per ton-mile is the measure of what freight shippers pay. For modes where users do not typically pay per use, like driving, complete data are difficult to obtain.

MR’s asset and staff productivity is low when compared to selected countries such as Bangladesh, Indonesia, Malaysia, Pakistan, Thailand and Vietnam. MR’s operating performance indicators for in comparison with other Southeast or South Asian countries see in Table (4.7).

Table shows that the selected countries of rail operating performance with benchmarks. MR’s performance indicators are lower than most other benchmarks, with the exception of the traffic units per locomotive. For instance, with a shorter network and about as many staff, Indonesia’s railways move 10 times more freight and 4 times as many passengers. Overall, MR physical assets (track and rolling stock) are underutilized, which means that there is extra capacity to handle additional passengers and freight. However, because of the condition of the assets, they must be rehabilitated or replaced if they are to be used more productively to handle higher traffic volumes.

Table (4.7): Selected Rail Operating Performance Benchmarks

Year of data	Myanmar	Bangladesh	Indonesia	Malaysia	Pakistan	Thailand	Viet Nam
	2014	2008	2008	2008	2008	2007	2008
Network operated (km)	**5,284**	2,835	4,815	1,665	7,791	4,429	2,347
Locomotives	**250**	285	495	92	555	271	319
Railcars	**79**	-	568	116	-	2,440	-
Coaches	**1,091**	1,416	1,576	359	1,868	1,509	1,060
Wagons	**2,673**	9,409	4,864	3,596	23,289	6,692	4,048
Staff (thousands)	**20**	35	26	5	87	18	34
Passengers (million)	**53**	54	198	39	80	45	11
Passenger-km (million)	**3,585**	5,609	18,511	1,527	24,731	8,037	4,139
Tons (million)	**2**	3	20	5	7	12	8
Net Tkm (million)	**676**	870	5,452	1,384	6,187	3,161	3,807
TU/route-km (million)	**1**	2	5	2	4	3	3
TU/staff (thousands)	**213**	184	940	542	357	625	231
TU/locomotive (million)	**17**	11	11	7	28	11	12
Pkm/car (million)	**3**	4	9	3	13	5	4
Tkm/wagon (million)	**253**	92	1,121	385	266	472	940
Av dist (passengers) km	**68**	104	94	39	309	178	374
Av dist (freight) (km)	**338**	265	279	265	855	266	467

Av dist = average distance,
km = kilometre, Pkm = passenger-kilometre, Tkm = ton-kilometre, TU = traffic unit.
Sources: Asian Development Bank estimates, based on Myanma Railways data and various sources.

Most of MR's network has little traffic. No line carries major traffic by international standards. About 68% of MR's traffic is carried on only 25% of the route network—the trunk lines or main corridors—while about 59% of the network carries just 14% of MR's traffic. This implies scope for rationalization of services to concentrate on serving key markets. The network can analyzed as comprising four sub-networks:

i. Trunk network (664 km). These are the YCR and Yangon–Mandalay lines, both of which are dual track. YCR has an average traffic density of about 10 million passengers annually, and Yangon–Mandalay an average traffic of

about 2 million units (counting one ton of freight as equal to one passenger). Only these lines would qualify as main lines according to the Union International Railways (UIC) classification.

ii. Secondary network (1,531 km). This includes the lines to Pyay, Mawlamyine, Myitkina, Magway and Chauk, and the Pathein–Hinthada line. Average traffic density is about one million traffic units annually, mostly passengers.

