



**ADDIS ABABA UNIVERSITY INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING**

**STUDY ON INTEGRATION OF ETHIOPIAN RAILWAY NETWORK
WITH REGIONAL COUNTRIES (Especially with Djibouti)**

By
Amen Gudeta

A thesis submitted to the school of Graduate Studies of Addis Ababa
University in Partial fulfilment of the degree of Master of Science in
Civil Engineering

Advisor
Mr. Yusuf Ahmed
September, 2015

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Approved by Board of Examiners

Mr. Yusuf Ahmed

Thesis Advisor

Signature

Date

Internal Examiner

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Date

External Examiner

Signature

Date

Chairman

Signature

Date

DECLARATION

I hereby declare that the work which is being presented in this thesis entitled “**Study on Integration of Ethiopia Railway Network with Regional Countries (Especially with Djibouti)**” is original work of my own, has not been presented for a degree in any other university; and that all sources of material used for the thesis have been duly acknowledged.

Amen Gudeta
(Candidate)

Signature

Date

Submitted to: **Addis Ababa University Institute of Technology, Department of Civil and Environmental Engineering, 2015**

Abstract

Although great improvements have been made in the expansion of road network, the country still suffers from limited connectivity, high cost and poor quality of services. Railway transportation is needed in the achievement of effective development, is an efficient, cost-effective and it is environmental friendly transport system which will make the cost of exports more competitive and reduce those of imported goods. In addition to the low railway network connectivity in Ethiopia like other developing countries, the available one was not modern; has been low capacity and was insufficient to facilitate transit trade.

In this study an attempt was made to show the significant of the regional integration through railway infrastructures and operation, specifically the Ethiopia – Djibouti rail project. In addition, to assess the economic viability and cost and benefit Analysis, to evaluate the socio-Environment impact assessment and Risk analysis of the new proposed Addis Ababa/ Sebeta – Djibouti Railway with standard gauge. To achieve such objectives, the research deals with literature review; data collection on the National Railway Network of Ethiopia; analysis and Result of the A.A/ Sebeta – Djibouti Railway project; and finally Conclusions and Recommendations.

A.A/ Sebeta – Djibouti Railway project is 756km in length with 3 sections: Sebeta - Mieso (329.15km); Meiso – Dewele (344.85 km); and Dewele – Nagad (82 km). The first two sections are in the Ethiopian territory and the third is in Djibouti territory. This rail project is constructed with 15% local finance and 85% with foreign Loan. Total cost of the project is estimated at USD 4,037.35 million. The break-even would be achieved in 4 years of operation; which will become 8 years upon considering the 4 years construction period. In this regard, the economic and financial internal rate of returns was estimated at 19% and 20% respectively.

The Social and Environmental impact assessment is the main issue during the construction and operation of the project. Proper Policy, legislative and institutional frameworks are required for execution and implementation of the project. The adverse impacts of the project during construction and operations must be minimal, and can be mitigated through the use of best practices and appropriate technologies. Internal and external monitoring and audits will be conducted to ensure that standards and regulations are being followed. Furthermore, risk analysis should be considered before the construction to protect the project accidental risk. It should indicate possible solutions for expected challenges.

In General, the project uses 1435mm standard gauge; National Railway Class II of China and 120km/h design speed as the main proposed technical standards. This Project is the most important international railway transport corridor of Ethiopia and most important hinterland collection and distribution corridors. The Construction of the Project is premise as a great significance for improvement of the transport systems of Ethiopia and Djibouti.

Acknowledgement

First of all I would like to thank the almighty GOD for his unspeakable gift, help and protection during my work.

I would like to express my genuine gratitude and appreciation to Ato Yusuf Ahmed, whose encouragement, guidance and support from the initial to the final level; also for day to day follow-up for the completion of this thesis. Similarly, I want to thank Ato Raed Ali, instructor at Addis Ababa University for suggesting valuable comments to keep the research on track.

Furthermore, I am deeply grateful to Ato Kassa Tesfaye, Chief Project Manager of the Addis Ababa/Sebeta – Djibouti Railway Project, Ato Zelalem Asemu, Design Team Leader, and the staff of the Ethiopian Railway Corporation (Especially the Ethiopia - Djibouti Railway project staff) for providing me the necessary information for the input of this thesis work.

Lastly, I want to offer my regards and thanks to my Mother W/r Ashagerech G/Meskel for being with me throughout the master program.

Amen Gudeta

September, 2015 Addis Ababa, Ethiopia

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1. Introduction

1.1. Background

Ethiopia is one of the landlocked Countries in the African continent and shares its national borders with Sudan on the west, Kenya on the south , Somalia on the East, Djibouti on the North – east and Eritrea on the North; also the oldest country of the world which is found in Eastern Africa, known as the Horn of Africa. From Africa, the second most populated county with a population of over 84million. Some of the humanity’s oldest traces are found in Ethiopia making the area a primary factor in the origin and development history of humanity. The country is origin coffee and is currently famous for its Olympic distance athletes.

Ethiopia has a federal democratic government system with nine Regional States and two Municipal Administrations (Addis Ababa and Dire Dawa, under the auspices of the Federal government). The Federal Constitution empowers each Regional States with sufficient power to exercise local parliament system and ruling internal affairs consistent with the Federal Constitution. Regional States have three tiers of administration known as Zone, Wereda and Kebele in their hierarchical order. The government’s over-reaching goals are to further pursue the socio-economic policies to eliminate poverty and vulnerability, to raise the living standards of the people and promote rapid growth and development of the country.

Transportation structures are very important as significant drive for the growth of both economy and society. In addition these infrastructures play crucial roles in the effort to achieve the goals of poverty eradication and sustainable development. Universally it is also witnessed that both cargo volume and loads are going on increasing from year to year with alarming rate all over the world. Such growth demands better transportation means for efficient and reliable transport of commercial and industrial products without delay and also for better regional integration.

Developing countries should increasingly turn to regional integration in response to the challenge of globalization, which has undermined autonomous national development strategies. (ECA Documentary)

Railway Infrastructure development is an essential component of regional integration, through physical connectivity. A regional approach to infrastructure development can substantially reduce infrastructure costs through economies of scale especially in the energy sector. Therefore, the Regional Integration and Trade Division (RITD) of UNECA undertake policy research on the interactions between various ingredients of economic transformation, notably, infrastructure, industrialization, food security, agriculture, land, investment, and trade, in the context of regional integration. In addition to research and policy analysis that offers insights and options on the regional integration agenda, and recognizing that Africa’s industrial and

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infrastructure development requires a larger regional market and effective cooperation between nations, and in efforts to promote regional integration,(ECA Documentary).

Railway transportation is one of the important infrastructures that are needed in the achievement of effective development; and provides an efficient, cost-effective, less land use and environmental friendly transport system which can quickly haul large volumes of goods which are not easily transported through motor vehicles for long distances.

In developed countries, railway transportation is becoming a reliable and regular form of transport hauling bulk goods with high speed and certainty. In addition, train travel brings much safety, convenience and comfort to passengers than other means of transportation systems. Whereas in Ethiopia, many passengers are transported by road transports, which have very significant impact on the infrastructure as well as accelerating distress and reducing the durability and performance of the road structure.

The Chemin De Fer Djibouti – Ethiopian Railway line (CDE) was the first Railway integration between Ethiopia and Djibouti. Due to World Globalization or Fast Economic growth of the world, it is not enough to compete to other Developed or developing countries. Moreover, the existing railway line is dysfunctional due to different factors [CDE, 2007]. General obstructive factors for the success of railway transportation on the existing lines were:

- Lack of maintenance,
- Poor management,
- Lack of commercial focus,
- Lack of investment capital
- Tight curves and high gradients,
- Lack of automatic signalling systems on major line sections and insufficient number of skilled and non-skilled staff.
- As for freight transportation, low operational speed, lack of sufficient traction power for long haulage, higher operational costs are leading factors of railways confining power to compete with other modes.
- Fierce competition from trucking industry on the corridor

In addition to the low railway network connectivity in Ethiopia like other developing countries [CDE, 2007], the existing line of CDE was not good enough to facilitate transit trade and was insignificant to transport mainly passengers and small parcels of goods in the corridor.

Ethiopia therefore needs a modern, economic, time saving and long lasting transportation system which will lead to inclusive growth. New railroad connecting the length and breadth of the Country seems to be the solution.

The Government of the Federal Democratic Republic of Ethiopia (FDRE) has for many years recognized the need to improve and expand the existing transportation network throughout Ethiopia. In its national Five Year Plan (2010/11 – 2014/15), referred as the “Growth and Transformation Plan” issued in September 2010, FDRE has confirmed its commitment to improve the country’s transportation infrastructure with the proposed development of a standard gauge railway network for Ethiopia. The target for construction of new rail infrastructure during this period consists of a 5,000 km of National Railway Network of Ethiopia (NRNE), which will be constructed along eight corridors in two phases, and a 34 km Light Rail Transit (LRT) system in the capital city of Addis Ababa. As part of the Growth and Transformation Plan (GTP) 2,500 km of the proposed railway network has been given first priority to be implemented between 2010/11 to 2014/15 (ERC, 2011).

The Ethiopian Railways Corporation (ERC) is responsible for the NRNE Ethiopia and Light Rail Transit (LRT) system. The key objective of ERC is to develop an integrated and efficient high speed, high capacity railway transport system in order to ensure competitive and affordable transport for freight and passengers at an affordable tariff structure.

The priority corridor for the NRNE will be the construction of a new standard gauge railway line from Addis Ababa (Sebeta) to Djibouti. The integration of the Ethiopian and Djibouti railway lines is the subject this Thesis. In addition, the integration of Ethiopian and Kenyan railway lines is discussed.

1.2. Statement of the Problem

Integration problem between countries adversely affect economical and the national development of countries in general and Ethiopia in particular. The industry by itself is not the solution to growth of one country, there must be suitable transportation demand. The integration also helps to establish good social, political and economic development with regional countries. Ethiopia’s development is being hindered by poor transport links, with relatively very small paved road network in comparison to its 1.1 million sq.km of area and 84 million populations. Although for a long time, the existing narrow gauge railway constituted the main route for Ethiopian external trade along the Red Sea, but now the line is dysfunctional. Moreover, the existing road transportation system is insufficient in respect of carrying capacity, speed, environmental friendliness and cost effectiveness.

In developing countries like Ethiopia, lack of rail network integration is a big problem. It affects the transportation system that cannot provide efficient, safe and affordable services. In addition, it affects the promotion of competitive trade and supporting national socio-economic development. There are vast movement of the people, huge import and export of goods which are not efficiently supported by railway transport. Ethiopia lacks rail transport integration with its neighbours countries despite there are strong railway transport activities in those countries i.e. Sudan Kenya, etc.

1.3. Objectives of the research

1.3.1. General Objective

Railway transport is becoming reliable and regular form of haulage of bulk goods, safe, conveniently and comfortably especially to passengers than other means of transportation system. This study was done in this sector in order to do further research in the development of modern system of railway transportation in Ethiopia.

The main objective of this research is to illustrate the significance of future integration of the Ethiopian Railway network with regional countries (especially with Djibouti) with the establishment of economically feasible construction, environmental friendly, safe, comfortable and competent mode of transportation system in Ethiopia.

1.3.2. Specific Objectives

The specific objectives of this study are:

- To assess the economic viability and cost and benefit Analysis of the new standard Addis Ababa / sebeta – Djibouti railway line;
- To evaluate the Socio- environmental impact Assessment(SEIA) of the Addis Ababa/Sebeta– Djibouti railway line; and
- To Perform the risk analysis of the Addis Ababa/Sebeta– Djibouti railway line

1.4. Scope of the research

The study basically concentrates on the integration of Ethiopian Railway network with regional countries especially with Djibouti railway connection. Similarly the integration Ethiopian and Kenyan railway network will be studied.

1.5. Research Methodology

The research methodology for this study involved the following major tasks: literature review; data acquisition on National Railway Network of Ethiopia (Data Analysis); and Analyse and Result on Ethiopia - Djibouti railway line. The types of data collected included document review, in respect of world railway networks, railway integration experience, the new proposed Ethiopia –Djibouti railway line, the new proposed Ethiopia –Kenya railway line and the new proposed Awash – Weldia railway line. The collected data were analysed through Cost and Benefit analysis and economic parameters were generated. Finally conclusions and recommendations for future work are forwarded.

2. Literature Review

In general from many literatures reviews, railway is the most frequently used transport system in the world both in the past and present. Due to its easy accessibility and many other positive reasons, it will continue to be used in the future as well.

2.1. Historical Background of Railway

2.1.1. Railway History of the World

Like so much in present day society, the railroad was the result of industrial revolution although the idea of a special track for hauling goods dates back about 2000 years. Railways that fit Lewis's definition, that is "railway is a prepared track which so guides the wheels of the vehicles running on it that they cannot leave the track", existed as far back as the 6th century BC; the Greek Diolkos was a railway with a track made from stone, 6km in length across the Peloponnese, used for transporting ships until the 9th century AC an extraordinarily long period (Coulls, 1999).

Most historians agree that the opening of the 48km (30 miles) double track line of metal rails of Liverpool-Manchester Railway in 1830 in the north-west of England (Coulls, 1999 and Bonnet, 2005), the world's first true railway, the prototype of the 'modern railway' had arrived: a combination of specialized track, the accommodation of public traffic, the conveyance of passengers as well as freight, mechanical traction, and some measure of public control.

In the second half of the 19th century, the more advanced industrial states engaged in a worldwide contest for strategic advantage, economic fortune and imperial expansion. As industrial empire arose, railways became a means to great power and status. The colonial railways in Africa, Asia and South America were thus an essential part of the spread around the world of the economic processes, ideas, and institutions of the European powers: the production of new foodstuffs and raw materials to feed the industries and peoples of the West, new populations to produce them, new patterns of land ownership, and new legal codes to make the conquered lands safe for investment and exploitation (Coulls, 1999).

The 'great' or 'golden' age of railways in the sense that they virtually monopolized inland transport was over in most countries by World War I (Coulls, 1999). After a mid of 20th century rationalization of the rail network began and the following activities were taken to compete with other massive mode of transportation (Coulls, 1999).

- Steam locomotives were avoided and replaced with full electrification of the lines
- Modernization of passenger coaches
- Safety system upgrading

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- Freight wagons were also highly improved with the introduction of high capacity and with box containers and fully braked units.

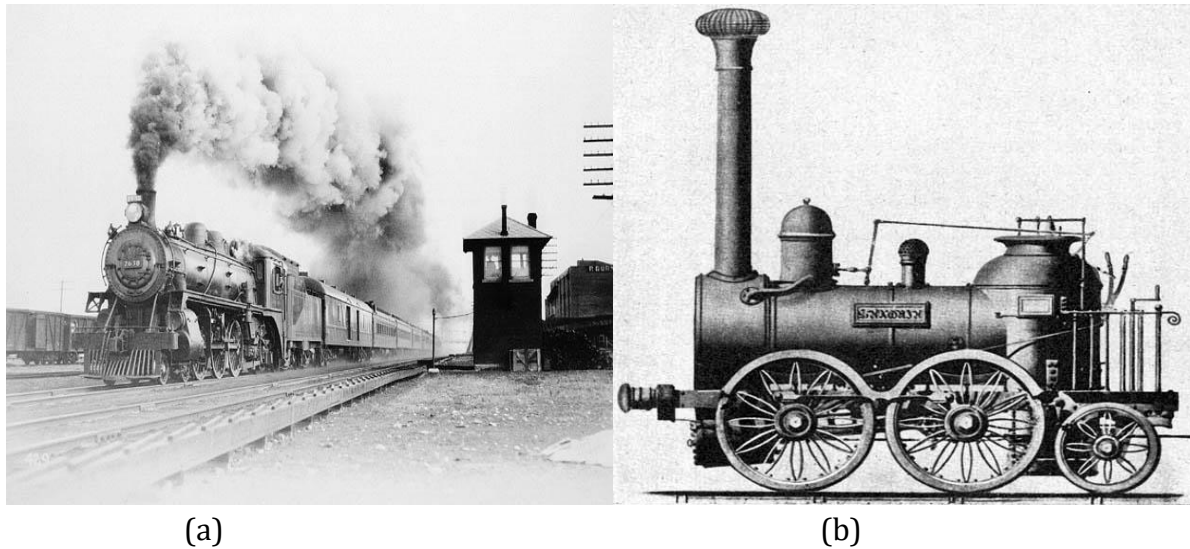


Figure 2.1: Railway transportation in the early 19th century (a) freight train (b) steam locomotive [David, 2006]

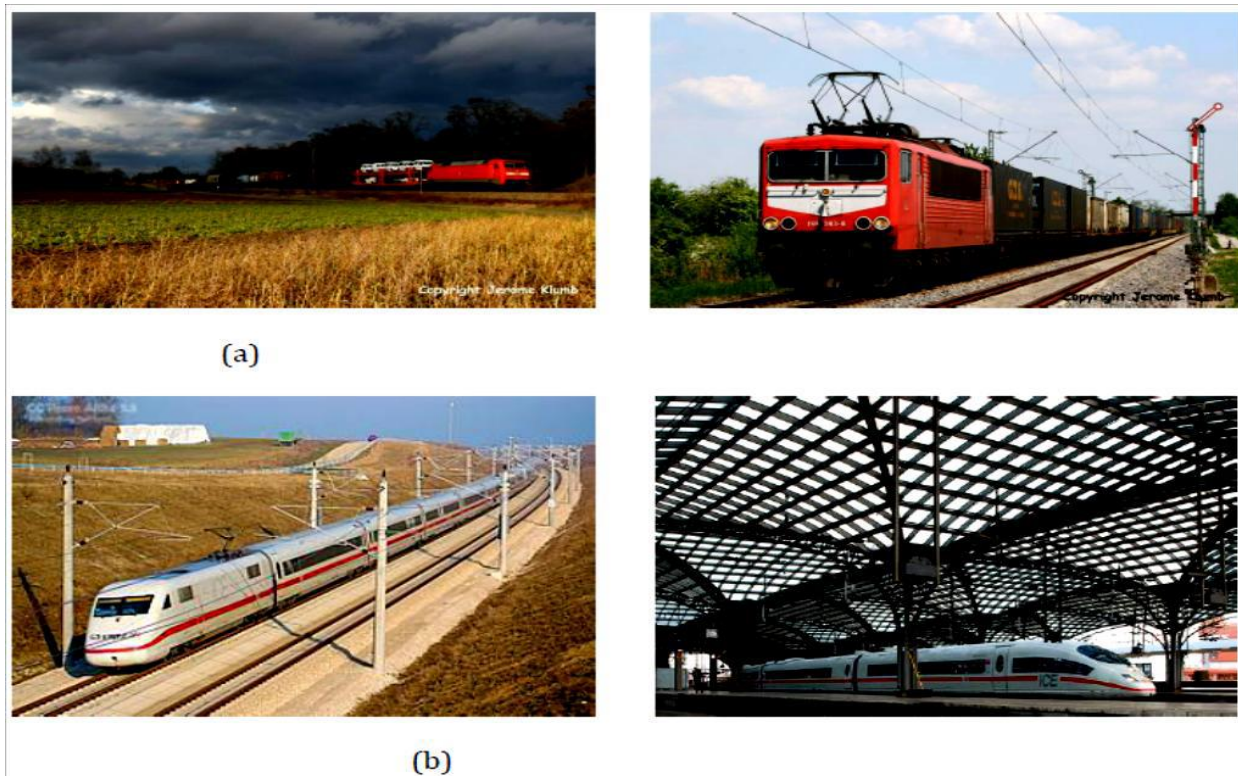


Figure 2.2: World's recent (a) cargo and (b) high speed trains with advanced infrastructures (Klumb, 2008; Siissalo, 2011) Siissalo, 2011)

2.1.2. Railway History of Ethiopia

The Ethio – Djibouti Railway (CDE) was initially named “The Ethiopia Government Railway” during the reign of Emperor Menelik II. The emperor gave a concession to a Swiss born Alfred Ilg who was by then a councillor to the Emperor, for the construction of a rail line that could run from Djibouti to Entoto (Addis Ababa) via Harar, and then to the White Nile, via Kaffa. It was then believed that the rail would fetch an access of foreign markets for gold, coffee, and ivory from the western part of Ethiopia (CDE, 2007).

Construction of the railway started at Djibouti in 1887. By 1902, the track reached Dire Dawa. However, it was not extended to Addis Ababa until 1917. The Construction of the railway that started at Djibouti was originally built by the French, who were involved in its management for many years. In 1981, a treaty between the governments of Ethiopia and Djibouti replaced the previous organization, the Compagnie Du Chemin de Fer Djibouti- Ethiopien at Addis Ababa, with the bi-national organizations the Chemin de Fer Djibouti- Ethiopien (CDE, 2007).

The CDE track provided freight and passenger services between Djibouti and Addis Ababa, serving intermediate locations as well. This single track has been 100 years old one meter gauge railway; with a total length of 781 km (681 km in Ethiopia and the remaining 100 km in the territory of Djibouti) connecting Addis Ababa to the Port of Djibouti. And it was a bilateral origination, jointly owned by the government of Ethiopia and Djibouti.

The CDE’s Track extends in a south westerly direction from the Port of Djibouti on the red sea to the city of Dire Dawa in Ethiopia, and from there to Addis Ababa, the capital city of Ethiopia which is located at the center of the country at an altitude of 8000 feet above the sea level.

Passenger traffic on the CDE had been steadily increasing in recent years. It has gone from 367,000 passengers in 1972 to 1,269,000 passengers in 1982/1983 an average annual growth of 13.2%. This growth in passenger traffic was accompanied by a corresponding increase in trip length. During the same period, however, freight traffic declined sharply from 405,000 tons in 1972 to 237,000 tons in 1982/1983 an average annual decrease of 5.5%. The rate of decline in traffic has been dramatic, but plans exist to reverse the declining role of the CDE in the Ethiopian transportation economy.

While there were considerable traffic movements by truck between Addis Ababa and the former Ethiopian port of Assab, the CDE was providing Addis Ababa’s only rail connection to the Red Sea. The vehicular route between Dire Dawa and Djibouti was almost impassable. Thus, the railway represents the principal means of transportation between Addis Ababa and the port of Djibouti.

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

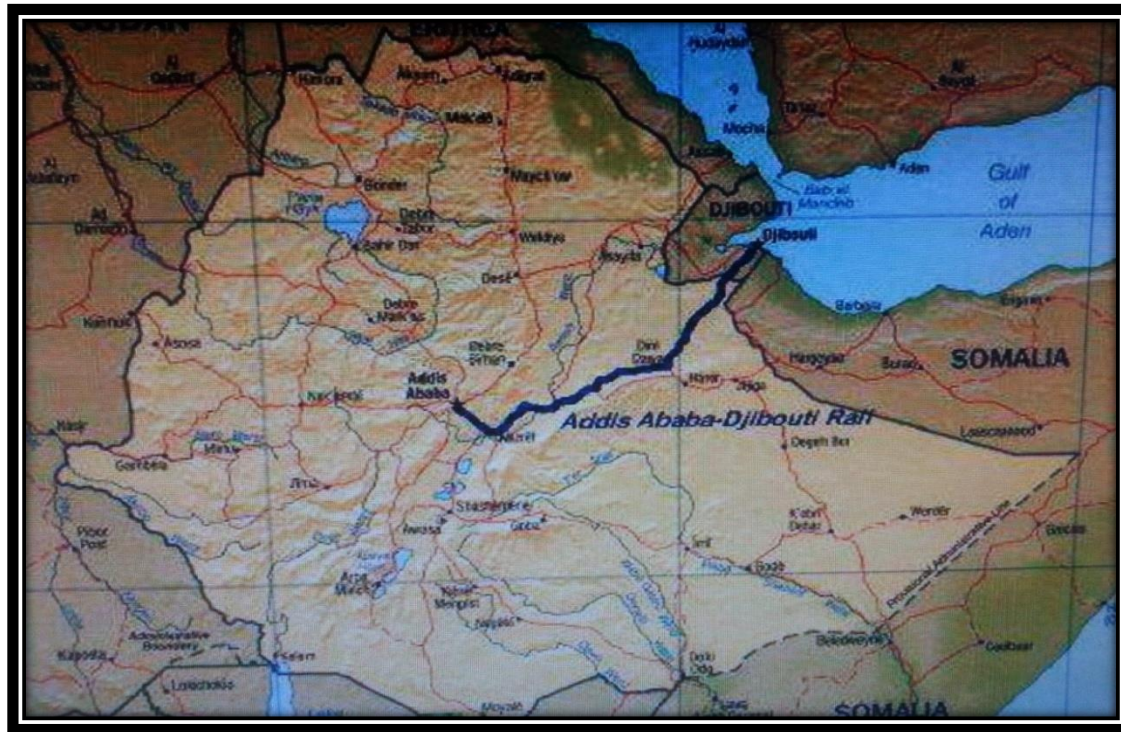


Figure 2.3: Ethio-Djibouti railway line (CDE, 2007)

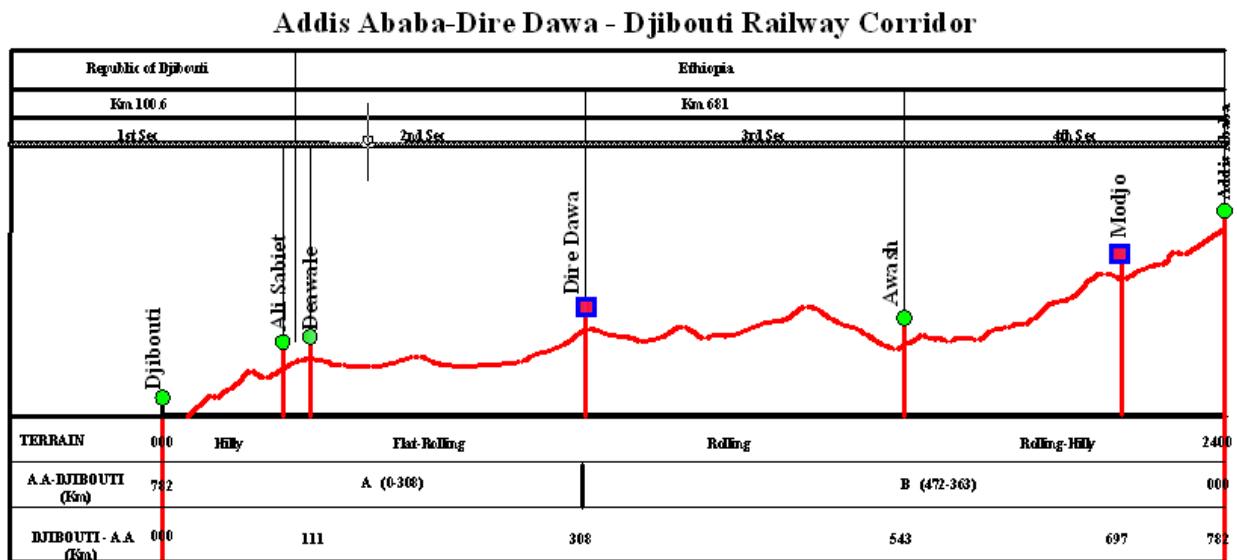


Figure 2.4: Addis Ababa – Dire Dawa Railway Corridor

The maximum permitted speed for auto passenger trains was 85 km/hr. For Freight trains and for standard passenger trains, it was 50km/hr. The maximum axle loading on 20kg/m rail was 14metric tons. 18 metric tons was permitted on rails of 30kg/m. the maximum bridge loading was 17 tons.

The railway line, which begins from sea level (Djibouti), gradually ascends to an altitude of 2,408m (Addis Ababa) at a maximum gradient of 2.7%. The horizontal curvature line comprises a total of 996 curves out of which 79 were very sharp with radius of less than 200m. And the Track was designed to accommodate a 14 ton axle load, with a variable loading (tonnage) characteristics corresponding to different gradients along the way. There are also 416 turnouts (switching and crossing), which were almost exclusively located at station.

Most mechanical maintenance was undertaken at Dire Dawa, where there were locomotives and car shops with substantial numbers of personnel for heavy and light maintenance. Running repair and service facilities exist at Addis Ababa and Djibouti workshops, but have been relatively modest equipment and staffing. Fuelling stations were located at crew change points and other location.

Ethiopia's scenic, archaeological, cultural, and architectural resources gave it significant potential as an international destination. The railroad trip between Dire Dawa and Addis Ababa was as considered one of the most spectacular in the world.

2.1.2.1. Rail track

The rail track has been the following composite assembly of rail weights.

- 20kg /m rail94.8km
- 25kg /m rail413.2km
- 26kg /m rail2.90km
- 30kg /m rail219 km
- 36kg /m rail51.1km

2.1.2.2. Rolling stock

At the beginning of the operation, CDE had the following rolling stocks:

- ✓ Locomotives _____ 54
- ✓ Passenger coaches _____ 36
- ✓ Freight Wagon _____ 445

After that, the CDE added the following stocks to upgrade the track:

- ✓ Locomotives _____ 14
- ✓ Passenger coaches _____ 27

Dry cargo _____ 332

Tank cars _____ 110

2.1.2.3. Stations of CDE

The CDE railway line was comprised of 34 stations out of which Addis Ababa, Dire Dawa and Djibouti constitute as being the principal stations. These major stations provide both passenger and freight services and the rest of the stations primarily give passenger services. The following table shows the station locations with distances.

Table 2.1: Major Station of Chemin de Fer Djibouti- Ethiopien (CDE) with Distances

No.	Town	Distance(km)from Addis Ababa
1	Addis Ababa	0
2	Kalliti	15
3	Akaki	22
4	Doukam	41
5	Debre-Zeit	52
6	Modjo	76
7	Adama	103
8	Welenchiti	127
9	Melka-Djilo	166
10	Metehara	205
11	Awash	236
12	Arba	266
13	Khora	288
14	Assabot	309
15	Messo	322
16	Moullou	334
17	Afdem	362
18	Bicket	389
19	Gotta	408
20	Errer	414
21	Ourso	446
22	Dire-Dawa	472
23	Shinille	484
24	Harrawa	518
25	Mello	525
26	Adigalla	581
27	Lassarat	620
28	Aisha	636
29	Dewelle	673
30	Ali-Sabiet	693
31	Dasbiou	711
32	Holl-Holl	730
33	Chebele	748
34	Djibouti	781

Source: (CDE, 2007)

2.1.2.4. The Objectives and Agreement of CDE

The Treaty of March 21, 1981 between the Governments of Djibouti and Ethiopia, which created the Ethiopia-Djibouti Railway, established the following objective for the CDE:

“The purpose of the corporation was to provide for the transportation of freight and passengers under optimum conditions of safety and profitability, both within the territories of Ethiopia and Djibouti, and between the two countries. “(CDE, 2007)

This brief and straight forward statement sets forth the CDE’s purpose in terms of the optimization of the railway transportation system. It mandates a well-run organization; one that serves its customers’ needs avoids accident, and makes money. Since service, safety, and profitability cannot always be maximized simultaneously, the Treaty property focuses on an optimum or appropriate balance among these considerations. This techno economic balance, according to the Treaty, was to be applied throughout the territory served by the CDE, regardless of the country of origin or destination of the traffic.

The Treaty’s statement of purpose seems to say that this bi-national railway should be run almost as if national boundaries did not exist. In this light, efficiency, productivity, and cost effectiveness should be the measure of the success of the organization and of the performance of its management.

The Treaty provisions reflect concerns which may well be as important to Djibouti and Ethiopia as those of system optimization: concerns of sovereign governments of equity in the distribution of the economic benefits of the CDE, as well as considerations of national status and prestige. Treaty negotiation was a complex and difficult task, involving trade off and compromise. It represents the art of the possible rather than the achievement of the ideal. It is not surprising that a railway organization resulting from negotiations among sovereign nations might depart somewhat from a model designed by a management expert.

There were indeed many other legitimate interest, which impact on the CDE’s stated purpose of system optimization or make that purpose more difficult to achieve: interests of national governments in controlling borders and collecting duties on goods moving across these borders; interests of unions in maximizing employment, providing job security and obtaining favourable resolution of grievances; interests of local governments in preventing adverse railway impacts on the local environments; interests of workers in raising their living standards and maximizing their leisure time; interests of railway users receiving service at low cost, and many other interests as well.

The governments of Ethiopia and Djibouti, the CDE Board, and the CDE Management could establish reasonably achievable annual quantitative goals for improvement in each of the areas of service, safety, and profitability. Such quantitative goals need not be comprehensive, complex or overly ambitious, but they should be very specific and readily measurable. The

Board of Directors could take management's record in achieving or not achieving these goals very seriously in evaluating management's performance.

As a conclusion, the Addis - Djibouti railway which for reasons of age, aging rolling stock, management, deteriorated permanent way, Investment problem, lack of resources, small transportation capacity and poor service quality to customers handles only about 3% of the Country's foreign trade and it is generally dysfunctional or closed. Nonetheless, the new construction of the national railway network should take more experience from this line.

2.2. Regional Integration Agreements (RIAs)

2.2.1. General

Regional integration agreements (RIAs) are one of the major international relations developments of recent years. Most industrial and developing countries in the world are members of regional integration agreements, and many belong to more than one: more than one-third of world trade takes place within such agreements. The structure of regional agreements varies hugely, but all have one thing in common the objective of reducing barriers to trade between member countries. At their deepest, they have the objective of economic union, and they involve the establishment of shared executive, judicial, and legislative institutions. Regional Railway Integration is one of the infrastructure regional integration. Hence, the agreements are the same for all types of regional integration (Unige, 2014).

The last 10 years have witnessed qualitative, as well as quantitative, changes in regional integration schemes. There have been three major developments (Unige, 2014).

- ❖ The first is the recognition that effective integration requires more than reducing tariffs and quotas. Many other barriers have the effect of segmenting markets and impeding the free flow of goods, services, investments, and ideas; and wide ranging policy measures going well beyond traditional trade policies are needed to remove these barriers. This so-called deep integration was first actively pursued in the Single Market Program of the European Union (EU), and elements of this program are now finding their way into the debate in other regional agreements.
- ❖ The second is the move from "closed regionalism" to a more open model. Many of the trading blocs that were formed between developing countries in the 1960s and 1970s were based on a model of import substituting development; and regional agreements with high external trade barriers were used as a way of implementing this model.

- ❖ The third development is the advent of trade blocs in which both high-income industrial countries and developing countries are equal partners in agreements designed to bolster the economies of the entire member, with the implementation of the Single Market Program in 1992, enlargement of its membership, and numerous agreements with other countries.

In Sub-Saharan Africa, the blocs in West Africa were reformed and reorganized. The Southern African Development Community (SADC) developed out of an earlier defence based organization, Southern African Development Coordination Conference, and was supplemented for many of its Members by the Cross Border Initiative. The East African Cooperation sprang up where the East African Community had failed.

2.2.2. Politics and Policymaking

Many of the arguments for membership in a regional agreement are political. There are three main issues (Unige, 2014).

2.2.2.1. Security

There may be perceived benefits from using a regional agreement as a basis for increasing security against non-members. A regional agreement may also enhance a country's security in its relationship with other members. These security arguments are driven by a variety of mechanisms. Interlocking economies can make conflict more expensive; regular political contact can build trust and facilitate other forms of cross-border cooperation. But a regional agreement can also create internal tensions, particularly if driven by economic rather than security considerations and if the economics appears to bring an unfair distribution of benefits.

2.2.2.2. Bargaining power

The likelihood of this occurring depends on who the member countries are. The EU has probably been able to secure more in some international negotiations than could its member states acting independently. Regional agreements between small developing countries cannot aspire to the EU's economic weight or political power, but can nevertheless enter negotiations more effectively than separate countries might be able to. Of course, these benefits depend on members being able to formulate a common position on issues, a goal that has often proved elusive.

2.2.2.3. Lock-in

A regional agreement can provide a "commitment mechanism" for trade and other policy reform measures. It can be a way of raising the cost, and thereby reducing the likelihood, of policy reversal. This argument can apply to political as well as economic reform, and there are

examples where regional integration agreements have reinforced democracy in member states. However, the effectiveness of regional agreements as “commitment mechanisms” depends on the interests and degree of involvement of all the countries concerned. Domestic political pressures and the activities of lobbies will also influence the form of many regional agreements quite possibly preventing them from being as effective as they might otherwise have been.

2.2.3. Economic Costs and Benefits

The economic effects of regional agreements are two main types (Unige, 2014).

2.2.3.1. Scale and competition effects

Removal of trade barriers is like a market enlargement, as separate national markets move toward integration in a regional market. This allows firms to benefit from greater scale and attracts investment projects for which market size is important, including foreign direct investment (FDI).

Removing barriers also forces firms from different member countries into closer competition with each other, possibly inducing them to make efficient improvements. Although these are major sources of benefit and that the effects depend on the design and implementation of the agreement. Some of these benefits may be achievable with unilateral trade liberalization.

2.2.3.2. The second source of economic change is “trade and location” effects.

The preferential reduction in tariffs within a regional agreement will induce purchasers to switch demand toward supply from partner countries, at the expense of both domestic production and imports from non-members. This is trade creation and trade diversion. Governments will lose tariff revenue, and the overall effect on national income may be positive or negative, depending on the costs of alternative sources of supply and on trade policy toward non-member countries. Changes in trade flows induce changes in the location of production between member countries of a regional agreement. These relocations are determined by the comparative advantage of member countries, by agglomeration or clustering effects, and by possible technology transfer between countries. In some circumstances, relocations can be a force for convergence of income levels between countries. Labour-intensive production activities may move toward lower-wage countries, raising wages there.