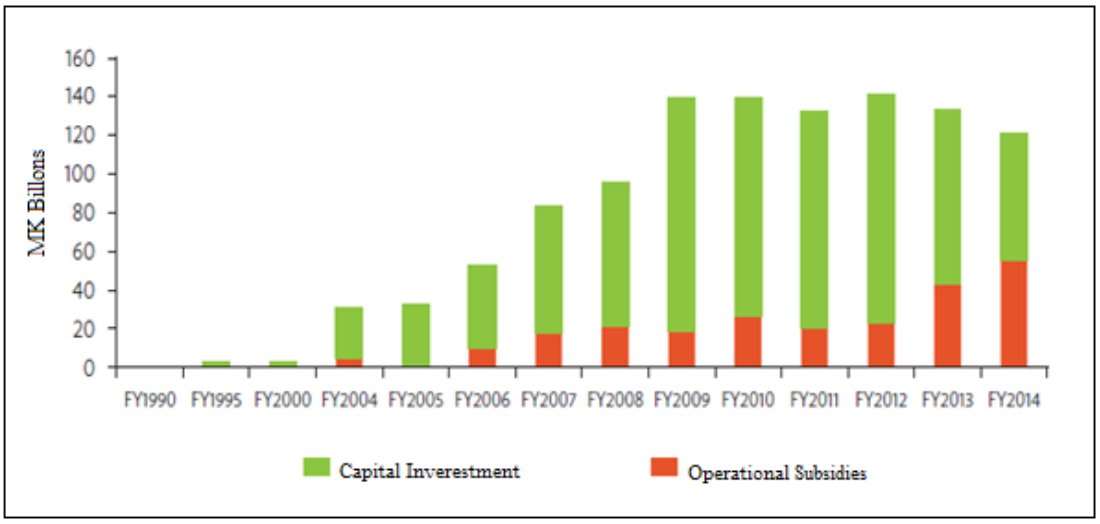
iii. Tertiary network (1,482 km). Traffic density is 200,000–400,000 passengers annually.

iv. Quaternary network (2,429 km). Traffic density is less than 200,000 passengers annually; for most of the lines constitutive of this network, traffic is even lower than 50,000 passengers annually. These lines are usually grouped with the tertiary network. These lines have been treated separately to highlight their very low contribution to MR's transport task.

4.5 Government Investments

The government's average annual investments reached $100 million during FY2008. However, 88% of investments have been for new railway lines (FY2009 data).The Myanmar government has invested more than MK800 billion ($800 million) into MR between 2009 and 2014. This includes MK186 billion in operational subsidies and MK620 billion in capital investments. The figure below shows the trend and extent of Myanmar's investment in its railway system (Figure 4.4).

Figure (4.4): Government Investments in Myanma Railways (MK Billons)



FY= fiscal year, Source: Myanma Railways (2014)

Almost 88% of capital investment in MR since FY2009 has been into track, a large share of which has been for the construction of new (mainly tertiary) lines. Although historically, capital investment in transport infrastructure has been only about 1% of GDP, roughly 30% of investment has been in railways, mostly in the construction of new railway lines. The size of MR's railway trackage has increased by almost 100% since 1988. There is no evidence that a serious feasibility study of the new lines was undertaken.

Investing in the construction of new trackage has led to the neglect and deterioration of other railway assets. Investment in other railway assets (track, rolling stock, equipment, signalling, and automation) has been negligible relative to the massive amounts invested in line construction.

As a result, MR's existing assets are in a poor state, which is now one of the major factors affecting MR's operational and financial performance. Further, MR has been tasked with operating these new lines (many of which are tertiary with low traffic density) without being given the financial capacity to operate them properly or to structure services consistent with demands.

4.6 Options for Improving Myanma Railways Performance

As the diagnosis and potential solutions show, there is a range of organizational and operating solutions to MR's problems. However, to reduce the constraints, change is necessary and decisions must be made in Table (4.8).