2.2.4. Policy Choices

Regionalism confronts countries with four broad areas of policy choice (Unige, 2014).

- The first choice is with whom, if anyone, to form an agreement. A developing country may face options ranging from an agreement with another low-income country, to partnership

with a high-income country or bloc, or membership of a large regional grouping such as the Asia Pacific Economic Cooperation (APEC).

- The second policy choice concerns the policy stance members of a regional agreement take toward the outside world. A regional agreement is inherently preferential discriminating in favour of members.
- The third area of policy choice is the “depth” of integration to be pursued. Different countries enter regional agreements with very different objectives and constraints. For some the objectives are to secure economic integration and to build deep political links, and there is a willingness to exert political effort to meet these objectives. “Deep” integration of this type may bring larger benefits in many areas of activity. For example, deep integration might involve harmonization of product standards and of parts of the fiscal system. This will make it more likely that economic “scale and competition” gains are realized. However, it also involves greater loss of sovereignty, greater political commitment, and far more complex policymaking than would a looser free trade agreement.
- In addition to the depth of integration, countries must also decide on the “width” of an agreement, and this is the fourth policy area. How wide a range of activities should be covered by an integration agreement just trade in goods, or also extension to services and factor mobility? Look at some of the economic issues that arise, and some of the practical problems that may be encountered as countries choose the depth and width of integration.

2.3. The world’s 10 longest railway networks



Figure 2.5: Map of countries' rail network

The most popular mode of travel still is the railways. Railroads are always the preferred mode of commuting for general public owing to many positive points. Connectivity by railways facilitates speedy travel at relatively low cost. Many countries have extensive network of railways connecting remote towns and cities with one another. Some countries have advanced a lot with regards to rail commuting while some are on the verge of improvement. It is rather fascinating to witness how wide a train network can be. Rail roads have an important place in the whole transport network of a country. Presenting a list of the longest rail networks in the world based on rail technology.com in February, 2014(Railway Technology, 2014).

United States- 250,000km



The US rail network, with an operating route length over 250,000km, is the biggest in the world. Freight lines constitute about 80% of the country's total rail network, while the total passenger network spans about 50,000km.

The US freight rail network consists of 538 railroads (seven Class I railroads, 21 regional railroads, and 510 local railroads) operated by private organizations. Union Pacific Railroad and BNSF Railway are among the largest freight railroad networks in the world. The national passenger rail network Amtrak comprises of more than 30 train routes connecting 500 destinations across 46 American states.

A plan is in place to build a 27,000km national high speed rail system in four phases by 2030. Construction of the California high-speed rail, the country's first high-speed rail project, was well underway by the beginning of 2014. Three more high-speed projects including the Midwest high-speed rail line connecting Chicago with Indianapolis or St. Louis, Texas high-speed rail, and the Northeast High-Speed Corridor are under development.

U.S. railroads still play a major role in the nation's freight shipping. They carried about 700 billion tons of goods in the 70's and 80's which doubled to 1.5 trillion ton-miles in 2005. The total ton-kilometer of freight that the United States accounted for is about 3000 billion in 2013. The entire European Union moved only 238 billion ton-kilometers of freight. The railways are classified in three distinct categories judged on their annual revenues.

Russia – 128,000km



Russia's whole network, operated by state-owned monopoly Russian Railways (RZD), runs for 128,000km, of which about half is electrified and carries most of the traffic, over 40% was double track or better. In 2013, the network carried 1.08 billion passengers and 1.2 billion tons of freight - the third highest freight volume after the US and China.

The Russian railway network incorporates 12 main lines, many of which provide direct connections to the European and Asian national railway systems such as Finland, France, Germany, Poland, China, Mongolia and North Korea. The Trans-Siberian Railway (the Moscow-Vladivostok line), spanning a length of 9,289km, is the longest and one of the busiest railway lines in the world.

RZD introduced the Sapsan high-speed rail service between St. Petersburg and Moscow in 2009, but it has not proved successful due to sharing existing lines with low-speed train operations. A dedicated high-speed corridor between the two cities has been planned with a proposed investment of \$35bn. RZD expects to have 2,500km of high-speed rail between Moscow and Kiev, Minsk and Kursk by 2015.

China – 103,144km



China's rail network, with a route length of 103,144km, ranks as the third biggest rail network in the world. The extensive network, operated by state-owned China Railway Corporation, carried 2.08 billion passengers and 3.22 billion tons of freight (the second highest after the US railway network) in 2013.

Rail is the principal mode of transport in China. The country's rail network consists of over 90,000km of conventional rail routes and approximately 10,000km of high-speed lines. The total rail network of the country is targeted to exceed 270,000km by 2050.

The rapid expansion of China's high-speed rail network in recent years makes it by far the largest in the world. The 2,298km Beijing - Guangzhou high speed line is the world's longest high-speed railway line. The total length of China's high-speed rail network is projected to reach 50,000km by 2020.

India - 65,000km



India probably has the most intricate rail system connecting even the remotest villages and towns. Rail transport is a commonly used mode of long-distance transportation in India. Rail operations are handled by the state. The Indian nationwide rail network, the fourth longest in the world, is owned and operated by state-owned Indian Railways and includes an operating route length of more than 65,000km. The network carried about eight billion passengers (the highest in the world) and 1.01 million tons of freight (fourth highest in the world) in 2013.

The Indian railway network is divided into 17 zones and operates more than 19,000 trains per day, including 12,000 passenger trains and 7,000 freight trains. The national railway operator plans to add 4,000km of new lines by 2017, as well as significant gauge conversion, doubling and electrification of its existing aging lines. It also plans to add 3,338km of exclusive freight network by 2017 with the implementation of Eastern & Western Dedicated Freight Corridors (DFC), two of the six identified dedicated freight corridors in India.

Six high-speed corridors have also been identified for implementation in the country. The 534km Mumbai-Ahmedabad high-speed link is being advanced as a pilot project with an estimated investment of \$9.65bn.

The operations cover twenty eight states and three union territories and also provide limited service to Nepal, Bangladesh and Pakistan. The Indian railways are also pursuing to build the highest railway track in the world overtaking current record of Beijing-Lhasa Railway line. Manipur to Vietnam rail is being considered was reported by Shashi Tharoor. Indian Railways and rail authorities in China are interested in starting a high-speed rail link that would link New Delhi with Kunming, China via Myanmar.

Canada - 48,000km



Canada's 48,000km of rail lines makes its national network the fifth longest in the world. Canadian National Railway (CN) and Canadian Pacific Railway (CPR) are the two major freight rail networks operating in the country, while Via Rail operates the 12,500km intercity passenger rail service. Algoma Central Railway and Ontario Northland Railway are among the other smaller railways providing passenger services to certain rural areas in the country.

Three Canadian cities - Montreal, Toronto and Vancouver - have extensive commuter train systems. In addition, the Rocky Mountaineer and Royal Canadian Pacific offer luxury rail tours to view the scenic beauty of certain mountainous areas in the country.

Canada, however, does not have a single high-speed line on its railway network. Many high-speed lines such as Toronto-Montreal, Calgary-Edmonton and Montreal-Boston have been proposed, but none of these have progressed beyond preliminary studies as of January 2014.

Germany - 41,000km

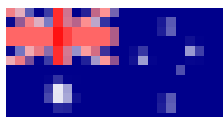


State-owned Deutsche Bahn dominates Germany's 41,000km railway network, accounting for about 80% of the total freight traffic and 99% of the long-distance passenger traffic.

More than 150 private railway companies apart from Deutsche Bahn operate on the network, providing regional passenger and freight services. The S-Bahn serves major suburban areas, while the Hamburg Cologne Express (HKX) is the major long-distance passenger operator after Deutsche Bahn.

The German railway network had more than 1,300km of high-speed railway track operational as of mid-2013 and more than 400km of new high-speed line under construction. Deutsche Bahn opened high-speed services, under the name Inter City Express (ICE), for the first time in 1991. The high-speed network, operated at speeds up to 320km/h, now connects major German cities and neighbouring countries such as France, Switzerland, Belgium, the Netherlands and Austria.

Australia - 40,000km



The Australian railway network is the world's seventh longest at more than 40,000km. Most of the railway network infrastructure is owned and maintained by the Australian government either at the federal or state level. The majority of the trains on the network are, however, operated by private companies.

Aurizon (formerly QR National), Genesee and Wyoming Australia, and Pacific National are among the major freight operators on the network. Great Southern Railway, NSW Train Link and Queensland Rail are the leading long-distance passenger rail operators. Metro Trains Melbourne, Sydney Trains, V/Line and Adelaide Metro operate commuter passenger services in major suburban areas. In addition, a number of private mining railways operate in the country.

The Australian railway network does not have a high-speed line yet. A high-speed rail network connecting Brisbane, Sydney, Canberra and Melbourne is proposed to be built with an estimated capital cost of \$114bn, but the first phase of the 1,748km high-speed network will not be realized before 2035.

Argentina - 36,000km

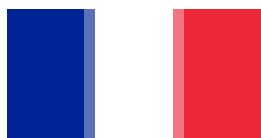


Argentina's current rail network spanning over 36,000km in length ranks the eighth largest in the world. Argentina used to have about 47,000km of rail network at the end of the Second World War, mostly operated by British and French-owned railway companies. But the decline of profits and the rise of highway construction in the subsequent decades reduced the network to the 36,000km of line that exists today. The railway companies operating on the network were nationalized in 1948 with the creation of the state railroad corporation Ferrocarrile Argentinos.

The Argentinean railway was privatized between 1992 and 1995 with the grant of concessions to different private companies for operating six divisions of the formerly state-owned rail network. Cities such as Buenos Aires, Resistencia and Mendoza offer extensive suburban passenger services, as well as the long distance passenger lines in the country.

The much talked-about Argentine high-speed railway is not a reality yet. An announcement was made in 2006 to develop a 310km high-speed line between Buenos Aires and Rosario. The project was, however, not implemented as of 2013. A second high-speed line stretching 400km between Rosario and Cordoba has also been proposed.

France - 29,000km



At 29,000km, the French railway network is the second biggest in Europe and the ninth biggest in the world. The French railway network is predominantly passenger-centric and more than 50% of the country's lines are electrified. State-owned Société Nationale des Chemins de fer Français (SNCF) is the principal railway operator in the country.

The country's high-speed long distance passenger services are known as Train à Grande Vitesse (TGV) and the standard long-distance passenger services are branded Intercités. The short and middle distance passenger rail services are known as Transport Express Regional (TER). The network offers linkages to adjacent countries such as Belgium, Italy and the UK.

France was one of the early adopters of high-speed rail technology; SNCF brought into operation the TGV high-speed rail in 1981. The country's current high-speed network exceeds a length of 1,550km. The Tours-Bordeaux high-speed rail project, which is due for completion in 2017, will add another 302km into the network.

Brazil - 28,000km



The railway network was nationalized in 1957 with the creation of Rede Ferroviária Federal Sociedade Anônima (RFFSA). The country's railway network was divided into different services to be operated by a range of private and public operators by 2007.

The 28,000km network is predominantly freight-focused and includes major iron ore rail lines. The country's passenger rail services are mostly concentrated in urban and suburban areas. Eight Brazilian cities have metro systems, São Paulo Metro being the biggest among them.

In 2012, the Brazilian government announced the construction of 10,000km of new lines comprised of freight and high-speed passenger lines. By 2042, a 511km high-speed rail link between São Paulo and Rio de Janeiro has been planned for development in the country, but the project is yet to take off.

Ethiopia is one of the oldest countries to adopt railway, even earlier than some of the countries stated above. Nevertheless, due to many problems the project has been stopped for many years. Based on International Union of Railways data ranks countries by length of rail transport network size, Appendix, Table C- 1, Ethiopia is put as 107th with 699km rail lines. Recently, a light rail transit (LRT) is under construction in Addis Ababa and similarly, the construction of National railway network has begun with standard gauge.

2.4. Reviews of some of Africa’s Railway Integration and Infrastructure

2.4.1. East Africa Regional Integration and Infrastructure



Figure 2.6: East Africa regions map

The thirteen countries of East Africa – Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Sudan, Tanzania, and Uganda have overlapping memberships of varying degrees of the eight recognized by the AU. Thus, this makes harmonization quite complex (Louri Elliott, 2013).

The countries of Burundi, Kenya, Rwanda, Tanzania, Ethiopia, and Uganda of the EAC have not experienced major conflict in many years, except for the election violence in Kenya in 2007 and the on-going, but diminished attacks of the Lord’s Resistance Army (LRA) in Uganda. However, the EAC, which has made tremendous strides in regional integration, is surrounded by other countries – Somalia, Sudan, Southern Sudan, Eritrean East Africa that have not done so well in

managing conflict. Moves are being made to mitigate the rise of these conflicts and the spill over into other countries, for example, Uganda allowing U.S. troops to hunt down the remaining members, Ethiopia, Uganda, Rwanda and Kenya sending troops into Somalia to fight Al-Shabaab.

The main regional strategy frameworks impacting East Africa are the tripartite agreement between Common Market for Eastern and Southern Africa (COMESA), East African Community (EAC), and Southern African Development community (SADC) and the EAC protocol framework. The major development partners in the region, World Bank, U.S. Agency for International Development (USAID), Norway, Holland, Germany, Denmark, European Commission (EC), Japan International Cooperation Agency (JICA), UK Department for International Development (DFID), and the multi-donor funded agency, Trade Mark East Africa (TMEA).

There is also an East African Railway Master Plan, which covers the revitalization of rail lines in all EAC countries with proposed rail lines reaching into Ethiopia, South Sudan, and the Democratic Republic of Congo (DRC).

The EAC is working on a financial integration scheme to harmonize all countries into one financial services market. Thus far, the EAC countries have been able to integrate regional payments systems and improve interconnectivity between payment card switches, which will help regional trade moving forward.

While there are several reasons for taking stronger offensive moves to avoid conflict spill over's, one key driver is economic development. In the case of Kenya and Ethiopia entering Somalia, both countries are involved with a newly planned development corridor called the Lamu Port – South Sudan – Ethiopia Transport (LAPSSET) and economic development corridor. Some areas through which this corridor will pass have recently seen more evidence of Al-Shabaab crossing over the border, including the kidnapping of Western tourists.

2.4.1.1. Lamu Port – South Sudan – Ethiopia Transport (LAPSSET)

The LAPSSET Corridor Project is the first huge, integrated, transformative and Game Changer Infrastructure Project the government has initiated and prepared under the Kenya Vision 2030 Strategy Framework, without any external assistance. The project endeavours to deliver a just and prosperous middle income Kenya by the year 2030 (LAPPSET documentary).

Lamu corridor is a key corridor as it will give Ethiopia and South Sudan, two landlocked countries, access to the sea. This will help boost trade and investment potential for both countries. In addition, it will eliminate oil-rich South Sudan's reliance on the pipeline through Sudan.

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

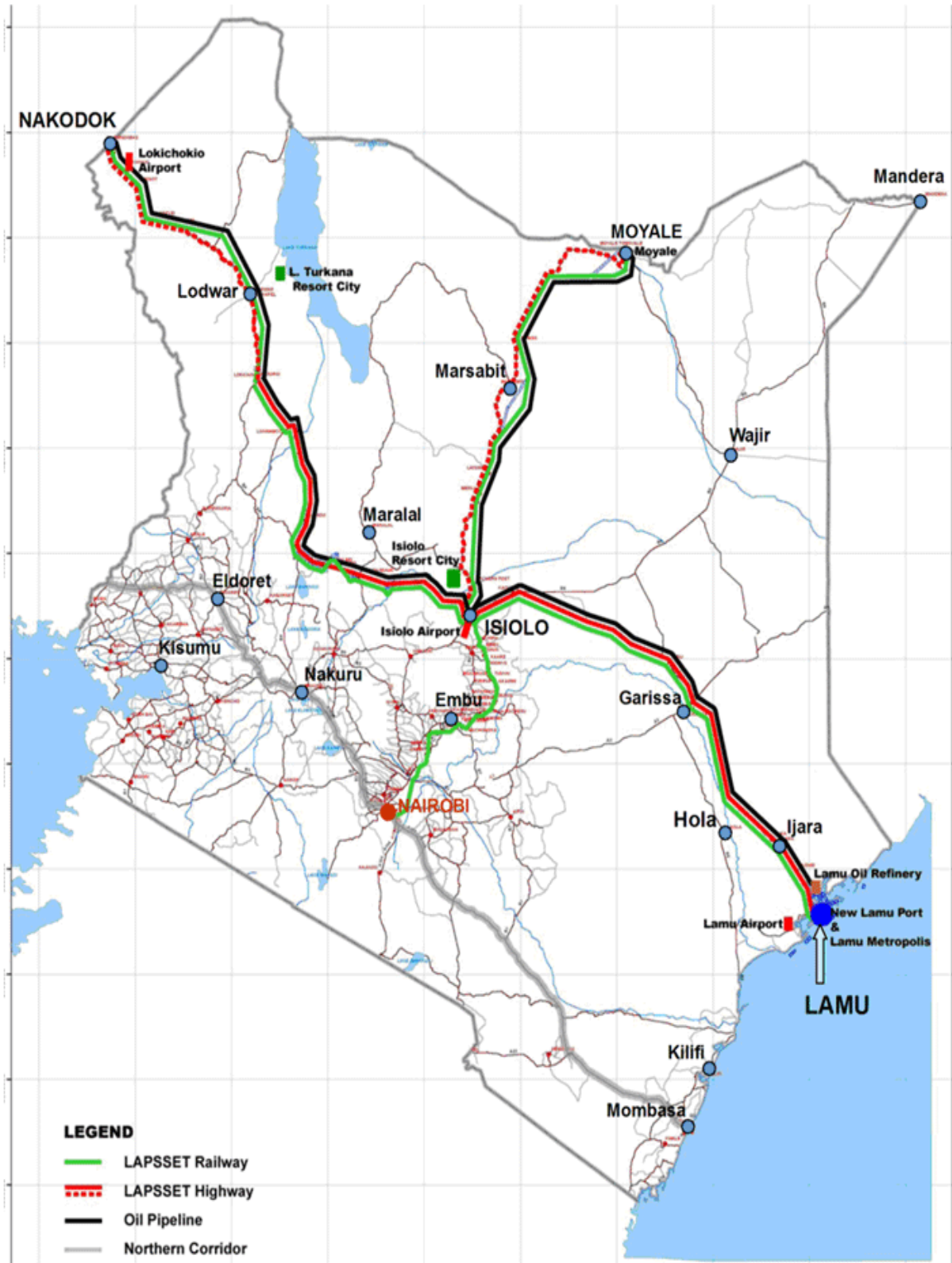


Figure 2.7: Map showing the scope of the LAPSSET Project within Kenya

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

The project will involve the following components:

- A port at Manda Bay, Lamu;
- Standard gauge railway line to Juba and Addis Ababa; the South Sudanese and Ethiopian capitals in that order. By 2030, the railway line is expected to handle 30 daily trains to Juba and 52 to Addis Ababa.
- Road network (LAPSSET road projects will run from Lamu to Isiolo and onwards to Juba and Addis Ababa through Moyale. This will be a 2 lane highway and will be at a cost of \$1.4 billion.) Construction of the 193 km Ageremariam-Yabelo-Mega already began from Moyale – Addis Ababa road corridor ;
- Oil pipelines (Southern Sudan and Ethiopia);
- Oil refinery at Bargoni;
- Three Airports; and
- Three resort cities (Lamu, Isiolo and Lake Turkana shores).

The project was initially conceived in 1975 but never took off due to various reasons. The project was later revived and included in Kenya's Vision 2030. In 2009, the cost of LAPSSET was estimated at D16 billion. Recent estimates after studies put the cost of the project between USD22 billion and USD 23 billion. On 1 April 2013, Kenya's government announced the setting up of a government agency, the Lamu Port Southern Sudan Ethiopia Transport Development Authority that will manage the project on behalf of the Kenyan government. The cost of the project was also put at KSh. 2.5 trillion (USD29.24 billion).

The aim of the project is to cut over-dependence on Kenya's main port of Mombasa as well as open up Kenya's largely under-developed northern frontier, through creation of a second transport corridor.

The exact timeline of the project is not clear, including when it would start and when it should be completed. But some projects like the Isiolo - Merille projects began in 2007; from Lamu to Juba, the estimated distance of the railway line estimated distance is 1,720 kilometers, and will be capable of handling trains with speeds of up to 160 kilometers per hour.

The railway line will be linked to the existing railway network and to Mombasa port by a line running from Lamu port to Mombasa port.

2.4.1.2. Rwanda, Uganda and Kenya to be connected by railway as EAC integration moves forward

The railway project is expected to change the region's economic landscape by providing efficient and cost-effective rail transport for both freight and passengers. It is intended to reduce the cost of doing business by reducing the cost of transport among the countries served by the Northern Corridor (Kinyarwanda, 2014).

The signing between countries also included an Institutional Framework based on the Northern Integration Corridor whereby East African community countries will concurrently build railway portions in their own countries that will connect with Kenya.

The East African community is home to 150 million people and joint integration projects will facilitate trade and movement of goods and people. Member Countries: Burundi, Kenya, Rwanda, the United Republic of Tanzania, and the Republic of Uganda are stepping up efforts to attain full integration in areas of economic affairs, infrastructure, science and technology; productive sector; social sector; and cooperation in legal, judicial and political matters.

Against this background, Rwanda, Uganda and Kenya have undertaken a series of joint projects aimed at fast-tracking regional development through joint infrastructure, trade and political and economic integration.

2.4.2. South Africa Railway Integration and Infrastructure

Along with the road transport sector, the railway system comprises all surface transport throughout Southern Africa. This extensive network has the potential to offer safe, efficient, and environmentally friendly transport across the Southern African Development Community (SADC) region, connecting all major centres of population and economic activity with developing rural areas (SADC, 2011).

However, railways in the region are currently operating below capacity and function as a collection of national systems rather than as an integrated regional rail network. Following the deregulation of road transport in the region, railway traffic subsided and, coupled with the high fixed costs of operations, stagnated at its current level of efficacy. Efforts to increase traffic volumes have been thwarted by poor track conditions and low operating capital.

Yet, due to railways' fuel efficiency and potentially cost-effective implementation, SADC remains committed to fostering a functional and integrated rail network throughout Southern Africa.

2.4.2.1. The Protocol on Transport, Communication and Meteorology

The Protocol on Transport, Communication and Meteorology addresses SADC's position on railways. In agreeing to the Protocol, Member States are required to facilitate an efficient and reliable railway service that helps to integrate the Region. In order to do so, Member States should collaborate on harmonized policies for railway use and implementation that economically restructures the railways by increasing the role of the private sector. As well, these harmonised policies should aim for common standards and procedures, particularly in terms of infrastructure.

The Protocol on Transport, Communication and Meteorology also advocates that Member States establish multilateral Railways Route Management Groups that facilitate and oversee railway networks in the region, operating in conjunction with the Corridor Planning Committees that administer development along established transport corridors.

2.4.2.2. Current Status

The railway system throughout Southern Africa faces substantial challenges. The deregulation of road transport caused an initial loss in traffic volume that has since rapidly expanded. Unlike road transport, the operating costs of railways remain largely fixed; therefore, a decrease in traffic forced railways to operate at a loss, with any income diverted toward salaries and fuel costs instead of maintenance and upkeep. Dwindling traffic and deteriorating infrastructure resulted in less investment into the rail system, resulting in unsustainable rail networks.

Recent plans for rehabilitating the rail network have tended toward installing new railway lines and implementing expensive upgrades, such as converting the entire network to European Standard Gauge rails as promoted by the African Union. However, these plans are mainly promoted by governments, not railway companies, which largely would prefer to revive existing infrastructure. While new railway lines are beneficial under certain scenarios, they are only effective when tied to a productive industry, as with the line to the Moatize coal site in Mozambique. Most current rail infrastructure can be made functional with minimal upgrades and is simply not operating at capacity. In order to become sustainable, additional capacity requirements can be met through increased freight loads, though this increase has yet to occur due to the unreliability and cost inefficiency of the current rail network in comparison with road transport.

2.4.2.3. Current Projects

In spite of these challenges, the region maintains a strong interest in revitalizing the railway sector, currently handling several proposals for new projects. As outlined in the 2012 Regional Infrastructure Development Master Plan, the SADC region has 31 rail projects under consideration. This interest is not unusual, though, as a properly implemented rail network is more efficient than road transport in terms of cost and fuel.



Figure 2.8: Map showing the scope of the SADC Project

In order for these projects to be financially viable, however, railways must significantly increase the volume of freight transported. Fortunately, many of the projects currently under development are intended to support industry, thereby offering potential for public-private partnerships to mitigate financial risk.

The following projects are anticipated in the short- to medium-term:

- Chingola (Zambia)– Solwezi Railway Extension
- Botswana – Lephale Railway
- Moatize, (Mozambique) – Nacala Railway
- Sena (Mozambique) - Railway Upgrading
- Beira (Mozambique) – Machipanda Line Upgrading

These projects currently under development offer the SADC region a prime opportunity to develop rail infrastructure while also fostering economic development through support of productive industries.

2.5. Reviews of some of the World’s Railway Integration and Infrastructure

2.5.1. China Railway Integration and Infrastructure

Global markets are shifting and the importance of the developing markets lies not only in their huge contribution to global growth, but also in their absolute importance. China as a developing economy must invest in infrastructure to ensure the bottleneck-free flow of passengers and goods. China has become one of the most tempting railway markets and is becoming a global leader in the rail industry(CRC, 2013).

Since ancient times, China has been recognized as a cultural and industrial leader, contributing to the world rich panoply of art, literature and scientific achievements. China boasts a recorded history of thousands of years of technology innovations, so it’s no surprise that the population of more than 1.3 billion people is on the move once again. The economic powerhouse has embarked on an ambitious course to provide high-speed rail service throughout the entire country (CRC, 2013).

Rail transport is an important mode of long-distance transportation in the People's Republic of China. As of 2013, the country has 103,144 km of railways, the third longest network in the world, including 11,028 kilometers of high-speed rail (HSR), in the world. All provinces and

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regions are connected to the rail network except Macau. Almost all rail operations are handled by the China Railway Corporation, a state-owned company created in March 2013 from dissolution of the Ministry of Railways.

The China Railway Corporation (CRC) is responsible for passenger services, regulation of the country's rail industry, development of the rail network and the overall rail infrastructure. The railway Corporation wanted a user-friendly interface that would make operating and managing the railway network as economical as possible. The Spring Festival Travel Season is the peak railway travel season of the year. During the three weeklong holidays in China, known as "Golden Week", demand for tickets increases dramatically due to many migrant workers returning home and others using the time to travel the country (CRC, 2013).

China's railways are among the busiest in the world. In 2006, they carried a quarter of the world's rail traffic volume on only 6 per cent of the world's tracks. In 2013, railways in China delivered 2.106 billion passenger trips, generating 1,059.56 billion passenger-kilometers and carried 3.967 billion tons of freight, generating 2,917.4 billion cargo tons-kilometers.

The railway network has been expanding rapidly in recent years. Driven by need to increase freight capacity, the country budgeted \$105.9 billion for railway investment in 2013, and has a long term plan to expand the network to 270,000 km by 2050.



Figure 2.9: The map of the railway network in China as of March, 2010

International linkages

Trains run by Chinese Railways link almost in every town and city in the mainland China. New high speed lines from 200 km/h up to 350 km/h high speed operation are constructed, and many conventional lines are also upgraded to 200 km/h operation (CRC, 2013).

The total length of operating rail network in China is 86,000 km by the end of 2009, this figure reached 91,000 km by the end of 2010, according to the Minister of Railways .Mr. Zhijun LIU at China's National Railway Conference opened on Jan 4, 2011 in Beijing. This means, in 2010 alone, China accomplished approximately 5,000 km newly-built rail lines. Similarly in 2013, the country reaches total 103,144 km of railway lines according to the China Railway Corporation. At present (2014), there are over 30,000 km rail lines under construction in China.

China plans to have basically complete rail network of over 120,000 km by the end of its 12th Five-Year Plan (2011-2015), among which 16,448 km will be high speed lines and 50,000 km rail lines will be built in the western part of the country. By 2015, 50% of Chinese rail network should be dual lines and 60% electrified (CRC, 2013).

China is a member of the International Union of Railways (UIC). Chinese railways has adopted and begun to implement the wireless rail communications standard. China is also a signatory to the Trans-Asian Railway Network Agreement, an initiative of the UN Economic and Social Commission for Asia and the Pacific to promote the integration of railway networks across Europe and Asia.

2.5.1.1. Current and past Regional links

International passenger train services are available to destinations in (CRC, 2013):

- ❖ Kazakhstan, Mongolia, and Russia. These countries use 1,520 mm (4 ft 11 27/32 in) gauge, so there is a break-of-gauge.
- ❖ Hong Kong SAR and North Korea. These use standard gauge.
- ❖ Vietnam, which uses 1,000 mm (3 ft 3 3/8 in), so there is a break of gauge at Hanoi.

Hong Kong



Figure 2.10: The Guangzhou-Kowloon through Train is jointly operated by the Hong Kong MTR and China Rail Corporation.

Train services to Hong Kong terminate at the Hung Hom Station in Kowloon. Within Hong Kong the cross-boundary services use the tracks of the East Rail Line. There are three through-train routes, Beijing line (to/from Beijing), Shanghai line (to/from Shanghai) and Guangdong line (to/from Zhaoqing and Guangzhou East). Another express train service linking Hong Kong and Guangzhou with intermediary stop in Shenzhen has been approved and construction in the China section has commenced. This new express rail line will reduce the train travel time between Hong Kong and Guangzhou from 2 hours to 1 hour (CRC, 2013).

North Korea



Figure 2.11: Sino-Korean Friendship Bridge near the mouth of the Yalu River between Dandong, Liaoning Province and Sinuiju, North Pyongan Province.

There are rail crossings along the border with North Korea at Dandong, Ji'an and Tumen. Dandong, in Liaoning Province, is 274 km (170 mi) east of Shenyang at the mouth of the Yalu River across from Sinuiju in North Korea's North Pyongan Province. This is the most heavily used rail connection between the two countries. Ji'an, upstream on the Yalu in Jilin Province and 400 km (250 mi) by rail from Siping, connects to Manpo in Chagang Province. Tumen, also in Jilin and 527 km (327 mi) east of Changchun is located across the Tumen River from Namyang, North Hamgyong Province (CRC, 2013).

There are four weekly trains with hard and soft sleepers from Beijing to Pyongyang, as well as a weekly carriage attached to the Vostok train from Moscow via Harbin, Shenyang and Dandong.

Russia

China's three rail crossings into Russia are all located along the eastern section of the border between the two countries.



Figure 2.12: A train leaving Russia and enter to China at Manzhouli

- ❖ The crossings at Manzhouli and Suifenhe are at either ends of the Trans-Manchurian Railway, which was a shortcut for the Trans-Siberian Railway built through northeastern China in the early 1900s. Manzhouli, in the Hulunbuir region of northern Inner Mongolia, is China's busiest inland port. It borders Zabaykalsk in Zabaykalsky Krai of Russia's Transbaikal region and handles the bulk of the bilateral freight trade and one of the Beijing-Moscow passenger train routes (CRC, 2013).
- ❖ Suifenhe, in southern Heilongjiang Province, borders the town of Pogranichny in Primorsky Krai of the Russian Far East. The rail station on the Russian's side is called Grodekovo. Freight trains from Harbin to Khabarovsk and Vladivostok pass through Suifenhe. As of November 2008, there was no through passenger service, but one could travel along this route with transfers in Suifenhe, Grodekovo and Ussuriysk (CRC, 2013).
- ❖ The other rail connection is located further south at Hunchun in eastern Jilin Province bordering Kraskino, near the southwest tip of Primorsky Krai. The station on the Russian side, called Makhhalino, is located on the Ussuriysk-Khasan-North Korean border line, about 41 km (25 mi) from Khasan. This border crossing began operating in February 2000, and saw only a minor amount of traffic (678 railcars of lumber) over the next two years. The line was closed in 2002–2003, reopened in 2003, but, as of the summer of 2004, it was still reported as seeing little traffic. The line was closed between 2004 and 2013. As of 2011–2012, plans emerged for reopening it, primarily to be used for shipping coal and mineral ores from Russia to China; the border crossing reopened, initially in a trial mode, in 2013. There are two weekly passenger trains in each direction between Beijing and Moscow (CRC, 2013).

Mongolia

The lone rail connection with Mongolia's railways is located at Erenhot, in Xilingol League of central Inner Mongolia, which borders Zamyn-Üüd in Mongolia's Dornogovi Province. There are two trains every week departing from Beijing and Hohhot to Ulaanbaatar, along with five trains per week from Erenhot. As with rail service to Russia, trains from China need to change bogies in Erenhot, since Mongolia uses broad gauge (CRC, 2013).

Kazakhstan

There are two rail crossings on the China–Kazakhstan border, at Alashankou and Khorgas, both located in the northern part of the Xinjiang Uyghur Autonomous Region. They are the only international rail outlets in western China (CRC, 2013).



Figure 2.13: The Westernmost point on the Northern Xinjiang Railway at the Kazakh border

- ❖ At Alashankou, in the Bortala Mongol Autonomous Prefecture, the Northern Xinjiang Railway passes through the Dzungarian Gate to the town of Dostyk, in Kazakhstan's Almaty Province and connects to Qazaqstan Temir Zholy (Kazakhstan's railway system). This crossing, opened in 1990, forms a New Eurasian Land Bridge, allowing trains from Lianyungang on the East China Sea to reach Rotterdam on the North Sea. There are two weekly passenger trains (one Kazakh and one Chinese) from Almaty to Ürümqi, the capital of Xinjiang. The Chinese train is generally of a higher standard than the Kazakh train.
- ❖ Khorgas, in the Ili Kazakh Autonomous Prefecture, is located southwest of Alashankou in the Ili Valley. The town on the Kazakh side of the border in Almaty Province has the same name, Khorgas. Here, the Jinghe–Yining–Khorgas Railway, a 286-km fork off the main Northern Xinjiang line built in 2009, meets the Zhetigen-Korgas Railway, a 239-km branch from the Turkestan-Siberian Railway completed by Kazakhstan in 2011. The Khorgas crossing, opened in December 2012, provides a more direct route from Ürümqi to Almaty.

Vietnam



Figure 2.14: Dual gauge tracks at Đồng Đăng in Vietnam accommodates both meter gauge trains from Hanoi and standard gauge trains from Nanning and other cities in China.

There are two rail connections between China and Vietnam, at the Friendship Pass and Hekou(CRC, 2013).

- ❖ At the Friendship Pass on the border between Pingxiang, Guangxi Zhuang Autonomous Region and Đồng Đăng in Vietnam's Lạng Sơn Province, the Hunan–Guangxi Railway connects to the dual gauge Hanoi–Đồng Đăng Line. The crossing, opened in 1955, has displaced the older Hekou crossing as the primary rail link between the two countries. There are twice weekly trains from Beijing to Hanoi and both traverse the Friendship Pass. The trains consist of a typical T style Chinese express from Beijing to Đồng Đăng. The train may require passengers to detrain in Nanning for 5 hours (especially on the northbound service); a lounge area with reclining chairs is available for Soft Sleeper passengers (CRC, 2013).
- ❖ At Hekou, the narrow-gauge Kunming–Hai Phong Railway from Kunming, in Yunnan Province crosses into Vietnam's Lao Cai Province. This line, also known as the Yunnan–Vietnam Railway, was built by France from 1904 to 1910 though rugged terrain. Cross-border service on this line ceased in late 2000, but freight trains has kept this crossing operational (CRC, 2013).

2.5.1.2. Proposed rail links

In recent years, China has been actively exploring and promoting the extension of its railway network to neighbouring countries and distant regions including the Russian Far East, Southeast Asia, South Asia, Central Asia, the Middle East and even North America(CRC, 2013).

Macau

Macau SAR is the only province-level division of China that has no railway. An extension of the Guangzhou Railway to Cotai through Hengqin Island has been proposed.

Russian Far East

In November 2008, the transport ministries of Russia and the China signed an agreement to build one more link between the railway systems of the two countries. One project involves the Amur River Bridge across the Heilongjiang (Amur) River, connecting Tongjiang in Heilongjiang Province with Nizhneleninskoye, a village in Russia's Jewish Autonomous Oblast. As of May 2014, it was announced that the construction would start "in a few months", and would be completed by 2016 (CRC, 2013).

Southeast Asia

Proposals have been made to connect Kunming, the capital of Yunnan Province in southwest China with Singapore by three rail routes (CRC, 2013).

- ❖ The eastern route via Vietnam, central route via Laos and the western route via Myanmar would eventually converge in Bangkok, Thailand and from there a single line would be extended to Singapore via Malaysia.
- ❖ The eastern route would replace the century-old narrow gauge Kunming–HaiPhong Railway with a standard gauge, higher capacity railway to Vietnam. The Kunming–Yuxi section was completed in 1993 and the Yuxi–Mengzi section opened in 2013. The Mengzi–Hekou Railway is under construction and expected to be completed by 2014.



Figure 2.15: Map of the proposed routes for the Kunming-Singapore Railway.

- ❖ As for the central route, a railway from Kunming to Laos via Yuxi was slated to begin construction in 2010 but has been repeatedly delayed. The expectations were renewed in October 2012.
- ❖ As for the western route, construction is underway on the Dali–Ruili Railway which would extend the Chinese railway network to the Yunnan-Myanmar border. In November 2010, Wang Mengshu, a railway engineering consultant from the Chinese Academy of Engineering, said that construction on a 1920 km high-speed railway to Yangon was set to begin recently. The railway may be further linked to a deep water port at Dawei. But in March 2011, the Chinese Commerce Minister Chen Deming stated that the project was

delayed due to the first elections in Myanmar in 20 years and differences in the railway gauge of the two countries (CRC, 2013).