Table (4.8): Summary Diagnostic

Factor	Observations	Constraints
Competitiveness	MR has lost significant market share to the road sector in a short time span. MR passenger service is cheap but uncomfortable, unreliable, and slow. MR's share of the freight transport market is insignificant. MR does not operate container transport services	MR assets need significant upgrading if MR is to sustain its current market share and adequately serve future markets. MR has limited freedom to structure and price services. MR's organization is not market responsive and is focused on keeping the railway running.
Assets	Perhaps 50% of locomotive, rolling stock, and coaches need to be replaced. Locomotive, rolling stock, and maintenance facilities are outdated and poorly equipped. Track conditions are poor and a major cause of derailments and speed restrictions. Signalling and train control systems are 60 years old. Capacity bottle necks on Mandalay-Myitkyina are significant. There is no automation of information processing. Staff technical skills need to be upgraded.	Government has invested heavily in the construction of new lines, leaving little money to rehabilitate or upgrade existing physical assets or to upgrade human resources and management systems. Investment decisions will be complex, and MR lacks capacity in financial and
Operational Performance	Asset productivity is low. Train performance is restricted by the condition of the tracks and rolling stock and by unreliable signalling. MR operates many uneconomic services in the public interest.	Investment is lacking. There is no framework to rationalize services.
Financial Performance	Current working ratio is near 140%. Expenses are increasing faster than revenues. Freight recovers most of its costs, and its market share could be increased. Passenger services recover about 50% of direct costs and are not viable without restructuring.	There is little scope for increasing tariffs and fares. MR funds historic staff pensions. Locomotives are old and not fuel-efficient.

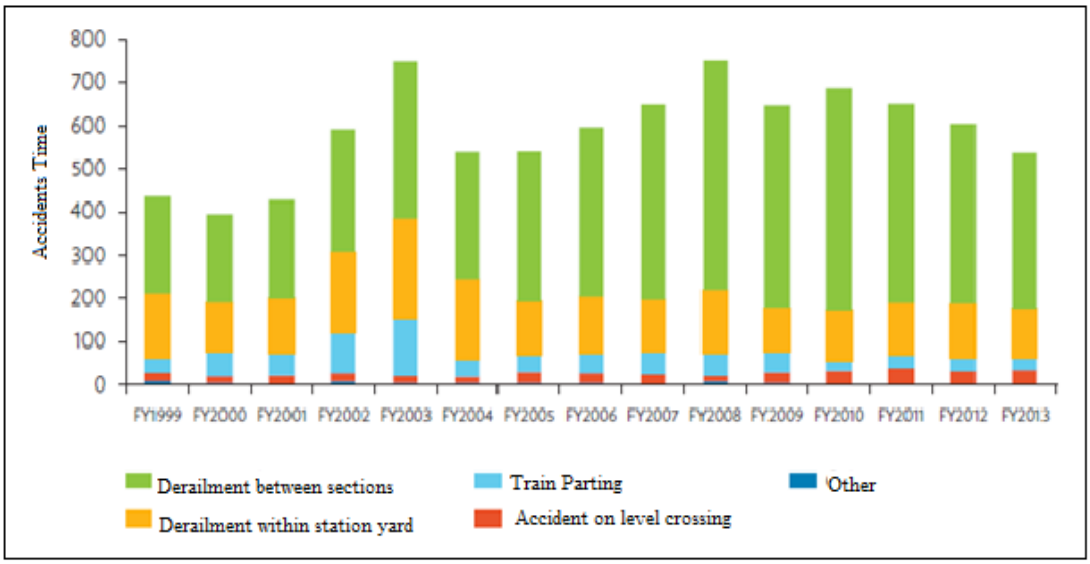
Source: Asian Development Bank

4.7 Safety

Transportation by the means of railway ensures safety for the desired goods because unlike the road transports a train only stops at a desired station instead of the will of the driver. MR has experienced a high number of derailments and other accidents over the years. MR's accident rate is 0.852 accidents per million traffic

units. This is about 50 times the level in modern railways. Most of these accidents are simple derailments in Figure (4.5), linked to poor track condition.

Figure (4.5): Number of Rail Accidents



FY=fiscal year
Source: Myanma Railways (2014)

Above the figure shows the number of accidents within FY 1999 and FY 2013. Derailment between sections is most accident than other accidents. In FY 2003 and FY 2008 had more accidents than other year because of flood, bad weather and disasters were cause accidents.

There is no central entity (office) within MR responsible for ensuring the safety of operations. MR operates according to a set of general rules that specify safety requirements and regulations, and MR trains staff on these rules periodically. Station masters manage safety at the station level, and the Mechanical Department inspects the trains prior to departure. Assistant permanent way inspectors, who routinely examine track for defects, manage safety on track sections.

The train controller manages track possession, and often radio communication (or paper authorization or manual unlocking) is required to ensure the protection of work gangs. Guards operate road crossings. Most crossing barriers are manually operated, except for some sections on the YCR.

Chapter V
Conclusion

Myanma Railways is facing big demand and lack of infrastructure and rolling stocks, the people will try to get very best for Myanma Railways to meet demand, and enhance the quality of the Rail Transport Service**,** with Modernization and Rationalization in the short future.

The Myanmar transport services market is expanding rapidly, but MR, the sole railway service provider is not in good shape to meet the demands. Twenty years ago, MR commanded a 44% share of the passenger market and 14% share of the freight market. As of 2015, its market share is only 10% for passengers and 1.5% for commercial freight. MR could disappear by 2025; hence critical decisions on MR's future should be made.

Future work will focus on the application of the evaluation of performance of current systems as well as the comparison and evaluation of system improvement approaches. This research provides a possible framework for optimizing railway system upgrading plans.

5.1 Findings

Railways transport is the largest in the government's transport performance. Myanma Railways runs an impressive number of services, but it is forced to limit speed and cannot ensure on-time performance. MR maximizes the use of its main tracks despite the poor quality of its assets. However, systematic track and rolling stock failures force MR to halve potential speed and constrain reliability to 60% on average.

Train derailments and other accidents are very frequent. The accident rate is about 50 times that of a modern rail system. Track condition is a lead issue. MR's asset productivity is very low. MR's assets are generally underutilized; they must be rehabilitated before they can be used more productively. Staff productivity is low, and

there may be scope for downsizing. Compounding the operational constraints, most of MR's network has little traffic and, in many cases, little potential market. Network rationalization would improve productivity.

MR revenues cover only half of MR's costs. MR has been making operational deficits since 2006.It is estimated that MR's passenger revenues cover only 66% of operational costs excluding infrastructure (37% of full costs). MR loses money each time it runs a passenger train, with the exception of some express trains. To the contrary, freight revenues cover 120% of operational costs excluding infrastructure (65% of total costs).

The government's average annual investments reached $100 million during FY2008. However, 88% of investments have been for new railway lines (FY2009 data).The Myanmar government has invested more than MK800 billion ($800 million) into MR between 2009 and 2014. This includes MK186 billion in operational subsidies and MK620 billion in capital investments.

MR is charged with being "all things to all people," and this is a difficult task. MR operates freight trains, mixed trains, intercity passenger trains, and commuter trains. It employs over 20,000 people directly (and even more indirectly). It maintains and operates a large rail network, and it must operate services even where such operations are not economically justified. It is required to operate and maintain many new railway lines without the financial and operating capacity to do so. It operates trains with non-standardized and aged rolling stock under the control of ancient signalling.

It is commendable that MR's staffs have managed to hold the railway together for so long, with most capital investment going to the construction of new lines. But despite this effort, MR is now at a crossroads. If the declining trend in the use of MR's services continues, MR risks becoming irrelevant in the freight transport market and losing more of its share of the passenger market. If service quality is not improved soon, fewer people will want to take the train regardless of cheap fares.

Low wages are a problem. The average salary of MR staff is about 70,000 kyats (MK) per month, plus an additional MK 30,000 per month contribution to employee welfare approximately $100 per month overall. These low levels of wages are not sufficient to attract skilled workers and managers (or even unskilled labor) within Myanmar's growing economy. Training and capacity development needs

attention. MR needs to modernize employee skills in all technical fields to operate and maintain new technology, rolling stock, and equipment.

5.2 Suggestion

There is now broad agreement that present trends in world transportation system are not sustainable. Many have concluded that fundamental changes in technology, operation, design, and financing are needed. In all societies, including developed and developing, regardless of their development in various fields, new technologies will have different negative consequences in long term. Concerns about environmental quality, social equity, economic vitality, and treatment of climate change due to increasing carbon dioxide (CO2) have converged to produce a growing interest in the alternative approach to sustainable development.