In addition to railways in Yunnan, an electrified line is being built from the Guangxi Zhuang Autonomous Region to the Vietnamese border. In March 2010, a branch line off the Nanning-Kunming Railway was completed from Tiandong to Debao. The line is being extended further southwest to Jingxi, with plans to eventually extend it all the way to the Long bang border crossing on the Vietnamese border.

Central Asia

Since 1997, the governments of China, Kyrgyzstan and Uzbekistan have discussed the building of a 476 kilometers (296 mi) railway across the Tian Shan mountains from Kashgar in the western Tarim Basin of the Xinjiang Uyghur Autonomous Region to the Fergana Valley via southern Kyrgyzstan. In March 2013, the China Road and Bridge Corp., an engineering firm, submitted a feasibility study to the Kyrgyz government, which found the project to be too expensive. In December 2013, Kyrgyz President Almazbek Atambayev expressed his preference for an alternative line that would connect the northern and southern halves of the country (CRC, 2013).

On May 5, 2014, the Export-Import Bank of China lent Uzbekistan \$350 million for the construction of a railway through the Kamchik Pass that would connect the Fergana Valley with the rest of Uzbekistan. On May 12, 2014, Presidents Xi Jinping of China and Gurbanguly Berdimukhamedov of Turkmenistan signed a declaration to study the possibility of inviting Chinese companies to build a cross-border railway linking the two countries. On May 22, 2014, the Foreign Minister of Kyrgyzstan reportedly suggested inviting China to join in another regional railway project linking Russia, Central Asian states and the Persian Gulf.

In January 2014, the China Railway Construction Corporation completed a 30-km section of the Ankara-Istanbul high-speed railway between Eskişehir and İnönü in western Turkey (CRC, 2013).

South Asia

- ❖ Since 2007, Chinese and Pakistani authorities have explored the possibility of building the Khunjerab Railway, which would cross the Karakorum Mountains and connect Kashgar with Havelian in the Abbottabad District of northern Pakistan. In June 2013, the Pakistani government indicated that the proposed railway could be extended to the Port of Gwadar on the Arabian Sea. As of February 2014, Chinese rail experts said the railway was unlikely to be built in the near term (CRC, 2013).

- ❖ In March 2011, Indian and Chinese rail authorities expressed interest in initiating a high-speed rail link that would link New Delhi with Kunming, China via Myanmar. The rail link

would utilize the railway from Manipur, India to Myanmar and the Dali-Ruili Railway under construction in western Yunnan Province(CRC, 2013).

Europe

In March 2010, Wang Mengshu said the country was in negotiations with 17 countries to build a continent-spanning high-speed rail network with destinations as far away as London and Germany, which could be completed within ten years. The 8,157 km journey (from Beijing to London) would take just two days to complete on trains travelling at speeds of up to 345 km/h (215 mph). One line would run through Russia and connect into the European rail system. Wang indicated that prospecting and survey work had already been undertaken and that Central and Eastern European countries were ready to cooperate (CRC, 2013).

North America

In May 2014, Wang Mengshu told Chinese media about a proposal to build a high-speed railway from China through Russia and Canada to the United States. The 13,000 kilometers) line would run through a tunnel 200 kilometers long under the Sea. At 350 km/h, a trip from China to the United States would take two days (CRC, 2013).

2.5.2. European Railway Integration and Infrastructure

The European Union is pursuing an active and balanced policy which aims to provide citizens with a quality rail transport service, to improve the management of rail infrastructure, to encourage the development and use of new technologies to build a modern and competitive rail network, and to make rail transport a privileged instrument for European integration (rail Europe, 2014).

Rail transport in Europe is characterized by its diversity, both technical and infrastructural. Rail networks in Western and Central Europe are often well maintained and well developed, whilst Eastern and Southern Europe often have less coverage and infrastructure problems. Electrified railway networks operate at a plethora of different voltages AC and DC varying from 750 to 25,000 volts, and signalling systems vary from country to country, hindering cross-border traffic.

The European Union aims to make cross-border operations easier as well as to introduce competition to national rail networks. EU member states were able to separate the provision of transport services and the management of the infrastructure. Usually, national railway companies were split to separate divisions or independent companies for infrastructure, passenger and freight operations. The passenger operations may be further divided to long-distance and regional services, because regional services often operate under public service obligations, while long-distance services usually operate without subsidies (rail Europe, 2014).

2.5.2.1. Differences between countries

While most railways in Europe use 1,435 mm standard gauge, in some other countries, like Spain or countries which territories used to be a part of Russian Empire and Soviet Union widespread broad gauge. For instance, in Spain it is 1,668 mm, while in Russia, Ukraine, Belarus, Finland, Baltic states gauge width is 1,520 mm or 1,524 mm (also known as Russian gauge). Likewise, electrification of lines varies between countries. 15kV AC has been used in Germany, Austria, Switzerland, Norway and Sweden since 1912, while the Netherlands uses 1500 V DC, France uses 1500 V DC and 25 kV AC, and so on. All this makes the construction of truly pan-European vehicles a challenging task and, until recent developments in locomotive construction, was mostly ruled out as being impractical and too expensive.

The development of an integrated European high-speed rail network is overcoming some of these differences. All high-speed lines outside of Russia, including those built in Spain and Portugal; use 1,435 mm standard gauge tracks. Likewise all European high-speed lines, outside of Germany and Austria, use 25 kV AC electrification. This means that by 2020 high-speed trains can travel from Italy to England, or Portugal to the Netherlands without the need for multi-voltage systems (rail Europe, 2014).

2.5.2.2. Cross-border operation

The main international trains operating in Europe are (rail Europe, 2014):

- Inter City Express (Germany, The Netherlands, Belgium, France, Denmark, Switzerland and Austria)
- Thalys (France, Germany, Belgium, The Netherlands)
- Enterprise (Republic of Ireland & Northern Ireland (UK))
- Eurostar (Great Britain, France, Belgium)
- Euro City/Euro Night (conventional trains operated by nearly all Western and Central European operators, with the notable exception of the United Kingdom and Ireland)
- TGV (France, Belgium, Italy, Switzerland, Germany, Luxembourg)
- CNL (Germany, Italy, Austria, Switzerland, France, Denmark, Czech Republic)
- Elipsos (France, Spain)
- Tren hotel (France, Spain, Portugal)
- Oresund train (Denmark, Sweden)
- SJ 2000 (Sweden, Denmark)
- Rail jet (Austria, Germany, Switzerland, Hungary, Czech Republic by 2014)

Additionally, there are a lot of cross-border trains at the local level. Some local lines, like the Gronau to Enschede line between Germany and the Netherlands, operate on the signalling system of the country the line originates from, with no connection to the other country's network, whilst other train services like the Saarbahn between Germany and France use specially equipped vehicles that have a certificate to run on both networks. When there is an electrification difference between two countries, border stations with switchable overhead lines are used. Venlo railway station in the Netherlands is one such example, the overhead on the tracks can be switched between the Dutch 1500 V DC and the German 15 kV AC, which means a change of traction (or reconfiguring a multiple-voltage vehicle) is necessary at the station (rail Europe, 2014).

2.5.3. Russia Railway Integration and Infrastructure

Rail transport in Russia has been called an economic wonder of the 19th, 20th, and 21st century. In length of track Russian railways are second globally to the railways of the United States. In volume of freight hauled, they are third behind the United States and China, using the standard measure of ton-kilometers (RZD, 2011).

JSC Russian Railways (JSC RZD) is a Russian vertically integrated company, both managing infrastructure and operating freight and passenger train services. In 2012 it became one of the three largest transport companies in the world. The company was established on September 18, 2003, when a decree was passed to separate the railways from the Russian Ministry of the Means of Communication (MPS).

Russian railways carry their freight and passengers over very long distances, often through vast, nearly empty spaces; their average length of haul is second in the world, behind only the United States and essentially tied with Canada. Coal and coke make up almost one-third of the freight traffic and have average hauls of around 1500 kilometers, while ferrous metals make up another 10 per cent of freight traffic and travel an average of over 1900 kilometers. Many remote shippers and customers have access either to only very poor alternative shipping options by road or water, and/or access to those alternative options for less than the entire year.

In 2009 Russia had 128,000 kilometers of common-carrier railway line, of which about half is electrified and carries most of the traffic, and over 40% was double track or better

Besides the common-carrier railways that are well covered by government statistics there are many industrial railways (such as mining or lumbering railways) whose statistics are covered separately, and which in 1981 had a total length almost equal to the length of the common carrier railways. Currently (2008) they are only about half the length of the common-carrier system. In 1980, about two-thirds of their freight flowed to and from the common-carrier

railroads while the remaining third was internal transport on industrial railways. About 4% of the industrial railway traffic was on track jointly "owned" by two companies (RZD, 2011).

2.5.3.1. Owners and management

The Russian Federation is the founder and sole shareholder of JSC Russian Railways. On behalf of its shareholders the powers are exercised by the Government of the Russian Federation. It approves the President of the Company, forms the Board of Directors annually and approves the annual reports (RZD, 2011).

2.5.3.2. Rail links with adjacent countries

Same gauge:

- Finland, the difference to 1,524 mm (5 ft) is so small that the same rolling stock can be used
- Estonia, same approximate gauge as Finland
- Latvia
- Lithuania – only from the Kaliningrad Oblast enclave
- Belarus
- Ukraine
- Georgia – currently, only connects with the breakaway Republic of Abkhazia; the line beyond, to Georgia proper, is closed for political reasons.
- Azerbaijan
- Kazakhstan
- Mongolia
- Break-of-gauge:
 - China, break-of-gauge 1,520 mm (4 ft 11 27/32 in) to 1,435 mm (4 ft 8 1/2 in)
 - North Korea, break-of-gauge 1,520 mm (4 ft 11 27/32 in) to 1,435 mm (4 ft 8 1/2 in)
 - Poland only from the Kaliningrad Oblast enclave- break of gauge 1,520 mm (4 ft 11 27/32 in) to 1,435 mm (4 ft 8 1/2 in)

Note that break-of-gauge between Poland and Belarus near Brest is in use of Russian Railways mostly (RZD, 2011).

2.5.3.3. Future Projects

According to the 2011 JSC RZD Annual Report the company plans to invest over 2.2 trillion rubbles (about 70 billion dollars) until 2020 to upgrade and expand the network infrastructure (without high-speed and high-speed projects). Seven priority infrastructure development projects were allocated. These are approaches:

- To the ports of the South of Russia,
- An approach to the ports of the North-West Russia
- Infrastructure in Western Siberia, and north of the Urals Federal District,
- Trans-Siberian Railway, Baikal-Amur Mainline,
- Mezhdurechensk,
- Abakan – Taishet station,
- The Moscow railway hub.

The company recognizes that, it has not sufficient funding for the major projects planned and the cost of borrowing in the bond market does not allow implementing infrastructure projects with positive financial results and returning on investment (RZD, 2011).

3. Data Acquisition on National Railway Network of Ethiopia

3.4. General

In order to sustain the country's economic growth, fast and efficient transport links are essential. However, although great improvements have been made in the expansion of road Network, Appendix, figure C-1: Ethiopia national road network map, Ethiopia still suffers from limited connectivity, high cost and poor quality of transportation services. In particular, an assessment of the sector indicates that the existing transport system could not adequately cope with expected growth of the economy and mobility needs of the people. Now, Ethiopia has launched the construction of a 5,000 km railway network which aims to link the capital, Addis Ababa, to various regions of the country which is part of the country's five-year transformation plan [ERC, 2011].

Therefore, The Ministry of Transport (MoT), as per Proclamation No. 4/1995 was given the responsibility of expanding and supervising rail transport. A Technical Advisory Group (TAG) drawn from relevant institutions in May 2007 to examine the need for railway transport in Ethiopia and how this would be developed.

The key objective of ERC is to develop an integrated and efficient high speed, high capacity railway transport system in order to ensure competitive and affordable transport for freight and passengers in the FDRE at an affordable tariff structure.

3.4.1. Overview of Ethiopia

Ethiopia is a land locked country in the horn of Africa bordering with Sudan in the west; Kenya in the south; Somalia in the east; Eritrea in the north and Djibouti in the north-east. Ethiopia, with an area of 1.1 million km² and a population of 84.32million in 2012 (Population and Housing Census Commission, 2010), has become the second most populous country in Africa. The occurrence of certain oldest human traces in Ethiopia makes the country famous for historical and scientific development. Ethiopia is an origin of coffee beans and famous for its long-distance runners.



Figure 3.1: Ethiopia and bordering countries (BBC, 2014)

Addis Ababa is the capital city of the country as well as the political capital of Africa, being the seat of the African Union and the UN Economic Commission for Africa, UN-ECA. Besides, at the moment it hosts 107 diplomatic missions. The altitude of Addis Ababa City is around 2400 m above sea level while the present population is 2.74 million (Population and Housing Census Commission, 2010). At the moment, it is growing fast and a rapidly changing metropolitan city.

The Ethiopian government adopted “Agricultural Development Industrialization Strategy – ADLI”, to transform the country from the current least developed status to the middle income level by 2025. Agriculture, as mainstay to the economy and with 85% of the population engaged in this sector, this sector is taken as the platform of development. However, in parallel, industrial development is being promoted with the focus to support and develop export-oriented agriculture productivity through various local processing capabilities [ERC, 2011].

Major agricultural commodities produced and exported from Ethiopia include: coffee beans, oil seeds, leather products, cut flowers, garment and meat products. Facilities for major industries

such as cement and sugar are under construction to provide substantial increases in existing capacities.

Ethiopian international trade mainly consists of imported goods which accounts for about 80% of commodity circulation. Main import items are petroleum and petroleum products, chemical products (fertilizer and industrial inputs), automobiles, heavy machinery and durable consumer goods. Saudi Arabia, China and India are the main suppliers of imported goods. Ethiopian export products are mainly coffee, *Catha edulis* (chat), gold, leather, livestock, flower and oil seeds. Ethiopian export destinations are Germany, Saudi Arabia, USA, Djibouti, China, Italy, Japan and Holland. At present international trade is mostly transported through the Port of Djibouti. The import/export volume through Port Sudan and the Port of Berbera are insignificant.

Ethiopia maintains a very good relationship with other countries of the world. It participated in the formation of the League of Nations in 1923 and signed the Declaration of the United Nations in 1942 and became the 51st founder member of the United Nations (UN). Its capital city, Addis Ababa, is the “Political Capital” of Africa, where the Headquarters for United Nations Economic Commission for Africa (UNECA) and the African Union; former Organization of African Unity (OAU), Ethiopia as the main founder and host.

Ethiopian transportation consists of three sectors; namely, surface transportation (road and railway), sea transportation and air. The Road transportation network, which mainly consists of asphalt and gravel, currently fulfils freight and passenger requirements. Although Ethiopia is a landlocked country, its maritime transportation service plays a key part in connecting Ethiopia with other parts of the world. Ethiopian Shipping Lines (ESL) is now promoting operation of maritime freight transportation service through the Port of Djibouti and Berbera Port. As an inland country, air transportation serves a significant role for its transportation network. Ethiopian Airlines has a long and distinguished air transportation history throughout Africa and the many worldwide destinations which the airline now serves.

Freight transportation in Ethiopia, as a landlocked country, is currently dependent on road transportation (truck), and is facing difficulties due to capacity constraints and high costs. Importers are forced to charge high transportation costs, while exporters fail to be competitive due to the high transport costs incurred for the long distance truck transport.

Therefore, it is envisaged that the planned National railway network of Ethiopia (NRNE) standard gauge railway development strategy launched by the government of Ethiopia, will address capacity, cost and customer satisfaction issues and ensure that the main export/import corridor, as well as planned growth centers and significant investment sites throughout corridor continue to be sustainable [ERC, 2011].

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A modern, high capacity, high speed standard gauge with electric traction railway system is planned for Ethiopia. It has launched the construction of a 5,000 km national railway network with 8 routes which aims to link the capital, Addis Ababa, to various regions of the country which is part of the country's five-year transformation plan (ERC, 2011):

Table 3.1: Proposed short- and long- term railway projects in Ethiopia and their length

Route #	Route name	Route Length(Km)
1	Addis Ababa-Modjo-Awash-Dire Dawa - Dewele- Djibouti	756
2	Modjo- Shashemene/Hawasa – Konso-Weyto(Including Konso-Moyale)	905
3	Addis Ababa- Ijaji-Combolcha-Gurafarda-Dima including Combolcha-Hara Gebeya (direct to Boma with further extension to south Sudan)	739.4
4	Ejaji_Nekemt_Asossa_Kurmuk	460
5	Awash_Combolcha_Mekele_Shire	757
6	Fenoteselam_Bahirdar_Wereta_Weldia_Mile_Djibouti	757
7	Wereta_Azezo_Metema_Railway	733.7
8	Adama_Indeto_Gasera	244

Source: ERC files

The latest Railway master plan study carried out in 2014 by ITALFERR for ERC, has detailed cost and benefit of analysis of 8 routes (Exclude A.A / Sebeta – Djibouti Railway project) shows a priority based on EIRR, Benefit cost Ratio and sum of the priority scores indicated below. Similarly, freight and passenger traffic volume, financial cost, benefit of the project and the evaluation result is shown in the Appendix, Table C-2.

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table 3.2 Rail Line Prioritization

LINES	Normalized EIRR	Normalized B/C	Sum of Priority Scores	RANK
2. Modjo - Moyale	96.39	100.00	2,062	1
6. Fenoteselam - Tadjourah	0.00	61.91	1,700	2
7. Wereta - Metema	89.93	53.60	1,507	3
8. Adama - Gasera	70.46	20.28	953	4
4. Ijaji - Kurmuk	64.93	22.91	922	5
3. Addis - Dima	58.90	12.67	751	6
5. Waldiya - Shire	28.25	-13.07	159	7

Source: ITALFERR, 2014

According to the Growth and Transformation Plan (GTP) of the Government, the projects selected in the first phase from the eight National Railway routes are (ERC, 2011):

- Addis Ababa/Sebeta – Mieso – Dewele
- Mekele – Hara Gebeya - Tadjourah
- Awash – Combolcha – Hara Gebeya
- Addis Ababa/Sebeta – Jimma – Bedele
- Modjo – Boditi - Weito

Three routes are selected in this research to discuss about the project especially Ethiopia Djibouti railway project.

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

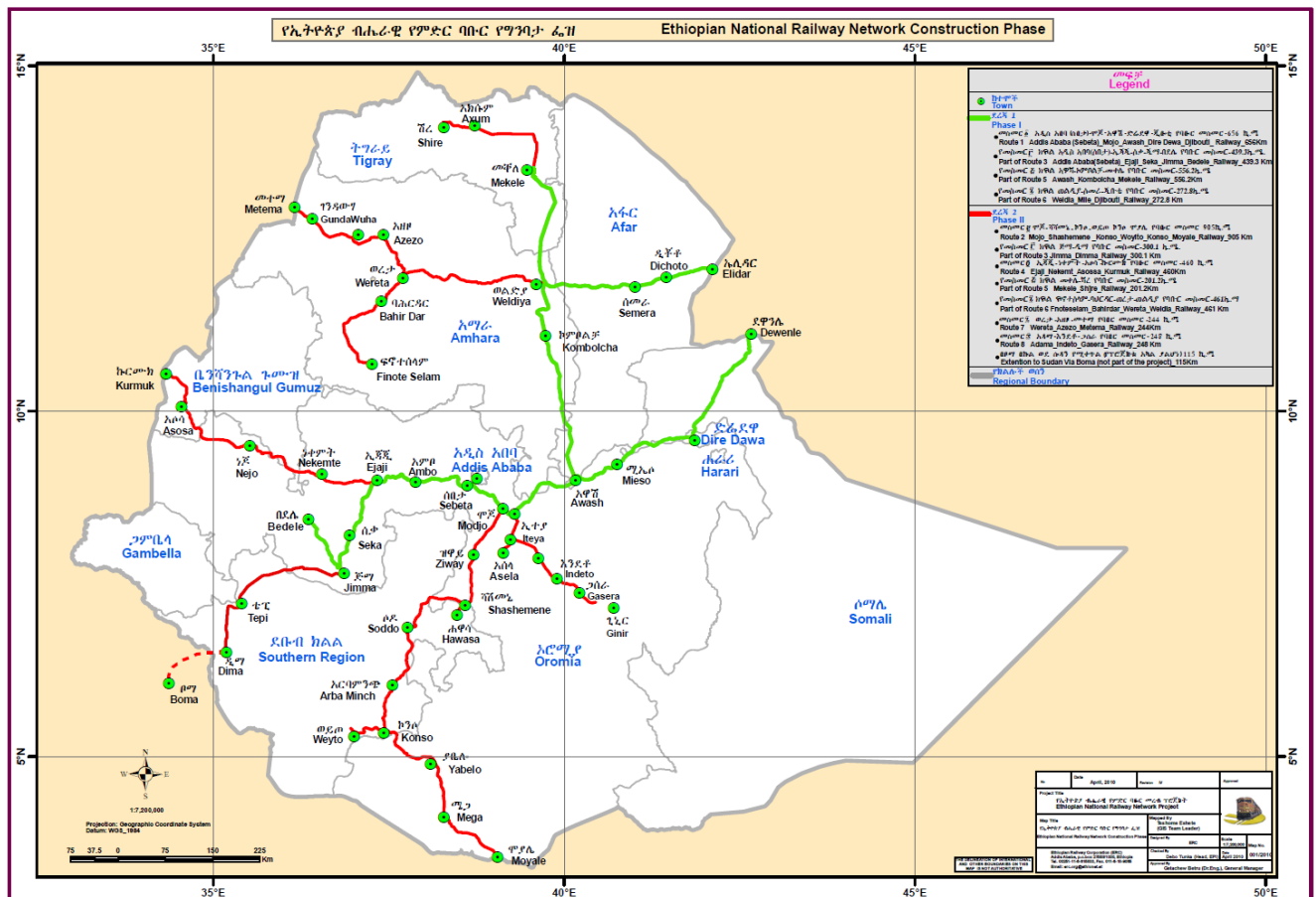


Figure 3.2: The Future Ethiopian national railway network

3.5. Addis Ababa /Sebeta -Djibouti Railway Project (Route 1)

3.5.1. Introduction

The new modern standard gauge railway was initiated by HE Meles Zenawi, the former Prime Minister of Ethiopia. The purpose of the new railway is not to complement the road transport buses and trucks, but more of to contest the road industries and take over the upper hand in the corridor traffic with the great enthusiasm, reinforced by its triple advantageous position:

- a new, superior and high speed technology compete;
- high level of economic growth and volume of traffic; and
- maximum energy efficiency and cleaner environment

The Government of the Federal Democratic Republic of Ethiopia (FDRE) has for many years recognized the need to improve and expand the existing transportation network throughout Ethiopia. In its national Five Year Plan (2010/11 – 2014/15), referred as the “Growth and

Transformation Plan” issued in September 2010, FDRE has confirmed its commitment to improve the country’s transportation infrastructure with the proposed development of a standard gauge railway network for Ethiopia.

The priority corridor for the NRNE will be the construction of a new standard gauge railway line from Addis Ababa (Sebeta) to Djibouti (Doraleh Ports), which will have an estimated length of 756 km (656 km inside Ethiopia and 100 km inside the territory of the Republic of Djibouti). This will replace the existing dysfunctional line between the capital cities of Ethiopia and Djibouti.

3.5.1.1. Overview of Djibouti

Djibouti is located in the western bank of the Gulf of Aden in the horn of Africa. It is along the coast of the Red Sea suitability to access the Indian Ocean. Its neighbours are Eritrea in northwest, Somalia in the southeast and Ethiopia in south and southwest. Its area is 23,200 km² with 372 km long coastline.

According to results of 2009 Census, the total population of Djibouti was 0.818 million. The official language is French and Arabic with Afar and Somali as main national languages. Most area is formed with low volcanic plateau and desert with low-laying plains and lakes between these areas. The East African Rift Valley passes through the middle of the country.

Economy is low and depends on animal husbandry, mainly sheep, goat, cow and camel. Agriculture is insignificant, with only a small amount of grains and vegetables grown near the city of Djibouti due to lack of productive arable land. There is fishery and salt industry in coastal areas. Tourism and Port services very well support the national economy while it imports food grain and all industrial products. The power supply is based on diesel generation and cannot support extensive industrial application. Currently, its electrical power supplied by Ethiopia.

The Ethio - Djibouti Railway, stretching from Addis Ababa to the Port of Djibouti is the oldest link; though, due to old-age its function has been limited on freight from Djibouti to the city of Dire Dawa. The country is reported to have 3,000 km highway network.

Passenger transportation to and from Ethiopia is mostly by air while freight is transported by trucks owned and operated by Ethiopians or Djiboutian. To-date, there is no public passenger bus transport between Ethiopia and Djibouti. However, this does not exclude personal movement using station wagon or automobile by holding necessary permit.

Djibouti encourages commerce and investment with very low minimum registered capital. The country has laws to regulate various investment activities. These include Investment Law, Industrial Free Trade Zone System and Bonded Enterprise Law. Investment Law and Industrial Free Trade Zone System offer preferential customs.

Diplomatic Relations attaches importance to develop peaceful relationship with neighbouring countries and emphasizes stability in the Horn of Africa. Djibouti hosts Headquarter of the Intergovernmental Authority on Development (IGAD), which initiates sustainable development and fighting against drought in the sub-region. Members of IGAD are Djibouti, Kenya, Ethiopia, Sudan and Uganda.

Djibouti is the main gateway to Ethiopia's foreign trade. It is situated on the East African coast where the Red Sea meets the Gulf of Aden. The Djibouti Corridor has three major surface transport routes that link Djibouti and Ethiopia.

- The Ethio-Djibouti Railway (or CDE) which was connects Addis Ababa and Djibouti via Dire Dawa.
- The Addis Ababa – Awash – Galafi - Djibouti road (the northern road link).
- The Addis – Ababa – Awash –Erer- Dire Dawa - Djibouti road (the southern road link)

These three form what is named as the Djibouti Corridor, which has gained significance since Ethiopia became a landlocked country. This corridor has several advantages over the others. Djibouti ports are geographically nearest to the main central hinterland and most of the country, it is linked with hinterland by two major modes: roads and a railway; and it is the biggest and modern but expensive port serving Ethiopia.

3.5.1.2. The Port of Djibouti



Figure 3.3: Djibouti port structures and layout

The Port of Djibouti is situated at the junction of the Red Sea and Gulf of Aden. It was established at the beginning of the 20th Century (1917) with the construction of a rough 500m long piers and the construction of the railway to Addis. Djibouti thus became Ethiopia first major modern port. In July 1926, the construction of the present port was started by filling

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around the sunken liner-ship, Fontainebleau, about 1500m from the sea shore, with rocks and building a causeway to the shore. Since then the port has been expanding through addition of new berths, facilities, dry port, container terminals and the recently completed Duraleh port with over 1.2Mn TEU and huge petroleum capacities (Port de Djibouti, 2013).

Table 3.3: presents the Profile of Djibouti port indicating basic features, strength, weaknesses, opportunities and threats and the future area of focus for development.

No.	Descriptor	Description
1	Name	Port of Djibouti
2	Location	19°53'N - 37°13'E, at Strait of Bab-el Mendeb a confluence of the Red Sea and Gulf of Aden
3	Country/REC	Djibouti; East/Horn of Africa; IGAD, COMESA
4	Maritime Routes	Strategically located on Maritime routes connecting it directly to Europe, Middle East and Asia
5	Infrastructure	No. of berths 15, adequate warehouse and port structures, dry port, free port and container and petroleum terminals
6	Equipment	Adequate dry-bulk, break-bulk and container handling equipment
7	Labour force	About 5000 employees
8	Management	Managed by Dubai Port International (DPI) under a 20 year management contract to manage and develop the port including development of free trade zone.
9	Capacity	Total Capacity: 10Mn tons; Cargo handled: 6.25Mn dry and 2.29Mn liquid bulk cargo in 2008. It also handled 152,798 import and 140,167 export containers (2008)
10	Performance	Perth throughput container handling 20/hr., container stay time 12 days; cargo stay time of 20 days, transit time of inland transport 3 days
11	Cost of Services	Container handling costs are as follows: Port charges for stuffing/un-stuffing is USD 113/TEU, Port Dues is USD45.3/TEU and storage charge is USD6.35/TEU and the total cost of USD700/TEU and 20/ton

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12	Countries Served	Djibouti (domestic), Ethiopia (landlocked) and some transshipment to other ports. It now serves about 98% of Ethiopian traffic which is about 85% of the whole port traffic.
13	Corridor Designation	Djibouti-Addis Ababa Corridor, the main import-export corridor of Ethiopia. There is a Joint transport agreements and corridor committee to follow the implementation
14	Transport Modes	Road = 910km, in very good condition, and another under consideration. Railway =782km, old and in bad conditions now dysfunctional
15	Strength	Good location, commercialized through private management, good infrastructure and equipment, adequate traffic, and completion of modern Duraleh container terminal
16	Weaknesses	Relatively expensive, poor handling of drivers and rail service, lack of rail siding to Duraleh in Djibouti delay in signing of the agreement, monopolistic attitude in providing services and increasing port charges without consultation.
17	Opportunities	Big economic growth of Ethiopia, rehabilitation of Ethio-Djibouti Railway and plan to construct dry port at Mojo, Semera and Dire Dawa; over all good relationship including recent multi-modal and investments agreements between the two countries.
18	Threats	Possible competition from Berbera, Assab and others; Cargo safety and security; delays at border crossing and transit checkpoints, poor customer handling, etc.
19	On-going Projects	Further expansion of Duraleh terminal, improving cargo handling equipment and rehabilitation of CDE
20	Planned Projects	- Axle load control (of COMESA), study of USD0.5Mn, projects in pipeline - Transit and trade facilitation program: USD 1Mn Road Safety and HIV/AIDS: on major transit routes atUSD1Mn
21	Way forward	Improving facilitation, increasing productivity, practicing client-friendly and consultative management approach and separation of policy and management domain

Source: By Ato. Yusuf Ahmed, Djibouti Port Authority, CDE and Road Transport Authority

The Djibouti corridor is the natural port of Ethiopia in every sense of the word. It is the shortest route. Over 85% of the port capacity is utilized by the Ethiopian traffic, the border crossing is efficient. The relation between Ethiopia and Djibouti is very good and there is now no major insurmountable difficulty in the transit services.

There are many corridor related agreements signed between the two countries: the General Agreement on Transport between the two countries, and the Treaty on the Djibouti-Ethiopia Railway (CDE), the multi-modal transport operation, the “Facilitation of Transport in the Djibouti – Ethiopia Corridor” and other related trade and transport agreements.

The governments of Djibouti and Ethiopia have recently signed and ratified a multimodal transport agreement involving a full scale Corridor Development Initiative (CDI) supported by preferential investment along the corridors and in their two countries. The three major dry ports along the Djibouti-Addis corridor; the first two are Mojo and Semera along the northern route and the proposed third is in Dire Dawa on the railway line/road junction between Addis and Djibouti. The new construction of dry port at Dire Dawa which could be a front line dry port at Semera with three objectives: first to serve Dire Dawa and the surrounding areas; second to serve as evacuation center to reduce the Djibouti port congestions; and third, support Mojo and other central freight terminals of the country.

The Corridor Chart of the Addis Ababa- Semera Road corridors and Port of Djibouti Layout are shown in Appendix, FigureC-2: (a) & (b), Total Volume of Djibouti Port chart and Container Throughput are also shown in the Appendix, Figure C-3: (a) & (b).

3.5.1.3. Project Profile

The NRNE priority corridor from Addis Ababa (Sebeta) to Djibouti, including corrections to the existing Port of Djibouti and the new Port of Durableh where new oil and container terminal handling facilities are in place. The existing Port of Djibouti is currently under rehabilitation to expand bulk and break bulk cargo handling facilities.

Main tracks

Ethiopia Djibouti Railway project has three sections:

- 1) Sebeta - Mieso (included), about 329.15km long;
- 2) Mieso (excluded)-Dewele (located in Ethiopia and on Ethiopia-Djibouti border), about 344.85km long;
- 3) Dewele (excluded)-Nagad, the front-port station of Djibouti, about 82.0km long.

The total length of the above tracks is 756km.

Relevant works

- 1) Nagad (front-port station of Djibouti)-existing port (Djibouti), with a track length of about 8.0km;
- 2) Nagad (front-port station of Djibouti)-new port (Duraleh), with a track length of about 5.8km.

Starting from Addis Ababa/Sebeta, the capital of Ethiopia, the line of the Project runs eastwards and gets to Nagad (front-port station of Djibouti) via Indode(Akaki), Bishoftu, Modjo, Adama, Metehara, Awash, Mieso, Bike, DireDawa, Arawa, Adigala, Aysha, Dewele, Queleleh, Ali Sabieh, and Holhol. It is 756km long and electric traction will be used. The total length of the tracks in Ethiopia (Sebeta-Dewele) is about 674km, and the length of main tracks in Djibouti (Queleleh-Nagad) is about 82.0km. The tracks of railway-related works in port area of Djibouti are about 13.8km long and diesel traction will be used. The design running speed is 120km/h.

Main stations inside Ethiopia along the route include Sebeta, Addis Ababa (Lebu), Indode (Akaki), Mojo, Adama, Metehara, Awash, Mieso, Dire Dawa, Adigala and Dewanle within the territory of Ethiopia. The final section of the route inside the territory of Djibouti will pass through the main town of Holhol and Djibouti, with branch lines, which will incorporate exchange siding facilities, to the Ports of Djibouti and Doraleh. The route alignment in both Ethiopia and Djibouti will also pass through a number of minor towns.

Ethiopia and China have now finalized the financial arrangements. The loan agreement providing for USD 2.9 billion was signed between Ethiopia, Djibouti and China for the construction of the 756km Addis Ababa/Sebeta - Djibouti railway project. The tripartite agreement was signed in the presence of HE Prime Minister Haile Mariam Dessalegn by Dr. Eng. Getachew Betru, CEO of the Ethiopian Railways Corporation and by Mr. Ilyas Moussa Dawazeh, the Djibouti Economy and Finance Minister and Mr. Zhu Xinqiang, the Vice President of Exim Bank of China, representing their respective countries.

The Contracts have been signed with two Chinese companies, China Railway Engineering Group (CREC) for the Addis Ababa to Mieso section of the corridor and China Civil Engineering Construction Corporation (CCECC) for the Mieso to Dewele (Ethio Djibouti border) section of the corridor in October and December 2011 respectively. For the Dewele (Ethio - Djibouti border) to Djibouti Ports section of the corridor, negotiations between CCECC and the Government of Djibouti (GoD) Ministry of Transport and Equipment are well advanced and finalization of associated contractual arrangements is anticipated. The Engineering, procurement and Construction (EPC) Contract Price of these two sections is USD 1.197 billion and USD 505 million respectively. The Project will replace the existing meter-gauge railway that is obsolete and become the railway corridor to the sea from Addis Ababa to Djibouti.

Ethiopia Standard Gauge Railway Location Map

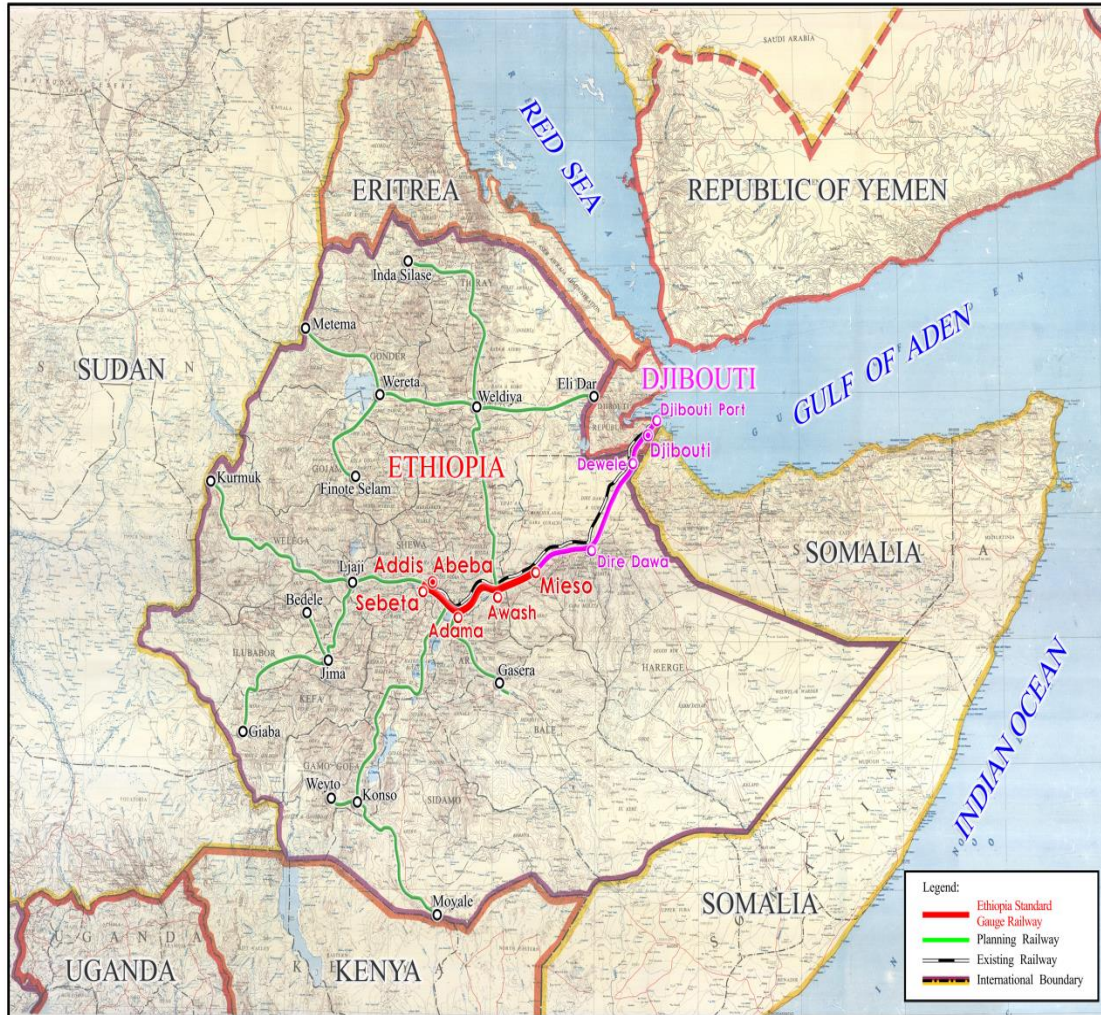


Figure 3.4: Proposed Ethiopia – Djibouti Standard Railway Line

3.5.2. Significance and Roles of the Project

3.5.2.1. Significance

- 1) Construction of the Project can meet the requirement of construction of National Railway Network of Ethiopia

In September 2010, the Government of Ethiopia issued its national Five Year Plan (2010/11 2014/15), referred as the Growth and Transformation Plan, and in the plan it has confirmed its overall guideline of improving the existing transport infrastructure with development of a

standard gauge railway network for Ethiopia. During this period, Ethiopia will build its National Railway Network with a total length of 2046km and a 34 km Light Rail Transit system in the capital city of Addis Ababa. According to the “Growth and Transformation Plan”, Ethiopia will give priority to construction of the Addis Ababa/Sebeta-Djibouti Port railway corridor for its National Railway Network. The completion of the Project and the adjoining Ethiopian national network, it will serve as the shortest passage for Northern Kenya and Southern Sudan to the Red Sea. Moreover, construction of the Project will have a positive impact and catalytic effect to construct Southern (towards Kenya) and Western trunk line (towards Sudan) of the East African railway link (ERC, 2011).

2) Construction of the Project will accelerate sustainable social and economic development of Ethiopia

Ethiopia is a developing country that has a relatively high social and economic growth rate in Africa. Since 2002, Ethiopia has witnessed a stable development of national economy and achieved double-digit growth of Gross domestic product (GDP) for consecutive years. However, Ethiopian economy is based on agriculture, and its industry is still at an early development stage. Due to lack of basic production bases, Ethiopia’s social and economic development mostly depends on the international trade. As an inland country, its international trade has to rely on ports of other countries. Ethiopia’s import/export goods are mainly transported through the Port of Djibouti. Regarding the goods imported via the Port of Djibouti, most of them are transported to Ethiopian central regions. The freight traffic volume of these regions; account for 75% of the total and the freight traffic volume of the north area and east area accounts for 15% and 10% respectively. Therefore, construction of the Addis Ababa – Djibouti Port railway corridor is an important transport infrastructure project for Ethiopia. Construction of the Project allows Ethiopia to build a short and convenient international transport corridor to the sea and so it is of great significance for sustainable social and economic development of this country.

3) Construction of the project is the demand of building a green transport corridor in Ethiopia

There is a meter-gauge railway connecting Addis Ababa to the Port of Djibouti, which is jointly owned by Ethiopia and Djibouti and run by Chamin de Fer Djibouti- Ethiopian (CDE). It was completed in 1910 and has 37 stations in total. Now, due to sub grade settlement, rail deformation, and rails blocked by highway in some sections, this railway cannot be put into operation. Although there is a European company performing partial repair for this railway; but, this seems ineffective. As this railway is nearly abandoned, goods transported between Addis Ababa and Djibouti Port mostly depend on the highway of which the construction standards are low. Along the railway line, the climate is dry and the eco-environment is fragile. Highway transport has such disadvantages as low transport capacity, high transport cost, and

large energy consumption and consequently, its exhaust emission results in environmental pollution.

High technical standards for standard-gauge railway will be applied to the Project. Compared with expressway transport, railway transport is a “green” high-capacity transport mode that is fast and convenient, land-saving, energy-saving, environmentally friendly, and safe. The land occupied by the project just roughly accounts for 1/2 of that occupied by highway project; if electric traction is adopted, the energy consumption will only accounts for 1/4-1/6 of that of highway project. Therefore, through construction of the Project, a green transport corridor of Ethiopia will come into being, and the railway line will be complementary to the current highway transport upon completion of the Project.

(4) The project will improve the inland transport system of Djibouti Port

Djibouti is located at the western bank of the Gulf of Aden in the horn of Africa endowed with tourism attraction and Port services very well support the national economy while it imports food grain and all industrial products. The Project will improve the inland transport system of the Djibouti Port and provide a fast and convenient through put with a high capacity for Djibouti Port and thus improve the inland collection, distribution and transport system. Furthermore, the Project will have a positive impact on main areas along the line and facilitate development of the port service industry and national economy of Djibouti.

In conclusion, the Project can meet the requirements of construction of National Railway Network of Ethiopia, and will provide a fast and convenient international transport corridor to the sea coast for Ethiopia and meanwhile accelerate sustainable social and economic development of Ethiopia. Through construction of the Project, a green transport corridor of Ethiopia will come into being, and the railway line will be complementary to the current highway transport upon completion of the Project. In addition, the Project will improve the inland transport system of Djibouti Port and facilitate development of the port service industry and national economy of Djibouti. Therefore, construction of the Project is necessary.

Ethiopian import and export is growing significantly every year. Most of Ethiopian imports and exports are handled through the Port of Djibouti. Therefore, construction of the railway will play an important role in supporting and promoting the economy of both countries.

3.5.2.2. The Roles of the proposed project

This line is the most important international railway transport corridor of Ethiopia and the most important inland collection, distribution and transportation corridor of Djibouti Port. The following are important roles:

- 1) Important international railway corridor to the sea coast and basic project for the planned national railway network of Ethiopia;

- 2) Most important for collection, distribution, and transport of cargoes through railway corridor for Djibouti Port;
- 3) A trunk railway between Ethiopia and Djibouti for mixed operation of passenger and freight with freight transport as the main part.

3.5.3. Technical Features/ Specification Requirements of the Project

The Addis Ababa/Sebeta – Port of Djibouti railway line starts at the highlands of Ethiopia and traverses along the rift valley and terminates in the low lands of Djibouti.

3.5.3.1. Terrain and Hydro-geological Conditions

The land form and terrain condition varies from highland and plateau in Ethiopian to desert plain land in Djibouti. Except in a few undulating sections, most of the railway line can be considered flat terrain with acceptable altitude differences. The entire route can be grouped as follows:

- Plateaus, highlands and shadow hill areas formed because of erosion and undercutting of seasonal flood for months and years, surface-deep dry gulch;
- Volcanic lakes at different sites;
- Low mountain and shallow hill areas;
- Plain and low hill area mainly covered with dense spiky shrubbery ;
- Plain area with sparse vegetation and locally developed gulch;
- Etc.

Lithology of Strata

The strata along the railway line are largely covered with tertiary-quaternary basalt, tuff, volcanic lava and Mesozoic sedimentary rocks and Palaeozoic substratum are sparsely exposed. Covering soils are mainly hard plastic-like black cotton soil, silt clay, moll sol and soft soil with large thickness difference.

Geologic structures

The railway line is located within East African Rift Valley, where crustal motion is active, geological structures mainly consisting of fault and volcano; are under abnormal development and fault mainly belongs to feather fracturing, mostly secondary fault of Great Rift Valley of Ethiopia (generally the result of a compression-shear fault).

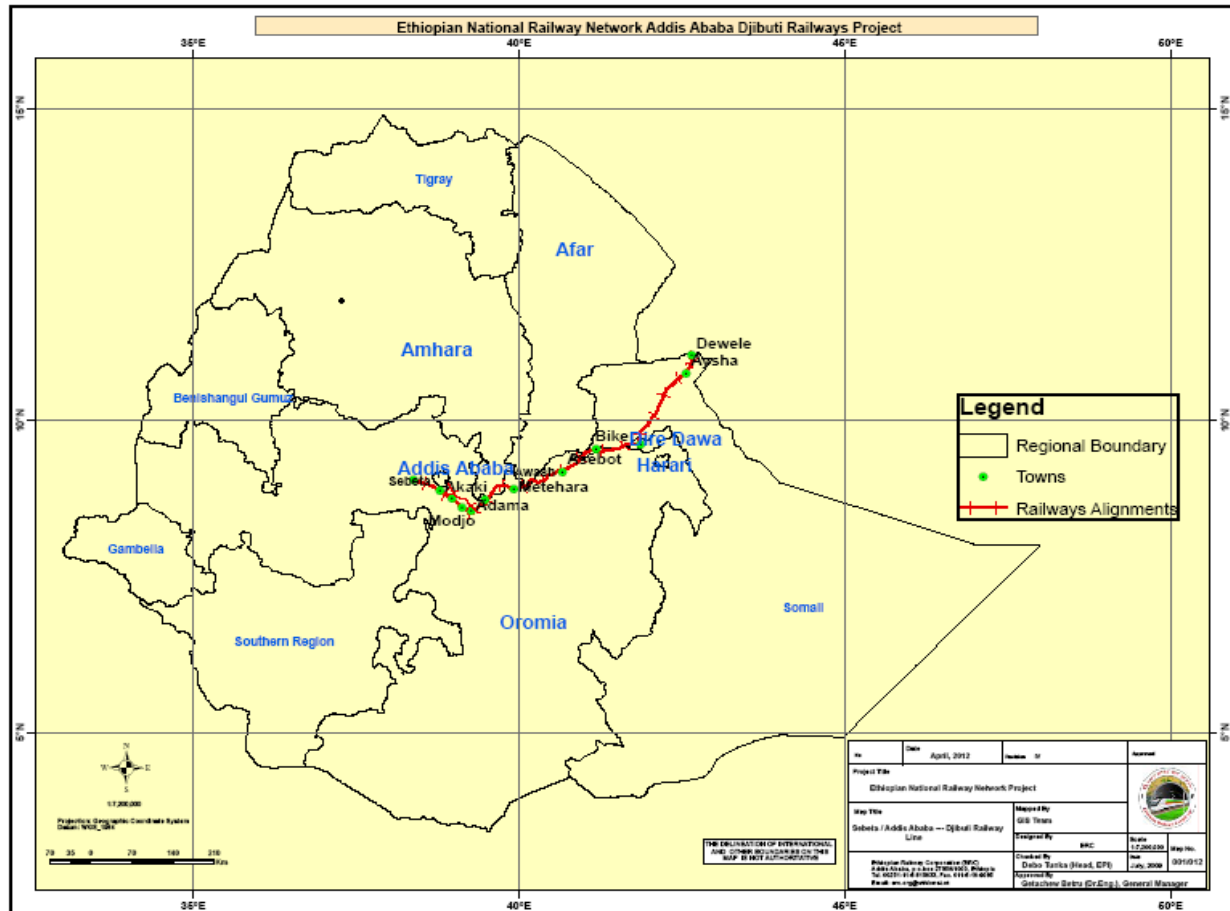


Figure3.5: The Addis Ababa /Sebeta- Djibouti route alignment

Hydro-geologic features

The underground water along the route mainly includes ditch-water, swamp water, and water from Awash River and Beseka Lake. There is no river with perennial water along the line except the Awash River. There are underground water resources at various sites along the route.

Main Engineering Geological Problems

The railway line is to be built in areas of highland terrace, shallow hill and plain, with wide terrain and small undulating in some sections. There is basically no natural disaster and major unfavourable geologies such as landslide, collapse, debris flow, coal bed and gob along the whole line. Main engineering geological problems are seismic faults, expansive soils, loose rock and bedrock soft interlayer, unstable slope and soft soil.

3.5.3.2. Main Technical Standards – Track and Civil Engineering Works

General

The main technical standards proposed in the Revised Feasibility Study Report of ERC are as follows:

Table 3.4: Technical Features of the Project

TECHNICAL ITEM	REQUIREMENT
TRACK	
Railway class	Referring to National Railway Class II in China
Track Length	756km
Gauge	1,435mm
Number of main lines	double track: Sebeta-Adama; single track: Adama-Mieso-Djibouti
Distance between centers of lines	4m
Passing loops	3 km long at 30 km intervals approximately or at stations (Subject to capacity assessment and performance)
Rail section	UIC54kg Long Welded Rail (LWR) on concrete sleepers at 60cm spacing
Turnouts and Passing loops	Suitable for 100kph in the loopline
Alignment	Where possible, construct as open route (i.e.in cuttings/Embankments, on bridges /viaducts as much as possible).Where tunnels are required; this need to be as short as possible.
Minimum curve radius	1200m for normal section and 800m for difficult section
Ruling gradient	Ruling Gradient: 9% and Pusher Gradient:18.5%
Maximum passenger train speeds	120kph
Maximum freight train speeds	80kph
Permanent speed restrictions	<10%of the route mileage
Axle loading	25Tones Maximum
Structure Gauge	UIC Compatible
Traction mass	3500t
Effective length of receiving-departure track:	880m for dual locomotives 850m for single locomotives
Block type	semi-automatic block

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TECHNICAL ITEM	REQUIREMENT
ELECTRIFICATION	
Traction type	electric traction
Traction supply	25KV 50Hz via Overhead Line Equipment
Sub-stations supply	From two separate sources
ROLLINGSTOCK	
Passenger rolling stock	EMU and Locomotive hauled passenger trains
Main line locomotives	9,600HP Electric Traction for freight and passenger train operation.
Freight rolling stock	100Tones gross weight. Examine option for double stacking containers. Freight train length756m
Maintenance locomotives	2,500HP Diesel Electric Traction (Can be used for project construction train operations, initial revenue earning Services and operational disruption recovery).
Shunting locomotives	1,000HP Diesel Hydraulic Traction or similar
Braking System	Dual Air Pipe (Operation and Fail Safe) or similar
Coupling Type	“Buck Eye “or similar automatic type
SIGNALS & COMMUNICATION	
Signalling	Semi-automatic block system
Communication	Fibre optic based; Fixed Line and mobile telephones.
Train control	CTC, ATC, ATS, remotely controlled points machines
OPERATION	
Trailing Load(Freight)	Short term (up to 2015): 3500t; Long term (after 2025): 4000t
Predicted Journey Time from Addis Ababa to Dire Dawa	Passenger Train 4Hours (Fastest Train)
Predicted Journey Time from Addis Ababa to Dire Dawa	Freight Train 8Hours (Fastest Train)
Predicted Journey Time from Dire Dawa to Djibouti	Passenger Train 3Hours (Fastest Train)
Predicted Journey Time from Dire Dawa to Djibouti	Freight Train 6Hours (Fastest Train)

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TECHNICAL ITEM	REQUIREMENT
MISCELLANEOUS	
Level crossings	To be avoided–use grade separation wherever possible. Where necessary in urban/developed areas, remote controlled and monitored by CCTV.
Line side Fencing	Animal proof fence to be provided in the open country with accommodation crossings or elevated sections to suit the environment and wildlife.
Marshalling Yards	Simple layout (to suit current capacity requirements with provision for future capacity aspirations).
Strategic Maintenance Depots	Addis Ababa(Indode) and Dire Dawa
General Maintenance Depots	At intervals, or convenient town or city. Provision to be made for stabling of“ on track” maintenance plant (tamping/rail grinding machines etc.);provision also to be made to stable diesel rescue locomotives for recovery of broken down trains.
Station structures	Platforms (length circa300m, number to be determined by capacity assessment/performance modelling), ticket offices, train maintenance/cleaning sheds, shopping complex at Main stations.
Environment	Compliant with national regulation. Pay particular attention to wild life conservation, forests, water ways and water Towers.

Source: ERC, Revised Feasibility study on Ethiopia – Djibouti Railway Project

Track

The design speed of the proposed railway is 120 km/h, consisting of the main line with trans-section continuously welded rails laid once on a ballasted track. In segments where tunnel may be necessary, resilient ballast-less track structure will be used.

Rail

Rails are new hot rolled rails, without bolt hole, of 52 or 54 kg/m with cut length of 25m.

Sleeper and fastening

Concrete sleepers with shoulders and spring clip fastenings will be employed whilst corresponding concrete turnout sleepers (bearers) are laid in turnout areas.

Crushed stone ballast bed

Minimum depth of ballast for single track ballast is 300 cm with a minimum 300 mm heaped ballast shoulder to prevent track “buckling”.

Main Structural Works

Bridge and culvert designs shall consider appropriate flood frequencies. Approved “run off” and hydraulic modelling software to be used to determine worse case opening sizes for major bridges and culverts. Railway bridge and culvert design live load are calculated on the basis of “medium-live load”. No unfavourable geology is anticipated along the route. Seismic influence will be taken into account and design of structures enhanced accordingly to minimize damage risk. Design principles of tunnel, if any, considers the maximum running speed of passenger train which is 120km/h and working life of tunnel lining to be 100 years.

Construction Materials

Mixing proportion of construction materials shall be adjusted depending on the materials to be employed and location specific project technical requirements. Sampling and testing of all materials to be used in the project shall be carried out.

Crossings and Turnouts

Regarding arrangement of turnouts, one crossover shall be set between two main lines at the throats at two ends of the overtaking station respectively to and from a splayed crossover. Intermediate station crossover shall be arranged reasonably according to the location of station freight yard and industrial siding. The number of turnouts on the main line shall be minimized. Radius of the connecting curve behind the turnout shall match with lateral passing speed regulated for adjacent turnout.

Stations and Yards

Major design principles of station platform capacity and the number of reception/departure tracks will consider existing and projected traffic volume. Expansion for long term operational requirements will be allowed for at the detailed planning stage and associated land reserved as part detailed planning process. The design of station depends on the capacity of the traffic volume.

The whole line is provided with 12 tentative stations in construction period. The Sebeta - Mieso section has 8 stations and basically approved, including 1 passenger station and 7 intermediate stations. Also, the main stations of the whole line are Labu Station, Indode Station and Adama Station others are small intermediate stations and all stations are arranged on a straight line, and on slopes not steeper than 1%.

Table 3.5: Stations along the Ethiopia-Djibouti railway Project

Range	Sequence	Name of Station	Type of Station	Plan	Territory
Double Track section	1	Sebeta	Intermediate station	Straight line	Ethiopia
	2	Labu	Passenger & main station	Straight line	Ethiopia
	3	Indode (Akaki)	Intermediate & main station	Straight line	Ethiopia
	4	Mojo	Intermediate & large station	Straight line	Ethiopia
	5	Adama	Intermediate & main station	Straight line	Ethiopia
single Track section	6	Metehara	Intermediate station	Straight line	Ethiopia
	7	Awash	Intermediate station	Straight line	Ethiopia
	8	Mieso	Intermediate station	Straight line	Ethiopia
	9	Dire Dawa	Intermediate station	Straight line	Ethiopia
	10	Adigala	Intermediate station	Straight line	Ethiopia
	11	Dewele	Intermediate station	Straight line	Ethiopia
	12	Nagad	Intermediate & main station	Straight line	Djibouti

Source: ERC, Revised Feasibility study on Ethiopia – Djibouti Railway Project

3.5.4. Social Impact Assessment

3.5.4.1. Purpose

The primary objective of social impact assessment is to eliminate and/or minimize negative social impacts resulting from the project to make sure that project implementation and operation meet local development goals, adapt to the local social situation and meet the needs of the affected population. Furthermore, the project shall bring opportunities to the local people and help in this way to reduce poverty; besides, it shall also benefit women and vulnerable groups, maintain social stability and facilitate both economic and social development.

3.5.4.2. Social Impact Identification

Project impacts can be characterized as follows:

1. Direct and indirect impacts: Direct impacts are those being caused immediately by the project, e.g. the loss of land due to project construction, while other impacts can be indirect consequences of project effects. For indirect impacts, the Social impact (SI) will have to focus on those which are clearly caused by the project
2. Short term and long term impacts: Some project induced impacts are short term and/or transient, meaning that they will last only for a limited period, while others might be long term and/or permanent. So is the fact that railway construction will produce job opportunities and thus income to the local population, a short term effect on poverty, limited to the construction period, while the loss of (agricultural) land due to the project will be permanent. Similarly, secondary effects on the development of the regional economy will have positive, cumulative effects in the long term.

For practical terms of an SI, the most important impacts of such projects are usually the following:

- Loss of land: the railway line and its appurtenant structures require land, and more land is occupied temporarily during the construction phase. Such losses need to be compensated, especially in the case of agricultural land.
- Noise and air pollution
- Separating effects: the fact that railways are linear structures often leads to a situation in which e.g. residential areas find them separated from service areas which were easily

accessible before, or access to certain categories of land (pastures, sources of firewood or water) is no longer possible. Here as well, mitigation will be required.

- Effects on natural habitats and landscapes: while this is rather an environmental than a purely social impact, it cannot be left without mentioning. It is possible that such entities, be it specific habitats or landscapes with a distinct characteristic, have an important cultural or spiritual meaning, offer important resources to the local population, or are of economic importance due to their potential for tourism.
- Direct and indirect economic project effects: these are negative impacts (loss of land as productive resource; loss of occupation due to the new competition from the railway system) as well as positive ones (job opportunities during construction, economic development made possible by the railway project).

3.5.4.3. Socioeconomic Impacts Mitigation of the Railway Project

The project has several short-term and long-term social and economic benefits. The main negative impact is on the social and economic environments that are short term and mitigation can be done through compensation and proper relocation as well as public participation. The main physical impact is on land (erosion and landscape change). Proper plans for erosion control and landscaping and restoration will relieve the impacts. Impact on hydrology is moderate from the points of view of the location of the project, water table depth and design condition. Full Resettlement Action Plan (RAP) study of the Route I project is completed by design consultants and some lots of the project resettlement and compensation payment is undergoing.

Among the mitigation measures are:

- To provide as much as possible replacement land for the relocation of affected persons;
- To deliver all necessary support to the project affected persons during the relocation and compensation processes
- To provide employment opportunities for local people during construction & operation
- Increase national Transport Network / Access.
- Increase Market Integration.
- Investment will be encouraged in the towns, which in turn open employment opportunity for the local community and others as well.
- Reduction of vehicular emissions (carbon and other atmospheric pollutants resulted from the combustion of fuel) and dust generation.

A railway project usually will guarantee huge employment opportunities during the construction period; besides, there is also a large demand for local construction materials and accommodation and other services for the construction workers. This will generate a large number of jobs and therefore income. Later on, railway operation and the economic activities resulting thereof will create a different type of employment and required services. In both periods, there is direct employment (workers hired for railway construction and operation) and indirect employment (in services to be provided to the workforce or in any other economic activity created by the project). Since indirect employment has a multiplier effect, the social analysis will usually be limited to quantifying direct employment. For this reason, as well as due to its contribution to the regional and national economic development, the public support is great as it has minimum impact on public properties.

3.5.5. Legal and Institutional Framework and Sustainability of the Railway Project

The Addis Ababa – Djibouti Railway Line is a strategic and huge investment Project. Thus, it requires coordinated move by the governments of Ethiopia and Djibouti. Recognizing and respecting the sovereign rights of each other, there is a strong economic convergence between these two long standing sisterly countries. To this effect, there is unreserved commitment by both nations Heads of States and Governments to ensure successful implementation of the Project. Continuous consultation and due consideration is given for the development and operation of a new Standard Gauge railway line between Ethiopia (Addis Ababa) and Djibouti (Durableh Port). The efforts exert are described below.

3.5.5.1. Institutional Arrangements

At the concept stage of the Addis Ababa – Djibouti Standard Gauge New Railway Project, the government of Ethiopia consulted the government of Djibouti regarding the socio-economic importance it avails to citizens of both countries.

Several initiatives were pursued at different levels. These includes Continental (AU Infrastructure), Regional (COMESA Infrastructure), Sub-regional (IGAD) and Bilateral (Ethio-Djibouti Joint Commission). Each of these initiatives lay basis for launching cross border projects as the Addis Ababa – Djibouti railway project.

Taking the Addis Ababa – Djibouti railway project as a jointly desired project, a Memorandum of Understanding (MoU) was signed on 10th of June 2010 at Djibouti by the Minister’s responsible for the Transport sector on “The Development and Operation of Standard Gauge Railway Line between Ethiopia and Djibouti”. As a follow-up to the signed MoU and

reinforcement to the speedy implementation of the new railway project, a working visit was made by the Transport Minister of Ethiopia to the Minister of Transport and Equipment of Djibouti from July 13 – 18, 2011.

3.5.5.2. Ownership, Management and Maintenance Modality

Each country owns the standard gauge railway infrastructure in its territory. Both countries will establish a railway company (Joint Venture) to operate and maintain the railway network. The management, operation and maintenance of the Standard Gauge railway network shall be conducted according to international principles and best practices to be mutually agreed by both countries.

Consultation has been underway between Ethiopia and Djibouti to sign a bilateral agreement for “The Development and Operation of a Standard Gauge Railway Network” few months ago. In this regard, the Ministry of Transport of Ethiopia has drafted such a bilateral agreement and submitted to the Ministry of Affairs, on April 18, 2012, requesting its dispatch to the government of Djibouti for consideration and subsequent signing as soon as practicable.

3.5.5.3. Sustainability of the Project

In order to smoothly operate in the railway line, the day-to-day functions of the railway system shall be handled by Railway Operator(s) as per defined modalities. Similar design parameters are applied to ensure interconnection and interoperability. Issues of license, standards, safety and security will be administered by Railway Sector Regulatory Agencies to be established in each country.

The design, construction, commissioning and sustained operation of the Railway Project will be overseen by Joint Committee drawn from Ministry of Transport, Ministry of Finance and Economic Development, Operators and Regulator of each country. Such monitoring and technical support will allow efficient and effective implementation of the project. The government of Ethiopia, being the leader of railway project execution, will provide professional assistance, share experience and offer sponsorship of Railway MSc Program to personnel of Djibouti.

The Government of Ethiopia has launched various development projects to transform the country from about 370 USD per capita in 2010/11 to a middle income country (1,000 USD in 2025). One of the ambitious projects is the development and operation of new standard gauge railway line in many parts of the country. The Ethiopian Railways Corporation (ERC) is established by the Council of Ministers Regulation Number 141/2007 to build railway infrastructure and provide freight and passenger rail transport service in the country and to and from adjacent countries. In the past four years, ERC has been strengthening its organizational structure and designing strategies to bear its responsibility. To successfully

implement the railway sector development in Ethiopia, a concerted effort is required from the Operator (ERC), Engineering Design Consulting Firms, Contractors, Metal Manufacturing Companies, Small and Medium Enterprises and Higher Education. To do so, sufficient number of qualified and professionals in the various railway engineering and management fields, which at the moment is lacking, is essential. Therefore, the capacity building is given due emphasis. In the Ethiopian context, capacity building consists of three important pillars; namely, Organizational Structure, Human Resource and Working System

I.Organizational Structure

Recognizant of the above challenges, ERC has undertaken studies how to overcome these challenges. Based on a worldwide assessment of Railway Industry setup, it has defined a robust Organizational Structure that can facilitate an immediate engagement to a full scale infrastructure development to become functional in a reasonably short time. The Organizational Structure is presented in Figure

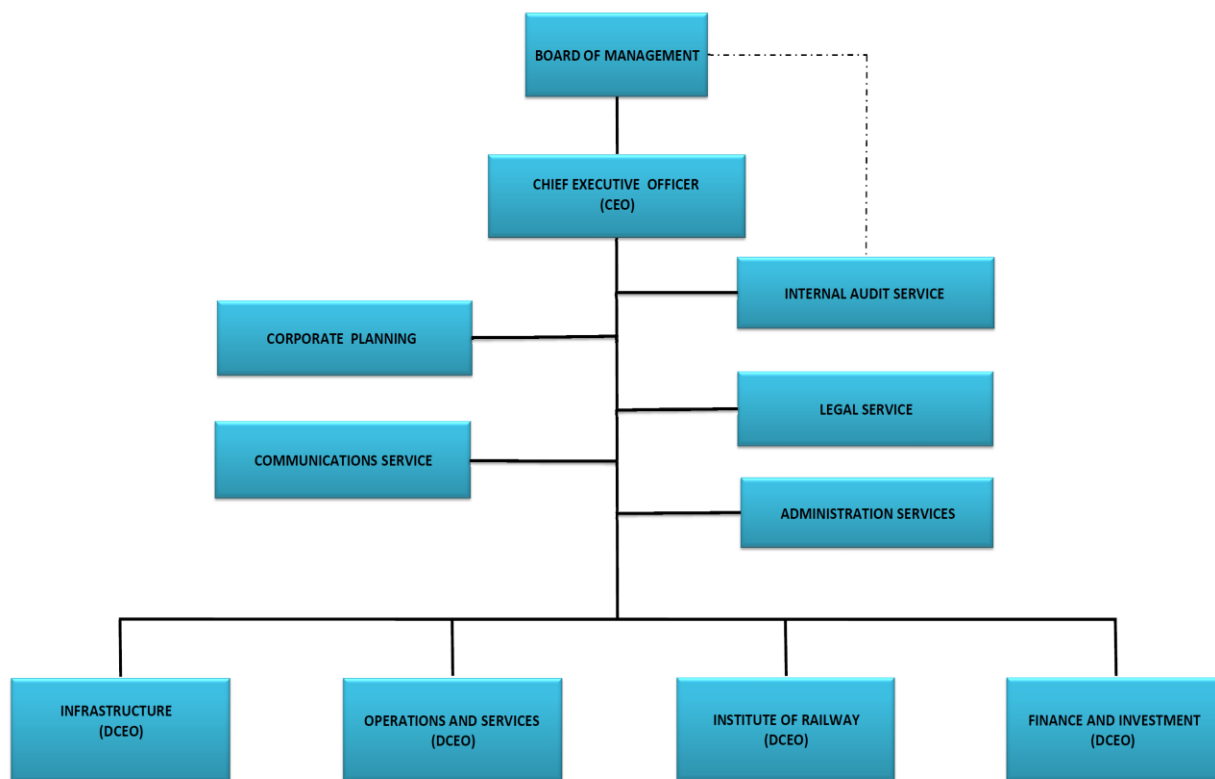


Figure 3.6: ERC Organizational Structure (approved in September 2011)

II. Human Resource (Manpower) Development

The manpower requirement of ERC will increase from 100 in 2011 to more than 500 in 2015. This number does not include professionals involved in the sector deployed by the different actors.

Human Resource Development of the sector is well defined. The manpower requirement up to 2019/2020 is estimated to be 434,020. Such huge figure is necessary since the national railway development is targeted to 5,060 km during the same period. The Ethiopian Railway Sector Human Resource Development Plan (2012 -2020) is shown in Appendix, Table C-2.

The Human Resource requirement is huge. Therefore, ERC in collaboration with the Ethiopian Ministry of Education has developed strategies how to meet these targets. For Technical and Vocational Education and Training(TVET) Program Occupational Standards are prepared which is under curriculum development that immediately will be administered by the TVET Schools all over the country. With respect to M.Sc. /MA Program, pertinent Universities are selected and curriculum developed. M.Sc. Railway Engineering Program is signed with the Addis Ababa Institute of Technology to educate 521 students in five years. Of this, 199 M.Sc. students were joining Addis Ababa University at May 2012. On the other hand, an abundant number of Science and Engineering students are enrolled by the Ministry of Education in 31 Universities and hence it is to hire as required.

III. Working Systems

This refers to procedures, rules, guidelines, standards, etc. that ensures smooth flow of work, makes an organization efficient and effective as well as clear, transparent and accountable. Methods and tools for such use need to be developed through time. At present few technical and administrative working systems are in place which will be complemented by customizing some more from best practices.

3.5.6. Forecasting of Traffic Volume

3.5.6.1. General

By the introduction of the new standard gauge rail line, it should be possible to handle passenger and freight traffic movements to and from the Port of Djibouti more easily and to boost traffic volumes, thus furthering the cause of the rail transport option. As a result, aspects of the project that involve relations with Djibouti are vital for the completion of the new railway line. The passenger services to be provided include a portion corresponding to domestic traffic for which an initial assessment has been made which requires detail analysis of the cross-border issue in the new railway system.

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The traffic forecast analysis of the corridor indicated that implementation of the new Standard Gauge Railway line is vital for supporting the economic development of the two countries by increasing the reliability, ensuring affordability, improvement of traffic flow and reductions road accident for the freight and passenger transport. It will also allow overcoming congestion of freight at the port of Djibouti by promptly dispatching bulk freight to its destination. In 2010 Traffic survey along the route was conducted by the Addis Ababa University (AAU), analysed and freight and passenger volumes forecasted for the years 2015, 2020, 2025 and 2035.

The Ministry of Transport (MoT) had also conducted import-export study and made 20-years traffic forecast based on the continuous sustained economic growth of the country. Both MoT and AAU study results are close, the AAU (in the Appendix, Table C-3 (a) & (b): Ethiopian Freight Export by AAU, Annual Ethiopian Freight Import), being relatively higher, and showed the accelerated traffic flow in the Addis Ababa – Djibouti corridor.

Table 3.6: Forecast annual Ethiopian Freight Imports and Exports (in Thousands, tons)

Year	Export	Import		Total
		Dry	Fuel	
2014/15	1,824	6,721	4,471	13,016
2015/16	2,036	7,304	4,862	14,202
2016/17	2,328	7,944	5,293	15,565
2017/18	2,646	8,646	5,767	17,059
2018/19	2,937	9,416	6,344	18,697
2019/20	4,494	9,597	6,401	20,492
2020/21	4,700	10,653	7,106	22,459
2021/22	4,903	11,825	7,887	24,615
2022/23	5,098	13,125	8,754.7	26,978
2023/24	5,281	14,569	9,718	29,568
2024/25	5,448	16,172	10,787	32,407
2025/26	5,595	17,950	11,973	35,518
2026/27	5,713	19,925	13,290	38,928
2027/28	6,063	22,117	14,752	42,932

Source: MoT, Ethiopia

The new freight service is expected to foster a major shift of traffic from road to rail and further increases in the traffic volumes handled to keep pace with national growth. It is, therefore,

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important to identify the mechanisms and the organizations to establish tariffs and fix rules for competition between the different transport modes.

Ensuring that the rail transport system is properly integrated into the overall transport chain in the Port of Djibouti is a condition for the success and efficiency of the future freight transport system between Ethiopia and Djibouti.

At this stage, future passenger services have only partly been defined, and, in the light of the traffic forecasts so far produced, only the section between Addis Ababa and Dire Dawa has been quantified at one intercity train per hour between 6:00 and 22:00 (last departure at 17:00) comprising the following:

- On the Addis Ababa – Adama section: a mixture of intercity and suburban and regional trains;
- On the Adama – Awash section: a mixture of intercity and regional trains
- On the Awash – Kulubi section: intercity trains
- On the Kulubi – Dire Dawa section: a mixture of intercity and regional trains

Passenger traffic count has been conducted by AAU in the corridor with specific Origin-Destination. The passenger estimate from 2010, 2015, 2020, 2025 and 2030 as presented in Table

Table 3.7: Passenger Forecast

Year	2010	2015	2020	2030
Passenger (mill)	0.31	0.499	0.804	2.089
Growth rate	10%	10%	10%	10%
Increase/yr.	-	0.0473	0.0763	0.1428

Source: Addis Ababa University

Annual passenger for the years 2016 through 2030 is determined by considering average increase rate based on the five years forecast provided. Hence, estimated passenger km of the corridor generated is shown in the table below.

Passenger traffic is obtained by assuming 10%, 70 % and 20% passenger share for the Addis Ababa – Djibouti; Addis Ababa – Dire Dawa and Addis Ababa – Mieso destinations, respectively.

Addis Ababa – Djibouti = 10% * 756km = 75.6km

Addis Ababa – Dire Dawa = 70 % * 466.15km = 326.305km

Addis Ababa – Mieso = 20% * 329.15km = 65.83km

Total = **467.735km**

Then, Annual flow (Passenger km) = 467.735km* No of Passenger (million)

Table 3.8: Estimated annual passenger traffic movement

Operation year	No of Passenger (million)	Annual flow Passenger (km)
2015	0.499	233.40
2016	0.549	256.74
2017	0.604	282.41
2018	0.664	310.66
2019	0.731	341.72
2020	0.804	376.06
2021	0.884	413.66
2022	0.973	455.03
2023	1.070	500.53
2024	1.177	550.59
2025	1.295	605.65
2026	1.424	666.21
2027	1.567	732.83
2028	1.723	806.12
2029	1.896	886.73
2030	2.089	977.10
2031	2.298	1074.81
2032	2.528	1182.29
2033	2.780	1300.52
2034	3.059	1430.57
2035	3.364	1573.63
2036	3.701	1730.99
2037	4.071	1904.09
2038	4.478	2094.50
2039	4.926	2303.95
2040	5.418	2534.34

The Percentage of shifting from Road to Rail technology and the growth rate of passenger and freight is so generous but it is Governmental policy and also, there are many Factors that affecting the volume fluctuation:

- Today, the truck moves empty haulage to import route in the ratio of 70 to 30 which means, there are a lot of cost loss by empty haulage in terms fuel, Tire, Spare parts, Time and Labour. Accordingly, most of the trucks expose of this cost can be saved by apply the pick pack transports of trucks from Addis Ababa to Djibouti;
- Transport to Djibouti corridor passing through foreigner countries, which means all exposes in Djibouti is in foreign exchange. Hence, Ethiopian government policy is to minimize this foreign expenditure.
- The social, political, economic, and cultural developments;
- Increase capacity of imports and Exports goods;
- The change in distribution of productivity;
- The economic prosperity and the improvement of living standards ;
- The natural census growth;
- The enlargement of carrying capacity in the area attracting passengers by upgrading existing lines and the construction of new lines;
- The development of modern transportation modes and the change in the capacity;
- The renovation of pricing strategy;
- Etc.