Development of sustainable is very important in every pattern especially in this century, so in the discussion of sustainable development is very important. Sustainable development at the transportation sector can be divided into three major sections: society, economy, and environment. Transportation sustainable development requires balancing to achieve the minimum expectations in these three sectors. For increasing the role of transportation in sustainable development, we need to use some strategies for increasing sustainability. These strategies include promoting public transportation, demand management, improving road management, pricing policies, vehicle technology improvement, using clean fuels, cultural enhancement, and transportation planning.

Only the revival strategy can ensure the long-term sustainability of the railways in Myanmar. It requires huge capital investment by government. Passenger traffic volumes are very high. Freight traffic is marginal.

Service quality improves due to redirection of investment into upgrading and replacing existing assets. Passenger and freight market shares stabilize with MR business units focusing on separate freight and passenger markets. Passenger volumes increase in Yangon–Mandalay corridor. Operating losses decrease as a result of rationalization, public service obligation (PSO) contract arrangements, better asset management and automation of activities, management performance targets, and increased revenue.

There are considerable opportunities for MR to thrive within a rapidly growing market for transport services. These opportunities are accessible to MR

provided that the government makes some changes in its railway policy. MR's problems, potential solutions, and operating constraints are summarized as follow:

Three reasonable policy scenarios could be adopted to address the performance of the railway sector.

1) Business as usual: Let MR continue to operate in largely the same fashion as it does today.
2) Extensive growth: A high growth scenario is one where MR continues to operate in the same manner as today (business-as-usual scenario), but with significant additional operational investment and subsidies to enable reduced fares and increase transport volume.
3) Revival: A "revival" scenario will require changes in the focus of investment and changes to MR governance and possibly to MR structure.

The MR market situation has suddenly deteriorated. In 2015, MR is operating in a very different market environment to that of 2005 or even 2010. Liberalization of vehicle imports is rapidly changing the transport market and these trends are likely to continue. Between 2009 and 2014, MR lost one-third of both its passenger and freight customers.

MR's revenues cover only about half its operational costs, which threatens even its medium-term sustainability. The market pricing of fuel has been a major shock to MR finances with many services now failing to cover even fuel costs, and annual operating subsidies are required. MR's shortage of funds will inevitably worsen the existing deferred maintenance backlog, with knock-off effects on train performance.

Restructuring of MR is a medium-term necessity. Any revival strategy will likely involve the following:

Better investments**:** Investment levels should be maintained but they should directed toward trunk line maintenance, rolling stock, signalling and information systems, and intermodal freight facilities—in effect ceasing further investments in tertiary lines and most secondary lines until the overall MR situation has improved.

Rationalizing assets and services: Lines and services will need to be scrutinized for their viability. Nonviable lines or services should be financed by the central government under public service obligations (PSOs), transferred to local governments, or abandoned.

Financial restructuring: This involves the government recapitalizing MR, taking over its debt—particularly pension liabilities—and potentially converting MR's land into equity.

New governance for the rail sector: MR should be fully separated from the government and given managerial autonomy. The government would need to create a new railway department, and eventually, a railway regulator. New management tools, such as a corporate plan with full government policy support, are also required.

Reorganizing Myanma Railways along commercial principles**:** MR should be corporatized and function as a commercial enterprise. Freight should be established as a separate business unit and separating infrastructure and services should be considered.