3.5.6.2. Freight and Passenger Tariff

For freight revenue calculation, the traffic volume by the Ministry of Transport is considered with 90% railway share of the total import and export for the base case. The freight tariff is 0.883 Birr/Tone km, which is 30% less than the average truck transport cost. The passenger tariff is 0.30 Birr/passenger km, equivalent to the asphalt first class public transport rate.

3.5.6.3. Number of Passenger and Freight Trains

Effective from 2015, the railway line is expected to commence service. Thus the rolling stock will increase according to the traffic forecast. Electric traction locomotives and EMU trains will be deployed. The freight train traction mass initially is 3,500 tons in the short run that will increase to 4,000 tons in the long run.

3.6. Addis Ababa/Sebeta – Kenya Railway Project (Route2)

3.6.1. Introduction

The proposed Addis Ababa to Moyale corridor will pass through Addis Ababa, Bishoftu, Mojo, Shashemene, Hawasa, Sodo, Arba Minch, Konso, Weyto, Yabelo and Moyale, which are mainly in the Administrative Regions of Oromia and SNNP.

However, based on the geographical distribution of the existing population, the proposed railway line is expected to positively impact (directly and indirectly) the lives of up to 30 million people in eight regions.

3.6.1.1. An Overview of the Addis Ababa - Moyale Railway Corridor

In order to provide an overview of the corridor, the planned railway alignment has been split into 7 areas as follows: -

Area 1 – Addis Ababa/Gelan to Shashemene/Hawassa

Area 2 – Shashemene to Sodo

Area 3 – Sodo to Arba Minch

Area 4 – Arba Minch to Konso

Area 5 – Konso to Weyeto

Area 6 – Konso to Yabello

Area 7 – Yabello to Moyale

The route Proceeding south west from Mojo, the alignment then passes close to or through the towns of AlemTena, Meki, Ziway, Adami Tulu, BulBula, Dole, Arsi Negele, and Shashemene to Hawassa. Various lakes (Ziway, Abijatta, Langarno, Shalla and Hawassa) are passed, both on the left and right hand sides of the alignment. No major structures are envisaged on this section of alignment.

The maximum permitted gradient of 2% has been used on the approach to Shashemene. An interchange station and major freight depot facilities are anticipated at this site. To the immediate south of the planned station site at Shashemene, a junction to connect the main alignment to intermediate stations to Sodo, Arba Minch, Konso and Moyale is required. In order to optimize passenger and freight traffic flows, some reversing of trains will however be necessary for services to/from Hawassa to the south.

In the Area 1, station is proposed at Gelan, Bishofetu (DebreZeyit) and Mojo. Map of Route Alignment Area 1 (Gelan/Mojo) to Area 7 (Moyale) is shown in the Appendix, Figure C-4.

Areas 2, 3, 4 and 5 – Shashemene to Konso including Branch to Weyto

South of Shashemene, this route currently crosses the main road three times before it reaches Konso, in order to avoid high altitude topography. The planned alignment also passes over Lake Abaya on the north side of Arba Minch.

The use of limiting gradients is unavoidable because of the topography, so performance and timetabling of both freight and passenger trains in the area will require detailed investigation. Also the use of major structures such as tunnels and viaducts is to be kept to a minimum.

The proposed branch line from Konso to Jinka has now been terminated at Weyto, due unacceptably difficult terrain conditions to between Weyto and Jinka.

In the Areas 2, 3, 4 and 5, stations are proposed at Hawassa, Arba Minch, Konso and Deritu. Alignment Passing over Lake Abaya to Avoid High Terrain North of Arba Minch is shown in the Appendix, Figure C-5 and Alignment passing through the Forest Area South of Arba Minch is also shown in Appendix, Figure C-6.

Areas 6 and 7 – Konso to Moyale

The terrain in the first part of this route immediately south of Konso (gorge of River Segen) continues to be difficult, and the issue of major structure assessment will require careful evaluation when the detailed survey information is made available.

Around and to the north of Yabello, due to the high altitude terrain, it has been necessary to take the planned outline track alignment to the north of these mountainous obstructions. Between Yabello and Moyale, the terrain is much less difficult and no major infrastructure construction problems are apparent on this section of the alignment.

At Moyale a significant area of land has been allocated to the project for station and rail freight management and exchange facilities. It is anticipated that this site will also accommodate FDRE customs and dry port facilities for cross border control and management both passenger and freight commodities into and out of Ethiopia.

In general in this section, major civil engineering works are still required at various locations along the alignment.

3.6.2. Project Wide Specification Requirements

There are a number of criteria which need to be considered during the procurement and selection of the “project wide” specification for any new railway system. During the course of the project development, it is anticipated that, for each of the railway disciplines, a series of performance specification will be developed by the nominated supplier or joint venture ERC contractor. ERC will review and check this documentation to ensure that it is fully compatible with overall system requirements. The main technical standards proposed in the Revised Feasibility Study Report of ERC are as follows:

Table 3.9: Technical Features of the Project and summary of anticipated key system infrastructure

TECHNICAL ITEM	REQUIREMENT
TRACK	
Gauge	1,435 mm
Passing loops	3-km long at = 30km intervals approximately or at stations (Subject to capacity assessment and performance modeling)
Rail section	UIC 54 or 60 kg rails CWR on concrete sleepers at 60 cm spacing
Turnouts and Passing loops	Suitable for 100 kph in the loop line
Alignment	Where possible, construct as open route (i.e. in cutting/embankment, on bridges/viaducts as much as possible). Where tunnels are required, these to be as short as possible.
Formation Width	Single Track (Suitable for Double Track provision in future)
Horizontal curvature	> 2,000 meters minimum (in urban areas and approaching developed cities, lower radii can be permitted).
Ruling gradient	<1.0% (In exceptional conditions 2% maximum gradient will

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	be permitted to minimize extent of tunnelling works),
Maximum passenger train speeds	160 kph (with future provision for 225 kph operation)
Maximum freight train speeds	120 Kph
Permanent speed restrictions	<1% of the route mileage
Axle loading	≥ 25 tones minimum
Structure Gauge	UIC Compatible
ELECTRIFICATION	
Traction supply	25 KV 50 Hz
Sub-stations supply	From two separate sources
ROLLING STOCK	
Passenger stock	EMU and Locomotive hauled passenger trains
Mainline locomotives	6,000 HP
Freight cars	100 tones gross weight with flats. Examine option for double stacking containers. Freight train length 775m
SIGNALS AND COMMUNICATION	
Signalling	Cab signaling; no line-side structures
Communication	Fiber optic based
Train controlling	CTC, ATC, ATS, remotely controlled points machines
MISCELLANEOUS	
Level crossings	To be avoided – use grade separation wherever possible. Where necessary in urban/developed areas, remote controlled and monitored by CCTV.
Line side Fencing	Animal proof fence to be provided in the open country with Accommodation crossings to suit environment and wildlife.
Marshalling yards	Simple layout (to suit current capacity requirements with provision for future aspirations).
Strategic Maintenance Depots	Addis Ababa, Dire Dawa, and Arba Minch or Yabelo.
General Maintenance Depots	At intervals of about 90 km, or convenient town or city. Provision to be made for stabling of “on track ”maintenance plant (tamping /rail grinding machines etc., provision also to be made to stable diesel rescue locomotives for recovery of broken down trains.

Station structures	Platforms (length circa 300m, number to be determined by capacity assessment/performance modelling), ticket offices, train maintenance/cleaning sheds, shopping complex at main stations.
Environment	Compliant with national regulation. Pay particular attention to wild life conservation, forests and water ways and water towers.

Source: ERC, Feasible study on Ethiopia – Kenya Railway Project

Performance specifications for all supply items will be developed during future stages of the project. ERC is preparing (almost finish) its own full set of railway standards, it may adapt this standard or UIC or similar international railway standards.

3.6.3. Environmental and Social Impact Assessments

3.6.3.1. Introduction

The proposed Addis Ababa – Moyale railway corridor is located in southern part of Ethiopia and it will provide a vital transportation link from the capital city in the central part of Ethiopia to all towns on the traditional route to the southern town of Moyale(at the Ethio-Kenya border) over a distance of about 905 km. Also on the Kenyan Planning for the construction of new railway infrastructure between Moyale, Nairobi and Mombasa is also now being progressed by the Kenyan Government. The Corridor Provides an efficient transport link to the important coffee growing part of the country with the regional and national capital, Hawassa and Addis Ababa respectively. The project will therefore enhance the planned Trans-East African Highway and as both countries are members of COMESA, optimum use of both corridors will be made to ensure import-export transit traffic costs are minimized.

The main objective of the preliminary Social and Environmental Impact Assessment (SEIA) is to ensure that the negative environmental and social impacts of the rail construction activities will be avoided or reduced to acceptable levels and positive impacts enhanced so as to improve the overall environmental and social performance of the rail project.

A major environmental assessment task in project lending operations is the screening of projects to determine to which environmental category a project shall be assigned. Projects shall be mandatorily assigned to one of following four categories:

- Projects will require a full SEIA, including the preparation of an Environmental and Social Management Plan (ESMP).These projects are likely to induce important adverse environmental and/or social impacts that are irreversible, or to significantly affect

environmental or social components considered sensitive by the Bank or the borrowing country

- Projects require the development of ESMP
- Projects require no impact assessment. These projects shall involve no adverse physical intervention in the environment and induce no adverse environmental or social impact.
- Projects involve investment of Bank's funds through Financial Intermediaries (FIs) in subprojects that may result in adverse environmental and/or social impacts.

3.6.3.2. Description of the Baseline Environment

Physical Environment

The topography over which the rail project will pass is predominantly flat followed by rolling terrain. The rail project is located in three climatic zones. The Weina Dega zone, warm temperate climate, whereas the Yabello - Moyale section falls in hot semi-arid climate zone. The predominant land cover along the route corridor is bush land and woodland. In addition, there is dense plantation forest and natural forest along the rail line. The dominant land cover type along the route is forest areas, broadleaved deciduous woodland, bush land and grasslands.

Biological Environment

The natural vegetation of the project area can be classified into three vegetation types. These are high forest, mixed broadleaved deciduous woodland and Acacia woodland, and Acacia wood land and bush land. The high forest land is a mixture of natural forest and plantation forest. The broadleaved deciduous woodland is mostly either mixed or interspersed with Acacia woodland and bush land. Acacia woodland and bush land, which is interspersed by grasslands in some areas, predominantly covers the corridor.

Socio-economic Environment

The total assessed portion of the population having access to Addis Ababa- Moyale railway corridor is up to 30 million people. Livestock husbandry plays the greatest role in the livelihood across the wealthy groups in the pastoral communities. The total livestock population in the project areas is estimated to be about 10 million, of which cattle accounts for 12% and sheep 8%, approximately.

Project Alternatives

In terms of route options, the rail project is found to be technically, economically, and socio environmentally the most feasible route to achieve the project objectives. There is no reasonable alternative route to achieve the project objectives. The rail project has local, national as well as international importance. It connects regional states ORS and SPNN (woredas), several towns and many villages and provides international connection to Kenya through Moyale.

3.6.3.3. Potential Environmental Impacts and Mitigation Measures

Adverse Impacts

There are a number of significant adverse environmental impacts that are likely to result from developing this railway project and its subsequent operation. These are summarized as follows, together with proposed mitigation measures: -

- **Soil erosion, compaction and pollution:** - resulting from land clearing and grubbing, extraction of construction materials, compaction by heavy equipment, use of detours and access roads and spillage of hazardous substances like fuel and oils. The potential impacts can be minimized by limiting land clearing to the imperative area for the project, applying half-way construction method, adjusting the railway construction for the dry season, lining the side and diversion drains with existing or potential gully erosion, establishing vegetation or grasses on ground surfaces exposed to water or wind erosion, and restoring borrow pits, detours and access roads when construction is completed.
- **Negative visual impacts/landscape quality:** -emanating from clearance of vegetation, exploitation of quarries and borrow pits, and side-tipping of spoil materials from road cuts. This impact can be mitigated through stockpiling spoil/excess materials at proper sites and utilizing them in back-filling of quarries or borrow pits, and restoration of borrow pits and quarries through back-filling, landscaping and by re-establishing vegetation cover.
- **Impacts on water resources:** -including sedimentation and water pollution as a result of excavation for foundation of culverts, spillage of hazardous substances, and conflicts over water with existing users. Recommended mitigation measures include carrying out cross drainage works during the dry season, proper storage and handling of hazardous substances, and developing water supply sources for the construction works and the campsite requirements.
- **Air and noise pollution:** -stemming from dust, exhaust emissions and noise generated during the earth moving activities, hauling of construction materials, and aggregate

production. Those potential impacts can be reduced by restricting traffic speeds and regular watering of detours and other active construction sites, regular and effective maintenance of construction equipment and vehicles, and locating contractor's site establishments away from sensitive receptors like villages & towns, water sources, schools, health units and religious sites etc.

- **Deforestation/damages of natural vegetation:** -caused by vegetation clearance during widening of the road, construction of detour roads, exploitation of material sources and contractor's site establishments (campsites, aggregate production & asphalt mixing plants). The potential impacts can be minimized through application of half-way construction method, careful sitting of material sources & contractor's site facilities by strictly avoiding forest lands & dense woodlands, replanting areas affected by temporary uses like borrow sites, campsites & access roads, and prohibiting cutting of vegetation by the construction workforce.
- **Impact on wildlife:**-related to increased disturbance of habitats, disruption of wildlife movements across the railway project, and increased animal fatalities mainly in relation to extraction and haulage of construction materials, execution of construction works, increasing of traffic volume and speed (during operation phase), and obstructions caused by the sections in high fill. The impacts can be minimized through avoidance of locating quarry & borrow sites and contractor's site facilities in major wildlife areas. Formal surveys of endangered species will be undertaken during full EIA studies.
- **Increased risks of accidents:** -to pedestrians or railway side's communities, domestic animals and wildlife mainly in relation to increased train traffic volume and speed during the operation period. Potential impacts can be reduced by establishing traffic management plan that includes erecting clearly visible warning signs; reducing dust levels by suitable palliative measures; raising the awareness of workers towards safety and health issues and provision of protective clothing for workers; and provision of health education on how to prevent HIV and other sexually transmitted infections, and provision of protective like condoms. Most of these potential impacts will be temporary and reversible nature as they result from earthwork activities, operation of construction equipment and vehicles, extraction and hauling of materials, processing and storage of construction materials, and establishment and operation contractor's site facilities. However, some impacts will be permanent mainly related to operation of the road.

Positive Impacts

Implementation of the Addis Ababa– Moyale rail project will bring a number important positive impacts to the local environment, provided appropriate mitigation and enhancement measures

are included and incorporated in the design and implementation of the rail project. The main positive potential environmental impacts of the proposed project include the following:

- The project is an essential component in the development of a national railway network that will increase freight transport in the south-west corridor.
- Constructing railway will enhance the development of the local as well as national economy and contribute to the continued improvement of the socio-economic condition of the nation.

Environmental Mitigation

Mitigation measures will be specified during full EIA study and can be implemented by following proper construction methods, or are engineering/physical features, which are part of the construction items like drainage facilities, erosion protection and slope stabilizing measures, traffic signs, speed calming measures, pedestrian crossing structures etc. Other mitigation measures that may have a separate cost implication can include:

- Replanting of trees to replace or compensate vegetation/trees removed or to prevent erosion or slope instability problems, and
- Re-grassing of cut/fill slopes and other erosion prone areas to stabilize slopes and prevent erosion.
- Awareness creation programs on traffic safety and public health issues for the local community to minimize traffic accidents and spreading of sexually transmitted diseases esp. HIV/AIDS.

3.6.3.4. Environmental Management Plan

The Environmental Management Plan (EMP) will comprises a set of mitigation, monitoring and institutional actions to be taken during detailed design, preparation for implementation, construction and operation stages of the project to eliminate, reduce or offset the adverse environmental impacts.

Details of the main environmental management activities during the construction and operation periods (anticipated environmental impacts and mitigation measures) as well as environmental protection investment will be provided during full EIA study such as:

- Soil erosion including soil conservation management framework;
- Flora and fauna,
- Historical, cultural and archaeological site

- Land acquisition and resettlement
- Public safety and health
- Environmental Mitigation, Management and Monitoring Costs
- Will appointed a qualified EI who shall intermittently follow up the environmental management activities duration the project implementation. The EI will be responsible for the monitoring of the implementation of the recommended environmental management plan (EMP).

3.6.4. Economic Analysis

3.6.4.1. Background to Railway Economics

There are a number of features which make railways more likely to succeed by making more effective in the time of operation and also by minimizing Economic effect. These include:

- Easy physical geographical conditions, which is a problem in parts of Ethiopia;
- Quantities of demand arising from major cities or industrial centers in respect of passengers and bulk commodities ;
- A lack of temporal demand peaks;
- A linear series of significant traffic centers, with few branch lines;
- Simple operations;
- High asset utilization;
- An appropriate regulatory environment, in particular allowing commercial freedom to set freight rates and passenger fares;
- The use of appropriate and modern technology;
- Good management of infrastructure and operating procedures;
- Easy access to and from the system.

Ethiopian labour is relatively cheap by international standards, the lack of an indigenous railway manufacturing industry means that almost all the equipment will have to be imported. The possible exception to this is probably concrete sleepers, where a dedicated local manufacturing plant using local cement seems can be established.

Also, the lack of a substantial existing railway industry will also have some impact on project timescales, and the development of local physical facilities may take more time than for other countries which have undergone rapid railway development based on an existing industry. In addition, a nation-wide workforce will have to be recruited and trained; however, some transfer of skill from the existing CDE (Djibouti to Ethiopia 1 meter gauge system) is anticipated, with retraining being provided as required.

The existence of the railway would also enhance the potential of any manufacturing facility for export to the neighbouring countries of Djibouti and Kenya, which have smaller economies even less likely to support manufacturing plants. The potential for inward traffic is an alternative to the current position of importing finished goods, but the bulk nature of manufacturing inputs, and the smaller number of fixed locations could make rail more competitive.

3.6.4.2. Background and Commercial Overview Summary

The sustainability of Ethiopian economic growth is directly related to the transportation of its exports, imports, and internal distribution of local products, as well as movement of people. With respect to this movement, the current land transportation systems are mainly dependent on road transport which currently dominates in Ethiopia.

Outside Ethiopia, mass transportation systems are becoming the most attractive methods of moving people and freight, and this is the modern mitigating solution for ever-increasing transport demand. Also, it is easier to achieve affordable reliability with rail-based systems which are not subject to road congestion. Reducing transportation costs will significantly enhance GDP because the price of export goods will become more competitive whilst imported goods become cheaper.

Ethiopia is a land-locked country and Djibouti port currently remains the main route for Export-Import trade. However, it is advantageous to have an alternative route for Ethiopian export import trade and development of a second transport corridor (from Lamu-Moyale-Addis Ababa and Southern Sudan) has been proposed by the Kenyan Government.

The distances between the main stations on the line are shown below, but it must be noted that additional track will be needed for passing loops, stabling sidings, freight yards etc.

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Table 3.10: distances between the main stations on the lines

No.	Line Section		Mainline Length(in Km)	Remarks
	From	To		
1	(A.A.) Gelan	Modjo	48	This optional 48 km work is included The GIS data for 905 km is sum of distances from Modjo-Moyale.
2	Modjo	Hawassa	197	
3	Shashemene	Weyto	389	
4	Konso	Moyale	318	
Total Sum			952	
5% added for alignment correction			48	
Grand-total (subject to detail design)			1,000	105% of mainline length of 952Km

Source; ERC, Feasible study on Ethiopia – Kenya Railway Project

The project financing strategy will be formed by a soft foreign loan facility and local birr contribution. EPC turnkey contract arrangements will be negotiated with potential sponsors, but is anticipated that this will be proportioned on a 60% foreign/40% local currency split. Prior to this arrangement being finalized, ERC will identify parts of the project which is anticipated to be delivered by local contractors and consultants.

Having examined the competitive situation for passengers vis-à-vis bus transport, and taken into account existing road freight rates, anticipated rail fare (but not final fare ratings) are as follows:-

- For passenger services: 0.04 USD per Passenger Kilo meter (0.04USD/PK)
- For freight train, the typical rate will be around: 0.04 USD per Ton-Kilometer (0.04USD/TK)

However, it should be noted that specific (and higher) rates apply for some traffics, notably the carriage of oil.

It is always difficult to estimate operation and maintenance (O&M) costs for a completely-new system, but such costs must be applied during the 30 years operation life of the railway system. This study has taken relatively high rates, in order to ensure that sufficient budgets are set aside for maintenance, thereby enabling the long-term success of the line. It is not clear whether any increases in operating costs can be compensated for through increases in traffic rates, given the competitive transport situation noted above.

3.6.4.3. Financial Use and Source

With regard to capital cost, it is anticipated that there will be not more than 2.0 million USD per km (Two million USD) and the foreign loan facility is assumed to be a soft loan option in which the interest rate is not more than 4% per p.a.. The Local portion is assumed to fully equitable and no interest rates are applied.

Table 3.11: Total estimated cost of the project

The finance use and source of the total project cost of the 1000km project					
No.		Finance use (million USD)			
			Equity share	Foreign loan facility	Sum
1	Total project cost	2,000	800	1,200	2,000
2	Local Currency portion	800	800	0	800
3	Foreign currency portion	1,200	0	1,200	1,200

Source; ERC, Feasibility study on Ethiopia – Kenya Railway Project

3.6.5. Conclusions and Recommendations

Addis Ababa to Moyale corridor will be only one of eight planned rail lines, all of which must be fully integrated in of infrastructure/asset specification and operational aspirations. This railway network will bring substantial regional benefits to southern Ethiopia and northern Kenya, as the railway provides a critical link in the Trans East African railway, connecting land locked Ethiopia to the port of Mombasa. The newly constructed railway line will enhance the development of the national and local economies in both countries, by promoting cross-border trade, creating market access for livestock, improving security, enhancing tourism and enabling rapid emergency response.

For the benefit of potential investors an overview of its economic, social welfare and transportation arrangements, as well as the vision for the development of standard gauge railway infrastructure throughout bordering countries in East Africa.

The main technical standards proposed for the project are as follows:

- 1) Gauge: standard gauge 1435mm (UIC Compatible)
- 2) Railway class: referring to National Railway Class II of China / Ethiopia railway standard;

- 3) Number of main lines: single-track (Suitable for Double Track provision in future)
- 4) Maximum passenger speeds - 160km/h (with future provision for 225 kph operation) Maximum Freight speeds - 120km/h
- 5) Minimum curve radius: >2000m (in urban areas and approaching developed cities, lower radii can be permitted)
- 6) Ruling Gradient : <1.0% (In exceptional conditions 2% maximum gradient will be permitted to minimize extent of tunnelling works),
- 7) Axle loading: ≥ 25 tones minimum

Capital costs have been estimated for infrastructure, based on line length and the number of tracks; together with rolling stock requirements the project is likely to cost in the order of 2 billion USD (Two Billion USD)

The Kenya Economy is faster time to time and Transportation system is the main concern for the government. The Kenya government railway network project is start to link with its regional countries of Rwanda, Burundi and Sudan. For this reason, linking with Kenya is more beneficial to link Ethiopia with others Africa country.

Ethiopian Railway Corporation on has a wide vision related to National networking, but the available information for the route is not enough to start the project. Intermediate project feasibility study report on this link was studied; however the report is out of date. This project can help the import and Export trade of Ethiopia contiguous with Djibouti port and Ethiopian import and Export trade cannot be dependent with one port, this can be alternative port for transit. Therefore, ERC should give attention on this project for detail design.

3.7. Awash - Combolcha-Hara Gebeya - Mekele-Shire Railway Project (Route 5)

3.7.1. Introduction

It is proposed to build New Standard Gauge (SG) railway line between Awash and Hara Gebeya. The project starts at Awash Station diverting from the new Addis Ababa -Djibouti Railway Project traversing the lowlands of Shewa towards Combolcha and Weldia side. This line follows most economical alignment to facilitate optimum freight transport as well as passenger movement.

The project starts at Awash Station diverting from the new Addis Ababa - Djibouti Railway Project traversing through the lowlands of Shewa towards Kombolcha, Weldia side, Mekele, Shire and goes to Eretria. This line follows the most economical alignment to facilitate optimum freight transport as well as passenger movement. Most of the alignment passes the through Amhara and Tigray regional states and some part of it through Afar regional state.

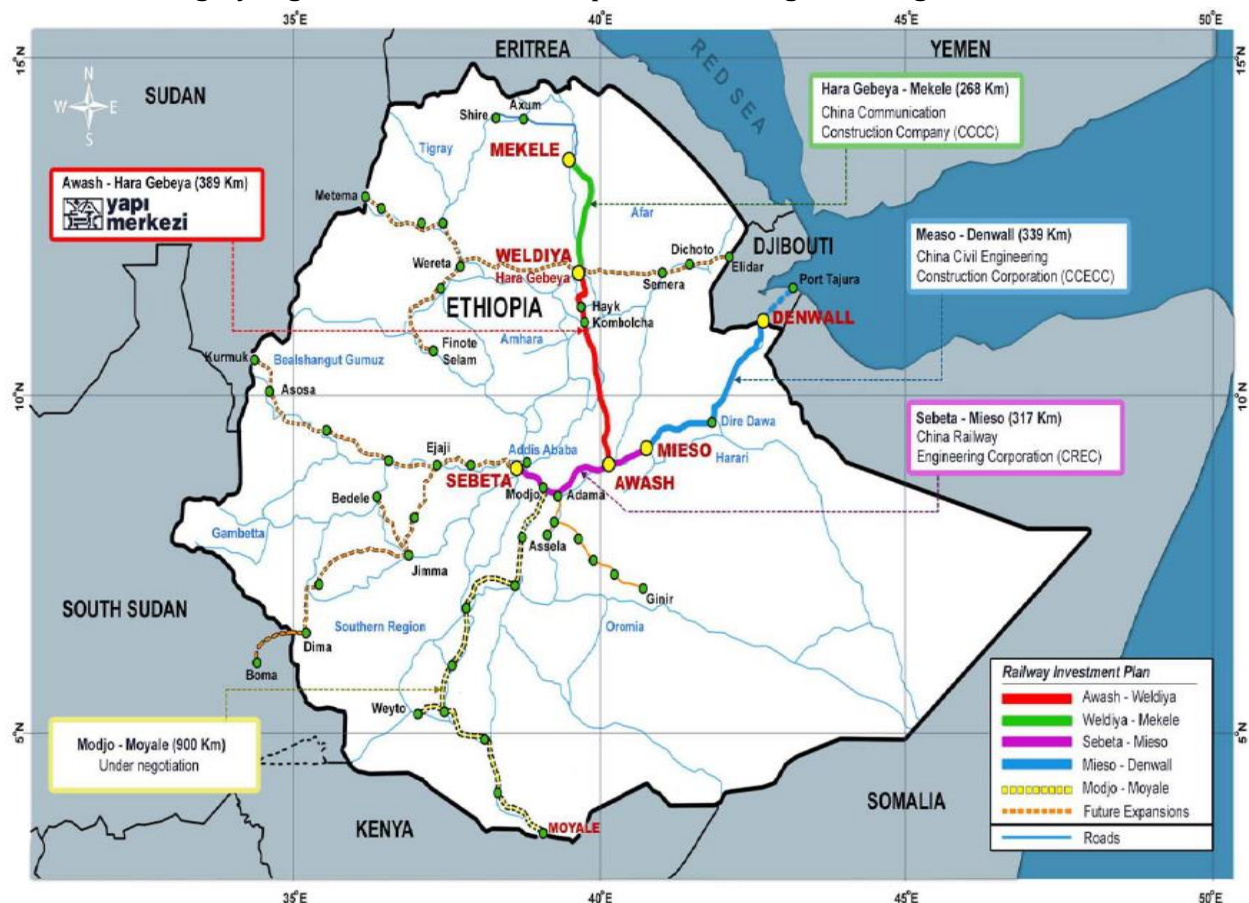


Figure 3.8: Proposed Awash to Hara Gabeya railway project route and other proposed project

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Final alignment shall however be determined only after detailed engineering survey but, Point to point alignment is described below:-

Table 3.12: Estimated line distance and milestones

Segment	From	To	Estimated Length(km)
LOT 10	Awash	Armanya	99
LOT 11	Armanya	Kemise	104
LOT 12	Kemise	Hayk	103
LOT 13	Hayk	Hara Gebeya	69
Total Length			375
Exact distance shall be finalized during the final Location survey			

Source; Source: NRN Awash – Wedia Project Feasibility study

Lot 10:- Awash-Armanya (Estimated distance 99km)

The segment is located in Afar and Amhara Regional State where the start of the project is Awash town (E627376 N996944) located on eastern part of Ethiopia, 200km from Addis Ababa along Addis-Djibouti main road and ends near Kure Beret village (E610655 N1087955) found on northern direction, 200km from Addis Ababa along Addis Dessie main road deflecting to the right at Shewa Robit.

Lot 11:- Armanya – Kemise (Estimated distance 104km)

This segment is located in Amhara Regional State starting at Kure beret village, the end of lot 10 and traversing through Zelo, Senbete ,Ataye, Kara Kore, and Jara towns . It ends to the left edge outside of Kemise town.

Lot 12:- Kemise-Hayk (Estimated distance 103km)

This segment starts at the outskirts of Kemise town and passes through Kombolcha, the northern industrial center of Ethiopia and terminates at Hayk town. It is fully traversing through the Amhara Regional State.

Lot 13:- Hayk - Hara Gebeya (Estimated distance 69km)

The final segment of the project starts at Hayk town and passes through valleys in Amhara Regional State between series of major escarpments in both sides of the line and puts its destination at Hara Gebeya town, a town around 7 km east of Weldia and a junction between the Awash – Hara Gebeya and the Mekelle – Tadjourah railway projects.

3.7.2. Project-Wide Specification Requirements

During the course of the project development, it is anticipated that, for each of the railway disciplines, a series of performance specification will be developed by the nominated supplier or joint venture ERC contractor. ERC will review and check this documentation to ensure that it is fully compatible with overall system requirements.

Table 3.13: Outline Technical Specification and Salient Features for the project

TECHNICAL ITEM	REQUIREMENT
TRACK	
Track Length	388 km 375km (main Line) and 13 km (passing Loops line)
Gauge	1,435 mm
	3* km long at 50*km intervals approximately or at stations (Subject to capacity assessment, performance modeling and route optimization studies).
Rail section	UIC 54 or 60 kg rails CWR on concrete sleepers at 60 cm spacing.
Turnouts and Passing loops	Suitable for 100 kmph in the loop line
Alignment	Where possible, construct as open route (i.e. in cutting/embankment, on bridges/viaducts as much as possible). Where tunnels are required, these to be as short as possible.
Formation Width	Double Track or Single Track (Suitable for Future Double Track)
Horizontal curvature	> 2,000 meters minimum (in difficult topography areas and in urban centers and approaching developed cities, lower radii can be permitted).
Ruling gradient	<1.0% (In exceptional conditions 2% maximum gradient will be permitted to minimize extent of cut/fill + tunneling works),
Maximum passenger train speeds	160 kmph (with future provision for 225 kmph operation)
Maximum freight train speeds	120 Kmph
Permanent speed restrictions	<10% of the route mileage
Axle loading	25 tons Maximum

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Structure Gauge	Ethiopia railway standard/ UIC Compatible
Track Drainage	Pipe with Filter Material or Open Channel (Other Railway Operators Where Risk of “Flash Flooding”).
ELECTRIFICATION	
Traction supply	25 KV 50 Hz via Overhead Line Equipment
Sub-stations supply	From two separate sources
ROLLING STOCK	
Passenger rolling stock	EMU and Locomotive hauled passenger trains
Mainline locomotives	6,000 HP Electric Traction
Freight rolling stock	100 Tons gross weight with flats. Examine option for double stacking containers. Freight train length 775m
Maintenance locomotives	2,500 HP Diesel / Electric Traction (Can be used for project construction train operations, initial revenue earning services and perturbations recovery).
Shunting locomotives	1,000 HP Diesel Hydraulic Traction or similar
SIGNALS AND COMMUNICATION	
Signalling	Fixed block + Line side Signals + In Cab Technology. (Moving Block signalling option to be assessed).
Communication	GSM- R or similar fiber optic based. Fixed + mobile telephones.
Train control	CTC, ATC, ATS, remotely controlled points machines
OPERATION	
Trailing Load (Freight)	3000 Tons Gross (2250 Tons Payload) Maximum. (E.g. 30 No x 100 Ton Petroleum Products/Aggregates/Metal Products/Bulk Cement etc. or 40 No Mixed Container/Grain/Livestock/Farm Products etc.
Trailing Load (Passenger Train)	600 Tons (10 x Passenger Coaches (@ 23m) + DVT/Baggage
Predicted Journey Time Awash to Hara Gebeya	Passenger Train 2 and half Hours (Fastest Train)
Predicted Journey Time Awash to Hara Gebeya	Freight Train 3 and quarter Hours (Fastest Train)

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MISCELLANEOUS	
Level crossings	To be avoided – use grade separation wherever possible. Where necessary in urban/developed areas, remote controlled and monitored by CCTV.
Line-side Fencing	Animal proof fence to be provided in the open country with accommodation crossings or elevated sections to suit environment and wildlife.
Marshalling Yards	Simple layout (to suit current capacity requirements with provision for future capacity aspirations).
Strategic Maintenance Depots	Awash or Combolcha (to be decided on completion of Transport Planning Studies and associated Capacity Assessment + Rail Infrastructure Requirements) and Hara Gebeya.
General Maintenance Depots	At intervals of about 90 km, or convenient nearest town or city. Provision to be made for stabling of “on track” maintenance plant (tamping /rail grinding machines etc.) provision also to be made to stable diesel rescue locomotives for recovery of broken down trains.
Station Structures	Platforms (length circa 300m, number to be determined by capacity assessment/performance modelling), ticket offices, train maintenance/cleaning sheds, shopping complex at main stations.
Environment	Compliant with national regulation. Pay particular attention to wild life conservation, forests, waterways and water towers.

Source: NRN Awash – Wedia Project Feasibility

Performance specifications for all supply items will be developed during future stages of the project. ERC is preparing (almost finishing) its own full set of railway standards, it may adapt its own standard or UIC or similar international railway standards.

3.7.3. Commercial overview

3.7.3.1. Traffic Potential along the Route

The Proposed new standard gauge route, lying between Awash and Hara Gebeya, is designed to carry both passengers and freight traffic. Much of the passenger traffic is expected to be between major stations and point to point between Awash, Kemise, Hayk, and Hara Gebeya.

Passenger potential along the Route

Availability of large concentrated population across the railway line creates ready passenger traffic opportunity and increases the viability of the railway project. As regards the Awash – Hara Gebeya railway, both the transverse side terrain of the link as well as the flat terrain people are expected to use the railway for travel distances in short time. Thus, 25-40 km buffer zone multiplied by the entire length of the link can be taken as influence area of the link.

Up to 25 million people are expected to bear the direct or indirect impact of the proposed railway. The population group is expected to be highly mobile. Thus, by the most conservative estimates, the passenger load arising out of this population (based on year 2007 census) is assumed at 30% of the mobile population i.e. 4.35 million across the 375 km railway line growing at 2.5% Cumulative Average Rate of Growth (CARG) over 20 year period.

Table 3.14: Passenger demand forecast

Year	2007	2010	2015	2018	2020	2025	2030
Estimated passenger (Million)	4.35	4.61	5.10	5.42	5.64	6.24	6.89

Source: NRN Awash – Wedia Project Feasibility

Freight potential along the Route

Along the proposed railway line there are existing and future potential for freight railway haulage as follow:

Existing Freight potential

- Transportation of liquors such as Bear, mineral water
- Transportation of mineral such as potash, gold, and lime stone
- Transportation of Agricultural products such as
 - **cereals**:- teff, corn, wheat, barley, sorghum, millet, oats, etc.;

- **Pulses:-** horse beans, chick-peas, haricot beans, field peas, lentils, soybean, and vetch ;
- **Oilseeds:-** linseed, Niger seed, fenugreek, Noug, rapeseed, sunflower, castor bean, groundnuts, etc. ;
- **Stimulants:-** coffee, tea, chat, tobacco, etc.;
- **Fibres:-** cotton, sisal, flax, etc.;
- **Fruits:-** banana, orange, grape, papaya, lemon, mandarin, apple, pineapple, mango, avocado, etc. ;
- **Vegetables:** (onion, tomato, carrot, cabbage, etc.);
- Root and tuber (potato, enset, sweet-potatoes, beets, yams, etc.; and Sugarcane.

Future freight potential

Newer industries, namely Large size agricultural production like rice, large size factories such as Potash mine, Ammonia, Urea, methanol production, cement and steel and sugar complexes at Kesem and Tendaho, etc. are expected to be commissioned within two-five years from now.

Considering the vitality of the line in connecting the most industrial and agricultural sites of northern Ethiopia to the two ports existing in neighbouring country Djibouti, from the freight estimate, 27.50 % of port based freight is taken as the portion of the project. With the above consideration, the future freight potential is estimated as shown below for 20 years operation:

Table 3.15: Future freight potential forecasting

Year	2015	2020	2025	2030	2035
Estimated freight (Million tons)	3.41	6.20	6.20	6.20	6.20
Domestic freight (50%)	1.71	3.10	3.10	3.10	3.10
Total freight	5.12	9.30	9.30	9.30	9.30

Source: Port Strategy by MoT of Ethiopia

3.7.4. Project cost, means of finance and project milestone

3.7.4.1. Introduction

Project cost of a Greenfield field railway project like the Awash – Hara Gebeya railway line is a complex exercise. Although there are few capital cost determinants in a typical railway project, assessment of realistic cost purely depends on the final location survey. The earthwork and Permanent way are the strongest determinants of the final project cost. An attempt is made herein under to assess the project cost of Awash – Hara Gebeya railway on realistic basis, purely based on price offers and in-house wisdom.

3.7.4.2. Project components and estimated cost

Table 3.16: Total estimate cost

Components	Estimated cost(USD)
Survey	6.573 million
Earthworks	455.854 million
Construction of Permanent way	214.543 million
Passenger and freight station infrastructure	14.096 million
Signalling and Tele-communication (S&T)	71.739 million
Railway Electrification	167.434 million
Rolling Stock	79.625 million
Maintenance infrastructure and manpower training	16.877 million
Equipment tools and tackles	19.842 million
Organization, Methods, training and development	9.634 million
Project consultancy and inspection costs	22.807 million
Logistic Cost	45.975 million
Total project cost estimation	1,125million

Source: NRN Awash – Wedia Project Feasibility

Estimated project cost of Awash - Hara Gebeya standard gauge railway single line amounts to USD 1125 million at current prices. This cost includes railway infrastructure and also takes into account local capacity building exercise. Products and services amounting to 45% of total project cost (equivalent to USD 506.25 million) can be procured locally in Ethiopia while the balance products and services will have to be imported into this country.

The total cost does not include the following:

- Provision for contingency costs
- Interest during construction
- Costs related to Environment and social impact assessment studies and mitigation measures
- Land compensation, if any.

3.7.4.3. Means of finance

Based on the estimated products and services requirement, it is proposed that the project owner shall make available funds amounting to USD 506.25 million (45% of the total cost) from its own resources in Local currency. Since the bulk of the money is required to fund construction of earthwork and permanent way in the initial years of project construction, local portion is required to be made available up-front year.

Total amount of this portion is USD 618.75 (55% of the total cost) foreign funding shall be raised in the international market on competitive terms. This funding shall be a judicious mix of long term concessional loans on bilateral basis, long term loans from multi-lateral agencies, commercial loans from international development banks, export-import banks, etc. with 2.5% interest rate p.a.

3.7.4.4. Project Key milestones

The project milestones are divided into three parts; pre-construction milestones, project construction milestones and Warranty or O&M milestones. The Detailed project implementation schedule shall be drawn up during the detail Execution planning stage. Here, the preliminary Indicative key milestones with relevant work packages are addressed in the table below:-

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Table 3.17: Project key milestones

No.	Package		Indicative timeframe
1	Pre-construction Package	Creation of legislative and regulatory framework	2 months
		Submission of feasibility study report and approval	2 months
		Preparation of Draft project report	6 months
		Financial closure	3 months
2	Construction Package	Project construction	3 years
3	Warranty O&M package	On Job training & Capacity building for ERC team	Subject to Employer's requirements & commercial Contract conditions.
		Defect Notification period (DNP) O&M completed successfully.	
		DNP payment released for the contractor as per contract.	

Source: (NRN Awash – Weldia Project Feasibility) northern direction 200km from Addis Ababa along Addis - Dessie main road deflecting to the right at Shewa Robit.

3.7.5. Conclusions and Recommendations

Increased transport cost and travel time, including the lesser quality of transport service has been a dragging force impend the economic activity of Ethiopia. Heavy reliance on high cost road transportation system and the defunct existing railway has impacted the cost of transportation. Due to its mass transportation nature and design, in addition to its efficiency in terms of cost, time, safety and security, nations are moving towards rail transportation system. It is now the interest of Ethiopian Government to build a new standard gauge railway line between Awash and Hara Gebeya. Its geographical reach connect Northern part of Ethiopia to Eastern Ethiopia and then to Djibouti port. If the national railway plan is implemented, this line will provide connectivity to the national railway network

The line is a pivotal link to the other railway corridors of the national railway network. The line will offer Ethiopia connectivity to the two ports existing in Djibouti namely Duraleh and Tadjourah thereby opening newer vistas of business and economic prosperity. Domestically, apart from moving freight quickly at least cost, the railway line will provide mobility to the population and open new avenues for balanced regional development.

This railway network will bring substantial regional benefits to Northern Ethiopia and Djibouti connecting land locked Ethiopia to the port of Djibouti. The newly constructed railway line will enhance the development of the national and local economies in both countries, by promoting

cross-border trade, creating market access for livestock, improving security, enhancing tourism and enabling rapid emergency response.

The main technical standards proposed for the project are as follows:

- 1) Gauge: standard gauge 1435mm (UIC Compatible)
- 2) Railway class: referring to National Railway Class II of China / Ethiopia railway standard;
- 3) Number of main lines: Double Track or Single Track (Suitable for Future Double Track)
- 4) Maximum passenger speeds - 160km/h (with future provision for 225 kph operation) Maximum Freight speeds - 120km/h
- 5) Minimum curve radius: >2000m (in urban areas and approaching developed cities, lower radii can be permitted)
- 6) Ruling Gradient : <1.0% (In exceptional conditions 2% maximum gradient will be permitted to minimize extent of cut/fill + tunnelling works),
- 7) Axle loading: 25 tons Maximum

Capital costs have been estimated for infrastructure, based on line length and the number of tracks; together with rolling stock requirements the project is likely to cost in the order of 1.125 billion USD, April, 2011.

The Ethiopian Railway Corporation (ERC) studies the feasibility of Awash – Hara Gebeya section. As per ERC, the remaining sections will be studied in the coming year.

Generally, the project will have contribution for Ethiopia transportation in many ways:

- Integral part of regional development & catalyst for local economy,
- Contributes to the economic development of hinterland Ethiopia
- The project will be a path to wealth and a path to wealth increase in the quality of life
- Facilitates large number of freight and passenger transportation
- The project will connect Mekele in Tigray Regional State to Port Tadjourah in Djibouti
- The railway will connect the main railway line from Mekele to Hara Gebeya and then Addis to Djibouti railway
- Main transport route for import and export via Djibouti port
- Connection with the other railway lines
- The railway will provide faster, more comfortable, safer and environmentally friendly services and economical results.

Therefore, the Ethiopian Railway Corporation should give more attention to this project. It could close the railway gap in the northern part of Ethiopia and in the north to close gap and connect Addis-Ababa - Djibouti line with the Weldiya - Mekele railway project.

4. Analysis and Result on Proposed Ethiopia – Djibouti Railway project

4.1. Economic Benefits of the Project & Cost-Benefit Analysis

The starting point of the Addis Ababa – Djibouti new railway line is at Sebeta town, 15 km south-west of Addis Ababa. Quite a number of major towns and business-oriented settlement sites are served along this corridor. The segment from Sebeta to Adama (115km) is a double track while all the stretch beyond Adama up to the Port of Djibouti (641 km) is a single track (Revised Feasibility Study Report of ERC, 2011).

4.1.1. Operation Revenue

In the base freight tariff is taken as 0.833 Birr/ton*km (as per Ethiopian commercial bank 1USD =20Birr), equivalent to USD 0.042/ton*km; the base passenger tariff is taken as 0.3Birr/person*km, equivalent to USD 0.015/person*km; other revenue is taken as 10% of the freight and passenger revenue (Revised Feasibility Study Report of ERC, 2011).

4.1.2. Operation Cost

As a base, operation costs specified in the Revised Feasibility Study Report of ERC consist of labour cost, application cost of passenger/freight rolling stocks, cost for stations and auxiliary facilities, track maintenance cost, telecommunication and signalling costs, communication cost, power supply cost and indirect management cost, etc.

In the evaluation, it is deemed that each of the operation costs is generally rational. The operation costs of the project adjusted in the evaluation based on the passenger and freight traffic volume predicted in the evaluation (see the table below) and the tariff standard recommended in the Revised Feasibility Study Report of ERC, 2011.

Table 4.1: Passenger Forecast

Year	2010	2015	2020	2030
Passenger (mill)	0.31	0.499	0.804	2.089
Increase/yr.	-	0.0473	0.0763	0.1428

Source: Addis Ababa University

Annual passenger for the years 2016 through 2030 is determined by considering average increase rate based on the five years forecast provided. Hence, estimated passenger km of the corridor generated is shown in Table 4.3. This passenger traffic is obtained by assuming 10%,

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70 % and 20% passenger share for the Addis Ababa – Djibouti; Addis Ababa – Dire Dawa and Addis Ababa – Mieso destinations, respectively.

Table 4.2: Annual Ethiopian Freight Import and Export Forecast traffic movement

year	Total Freight (import + Export) tons
2014/15	13,016
2015/16	14,202
2016/17	15,565
2017/18	17,059
2018/19	18,697
2019/20	20,492
2020/21	22,459
2021/22	24,615
2022/23	26,978
2023/24	29,568
2024/25	32,407
2025/26	35,518
2026/27	38,928
2027/28	42,932
2028/29	46,843
2029/30	51,111
2030/31	55,767
2031/32	60,847
2032/33	66,390
2033/34	72,438
2034/35	79,037
2035/36	86,238
2036/37	94,094
2037/38	102,666
2038/39	112,019
2039/40	122,224

Source: MoT, Ethiopia

Table 4.3: Estimated annual passenger

Operation year	No of Passenger (million)
2015	0.499
2016	0.549
2017	0.604
2018	0.664
2019	0.731
2020	0.804
2021	0.884
2022	0.973
2023	1.070
2024	1.177
2025	1.295
2026	1.424
2027	1.567
2028	1.723
2029	1.896
2030	2.089
2031	2.298
2032	2.528
2033	2.780
2034	3.059
2035	3.364
2036	3.701
2037	4.071
2038	4.478
2039	4.926
2040	5.418

Source: Addis Ababa University study

4.1.2.1. Labour cost

Organization structuring: The railway headquarter shall be established in Addis Ababa (LABU) of Ethiopia and railway branch in Djibouti; ERC shall establish passenger transport depot and locomotive maintenance management departments in LABU; the Djibouti Railway Branch shall establish locomotive maintenance depot management departments in Djibouti; railway dispatching centres will be set up in Addis Ababa (LABU), railway dispatching branch center will be set up in Djibouti, comprehensive maintenance depot will be set up in LABU, and rolling stock depot will be set up in INDODE. According to statistics from each discipline design, staffing for the whole railway line is 3054 persons in the short term and 3615 persons in the long term (ERC, 2011).

Salary standards: the average monthly salary of the professional technical labour is about 12,600 Birr (USD 700) and that of other labours is about 1800 Birr (USD 100). After overall balance, the average monthly salary in the short term is taken as 7020 Birr (USD 390) and the average annual salary is USD 4680; the average monthly salary in the long term is taken as 8208 Birr (USD 456) and the average annual salary is USD 5472.

4.1.2.2. Application cost of passenger/freight rolling stocks

Repair cost of locomotives is estimated based on the average level in China and the local conditions in Ethiopia: USD 31,000/set for repair cost of SS4, USD 14,000/set for repair cost of SS9, and USD 9400/set for repair cost of shunting locomotive; the overhaul period is 9 years.

For the repair of passenger cars, the cost is estimated with reference to the actual level of Kunming Railway Bureau of China, i.e. USD 2100/car; the depot repair cost is estimated based on the budgetary rating specified by the Ministry of Railways in 2011 and considering the labour cost and depreciation expense in China, i.e. USD 9,400/car, and the depot repair is carried out once every 2 years. For the repair of freight cars, the cost is approximately USD 400/car; the depot repair cost is estimated with reference to the actual level of Kunming Railway Bureau of China in 2010, i.e. USD 700/car and the depot repair is carried out once every 2 years(ERC, 2011).

4.1.2.3. Cost for station and ancillary facilities

The station costs are calculated with reference to the actual level of Kunming Railway Bureau of China: USD 1063 million for delivery of 10,000 passengers and USD 328 million for delivery of 10,000 tons. The station shunting and other costs are calculated based on the actual level of Kunming Railway Bureau of China: unit consumption of 27.19 kg/shunting hour and the unit price of diesel USD 1125/ton.

4.1.2.4. Track maintenance cost

This railway line is 756km long in total. With reference to the actual level of Kunming Railway Bureau of China and the local conditions in Ethiopia, the track maintenance cost is calculated as per USD 3900/linear kilometer. During the operation period, the overhaul period is 10 years on the average, i.e. about 75km/year; the overhaul cost is calculated with reference to the actual level of replacement of track, sleeper, turnout and ballast clearing in China, i.e. USD 280,000/km on the average(ERC, 2011).

4.1.2.5. Cost for telecommunications and signalling, communications and power supply

With reference to the actual level of Kunming Railway Bureau of China, the maintenance costs of telecommunications & signalling are estimated based on USD 2300/km on the average and the maintenance cost of power supply and water and electricity lines is estimated based on USD 1900/OCS-km.

4.1.2.6. Management cost

Management cost includes training expense, home visit fee, apartment maintenance cost, development and maintenance cost of information system, sanitary and medical cost, security cost, other indirect cost and other management cost, etc. which are calculated according to 10% - 8% of all cost.

4.1.2.7. Fund Raising

For fund raising, it is temporarily determined that ERC contribute 15% and the rest 85% comes from loan. The debt will be based on (London Inter-Bank Offer Rate (LIBOR)) plus margin, which is taken to be 6% at for the base case. Five years grace period and bi-annual repayments of 15 years are accounted for the loan portion of the finance. The loan will be repaid with equal principals and interests within 10 years. According to the Ethiopian plan, working capital is not included in the total investment temporarily, which will be raised by ERC themselves during the initial operation of the project after completion (ERC, 2011).

4.1.3. Project Costs

The total investment cost is estimated to be 4,037 million USD. Of this amount, 638.9million forms part of the Equity while the remaining is Debt portion. Cost breakdown of the Project is shown Table 4.4.

Table 4.4: Project Cost Breakdown

Investment Costs (million USD Equivalent)			
Cost Category	Equity Financing (USD)	Debt Financing (USD)	Total (USD)
Railway Works	535.1	3,032.29	3,567.4
Telecom Supply	4.4	0.0	4.4
Power Supply	62.2	0.0	62.2
Right-of-way	29.5	0.0	29.5
ESIA	7.6	0.0	7.6
Rolling stock	0.0	366.2	366.2
Total	638.860	3,398.490	4,037.35

4.1.4. Relevant Taxes

According to the information from ERC, value-added tax is exempted during the operation of the railway infrastructure. The income tax rate is 30% and the government promises to exempt the income tax of the Project for 10 years.

$$\text{Income Tax Rate} = 30\% * (\text{Total Benefit, B} - \text{Total Cost, C})$$

4.1.5. Cost Benefit Analysis

The financial assessment is focused on Cost-benefit analysis based on freight and passenger traffic volume. As there is no electric traction standard gauge rail in use in Ethiopia, operation and maintenance cost is taken as 20% of revenue generated. This percentage might be relatively high but can safely compensate the low start-up efficiency and learning curve of the new system. The freight and passenger tariffs applied for calculating the benefit are lower than prevailing rates for trucks and buses. In fact the freight tariff for the base case is taken to be 30% less than truck fares. The project parameters applied are (Revised Feasibility Study Report of ERC, 2011):

- Construction period 4 years (2012 – 2015);
- Warranty period (Defect notification period) 1 year (2014);
- Service commencement 2015;
- Foreign finance preferential loan (LIBOR + margin) 6% per year (ERC, 2011);
- Foreign finance loan period 15 years excluding grace period;
- Foreign finance repayment 15 years, with two equal payments per year;
- Local Finance to be covered by ERC paid up capital without Bank loan (ERC, 2011);
- Freight Traffic volume rail share for base case..... 90% of total annual import and export;
- Exchange rate applied 1 USD = 19.83 Birr (Ethiopian commercial bank);
- Base freight tariff 0.833 Birr/Tone km;
$$\text{Freight Revenue (USD)} = 0.833/19.83 * \text{Freight (million T, km)}$$
- Base passenger tariff f 0.3 Birr/passenger km;
$$\text{Passenger Revenue (USD)} = 0.3/19.83 * \text{Passenger (million T, km)}$$
- Base Interest Rate of Debt 6% and Corporate Profit Tax 30% (ERC , 2011)
- Operation and maintenance cost(O&M) 20% of revenue generated from freight and passenger (= 20% (freight revenue + passenger revenue))
- From advertising service, office and shopping rent, considered as Other Revenue..... 10% revenue of freight and passenger generated(10% (freight revenue + passenger revenue));
- The entire length of A.A – Djibouti 756 km (656 km in Ethiopia and 100 km in Djibouti)
- Freight Traffic volume rail share for base case is 90% of the total Length
$$\text{Freight share} = 90\% * 756\text{km} = \mathbf{680.4\text{km}}$$
- Passenger traffic is obtained by assuming 10%, 70 % and 20% passenger share for the Addis Ababa – Djibouti; Addis Ababa – Dire Dawa and Addis Ababa – Mieso destinations, respectively.
$$\text{Addis Ababa – Djibouti} = 10\% * 756\text{km} = 75.6\text{km}$$
$$\text{Addis Ababa – Dire Dawa} = 70\% * 466.15\text{km} = 326.305\text{km}$$
$$\text{Addis Ababa – Mieso} = 20\% * 329.15\text{km} = 65.83\text{km}$$
$$\text{Total} = \mathbf{467.735\text{km}}$$

Net Present Value (NPV)

The NPV will estimate the economic worth of the project in terms of the present worth of the total net benefits. The difference between the present value of the future cash flows from an investment and the amount of investment. Present value of the expected cash flows is computed by discounting them at the required rate of return. The normal rule is to accept the investment if its present value is positive and to reject it if the present value is negative. The project with the highest positive NPV is usually the most attractive.

$$NPV = \sum_{n=0}^n \frac{R_n}{(1+i)^n} \quad \text{where: } R_n = \text{net cash flow}$$

i = Discount rate
n = the time of the cash flow

Internal rate of return (IRR)

The internal rate of return is calculated from the NPV equation on condition that there is such an interest rate for which the NPV is equal to Zero:

The IRR has been observed in two different ways:

- By Economic Internal Rate of Return (EIRR) or Economic Net Present Value (ENPV) which takes into account project costs excluding taxes (e.g. VAT), import duties, other taxes and costs of project financing.
- In contrast to EIRR OR ENPV, Financial Internal Rate of Return (FIRR) or Financial Net Present Value (FNPV) is based on assumption that all taxes, duties and project financing costs are incorporated into the project costs.

Payback period (PBP)

The payback period then indicates a time interval after which the capital invested will be recovered by the annual returns. The static payback period is calculated as a ratio of the capital invested to annual returns:

$$PBP = I_0 / NP$$

where: I_0 = Initial investment costs

NP = Average annual net returns

Accept if $PBP <$ standard Payback Period which in 5 year

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Details of the Project parameters are presented in Table 4.5: Basic Data of Ethiopia-Djibouti port according to the Revised Feasibility Study Report of ERC, 2011.

Tables 4.5 Total Base Case Basic Data(ERC, 2011)

Route Segment	Length(km)
AA - Adama - Mieso	329.15
Mieso - Dire Dawa	137
Dire Dawa - Dewale	207.85
Dewale - Nagad	82
Total	756

Track Type	Route	Length(km)
Double Track	AA/Sebeta - Adama	115
Single Track	Adama - Djibouti	641
	TOTAL	756

Initial Investment (mill. USD)	Local portion (mill. USD)	Foreign portion (mill. USD)
858	129	729
2709	406	2303
3567	535	3032

Investment Costs(million USD Equivalent) ERC, 2011			
Category	Equity	Debt	Total(USD)
Railway Works	535.1	3,032.29	3,567.4
Telecom Supply	4.4	0	4.4
Power Supply	62.2	0	62.2
Right of way	29.5	0	29.5
ESIA	7.6	0	7.6
Rolling stock	0	366.2	366.2
Total	638.86	3,398.49	4,037.35

Base tariff	
Freight (Birr/T km)	Passenger (Birr/P km)
0.833	0.3

Investment Schedule (Addis Ababa/Sebeta - Djibouti) 756km (ERC, 2011)				
Year	Payment Schedule (%)	Local (mill. USD)	Foreign (mill. USD)	Total (mill. USD)
1	20	638.86	679.7	1318.56
2	25	0	849.62	849.62
3	25	0	849.62	849.62
4	20	0	679.7	679.7
(Retention) 5	10	0	339.85	339.85
Sum	100	638.86	3398.49	4037.35

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Financing Term	
Repayment Period (years)	15
Debt Portion Interest rate/yr. (%)	6
Debt Repayment Per year	2
Exchange Rate (USD/Birr)	20

Passenger Forecast Based on Addis Ababa University Traffic Study				
Years	2010	2015	2020	2030
Passengers (mill.)	0.31	0.499	0.804	2.089
Increase/yr.		0.0473	0.0763	0.1428

Railway Share of Freight Import Export by MoT April 2012				AAU study
Operation Year	Import (mill. T)	Export (mill. T)	Total Freight(mill. T)	Passenger (mill.)
(2015) 1	11.192	1.824	13.016	0.499
2	12.166	2.036	14.202	0.549
3	13.237	2.328	15.565	0.604
4	14.413	2.646	17.059	0.664
5	15.76	2.937	18.697	0.731
(2020) 6	15.998	4.494	20.492	0.804
7	17.758	4.701	22.459	0.884
8	19.712	4.903	24.615	0.973
9	21.88	5.098	26.978	1.070
10	24.287	5.281	29.568	1.177
11	26.958	5.449	32.407	1.295
12	29.924	5.594	35.518	1.424
13	33.215	5.713	38.928	1.567
14	36.869	6.063	42.932	1.723
15	40.113	6.730	46.843	1.896
(2030) 16	43.641	7.470	51.111	2.089
17	47.475	8.292	55.767	2.298
18	51.643	9.204	60.847	2.528
19	56.173	10.217	66.390	2.780
20	61.098	11.34	72.438	3.059
21	66.441	12.596	79.037	3.364
22	72.237	14.001	86.238	3.701
23	78.538	15.556	94.094	4.071
24	85.381	17.285	102.666	4.478
25	92.817	19.202	112.019	4.926
(2040) 26	100.885	21.339	122.224	5.418

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Operation Year	Freight (mill.T)	No of Passenger (mill.)	Freight Traffic Length (km)	Passenger Traffic Length (km)	Freight flow (mill. T km)	No. of Passenger flow (mill. km)
(1)	(2)	(3)	(4)	(5)	(6) = (2)* (4)	(7) = (3)* (5)
(2015) 1	13.016	0.499	680.40	467.735	8,856.09	233.40
2	14.202	0.549	680.40	467.735	9,662.88	256.74
3	15.565	0.604	680.40	467.735	10,590.51	282.41
4	17.059	0.664	680.40	467.735	11,607.20	310.66
5	18.697	0.731	680.40	467.735	12,721.49	341.72
(2020) 6	20.492	0.804	680.40	467.735	13,942.76	376.06
7	22.459	0.884	680.40	467.735	15,281.26	413.66
8	24.615	0.973	680.40	467.735	16,748.26	455.03
9	26.978	1.070	680.40	467.735	18,356.09	500.53
10	29.568	1.177	680.40	467.735	20,118.28	550.59
11	32.407	1.295	680.40	467.735	22,049.63	605.65
12	35.518	1.424	680.40	467.735	24,166.40	666.21
13	38.928	1.567	680.40	467.735	26,486.37	732.83
14	42.932	1.723	680.40	467.735	29,210.93	806.12
15	46.843	1.896	680.40	467.735	31,872.05	886.73
(2030) 16	51.111	2.089	680.40	467.735	34,775.59	977.10
17	55.767	2.298	680.40	467.735	37,943.65	1,074.81
18	60.847	2.528	680.40	467.735	41,400.32	1,182.29
19	66.390	2.780	680.40	467.735	45,171.88	1,300.52
20	72.438	3.059	680.40	467.735	49,287.04	1,430.57
21	79.037	3.364	680.40	467.735	53,777.09	1,573.63
22	86.238	3.701	680.40	467.735	58,676.19	1,730.99
23	94.094	4.071	680.40	467.735	64,021.59	1,904.09
24	102.666	4.478	680.40	467.735	69,853.95	2,094.50
25	112.019	4.926	680.40	467.735	76,217.65	2,303.95
(2040) 26	122.224	5.418	680.40	467.735	83,161.08	2,534.34

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Base Case					
Operation Year (1)	Freight flow (mill. T km) (2)	No. of Passenger flow (mill. km) (3)	Freight Revenue (USD) (4)=(2)*0.833/19.83	Passenger Revenue (USD) (5)= (3)*0.3/19.83	Operation & Maintenance (USD) (6)=20%*(4+5)
(2015) 1	8,856.09	233.40	372.02	3.53	75.11
2	9,662.88	256.74	405.91	3.88	81.96
3	10,590.51	282.41	444.88	4.27	89.83
4	11,607.20	310.66	487.58	4.70	98.46
5	12,721.49	341.72	534.39	5.17	107.91
(2020) 6	13,942.76	376.06	585.69	5.69	118.28
7	15,281.26	413.66	641.92	6.26	129.64
8	16,748.26	455.03	703.55	6.88	142.09
9	18,356.09	500.53	771.09	7.57	155.73
10	20,118.28	550.59	845.11	8.33	170.69
11	22,049.63	605.65	926.24	9.16	187.08
12	24,166.40	666.21	1,015.16	10.08	205.05
13	26,486.37	732.83	1,112.61	11.09	224.74
14	29,210.93	806.12	1,227.07	12.20	247.85
15	31,872.05	886.73	1,338.85	13.41	270.45
(2030) 16	34,775.59	977.10	1,460.82	14.78	295.12
17	37,943.65	1,074.81	1,593.90	16.26	322.03
18	41,400.32	1,182.29	1,739.11	17.89	351.40
19	45,171.88	1,300.52	1,897.54	19.68	383.44
20	49,287.04	1,430.57	2,070.40	21.64	418.41
21	53,777.09	1,573.63	2,259.02	23.81	456.56
22	58,676.19	1,730.99	2,464.81	26.19	498.20
23	64,021.59	1,904.09	2,689.36	28.81	543.63
24	69,853.95	2,094.50	2,934.36	31.69	593.21
25	76,217.65	2,303.95	3,201.68	34.86	647.31
(2040) 26	83,161.08	2,534.34	3,493.35	38.34	706.34

Base case: 90% of Export and Import; 30% tax; Normal Tariff(0.833Br/T km and 0.3 Br/P km) interest rate 6%

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table 4.6: A.A/Sebeta – Djibouti Port total cost cash flow (Life Cycle Cost) 756km

Life cycle Cost (LCC) in Million USD							
Year (1)	Operation Year (2)	Capital in Lx (3)	Capital Loan in Fx (4)	Loan Repayment (5)	Interes t (6%) (6)	Operation & Maintenance (7)	Total Cost, C (8)=(3+5+6+7)
1	-4	638.86	679.7	-	40.78	-	679.64
2	-3	0	849.62	-	50.98	-	50.98
3	-2	0	849.62	-	50.98	-	50.98
4	-1	0	679.7	-	40.78	-	40.78
5	0	0	339.85	-	20.39	75.11	95.50
6	1	-	-	226.57	20.39	81.96	328.92
7	2	-	-	226.57	19.03	89.83	335.43
8	3	-	-	226.57	17.67	98.46	342.70
9	4	-	-	226.57	16.31	107.91	350.79
10	5	-	-	226.57	14.95	118.28	359.80
11	6	-	-	226.57	13.59	129.64	369.80
12	7	-	-	226.57	12.23	142.09	380.89
13	8	-	-	226.57	10.88	155.73	393.18
14	9	-	-	226.57	9.52	170.69	406.78
15	10	-	-	226.57	8.16	187.08	421.81
16	11	-	-	226.57	6.8	205.05	438.42
17	12	-	-	226.57	5.44	224.74	456.75
18	13	-	-	226.57	4.08	247.85	478.50
19	14	-	-	226.57	2.72	270.45	499.74
20	15	-	-	226.57	1.36	295.12	523.05
21	16	-	-	-	-	322.03	322.03
22	17	-	-	-	-	351.40	351.40
23	18	-	-	-	-	383.44	383.44
24	19	-	-	-	-	418.41	418.41
25	20	-	-	-	-	456.56	456.56
26	21	-	-	-	-	498.20	498.20
27	22	-	-	-	-	543.63	543.63
28	23	-	-	-	-	593.21	593.21
29	24	-	-	-	-	647.31	647.31
30	25	-	-	-	-	706.34	706.34
Sum		638.86	3,398.49	3,398.55	367.04	7,520.52	11,924.97

Note: Fx is Foreign loan capital
Lx is Local capita

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table 4.7: Addis Ababa/Sebeta – Djibouti Port total Life Cycle Benefit 756km

Life cycle Benefit (LCB) in Million USD							
Year (1)	Operation Year (2)	Capital in Lx (3)	Capital Loan in Fx (4)	Freight Revenue (5)	Passenger Revenue (6)	Other Revenue (7)	Total Benefit, B (8) = (5+6+7)
1	-4	638.86	679.7	0	0	0	0
2	-3	0	849.62	0	0	0	0
3	-2	0	849.62	0	0	0	0
4	-1	0	679.7	0	0	0.00	0
5	0	0	339.85	372.02	3.53	37.55	413.10
6	1	-	-	405.91	3.88	40.98	450.77
7	2	-	-	444.88	4.27	44.91	494.06
8	3	-	-	487.58	4.70	49.23	541.51
9	4	-	-	534.39	5.17	53.96	593.52
10	5	-	-	585.69	5.69	59.14	650.52
11	6	-	-	641.92	6.26	64.82	713.00
12	7	-	-	703.55	6.88	71.04	781.47
13	8	-	-	771.09	7.57	77.87	856.52
14	9	-	-	845.11	8.33	85.34	938.78
15	10	-	-	926.24	9.16	93.54	1028.94
16	11	-	-	1015.16	10.08	102.52	1127.76
17	12	-	-	1112.61	11.09	112.37	1236.07
18	13	-	-	1227.07	12.20	123.93	1363.19
19	14	-	-	1338.85	13.41	135.23	1487.49
20	15	-	-	1460.82	14.78	147.56	1623.16
21	16	-	-	1593.90	16.26	161.02	1771.18
22	17	-	-	1739.11	17.89	175.70	1932.69
23	18	-	-	1897.54	19.68	191.72	2108.93
24	19	-	-	2070.40	21.64	209.20	2301.25
25	20	-	-	2259.02	23.81	228.28	2511.11
26	21	-	-	2464.81	26.19	249.10	2740.10
27	22	-	-	2689.36	28.81	271.82	2989.98
28	23	-	-	2934.36	31.69	296.60	3262.65
29	24	-	-	3201.68	34.86	323.65	3560.19
30	25	-	-	3493.35	38.34	353.17	3884.86
Sum		638.86	3,398.49	37,216.42	386.16	3,760.26	41,362.83

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

If the income 30% tax rate is start from the beginning of the operation railway infrastructure, the Break- event graph will be:

Table 4.8: Financial net present value (including 30% tax from the start of operation)

Year	Operati on Year	Total Cost, C (USD)	Total Benefit, B (USD)	Tax USD (30%*(B-C))	Net cash flow USD (B-C-Tax)	Disco unt rate 6%	FNPV 1	Disc out rate 12%	FNPV 2
1	-4	679.64	-	0.00	(679.64)	1.00	(679.64)	1.00	(679.64)
2	-3	50.98	-	0.00	(50.98)	0.94	(48.09)	0.89	(45.52)
3	-2	50.98	-	0.00	(50.98)	0.89	(45.37)	0.80	(40.64)
4	-1	40.78	-	0.00	(40.78)	0.84	(34.24)	0.71	(29.03)
5	0	95.50	413.10	95.28	222.32	0.79	176.10	0.64	141.29
6	1	328.92	450.77	36.56	85.30	0.75	63.74	0.57	48.40
7	2	335.43	494.06	47.59	111.04	0.70	78.28	0.51	56.26
8	3	342.70	541.51	59.64	139.17	0.67	92.56	0.45	62.95
9	4	350.79	593.52	72.82	169.91	0.63	106.60	0.40	68.62
10	5	359.80	650.52	87.22	203.51	0.59	120.46	0.36	73.39
11	6	369.80	713.00	102.96	240.24	0.56	134.15	0.32	77.35
12	7	380.89	781.47	120.18	280.41	0.53	147.72	0.29	80.61
13	8	393.18	856.52	139.00	324.34	0.50	161.19	0.26	83.25
14	9	406.78	938.78	159.60	372.40	0.47	174.60	0.23	85.35
15	10	421.81	1028.94	182.14	424.99	0.44	187.97	0.20	86.96
16	11	438.42	1127.76	206.80	482.54	0.42	201.35	0.18	88.16
17	12	456.75	1236.07	233.80	545.52	0.39	214.74	0.16	88.99
18	13	478.50	1363.19	265.41	619.28	0.37	229.98	0.15	90.19
19	14	499.74	1487.49	296.32	691.42	0.35	242.24	0.13	89.91
20	15	523.05	1623.16	330.03	770.08	0.33	254.52	0.12	89.41
21	16	322.03	1771.18	434.74	1014.40	0.31	316.30	0.10	105.16
22	17	351.40	1932.69	474.39	1106.90	0.29	325.60	0.09	102.45
23	18	383.44	2108.93	517.65	1207.84	0.28	335.18	0.08	99.82
24	19	418.41	2301.25	564.85	1317.99	0.26	345.05	0.07	97.25
25	20	456.56	2511.11	616.36	1438.18	0.25	355.20	0.07	94.75
26	21	498.20	2740.10	672.57	1569.33	0.23	365.65	0.06	92.31
27	22	543.63	2989.98	733.90	1712.44	0.22	376.41	0.05	89.94
28	23	593.21	3262.65	800.83	1868.61	0.21	387.49	0.05	87.63
29	24	647.31	3560.19	873.86	2039.02	0.20	398.89	0.04	85.37
30	25	706.34	3884.86	953.56	2224.97	0.18	410.63	0.04	83.18
Sum		11,924.97	41,362.83	9,078.07	20,359.79		5,395.5		1,454.3

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table 4.9: Economic net present value (including 30% tax from the start of operation)

Yr .	Operatio n Year	Total Cost, C (USD)	Total Benefit, B (USD)	ECONOMI C COST 90% (USD)	Gross Income USD (B-C)	Discou nt rate 6%	ENPV 1	Disc ount rate 12%	ENPV 2
1	-4	679.64	-	611.68	(611.68)	1.00	(611.68)	1.00	(611.68)
2	-3	50.98	-	45.88	(45.88)	0.94	(43.28)	0.89	(38.65)
3	-2	50.98	-	45.88	(45.88)	0.89	(40.83)	0.80	(32.55)
4	-1	40.78	-	36.70	(36.70)	0.84	(30.82)	0.71	(21.93)
5	0	95.50	413.10	85.95	327.15	0.79	259.14	0.64	164.69
6	1	328.92	450.77	296.03	154.75	0.75	115.63	0.57	65.61
7	2	335.43	494.06	301.89	192.18	0.70	135.48	0.51	68.64
8	3	342.70	541.51	308.43	233.09	0.67	155.02	0.45	70.12
9	4	350.79	593.52	315.71	277.81	0.63	174.30	0.40	70.40
10	5	359.80	650.52	323.82	326.70	0.59	193.38	0.36	69.73
11	6	369.80	713.00	332.82	380.18	0.56	212.29	0.32	68.35
12	7	380.89	781.47	342.80	438.67	0.53	231.09	0.29	66.43
13	8	393.18	856.52	353.86	502.66	0.50	249.81	0.26	64.12
14	9	406.78	938.78	366.10	572.68	0.47	268.50	0.23	61.53
15	10	421.81	1,028.94	379.63	649.31	0.44	287.19	0.20	58.77
16	11	438.42	1,127.76	394.58	733.19	0.42	305.93	0.18	55.89
17	12	456.75	1,236.07	411.08	825.00	0.39	324.76	0.16	52.97
18	13	478.50	1,363.19	430.65	932.53	0.37	346.31	0.15	50.44
19	14	499.74	1,487.49	449.77	1,037.72	0.35	363.56	0.13	47.28
20	15	523.05	1,623.16	470.75	1,152.42	0.33	380.89	0.12	44.22
21	16	322.03	1,771.18	289.83	1,481.35	0.31	461.89	0.10	47.88
22	17	351.40	1,932.69	316.26	1,616.43	0.29	475.48	0.09	44.01
23	18	383.44	2,108.93	345.10	1,763.84	0.28	489.47	0.08	40.45
24	19	418.41	2,301.25	376.57	1,924.68	0.26	503.88	0.07	37.18
25	20	456.56	2,511.11	410.91	2,100.20	0.25	518.70	0.07	34.17
26	21	498.20	2,740.10	448.38	2,291.72	0.23	533.97	0.06	31.41
27	22	543.63	2,989.98	489.27	2,500.71	0.22	549.68	0.05	28.87
28	23	593.21	3,262.65	533.89	2,728.76	0.21	565.86	0.05	26.54
29	24	647.31	3,560.19	582.58	2,977.61	0.20	582.51	0.04	24.39
30	25	706.34	3,884.86	635.70	3,249.16	0.18	599.65	0.04	22.42
							8,557.75		711.70