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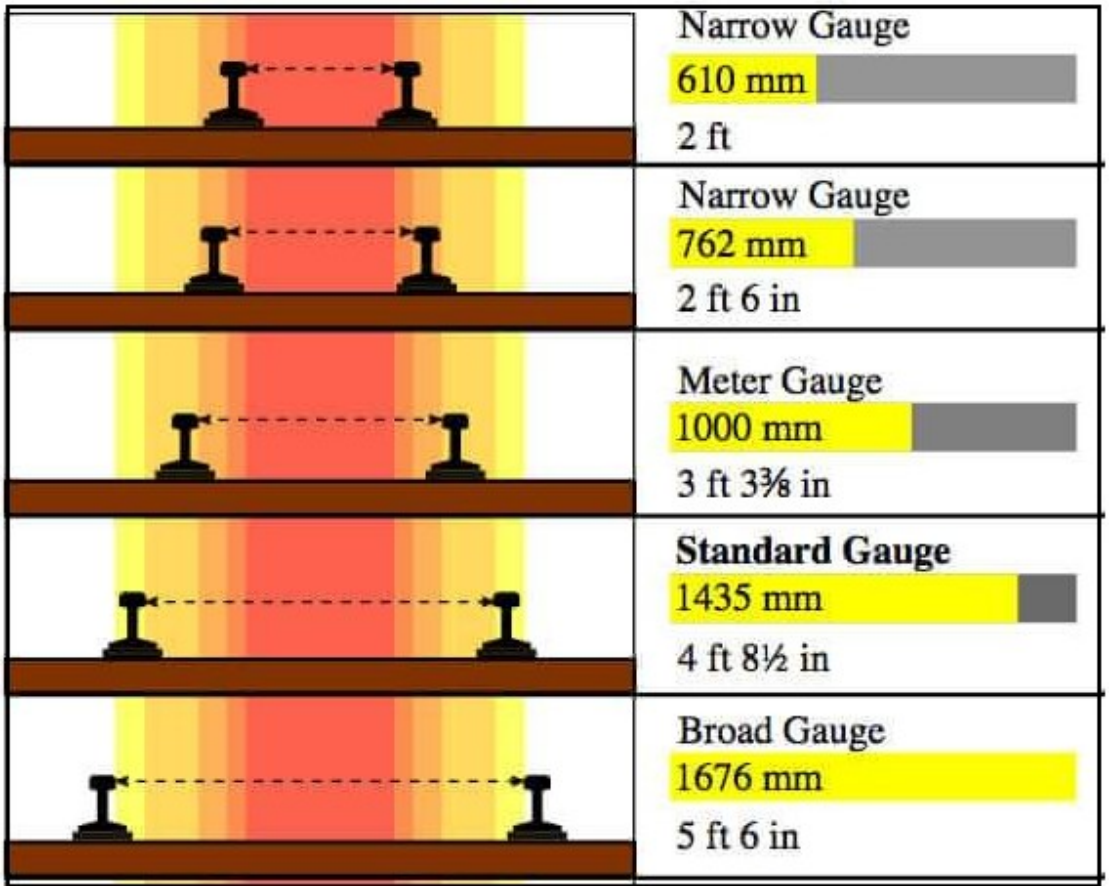
APPENDIX (A)

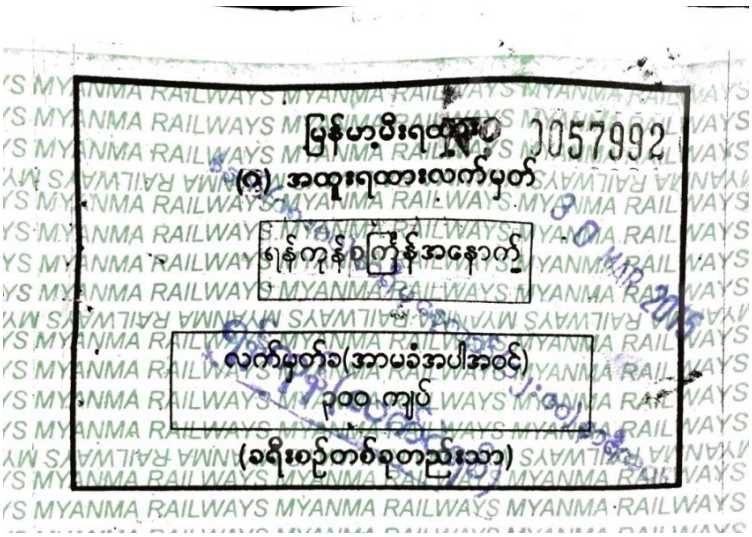
The Size of Gauge with Length



Source: Internet

APPENDIX (B)

Railway Tickets of Myanma Railways



Source: Myanma Railways

APPENDIX (C)

(a) Yangon Station Train Control Equipment

Photo by Paul Power (2014).

(b) Yangon Station Train Control Circuitry

(c) Condition of Relay Points

Photo by Paul Power (2014).