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table 4.10: Break - even point (including 30% tax from the start of operation) for AA/Sebeta - Djibouti port 756km

Year	Life Cycle Cost(USD)	Life cycle Benefit(USD)	Net Cash Flows (USD)
-4	679.64	-	(679.64)
-3	730.62	-	(730.62)
-2	781.60	-	(781.60)
-1	822.38	-	(822.38)
0	917.88	413.10	(600.06)
1	1,246.80	863.88	(514.76)
2	1,582.23	1,357.94	(403.72)
3	1,924.93	1,899.45	(264.54)
4	2,275.72	2,492.97	(94.64)
5	2,635.51	3,143.49	108.87
6	3,005.31	3,856.49	349.11
7	3,386.20	4,637.96	629.52
8	3,779.38	5,494.49	953.86
9	4,186.16	6,433.27	1,326.27
10	4,607.97	7,462.21	1,751.26
11	5,046.38	8,589.97	2,233.80
12	5,503.13	9,826.05	2,779.32
13	5,981.64	11,189.23	3,398.60
14	6,481.38	12,676.73	4,090.03
15	7,004.43	14,299.89	4,860.11
16	7,326.46	16,071.07	5,874.51
17	7,677.86	18,003.76	6,981.41
18	8,061.30	20,112.69	8,189.26
19	8,479.71	22,413.94	9,507.25
20	8,936.28	24,925.05	10,945.43
22	9,434.48	27,665.15	12,514.76
23	9,978.11	30,655.13	14,227.20
24	10,571.32	33,917.78	16,095.81
25	11,218.63	37,477.97	18,134.83
26	11,924.97	41,362.83	20,359.79

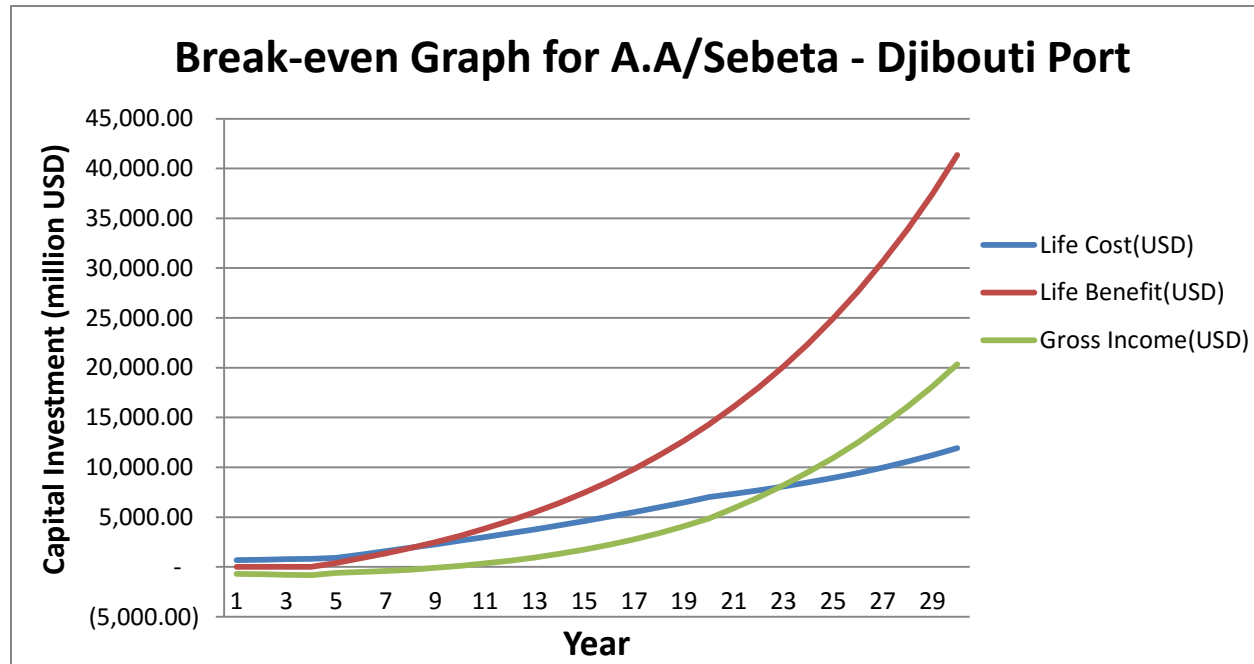


Figure 4.1: Break-even Graph for A.A/Sebeta - Djibouti Port (included 30% tax from the start of operation)

Freight Share	90% of Export and Import	680.4 km
Passenger Share	10% A.A - Djibouti	75.6
	70% A.A - Dire Dawa	326.305
	20% A.A - Mieso	65.83
Total Passenger Share		467.735

Financing Term	
Grace Period (years)	5
Repayment Period (years)	15
Debt Portion Interest rate/yr. (%)	6
Debt Repayment Per year	2
Exchange Rate (USD/Birr)	20

FNPV @ 6%	5,395.25
FNPV @ 12%	1,454.13
FIRR	20%
ENPV @ 6%	8,557.75
ENPV @ 12%	711.7
EIRR	19%
Benefit-cost ratios	3.47

Invest	4,037.35
Average annual Revenue	~1010
PBP (years)	4
Break-Even	5 yrs. Operation + 4yrs construction = 9 years

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

From information of Ethiopian Railway Corporation (ERC), the income 30% tax rate start after 10 years of the operation railway infrastructure is begin. If the promising of the government continues, the Break- event graph will be:

Table 4.11: Gross Income less Tax (including 30% tax from 10 years of operation)

Yr.	Operation Yr.	Total Cost, C (USD)	Total Benefit, B (USD)	Tax USD (30%*(B-C))	Net cash flow USD (B-C-Tax)	Discount rate 6%	FNPV 1	Discount rate 12%	FNPV 2
1	-4	679.64	-	-	(679.64)	1.00	(679.64)	1.00	(679.64)
2	-3	50.98	-	-	(50.98)	0.94	(48.09)	0.89	(45.52)
3	-2	50.98	-	-	(50.98)	0.89	(45.37)	0.80	(40.64)
4	-1	40.78	-	-	(40.78)	0.84	(34.24)	0.71	(29.03)
5	0	95.50	413.10	-	317.60	0.79	251.57	0.64	201.84
6	1	328.92	450.77	-	121.85	0.75	91.06	0.57	69.14
7	2	335.43	494.06	-	158.63	0.70	111.83	0.51	80.37
8	3	342.70	541.51	-	198.82	0.67	132.22	0.45	89.93
9	4	350.79	593.52	-	242.73	0.63	152.29	0.40	98.03
10	5	359.80	650.52	-	290.73	0.59	172.08	0.36	104.84
11	6	369.80	713.00	-	343.20	0.56	191.64	0.32	110.50
12	7	380.89	781.47	-	400.59	0.53	211.02	0.29	115.16
13	8	393.18	856.52	-	463.34	0.50	230.27	0.26	118.93
14	9	406.78	938.78	-	532.01	0.47	249.42	0.23	121.92
15	10	421.81	1,028.94	182.14	424.99	0.44	187.97	0.20	86.96
16	11	438.42	1,127.76	206.80	482.54	0.42	201.35	0.18	88.16
17	12	456.75	1,236.07	233.80	545.52	0.39	214.74	0.16	88.99
18	13	478.50	1,363.19	265.41	619.28	0.37	229.98	0.15	90.19
19	14	499.74	1,487.49	296.32	691.42	0.35	242.24	0.13	89.91
20	15	523.05	1,623.16	330.03	770.08	0.33	254.52	0.12	89.41
21	16	322.03	1,771.18	434.74	1,014.40	0.31	316.30	0.10	105.16
22	17	351.40	1,932.69	474.39	1,106.90	0.29	325.60	0.09	102.45
23	18	383.44	2,108.93	517.65	1,207.84	0.28	335.18	0.08	99.82
24	19	418.41	2,301.25	564.85	1,317.99	0.26	345.05	0.07	97.25
25	20	456.56	2,511.11	616.36	1,438.18	0.25	355.20	0.07	94.75
26	21	498.20	2,740.10	672.57	1,569.33	0.23	365.65	0.06	92.31
27	22	543.63	2,989.98	733.90	1,712.44	0.22	376.41	0.05	89.94
28	23	593.21	3,262.65	800.83	1,868.61	0.21	387.49	0.05	87.63
29	24	647.31	3,560.19	873.86	2,039.02	0.20	398.89	0.04	85.37
30	25	706.34	3,884.86	953.56	2,224.97	0.18	410.63	0.04	83.18
Sum		11,924.97	41,362.83	8,157.23	21,280.64		5,933.7		1,787.33

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table 4.12: Break - even point (including 30% tax from 10 years of operation) for AA/Sebeta - Djibouti port 756km

Year	Life Cost, B(UDS)	Life Benefit, C (USD)	Net cash flow (USD)
-4	679.64	-	(679.64)
-3	730.62	-	(730.62)
-2	781.60	-	(781.60)
-1	822.38	-	(822.38)
-	917.88	413.10	(504.78)
1	1,246.80	863.88	(382.92)
2	1,582.23	1,357.94	(224.29)
3	1,924.93	1,899.45	(25.47)
4	2,275.72	2,492.97	217.25
5	2,635.51	3,143.49	507.98
6	3,005.31	3,856.49	851.18
7	3,386.20	4,637.96	1,251.77
8	3,779.38	5,494.49	1,715.11
9	4,186.16	6,433.27	2,247.11
10	4,607.97	7,462.21	2,672.11
11	5,046.38	8,589.97	3,154.65
12	5,503.13	9,826.05	3,700.17
13	5,981.64	11,189.23	4,319.45
14	6,481.38	12,676.73	5,010.88
15	7,004.43	14,299.89	5,780.96
16	7,326.46	16,071.07	6,795.36
17	7,677.86	18,003.76	7,902.26
18	8,061.30	20,112.69	9,110.11
19	8,479.71	22,413.94	10,428.10
20	8,936.28	24,925.05	11,866.27
21	9,434.48	27,665.15	13,435.61
22	9,978.11	30,655.13	15,148.05
23	10,571.32	33,917.78	17,016.66
24	11,218.63	37,477.97	19,055.67
25	11,924.97	41,362.83	21,280.64

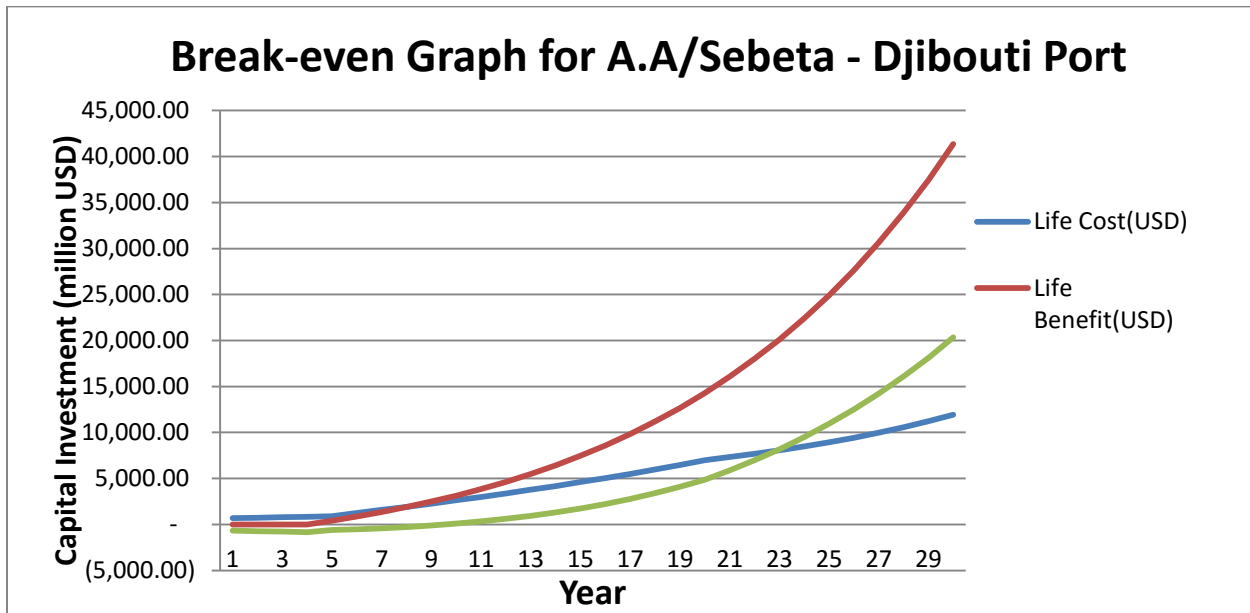


Figure 4 -2: Break-even Graph for A.A/Sebeta - Djibouti Port (included 30% tax after 10 years of operation start)

Invest	4,037.35
Average annual Revenue	~1,010
PBP (years)	4
Break-Even	4yrs. Operation + 4yrs construction = 8years

FNPV @ 6%	5,933.27
FNPV @ 12%	1,787.33
FIRR	22%
ENPV @ 6%	8,557.75
ENPV @ 12%	711.7
EIRR	19%
Benefit-cost ratios	3.47

Base case: 90% of Export and Import; 30% tax; Normal Tariff(0.833Br/T km and 0.3 Br/P km) interest rate 6%

Financial Rate of Return and Economic Rate of Return

Project investments are usually seen differently depending on the financier. Hence, the minimum acceptable financial rate of return of the project depends on specific characteristics and importance of the project, attitude towards risk, level of financing and forecast on benefit.

For the base case, the financial rate of return (FIRR) is estimated to be 20%. The break-even is attained in 5 years of operation; which will become 9 years upon considering the four years construction period and the Economic rate of return (EIRR) is 19%, if the income tax rate started when the operation will begin. Or the break-even is attained in 4 years of operation; which will become 8 years upon considering the four years construction period, if the income tax rate started after 10years. of operation. The payback period (PBP), an indicator that ignores time value of money in one hand and do not account revenue generated after such period, is 4 years.

The net cash flow is increase from the total cost of the project at 23 years when the tax starts from the beginning of the railway operation: 22 years when the income tax start after 10 years of the railway operation start.

Financial Net Present Value (FNPV) and Economic Net Present Value (ENPV)

The Financial Net Present Value (FNPV) is relative depending on the time under consideration either from commencement of construction or operation. The FNPV of total investment (4,037 million USD) generated in 30 years, effective from the commencement of construction period (2012) at 6% discounted interest rate is 5,395.25million USD, which indicates the profitability of the project. Similarly, The Economic Net Present Value (ENPV) of the total investment generated in 30 years, is 8,557.75million USD.

The normal rule is to accept the investment if its present value is positive and reject if the present value is Negative. Accordingly, this project has highest positive value of ENPV and FNPV so; the project is most attractive.

4.2. Social and Environmental Impact Assessment (SEIA)

4.2.1. Introduction

The railway project is aimed at improving the infrastructure network of the country. Railway line is reliable, affordable and environmentally friendly transport system. The provision of railway transport in the country will provide better access to economic development and increase the flow of tourists. Construction of the railway will attract private investors to the project influence areas and increase public and private participations in the development endeavours to boost the country's economy.

However, constructions such as highway and railway do not always have high socioeconomic benefits without causing adverse effects on physical, biological and social environment. Serious disruptions of the social structures and infrastructures can be resulted if the proposed railway project designed and constructed without considering relevant socioeconomic issues. Therefore, integrating socio-environmental and economic concerns into development activities will be essential to ensure sustainable development. Socio-environmental and economic impact assessment as one of the socio-environmental management tools facilitates the inclusion of principles of sustainable development aspiration well in advance.

The main objectives of the SEIA study are as follows:

- To describe the socio-environmental and economic baseline conditions of the road environment;
- Assess relevant social aspects and predict the anticipated social as well as socioeconomic impacts associated with the proposed construction of a railway line;
- Recommend appropriate mitigation measures to avoid or minimize any undesirable effects resulting from construction and operation of the proposed railway project.
- Prepare environmental management and monitoring program.

The SEIA is beneficial both for the implementation of the proposed Railway Section and for the protection of the environment of the project influence areas. The benefits of SEIA will include:

- It involves identifying and assessing the favourable and unfavourable effects of the Project on the environment prior to the Project's construction;
- It identifies migration measures that will help avoid or minimize to the extent possible any negative effect occurring during the Project's life cycle;
- It establishes a monitoring plan describing the monitoring and managing procedures required to ensure that the Project is not exceeding relevant standards and criteria and that migration measures are being implemented adequately; and
- It can be a source of warning signals in case of unanticipated or greater than expected impacts.

Environmental impact assessment (EIA) is a planning tool used in project appraisal and design, in view of ensuring sustainability. Accordingly the fundamental objective of the environmental assessment for the current project is to ensure that the proposed Railway project is environmentally sound and contributes to the development of environmental assets.

Ethiopian Railway Corporation (ERC) calls for the assessment of impacts of the Railway Project on physical and cultural resources (PCRs) of the project area; and to examine the potential sources of environmental impacts. It also requires the consultant to forward mitigation measures for adverse impacts; to undertake public consultation and to prepare Environmental Management and Monitoring Plan.

To assess the potential impacts of the project on the environmental resources, it is necessary to identify and analyse the potential impact areas of the project. The EIA-study dealt with the identification, prediction and evaluation of the impacts of the proposed railway project. Following the identification and evaluation of impacts, it also identifies and proposes measures aimed at avoiding or minimizing adverse impacts on the one hand, and enhancement measures of the beneficial ones on the other hand.

The EIA process followed the guidelines prepared by Environmental Protection Authority (EPA) of Ethiopia and that of the regional level EPAs, and Environmental Procedure manual of the Ethiopian Roads Authority (ERA). The consultant has also made use of specific methods and tools to accomplish the Environmental Impact Assessment including desktop document review, field visits and stakeholders' consultation.

The need to incorporate environmental and social impact considerations during the planning and implementation phases of the project will become a pressing issue to minimize the anticipated adverse effects on the environment. Therefore, the Socio-Environmental Impact Assessment (SEIA) is a set of activities that will be undertaken to ensure that a railway development project enhances both the environmental context in which it is implemented, and the well-being of the communities that it is meant to serve.

The environmental Impact Assessment study has been conducted for those areas that would be influenced by the impacts of the rail-way project implementation. The rail-way route corridor, the woredas traversed by the rail-way and the neighbouring woredas are the most impacted areas either directly or indirectly by the project implementation. The socio- economic and environmental impacts can, however, be felt beyond those limits.

4.2.2. Policy, Legislative and Institutional Frame

Development programs and projects should comply with available policies, legislative and institutional frameworks and standards for proper execution and implementation. Knowledge of the policy and legal frameworks within which the project is going to be implemented would facilitate the project performance and helps to ensure sustainable development. There are several policy and legal documents both at federal and regional level as regards to environmental management and development projects. . Here will be discuss main part of Policy, Legislative and Institutional Frame Works:

4.2.2.1. Policy Issues

The economic policy of the Federal Democratic Republic of Ethiopia (FDRE) is a market – based, agricultural led industrialization mode of economic development. The administrative structure is at federal as well as regional level with duties and responsibilities shared among them. Responsibilities of development activities are clearly demarcated between Federal and Regional Governments based on the scale, characteristics and magnitude of the investment to be undertaken.

The Constitution of FDRE

The Constitution (FDRE 1995), contains a number of articles which are relevant to environmental matters in connection with development projects, as well as to the environment in general, and forms the fundamental basis for the development of specific environmental legislative instruments.

In the section which deals with democratic rights, Article 43 gives the right to people to improved living standards and to sustainable development. Article 92 of Chapter 10 (which sets out national policy principles and objectives), includes the following significant environmental objectives:

- Government shall endeavour to ensure that all Ethiopians live in a clean and healthy environment (Article 44 states that all persons have the right to a clean and healthy environment)
- Development projects shall not damage or destroy the environment
- People have the right to full consultation and the expression of views in the planning and implementation of environmental policies and projects that affect them directly
- Government and citizens shall have the duty to protect the environment

Environmental Policy of Ethiopia (EPE)

The overall policy goals of the Environmental Policy of Ethiopia is described as “...to improve and enhance the health and quality of life of all Ethiopians and to promote sustainable social and economic development through the sound management and use of natural, human made and cultural resources and the environment as a whole so as to meet the needs of the present generation without compromising the ability of future generations to meet their own needs”.

The guiding principles of the EPE are:

- Every person has the right to live in a healthy environment;
- To ensure that environmental impact assessments (EIA) consider not only physical and biological impacts but also address social, socio-economic, political and cultural conditions;
- Sustainable environmental conditions and economic production systems are impossible in the absence of peace and personal security. This shall be assured through the acquisition of power by communities to make their own decisions on matters that affect their life and environment;
- The development, use and management of renewable resources shall be based on sustainability;
- The use of non-renewable resources shall be minimized and where possible their availability extended (e.g. through recycling);
- Appropriate and affordable technologies which use renewable and non-renewable resources efficiently shall be adopted, adapted, developed and disseminated;
- When a compromise between short-term economic growth and long-term environmental protection is necessary, then development activities shall minimize degrading and polluting impacts on ecological and life support systems. When working out a compromise, it is better to err on the side of caution to the extent possible, as rehabilitating a degraded environment is very expensive, and bringing back a species that has gone extinct is impossible;
- Full environmental and social costs (or benefits foregone or lost) that may result through damage to resources or the environment as a result of degradation or pollution shall be incorporated into public and private sector planning and accounting, and decisions shall be based on minimizing and covering these costs;
- Market failures with regard to the pricing of natural, human-made and cultural resources, and failures in regulatory measures shall be corrected through the assessment and establishment of user fees, taxes, tax reductions or incentives;
- Conditions shall be created that will support community and individual resources to sustainably manage their own environment and resources;

- The existence of a system which ensures uninterrupted continuing access to the same piece(s) of land and resource creates conducive conditions for sustainable natural resource management;
- Social equity shall be assured particularly in resource use;
- Regular and accurate assessment and monitoring of environmental conditions shall be undertaken and the information widely disseminated within the population;
- Increased awareness and understanding of environmental and resource issues shall be promoted, by government officials and by the population, and the adoption of a “conservation culture” in environmental matters among all levels of society shall be encouraged;
- Local, regional and international environmental interdependence shall be recognized;
- Natural resource and environmental management activities shall be integrated laterally across all sectors and vertically among all levels of organization;
- The wealth of crop and domestic animal as well as micro-organism and wild plant and animal germ plasma is an invaluable and inalienable asset that shall be cared for;
- Species and their variants have the right to continue existing, and are, or may be, useful now and/or for generations to come; and
- The integrated implementation of cross-sectorial and sectorial, federal, regional and local policies shall be seen as a prerequisite to achieving the objectives of this Policy on the Environment.
- The Policy further outlines both sectorial and cross-sectorial environmental policies.
- To ensure that preliminary and full EIAs are undertaken by the relevant sectoral ministries or departments, if in the public sector, and by the developer, if in the private sector, in accordance with Proclamation No. 299/2002 in order to predict and manage the environmental effects of proposed development activities and resulting in modification or termination of its design or on-going construction/operation;
- To recognize that public consultation is an integral part of an EIA (Proclamation 299/2002, Part Five-Article 15, Public Participation) and ensure that EIA procedures make provision for both an independent review and public comment before consideration of decision makers;
- Environmental impact assessments consider not only physical and biological impacts but also address social, socio-economic, political and cultural conditions;
- To ensure that, at specified intervals during the project implementation, environmental audits regarding monitoring, inspection and record keeping take place for activities where these have been required by the Environmental Impact Statement (Proclamation 299/2002, Part Four-Article 12, Implementation Monitoring);
- To ensure that an environmental impact statement always includes mitigation plans for environmental management problems and contingency plans in case of accidents;

- To establish the necessary institutional framework and determine the linkages of its parts for undertaking, co-coordinating and approving EIAs and the subsequent system of environmental audits required to ensure compliance with conditionality's;

Railway and Road Sector Policies and Guidelines

The guideline on environmental assessment of Federal EPA, 2004 describes major environmental issues related to a road or railway Projects. The guideline highlights major issues and potential impacts that should be taken into account during the preparation and assessment phases. It emphasizes that appropriate enhancement and mitigation measures should be integrated as early as possible, preferably in the project design.

Proclamation on Environmental Impact Assessment

The aim of this Proclamation No. 299/2002 is to make an EIA mandatory for specified categories of activities undertaken either by the public or private sectors and is the legal tool for environmental planning, management and monitoring. The Proclamation elaborates on considerations with respect to the assessment of positive and negative impacts and states that the impact of a project shall be assessed on the basis of the size, location, nature, cumulative effect with other concurrent impacts or phenomena, trans-regional context, duration, reversibility or irreversibility or other related effects of a project.

Proclamation on Environmental Pollution Control

This Proclamation No. 300/2002 is mainly based on the right of each citizen to have a healthy environment, as well as on the obligation to protect the environment of the Country and its primary objective is to provide the basis from which the relevant ambient environmental standards applicable to Ethiopia can be developed, and to make the violation of these standards a punishable act. The Proclamation states that the "polluter pays" principle will be applied to all persons. Under this proclamation, the EPA is given the mandate for the creation of the function of Environmental Inspectors. These inspectors (to be assigned by EPA or regional environmental agencies) are given the authority to ensure implementation and enforcement of environmental standards and related requirements. In addition to this, Proclamation No. 200/2000 addresses public health issues.

4.2.2.2. Legal Framework

Environment related proclamations

There are several proclamations provided by the FDRE related to Environmental protection issues. Among these are:

- ❖ The Federal Constitution of 1995 sets out important articles related to Development and Environmental rights; Article 43 discusses the right to development.
- ❖ The Constitution under Article 44 highlights about environmental rights as follows:
 - All persons have the right to a clean environment.
 - All persons who have been displaced or whose livelihoods have been adversely affected as a result of state programs have the right to commensurate monetary or alternative means of compensation, including relocation with adequate state assistance.
- ❖ Proclamation No. 9/1995 establishes the Federal Environmental Protection Authority (EPA). EPA prepares environmental protection proclamations and does the federal government approve it.
- ❖ Proclamation on Conservation, Development and Utilization of Forests, Proclamation No. 94/1994, was issued in 1994 to provide for the Conservation, Development and Utilization of Forests.

Ethiopian Railway establishment Regulation No. 141/2007)

Through this regulation the Ethiopian Railway Corporation (ERC) is established as a new organization .The primary objective of ERC is realizing modern nationwide railway development to achieve an integrated and efficient, high speed, high capacity railway transport system with the aim to ensure competitive and affordable transport for freight and passengers in the FDRE at an affordable tariff structure. This regulation defines objectives, powers and duties of the corporation and its organization.

Environmental pollution control proclamations NO. 300/2002 sets rules on control of pollution, management of hazardous waste, chemical and radioactive substances, management of municipal wastes etc. Outlines sectors that require environmental standard, environmental inspectors, incentives, rights to appeal, Offences and penalty.

Environmental impact assessment Proclamation No. 299/2002is promulgated in December 2002. The primary objectives of this proclamation are to make EIA mandatory for defined Categories of activities undertaken either by the public or private sector. Article – 5 describes projects requiring Environmental Impact Assessment as follows:

- Every project, which falls in any category listed in any directive issued pursuant to this proclamation, shall be subject to Environmental Impact Assessment.
- Any directive provided under sub- article-1 of Article –5 should among other things, determine categories of; a) Projects not likely to have negative impacts and so do not require EIA, b) Projects likely have negative impacts and thus require environmental impact assessment.

Proclamations NO.52/1993 which deals with the development of mineral resources

Proclamation No.209/2000, a proclamation to provide for research and conservation of cultural heritage

Proclamation NO.197/2000 deals with Ethiopian water resources management.

Proclamation NO200/2000 refers to public health issues.

4.2.2.3. Institutional and Administrative Framework

Federal and Regional Administration

The Federal Democratic Republic of Ethiopia comprises of the Federal states with nine Regional State members. The Federal Government acts from the centre to the regions and localities, and its respective duties and authority including fiscal matters at the different levels (Federal, Regional and Local) have been defined by the Constitution.

The duties and responsibilities of the Regional States include planning, directing and developing social and economic programs as well as the administration, development and protection of natural resources of their respective regions. The basic administrative units in each Regional Government are the Woredas, which sub-units are the Kebeles in urban areas and farmers associations in rural areas. Further, based on their authority and responsibilities the regional governments have established Sectoral Bureau, Commissions and Authorities.

The Environmental Protection Authority

The Environmental Protection Authority (EPA) was established in August 1995, in response to the requirements of the Constitution (Proclamation No 9/1995).

The objective of the EPA is to:

“...ensure that all matters pertaining to the country’s social and economic development activities are carried out in a manner that will protect the welfare of human beings as well as sustainability of the project, to develop and utilize the resource bases on which they depend for survival” (Federal Negarit Gazeta of the Federal Democratic Republic of Ethiopia - Proclamation No 9/1995)

The Environmental Protection Authority (EPA) is the Competent Agency at the Federal level in Ethiopia. It is, therefore, the responsibility of this authority in the EIA process is:

- To ensure that the proponent comply with requirements of the EIA process;
- Maintain co-operation and consultation between the different sectoral agencies throughout the EIA process;
- Maintain a close relationship with the proponent and to provide guidance on the process; and Evaluate and take decisions on the documents that arise from the EIA process.

At the regional level, the Federal EPA has devolved responsibility to the Regional equivalent of the EPA. It is the responsibility of the regional EPA bodies to inform the Federal EPA of projects that may be of national significance. Therefore the Federal authority should only be involved in EIA processes where a proposed activity may:

- Have an environmental effect across the international boundaries of Ethiopia;
- Have an environmental effect across regional boundaries within Ethiopia;
- Have an effect on an environment of national or international significance, including but not limited to natural forests, wetlands/marshlands, national parks, cultural heritage sites etc.
- Have a Federal government department, the relevant regional authority or another statutory body as the proponent;
- Have the Federal Investment Authority as the investment approval body.

Ethiopian Railway Corporation (ERC)

The ERC was established through regulation Number 141/2007 of the council of Ministers of FDRE. The corporation reports to the ministry of transport and communications. The regulation mandates the corporation (ERC) to develop railway infrastructure and provide passenger and cargo rail transport services.

4.2.3. Socio – Environment Impacts and Mitigation Measures

4.2.3.1. General

The major positive impacts of the rail way project are those of social and economic benefits attained from the improved transport access in the region due to the construction of rail way, while major adverse impacts are attributed to the impact on the vegetation and wildlife habitats traversed by the rail way project route, and pollutions emanated from construction and operation phases, loss of farm and grazing lands.

Hence, early in the design process, a decision has to be made to avoid disrupting important historic and ecological sites. The socio-environmental and economic impacts of the railway construction were assessed to identify the possible impacts. Most of the negative effects will be short-term and reversible, stemming from ground disturbance, operation of equipment, construction camps and construction materials processing and storage. But, some impacts such as loss of structures and land acquired for the ROW will be permanent.

Based on the Environmental and Social Impact Assessment Report, and as per the chapter of Environmental Protection and Soil & Water Conservation, Sebeta~Mieso section (Section I) involves the important environmental protection object-Awash National Park. And it still needs to be determined further whether Mieso~Dewele, Dewele~Nagad and Nagad~Djibouti Port sections (Section II, Section III and Section IV) involve the environmental-sensitive objects and the location relations with the line.

4.2.3.2. Negative/Adverse impacts of the Railway project

I. Loss of Land under Various Uses

Construction of the rail way project will cause a permanent loss of land due to land acquisition for railway line. In addition, there will be temporary land losses that mainly will arise from construction of access roads to material sites, exploitation of quarries and borrow pits, establishment of contractor's site facilities (campsites and construction materials processing and storage sites), and disposal of spoil materials from tunnels and land cuts. The land loss at most of the quarries and borrow sites could be permanent as restoration of those sites to productive state may be not feasible.

Mitigation Measures

Mitigation measures to minimize land losses include the following:

- Apply appropriate engineering design in order to keep the land requirement for the construction of the road to the absolute minimum.
- Avoid side-tipping of excavated materials onto adjacent agricultural lands or vegetation areas or down-slopes. All surplus excavation materials should be disposed of in approved spoil disposal areas with appropriate landscaping and planting with appropriate species afterwards.
- Reinstatement of the land areas affected by temporary uses like campsites, detour roads, and access roads to productive state by removal of existing pavement materials, loosening of compacted soils and spreading of the topsoil stockpiled for this purpose.
- Implement effective drainage systems that would minimize erosion or flooding by runoff water diverted or concentrated and released onto productive lands in adjacent or downstream areas.

- Restore borrow sites, construction camps and materials processing and storage sites through back-filling, landscaping, covering with top soil and re-establishing vegetation cover to the extent possible.
- Preserve topsoil from the realignments, borrow sites and site facilities for re-use on embankment slopes

II. Air Pollution and Noise

During construction, there will be a moderate and temporary deterioration in air quality, caused mainly by dust. The dust will settle on trees and crops, and will cause some degree of respiratory stress for nearby residents. Construction work and equipment will cause noise and dust development which creates nuisance for local residents or endangering of traffic and will disturb traditional irrigation. Moreover, the exploitation of borrow pits and quarries, and the transport of construction material will create noise and dust, which finally leads to nuisance of local community.

The main project activities that are likely to cause significant dust, pollutant gases and noise Emissions include:

- Heavy earthworks/excavations and blasting activities involved in the construction of the railway and drainage structures,
- Extraction of construction materials (borrows and quarries) and their haulage to the construction front or processing plant sites,
- Construction materials processing activities like aggregate production and concrete batching,
- Filling of the embankment with select (borrow) materials and aggregates, and compaction using heavy equipment, and
- Haulage of spoil materials to disposal sites.
- The noise source strength of passenger and freight vehicles shall be verified as per the vehicle conditions such as the type selection and velocity of the passenger and freight vehicles of the project and the line conditions. For the section that runs through the residential district, the conditions and investment for noise reduction measures such as the acoustic barrier shall be provided as per the actual condition of line operation and environmental impact and the location relation between the line and the sensitive points. The noise reduction measures such as acoustic barrier shall be adopted if necessary.

Mitigation Measures

Mitigation measures to minimize Air Pollution and Noise include the following:

- Limiting traffic speeds and applying water regularly on dusty roads esp. along those sections passing through or nearby human settlements (towns, villages), business/ agricultural areas, social services (health units, schools, water supply points), religious places (churches & mosques), and other sensitive areas,
- Use of modern and well-maintained equipment (with mufflers where appropriate), regular maintenance of diesel powered machinery and vehicles to reduce exhaust emissions and noise levels,
- Regular maintenance of emission intensive plants like aggregate production plants and application of dust suppressant mechanisms,
- Locating the aggregate production plants and concrete mixing plants at a minimum distance of 2km from any sensitive receptors such as residential areas, religious places, health units, schools and drinking water supply sources,
- Construction works must comply with relevant health and safety standards pertaining to noise and emissions, such as wearing ear protection when operating plants or heavy machinery,
- Implementing well-designed traffic management plan that considers traffic safety and working hours for materials transport thereby minimize transport-related disturbances to local residents and road users, and reduce traffic accidents,
- Carrying out noisy construction activities during normal working hours,
- Avoiding burning of materials such as tires, plastic, rubber products or other materials that create heavy smog or nuisance odour,
- Avoiding disposing of any volatile chemicals to the air, and
- Informing local people in advance when there will be blasting or unusual unavoidable noise.

III. Competition for water resources

The contractors will require substantial volumes of water for various construction purposes such as adjustment of moisture content of fill, road sub base and base courses, and watering of haul routes to suppress dust. In addition, the water requirements at the base camps will be relatively high, although these will be much lower than those needed in connection with construction. It is probable that some of the contractors' water requirements will be met by abstraction from watercourses.

All watercourses in the project area are used for drinking, washing, cattle watering and in some areas for small scale irrigation purposes. During the dry season, most watercourses which the

road crosses have no flow and where there is, it will be very low and any amount of withdrawals by contractors could reduce water availability to existing downstream users. In view of the widespread need for contractor abstraction over a large part and the serious implications of reduced supplies for the local communities especially for low flowing watercourses potential impact is considered to be very significant.

Mitigation Measures

Impact can be minimized satisfactorily by requiring the contractor to make their own arrangements for water supply which will not affect the rights of others, and to provide an alternative supply if interference does occur. Therefore, water for construction either has to be made available by constructing ponds or transporting from River or other streams in the vicinity where there is no crowded users.

The possibility whether the Akaki water source area is involved in Akaki - Bishoftu/Ada'a section and the impact that may be caused for the water quality and water yield during construction shall be further verified. The location relation between the line and the water source area shall be further verified to optimize the construction scheme and enhance the wastewater management during construction. Sewage treatment facility shall be provided at Indode rolling stock depot to carry out the sewage treatment for the wastewater generated by washing car and the domestic sewage and discharge them after reaching the discharge standard.

IV. Impacts on Flora and Fauna Resources

The railway route construction requires plots of land to be cleared along the rail line alignment and within the ROW width, at material production sites and at locations for facilities erection and camp establishment. Clearance and degradation of the vegetation resource, can affect both the wildlife and plant species of the area, especially in the forest conservation area. Disturbance and accidental risks to the wildlife will be severing during the construction as well as the operation phases of the railway.

Forest degradation can cause Shift in flora and fauna species of the conservation sites. Impacts on wildlife would be relatively high due to traffic accidents and also due to poachers and illegal hunters. Disturbance and interferences with the forest resource can introduce and encourage further development of exotic plant species. Vegetation clearance also exposes the land to soil erosion effects. The land in the area is fertile and untouched so far. However, the site clearance and excavation works for the railway project can open up ways for soil removal by wind action and runoff water. The plot of land for the rail line will be permanently devoted as transport route and will not be put for other economic uses; this will have adverse impacts to the local economy and lively hood of the agro - pastoral community.

Ethiopia is making efforts to protect biodiversity and conserve resources through the creation of protected parks, wildlife resources, and controlled hunting areas. The establishment of these Conservation and Protection Areas has been one of the more farsighted and ecologically beneficial occurrences in the country.

Awash National Park is the oldest and most developed wildlife reserve in Ethiopia and it locate in the Ethiopia Djibouti railway line (Route1) of the 1st section Sebeta – Mieso section. There is the Fantale volcano of 1800m height in the Park, and there are abundant mineral springs and unique volcanic terrain here. The Awash National Park is covered by thick vegetation and there are many species of animals and plants, but the eco-system is relatively weak. In order to mitigate the impact over the environment of the national park by the project construction, the scheme of detouring at the north side of the park, the scheme of detouring at the south side of the park and the scheme of running across the park are compared.

Mitigation measures

Therefore, the following measures should be taken to minimize the adverse impacts on the flora and fauna resources;

- The contractor is required to prepare detailed Site Environmental Plan (SEP) for the construction activities within the boundaries of the forest covered areas, and get it approved by the engineer.
- Camps and garages should not be located in the dense forest areas, the supervising consultant should be informed that no approval of such site is given to the contractor. The environmental inspector and the resident engineer have the responsibility of ensuring that these requirements are met.
- The design will have wildlife and animal crossing corridor at suitable locations and intervals
- A clause should be included in the construction contract which makes it clear that the contractor will be responsible for any fire accident caused by his activities within the forest areas.
- The respective regional and / or zonal Land Administration, Natural Resources Development and Environmental Protection offices should be informed about the project and arrange special policing to protect illegal timber extraction during construction.
- Trees cut / removed for the project should be replaced by planting and growing seedlings at appropriate place in the premises.
- Adequate monitoring mechanism should be established to supervise and control illegal deeds within forest conservation sites like; illegal logging, timber trade and charcoal making.
- Awareness creation programs on the precautions to be taken while operating in wildlife areas shall be organized and conducted by the contractors.

- The impacts due to poaching and intruder can be minimized through awareness creation among the employees and to the community of the area, setting regulations and employment obligations that prohibit poaching, illegal timber cutting and setting fire to the forest.
- The contractor shall instruct and supervise his work force not to involve in illegal hunting, poaching and encroaching in to wildlife habitat and killing of wild animals, not to involve in trading, transporting and endangering wild animals.
- The contractor shall maintain rail side vegetation cover and forest trees that can serve as wild life habitat and as wildlife corridor.
- The contractor shall install warning signs and speed control signs at all animal crossing corridors as identified by the design engineer and in consultation with local community.

The line shall run across Awash National Park twice in the form of bridge and subgrade at the south western edge and the south eastern side of the park separately. The sections that run across the park with the length being 7.2km and 19.99km respectively and the total length being 27.19km. In addition, Duftu station and Awash Park station shall be provided inside the park.

It is recommended that the route design and the site selection for station should be study to bypass Awash National Park as far as possible. Where it is impossible of detouring, the route scheme of running across Awash National Park shall be reported to the local competent authority for review and approval. According to the requirements of the competent authority, necessary ecological protection measures shall be adopted. It is recommended to adopt the low embankment scheme for the section that runs across Awash National Park, to conduct the scheme optimization, comparison and selection towards relevant engineering measures from the perspective of traffic safety, animal conservation and project investment further, and to carry out the design according to the suggestions of relevant authorities such as the local environmental protection authority.

V. Impacts on Sensitive Ecosystem Wetlands

The railway construction can affect the ecosystem by increased movements of heavy trucks in the wetland, dumping spoil soil on the swampy areas, increased more pressure by extracting water from the wetlands for the consumption of different purposes, which results in drying up of the wetlands. This can damage the life system found in the wetland and consequently affects the proper functioning of the wetland.

Mitigation Measures

The proposed mitigation measures in order to maintain the proper functioning of the wetland ecosystem are;

- The design of the railway has to be done taking in to account to create buffers between the railway line and the wetland
- The contractor has to take the responsibility of not disposing spoil soil and other waste materials in the wetland. They have to use environmentally sound waste disposal sites
- The contractor has to arrange to use its own water sources either by digging bore holes or fetching from rivers without competing with local community
- The borrow pits and quarry site are not located crossing the wetland in order to reduce the movement of heavy trucks and other vehicles over the wetland to transport the raw materials

VI. Environmental Health and occupational Diseases

The influx of people by the contractor's work force may create an impact on the community health as well as on the construction workers themselves through communicable diseases and sexually transmitted infections. Stagnant waters caused by uncompleted construction activities in/near housing areas could bother people and create hygienic problems. The exploitation of borrow pits and quarries with heavy machinery could create health risks for the worker's.

Mitigation Measures

Concerning general health problems in the project area and sexually transmitted infections including HIV/AIDS, the contractor's Safety/Health Officer shall liaise with the local health authorities and provide the necessary information on precautionary measures to the work force through educational lesson. According to the nature of work and with regards to the climatic conditions in the project area the workers need to be provided with appropriate protective clothing. First aid facilities have to be on site as well as a first aid station in the camp.

VII. Impact on Traffic Safety and Control

During the construction period, there will be equipment and machinery movements that could increase the risk of accidents to the local communities (particularly children) and their cattle, especially when they are crossing the road.

Mitigation Measures

- During construction, the behaviour of site traffic should be controlled and properly managed by the contractor's site office in order to minimize the risks;
- Contractors should provide, erect and maintain such traffic signs, road markings, lamps, barriers and traffic control signals and such other measures like awareness creation about

traffic safety before drivers start their jobs as may be necessitated by the construction of the railway works;

- Contractors should not commence any work that affects public roads until all traffic safety measures necessitated by the work are fully operational; and
- All traffic signals including temporary signals used at project works should be approved before they can legally be installed for public use. Portable traffic signals should be also complying with the current requirements of the traffic signs regulations, which lay down the size, colour and type of prescribed traffic signals.

VIII. Exposure to HIV/AIDS and Other Sexually Transmitted Diseases (STDs)

Ethiopia, the HIV/AIDS pandemic has emerged as a major health hazard, affecting mainly the age group 15 to 49 years who are supposed to be highly productive. Road construction and other similar type of project workers and truck drivers are considered to have high potential for the spread of HIV/AIDS and other sexually transmitted diseases (hereafter called STDs) due to their mobility. This is partly because construction workers are mostly young, sexually active group of the population, mobile and are partly because they are forced to live in hotels and camps without their families.

Impacts from the construction camps will be severe if camps are built close to the local settlement areas. The impact from the construction camps that are constructed close to settlement areas may contribute more to the spread of communicable diseases such as STD and HIV/AIDS. The other impact is transmission of HIV/AIDS from local sex workers to the project workforce. Hence, when dealing with the pandemic problem, not only the project workers shall be assumed as carriers, rather, they may be equally vulnerable from local (sex workers) carriers.

Mitigation Measures

As preventive measures, construction workers and local population must be informed through education campaigns about HIV/AIDS. This has to be done on the one hand by the contractor, responsible for his workers and on the other hand by the communities along the railway project targeting.

Condoms shall be provided at subsidized rate or for free and health facilities must be supported with supply of condoms and must communicate information about risks. To have an effect in the long-term, schools should include information campaigns and/or special courses as suggested below:-

- Conduct education and awareness creation campaigns on the spread and transmission of HIV/AIDS and other STDs for the construction workers and local communities living close to the construction camp sites.

- Provide free distribution of condoms to construction workers by the contractor to check the spread of HIV/AIDS and other STDs.
- Put educational posters and flyers on HIV/AIDS using local language at public gathering locations, bus terminals schools and road sides to minimize the spread of HIV/AIDS
- Monitor the mitigation measures through proper monitoring indicators.
- Adopt ERA's /ERC policy on HIV/AIDS and make a condition on the contract of the construction works.
- Spread education for preventing communicable diseases, HIV/AIDS and other STDs and practicing Safe Sex by using condom.

4.2.3.3. Positive/ Beneficial Impacts of the Railway Project

I. Benefits for the Transport System

Comparing rail traffic with other traffic modes, the rail traffic is undoubtedly the most reliable traffic mode. This reliability does not only result from a lower number of traffic accidents, but it will prevent the occurrence of casualties, injuries and human losses. At the same time, rail traffic disburdens overburdened network of highways and primary roads.

With regard to improvement of transport system, the implementation of the proposed railway line, in general, will have the following benefits:

- Public transport system will be improved;
- Safety reliable transportation of goods and passengers;
- Significant reduction in travel time;
- Improved accessibility to foreign markets;
- More efficient transit services; and
- Reduce car dependency and decreased car congestion.
- Air quality benefits; and other social and economic impacts

II. Increase Transportation Capacity and Improvement of Price Conditions

In growth of national economy, the proposed railway line has its specific and irreplaceable position. It enables and facilitates transportations of bigger quantity of goods on long or medium distances in which a different traffic mode would be too expensive and therefore inefficient. Besides, the introduction of railway transport increases mobility. Mobility is one of the most fundamental and important characteristics of economic activity as it satisfies the basic need of going from one location to the other, a need shared by passengers, freight and information. It is the fact that reduced mobility impedes development while greater mobility is a catalyst for development.

III. Lower Transport Restrictions

In comparison with road carriers, the important advantage of railway transport can also be lower transport restrictions. As it is known, the road carriers must respect several regulations, such as limitations in utilizing highways and primary roads, limitations in traffic peaks, or obligations to keep safety breaks. There are no such problems in connection with railway transport.

IV. Benefits for Local Employment

One of the major positive impacts of the project during the construction stage is the creation of employment opportunity. The railway project will employ significant number of people during the project construction and operation phases. The benefit collected from the project in terms of wage will be supplementary cash income as it is needed in rural household for various purposes such as to pay for debts, manufactured goods, education and cloths.

V. Benefits for Local Economy

The employment opportunity, income from shops, house rental, increases demand for food, beverage, etc. are the areas of income during project construction period. Furthermore, local contractor will also be used for some construction works which is considered positive impact for the local economy.

The likely impact on rural economy due to increased economic activities during construction phase is considered positive impacts for the area. As the result of increased trade and business, significant amount of cash will be channelled into local economy. This short term economic boom will contribute to improve the living conditions of the people in the project area. Moreover, establishing railway transport network will encourage producing diversified market oriented surplus for marketing. This will in turn contribute not only to boost intra-regional and inter-regional trade but also contribute for poverty reduction and sustainable local economy development.

VI. Benefits for National Economy

It is the fact that establishing railway transport system in selected corridors; and railway lines will certainly create better access and connectivity in the country. The proposed railway will connect regions to regions and gives access to the neighbouring countries and alternate ports so that there will be strong socio-cultural and economic relationships among them. This will contribute to the economic development of the country. It will also create access to local and foreign markets and in turn it will encourage development as the railway transport is low cost, safe and speedier.

Moreover, since the project influence regions are widely known by its tourist attractions due to its natural endowments, historical and cultural heritages, the introduction of railway transport in such areas would contribute for ecotourism development.

In general, the benefits for national economy due to the proposed railway project will include:

- Improved productivity;
- Immediate job creation;
- Knowledge transfer;
- Urban development along the route;
- Stimulation of economic development; and
- Positive impacts on tourism development

VII. Benefits for Public Health and Living Conditions

The proposed railway transport would reduce dependence on human portage, which benefits the female members of the communities in particular. It would also increase mobility, social communication and interaction of women both within and outside of the project influence areas. Hence, business women will be among the most beneficiaries as the railway transport is low cost, safe and speeder.

Besides, the railway transport would contribute to improve social services of the project influence areas; such as schools, health institutions, banks and agro-industry businesses. In general, the benefits in terms of public health and living conditions would include:

- More time for family and community activities;
- Increase in leisure time;
- Improved sense of security during travel;
- Reduction of air pollution;
- Reduction of stress and road rage; and
- Reduction of accidents and fatalities.

VIII. Facilitate Humanitarian Aid

The proposed railway transport would greatly facilitate humanitarian works during emergency cases as it enables transportation of bigger quantity of goods on long or medium distances at relatively low costs and speeder than of other mode of transport.

IX. Responsibility for Ecology

Railway traffic is an efficient and environment-friendly transport system in many cases. Large volumes of goods can be transported on long distances quickly with a minor impact on

environment. Compared with automobile or air transport, railway transport produces the lowest amount of emissions and requires much lower costs on regeneration of damaged environment. Another important of railway transport above the road transport is a lower occupation of agricultural land.

X. Cultural Development

The in-migrant people for job opportunities will bring both positive and negative impacts to the local people. Some of them will have different cultural backgrounds and behaviours; they might not be complying with the culture of the local communities. On the other hand, the existence of social interactions between the influx of people and local persons will create suitable opportunities for skill transfer and other socio-cultural developments to the local communities. In general, the railway transport will promote cohesion and interaction among community members of the project influence regions. Besides, the flow of tourists will be increased due to the railway transport and this will induce growth in ecotourism development.

4.2.4. Socio – Environmental Management and Monitoring Plan

Environmental management plan specifies mitigation and monitoring actions with time frames, specific responsibilities assigned and follow-up actions defined. Implementations of the measures have to be carried out at different stages of the railway construction & operation phases.

During the design stage the consultant should incorporate mitigation measures in the design and tender documents. The contractual agreement should also include articles to enforce the environmental issues. Construction stage activities are mainly the responsibility of the constructor and that of the construction supervision consultant. The actual physical implementation works are carried out mostly at this stage. The execution of the railway construction work should also equally treat the implementation of the physical works of environmental mitigation measures.

Mitigation measures proposed for socio-economic issues like compensation to damaged properties, lost/degraded plots of land should be handled by a committee, composing of representatives of all stakeholders, other local government administrative organs, NGOs, and the affected group.

Continued enjoyment of the benefits arising from implementation of the project will only be achieved if effective routine and periodic maintenance, earthworks and drainage system maintenance is carried out in a timely manner. Environmental management and monitoring during the operation phase of the railway shall be handled by the ERC, the relevant agency and environmental departments of the two countries (Ethiopia and Djibouti) with implementation being carried out either by the department itself or by contractors. The staff of the ERC or a

designated unit in the ERC should acquire basic knowledge of the environmental monitoring activities to effectively assume the responsibility. Training of personnel is, therefore, essential.

The Implementing agent will work directly with national and local government agencies and with contractors to ensure compliance with standards and the implementation of mitigation measures. The Implementing agent will establish an environmental and social monitoring unit that will ensure implementation of the social/environmental management and monitoring plan during construction and operation phases of the project.

4.2.5. Conclusion and Recommendations on SEIA

Successful implementation of measures to minimize environmental impacts is a priority for the owners of the railway infrastructure and the local authorities along the alignment. The potential adverse environmental impacts include soil erosion, spoil disposal, air pollution, water pollution, noise and vibration, solid wastes, disturbance or contamination of historic and ecological sites, public safety, land acquisition/land take and altered land use patterns, population resettlement, and induced impacts.

Investment in environmental protection and mitigation measures the environmental investments will be for soil and water conservation, which is especially important in areas subject to high rates of soil erosion. Other important mitigation measures for noise and vibration from the high-speed train have to be designed for the populations, agencies, and enterprises along the alignment by the Design consultants.

Generally, the positive impacts of the project are found to outweigh the negative impacts provided that the proposed mitigation measures are implemented properly as the project road follow more or less the existing alignment

It is, therefore, recommended that in order to reduce the adverse environmental impacts,

- the works contract should incorporate strong environmental clauses;
- enforcing measures for contractor's non-conformance should be included so that contractor follows environmentally friendly work discipline, and
- Project executing agency, ERC, together with the federal and environmental authorities should make sure the provisions in the country's and international laws/regulations are respected or fulfilled.

As a conclusion, the project impacts from both construction and operations will be minimal, and can be mitigated through the use of best practices and appropriate technologies. Internal and external monitoring and audits will be conducted to ensure that standards and regulations are being followed, and if they are not, that they are immediately corrected.

4.3. Risk Analysis

4.3.1. Political Risk

In 1994, a new constitution was passed at the Constitutional Convention of Ethiopia, defining a federal parliamentary system and a framework of separation of the executive, legislative and judicial powers and separation of religion from politics. The President is the head of state with a term of office of 6 years; the Prime Minister and the Parliament owns the highest executive power. There is a bicameral parliament made of the House of Federation and the House of Peoples Representatives. Main parties in Ethiopia are Ethiopian Peoples' Revolutionary Democratic Front (EPRDF), Coalition for Unity and Democracy Party and Ethiopian Federalist Democratic Unity Forum, etc.

In 1995, EPRDF won the national election and established the Federal Democratic Republic of Ethiopia. After that, EPRDF won the election continuously in 2000, 2005 and 2010. Since being in power, EPRDF has established the federal system on the basis of regional autonomy of minority nationalities, focused on economic development and emphasized the relation among stability, development and national unity. Over the past few years, GDP of Ethiopia has sustained and stable growth and the political situation of Ethiopia have been stable.

4.3.2. Project Implementation Risk

Studying from on-site construction conditions, the project has no remarkable engineering technical difficulty and is not hard to construct. At present, under CREEC and cooperation, the feasibility study report for the whole railway line is generally completed on behalf of ERC, overall design and systematically design are conducted for the whole line, unified design standards and principles are established, and the traffic volume, operation and maintenance, rolling stocks, allocation of maintenance and repair facilities and organization setting, etc. are generally unified. If the further design and construction is carried out as per the construction scheme in the Revised Feasibility Study Report of ERC, the overall construction risk will be under control.

4.3.3. Power Supply Risk

Although Ethiopia boast rich power resources, more supporting power facilities should be constructed to meet the requirements of power supply stations along the railway track. In addition, Djibouti is with serious power shortage so the study should be accelerated to determine power supply scheme in the section of Djibouti so as to meet the demands of power consumption in the whole railway line. On-site investigations have shown that the construction of supporting power supplies and the contact work of different organizations has slightly lagged. It is suggested that the two countries launch construction of the supporting electric works for the electrified railway timely and realize contact of the Railway Company and electric power corporation as soon as possible so as to determine the external power supply scheme of the traction substations. The construction progress of external supporting power supplies is a big risk for the smooth implementation of the project.

4.3.4. Labour Risk

The average wage of Ethiopian labour force is low. However, as there is a serious shortage of technicians and the salary for local technical labours and higher management is very high, the contractors prefer technicians and management assigned from China. The Ethiopian government has recently strengthened the restriction in foreign labours, asking them to provide corresponding education or skill certificates for handling of work permits. For some projects, the employers have certain regulations and requirements on employment of local labours. Moreover, local labours must be employed for some lower posts. During the construction, large quantities of local labours will be employed. In order to prevent and control labour risk, the Chinese construction contractors shall strengthen communication with the local labours, respect local culture and provide regular training to promote compatibility of the culture between both parties.

4.3.5. Exchange Rate Risk

Ethiopian currency belongs to soft currency. Birr devaluation is faster during the financial crisis. The exchange rate against USD dropped to 18:1 in June 2012 from 9:1 in 2008. Currently, 40% of construction cost is paid in Birr in the commercial contracts of Ethiopia section signed between the contractors, CREC and CCECC, and ERC. Meanwhile, as Ethiopia has an extreme lack in foreign exchange reserves, it is predicted that Birr will still keep the state of devaluation in the future, so the Project has certain exchange rate risk.

4.3.6. Operation Risk

After the project is completed, all the risks of the project will be reflected during operation process. Operation risks refer to the risks that the project cannot normally operate and fail to realize predicted use result due to the improper management of the operation company after the project is completed and delivered to the Employer for use. Operation problems will also bring passive impacts to the China Contractors. Operation risks generally occur in the following processes:

- (1) Due to lack of operation management experience of national railway projects, the project operation organization may not have the capacity of operation management, resulting in operation risk. Moreover, as the project spans two countries, the national railway ministries of the two countries should establish a joint operation organization to design effective operation mechanism, learn lessons from other similar projects and strengthen its own soft power during the operation process, so as to evade operation risks as many as possible.
- (2) The national finance departments and the project employer fail to establish reasonable financial subsidy principles for the operation company, leading to unstable continuous fund supply during the operation and unsustainable operation of the project.
- (3) The prediction of transport demand is inaccurate during planning. An overestimate will reduce the expected operating revenues and increase the construction and maintenance costs of infrastructure and subsequent operation risk. To reduce such risks, the Designer should plan prudently.

4.3.7. Repayment Risk

As an important infrastructure project in both Ethiopia and Djibouti, the railway will play a significant role in promoting the economic development in vicinity areas. However, it is difficult for the railway to repay the loan and interest by its own financial benefit and subsidy from the government is needed. Therefore, the project has certain repayment risks.

5. Conclusions and recommendations

5.1. Conclusions

Significance of the Project

The Project is the most important international railway transport corridor of Ethiopia and the most important inland corridor of collection, distribution and transport for Djibouti Port. Construction of the Project is a great significance for improvement of the transport systems of Ethiopia and Djibouti and promotion of the social and economic development of the two countries. Therefore, construction of the Project is imminent.

Although there could be many possible routes for railway development in Ethiopia, the proposed new Addis Ababa – Djibouti line serves the principal traffic corridor of the country and is the best and most urgent of the planned projects.

Main Technical Standards

The new Addis Ababa – Djibouti line is designed by referring to the standards for National Railway Class II in China, and the main line is of a sub-heavy track structure and designed as an ordinary line, which conforms to the national conditions of Ethiopia and Djibouti. In addition, higher requirements will be proposed for the maintenance work, which does not conform to the traffic volume of the line and the actual conditions of Ethiopia. The main technical standards, the design principals and equipment for each subsystem are basically reasonable so as to promote the smooth implementation of the Project.

The Ethiopia - Djibouti new railway project will connect the railway truck line from Djibouti to Addis Ababa, which is the main transport corridor for passenger and traffic from Ethiopia National Railway Network Program (phase 1) and it is a key project in the “new five year plan” of Ethiopian Government. Generally, the project is the best and most urgent of the planned projects for main reasons summarized as follows:

- The route has a very suitable distance for railway project, 756 km;
- There is already more than adequate traffic, over 9 million tonne in 2010, and is growing fast;
- The route has the shortest distance from the seaport to Addis Ababa and the Central regions with big traffic generating hinterland of the country;

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- The corridor terrain is acceptable for plain, rolling & mountains topography, respectively with ample construction materials and traversing through many of the business cities and growing towns;
- The corridor is a strategic route serving both domestic and export/import trade traffic;
- The route has regional significance by providing interconnection to IGAD member countries and African East – West trunk railway connection;

It is clear from the information presented in this Research that, the construction of a standard gauge railway between Addis Ababa and Djibouti is technically feasible, socially acceptable, economically viable, and environment friendly.

5.2. Recommendation

- 1) The design of plane section and longitudinal section should be further optimized so as to reduce the cost for construction according to arrangement of overpass, flood discharge by bridges and culverts, and elevation design of subgrade of riverside sections, etc.
- 2) From Ethiopia – Djibouti railway line of the 1st section Sebeta – Mieso section the construction is start in 2012 but the progress is very low due to problem in the progress. During construction period, ERC should control the existing problem on the progress. Due to monthly Supervision report no.13 in May, 2014 of Ethiopian railways corporation for route 1 of the 1st section, the existing problem on progress is listed below:
 - Lack of Land acquisition and relocation of legal houses and illegal houses
 - Relocation of High voltage electricity, low voltage electricity and wooden poles is delayed, which Seriously affected the construction progress
 - Insufficient Construction material: contractor’s manpower, turnover material and equipment’s should be fulfilling.
 - In general, unqualified result of some test, Quality problem in some section, Chiselling problem, problem of temporary drainage facility and other reasons should be control.
- 3) During construction period, employee’s safety should be the first thing to be considered. Moreover, in the Sebeta – Mieso section there is some problem:
 - Workers without safety belt at height
 - Worker wearing slippers on the scaffold
 - No Protective barrier around the pile foundation water pool
 - No temporary guardrail or warning sign around the foundation ditch
 - No safe working platform at height

The contractor should control their own employee’s safety and also the consultant should force the contractor to control the safety the project manpower’s.

- 4) It is suggested that authorities of Ethiopia and Djibouti shall negotiate to determine the setting of boundary stations as soon as possible. The investment was temporarily calculated based on the scheme of centralized handling at Dewele Station. The changes of boundary station will have great influence on the design and total investment.
- 5) The Project will be an electrified railway therefore power supply is a significant issue. Ethiopia has rich power resources, but power facilities should be built along the railway line. Djibouti suffers from severe power shortage, hence the power supply for the railway

shall be ensured. It is suggested that the railway companies shall coordinate with electricity companies of the two countries as soon as possible to determine the grid construction plan and the investment source so that the power grid can be synchronously completed with the railway.

- 6) The communication facilities are very important to guarantee safe, normal and efficient operation of the railway. It's suggested that the railway companies of the two countries shall coordinate with the telecommunication authorities to determine the communication network construction plan and investment source so that the communication network can be synchronously completed with the railway.
- 7) The water supply facilities for stations are very important to ensure normal operation of the railway. ERC should be committed to supplying production and domestic water in conformity with relevant standards to the water tank of each station.
- 8) The organization, equipment, and technical training program for maintenance, repair, operation, and traffic control should be studied and determined as soon as possible.
- 9) It is considered that single-track for the Sebeta-Adama section has been able to meet the demands of the area in the initial stage and short term, and double-track may be constructed in the long term according to the demands. From the revised feasibility studies of ERC information, the single track solution with condition reserved for double track will reduce the total investment lost by around USD 300 million as compared with the double track solution. Due to the financial evaluation, the single-track solution for this section is recommended.
- 10) The consultant and the contractor in the Route 1 project is a Chinese company but for safety of protection, encourage own country skilled company and for main reasons, Ethiopian company with more familiar with Chinese standards should be assigned to undertake the consultation work.

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7. Appendixes

Appendix A: Definition

Intercity Express is a system of high-speed trains predominantly running in Germany and its surrounding countries (Netherlands, Belgium, France, Denmark, Switzerland and Austria).

Thalys is an international high-speed train operator originally built around the LGV Nord high-speed line between Paris and Brussels. This track is shared with Eurostar trains that go from Paris or Brussels to London. Thalys reaches Amsterdam (Netherlands) and Cologne (Germany).

LGV Nord is a French 333-kilometre-long high speed rail line, opened in 1993, that connects Paris to the Belgium border and the channel tunnel via Lille.

Euro City/ Euro Night are high-speed railway conventional trains operated by nearly all Western and Central European operators, with the notable exception of the United Kingdom and Ireland.

Euro Star is a high-speed railway service connecting London with Paris and Brussels (Belgium). All its trains traverse the Channel Tunnel between the United Kingdom and France, owned and operated separately by Eurotunnel.

Enterprise is a High Speed railway service connecting with Republic of Ireland & Northern Ireland (UK).

Elipsos is a High Speed railway service connecting with France and Spain.

Tren hotel is a long distance, high-quality overnight train service connecting France, Spain and Portugal).

Oresund train is a railway between Copenhagen in Denmark and Malmö in Sweden via the Oresund Bridge. On the Swedish side it is managed by the Swedish Transport Administration, on the Danish side by Banedan mark.

SJ 2000(previously X 2000), also called X2, is a railway service tilting train operated by SJ in Sweden and Denmark.

Rail jet is the premier service of the high-speed train of the Austrian Federal Railways and operates both domestically within Austria and on international services to adjacent countries(Germany, Switzerland, Hungary and Czech Republic by 2014).

TEU is an inexact unit of cargo capacity often used to describe the capacity of container ships and container terminals (metal box).

EPC is common form of contracting Arrangement within the construction industry

Benefit- Cost ratio (BCR) is an indicator, used in the formal discipline of cost- benefit analysis that attempts to summarize the overall value for money of a proposed project. It is a ratio of the benefit of a project to its cost.

Appendix-B: Abbreviations

AAU = Addis Ababa University

AC = Alternating Current

AIDS = Acquired Immune Deficiency Syndrome

AREMA = American Railway Engineering and Maintenance of Way Association

ATC = Automatic Traffic Control

ATS = Automatic Traffic Stop

AU = African Union

CCECC = China Civil Engineering Construction Corporation

CCTV = Closed-Circuit Television

CDE = Chemin De Fer Djibouti – Ethiopian

CEO = Chief Executive Officer

CIECC = China International Engineering Consulting Corporation

COMESA = Common Market for Eastern and Southern Africa

CRC = China Railway corporation

CREC = China Railway Engineering Group

CREEC = China Railway Eryuan Engineering Group

CTC = Centralized Traffic Control

DC = Direct Current

EAC = East African Community

EIA = Environmental Impact Assessment

EIRR = Economic Rate of Return

EMP = Environmental Management

EMU = Electric Multiple Unit

EPAs = Environmental Protection Authority

EPC = Engineering, procurement and Construction

EPE = Environmental Policy of Ethiopia

EPRDF = Ethiopian People's Revolutionary Democratic Front

ERC = Ethiopian Railway Corporation

ESMP = Environmental and Social Management

EU = European Union

FDRE = Federal Democratic Republic of Ethiopia

FIRR = Financial Rate of Return

GDP = Gross Domestic product

GoD = Government of Djibouti

GTP = Growth and Transformation Plan

HIV = Human Immunodeficiency Virus

IGAD = Intergovernmental Authority on development

JSC = Joint Stock Company

LAPSSET – Lamu Port - South Sudan - Ethiopian Transport

LCB = Life Cycle Benefit

LCC = Life Cycle Cost

LRA = Lord's Resistance Army

LRT = Light Rail Transit

MoT = Ministry of Transportation

MOU = Memorandum of Understanding

NPV = Net Present Value

NRNE = National Railway Network of Ethiopia

O&M = Operation and Maintenance

PBP = Payback Period

RIAs = Regional Integration Agreements

ROW = Right of Way

RZD = Russia Railways

SADC = Southern African Development community

SEIA = Social and Environmental impact Assessment

SG = Standard Gauge

SI = social impact

STDs = Sexually Transmitted Diseases

TAG = Technical Advisory Group

TEU = Twenty-foot Equivalent Unit

UIC = International Union of Railway

UK = United Kingdom

UNECA = United Nations Economic Commission for Africa

US = United State

Appendix C- Cited Maps, Figures and Tables

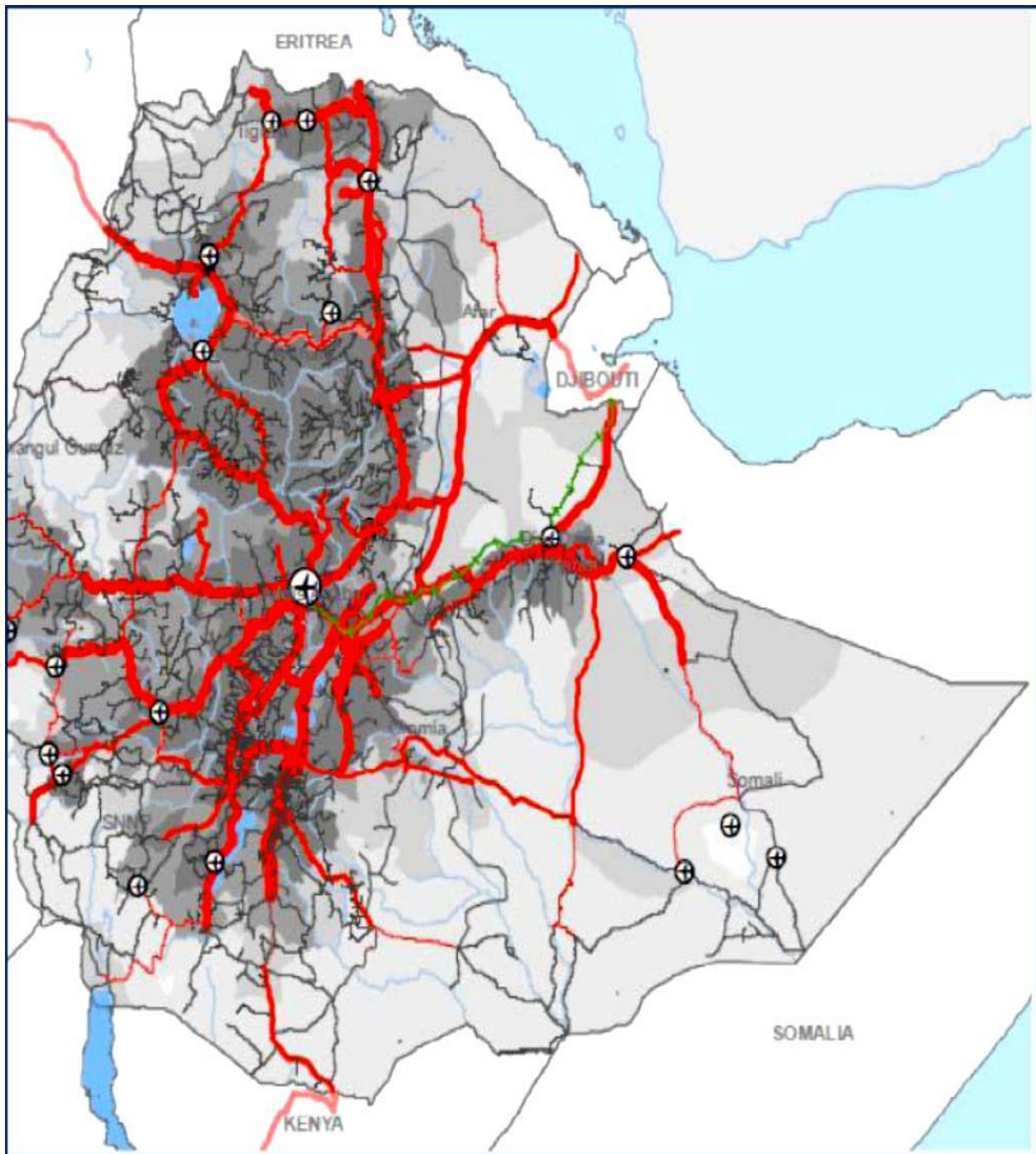



Figure C-1: Ethiopia national road network map [Ibrahim Worku, 2011]

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Table C- 1: list of countries by rail transport network size based on International Union of Railways data ranks countries by length of rail lines worked at end of year updated with other reliable sources (UIC, 2013)

Rank	Country	Railway length (km)	Date of info.	Area (km ²) per km track	Population per km track	Nationalized or Private
1	 <u>United States</u>	224,792	(2011)	43.40	1379	Private
2	 <u>China(PRC)</u>	103,144	(2013)	93.47	13227	Nationalized
3	 <u>Russia</u>	128,000	(2012)	133.58	1117	Nationalized
4	 <u>India</u>	64,460	(2013)	45.74	19,133	Nationalized
5	 <u>Canada</u>	46,552	(2011)	174.51	468	Private
6	 <u>Germany</u>	41,981	(2011)	9.47	2210	Nationalized
7	 <u>Australia</u>	38,445	(2011)	199.94	572	Nationalized
8	 <u>Argentina</u>	36,966	(2011)	77.45	1117	Nationalized
9	 <u>France</u>	29,640	(2011)	21.53	2201	Nationalized
10	 <u>Brazil</u>	28,538	(2011)	285.57	6397	Nationalized
11	 <u>South Africa</u>	20,247	(2013)	49.79	2066	Nationalized
12	 <u>Mexico</u>	26,704	(2009)	73.56	4207	Private
13	 <u>Italy</u>	24,179	(2007)	12.46	2507	Nationalized
14	 <u>Japan</u>	23,474	(2007)	16.10	5451	Both
15	 <u>Ukraine</u>	22,300	(2010)	27.07	2048	Nationalized
16	 <u>Romania</u>	22,298	(2008)	10.69	854	Nationalized
17	 <u>Poland</u>	19,627	(2008)	15.93	1946	Nationalized
18	 <u>United Kingdom</u>	17,732	(2008)	15.00	3825	Private
19	 <u>Kazakhstan</u>	15,372	(2010)	180.71	1061	Nationalized
20	 <u>Spain</u>	15,947	(2012)	33.55	3062	Nationalized
21	 <u>Sweden</u>	12,821	(2010)	35.12	732	
22	 <u>Turkey</u>	12,000	(2011)	71.29	6708	
23	 <u>Iran</u>	12,998	(2014)	148.41	6816	
24	 <u>Czech Republic</u>	9,487	(2008)	8.31	1111	
25	 <u>Indonesia</u>	8,529	(2008)	223.31	27853	Nationalized















STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Rank	Country	Railway length (km)	Date of info.	Area (km ²) per km track	Population per km track	Nationalized or Private
26	 Hungary	7,942	(2008)	11.71	1257	Nationalized
27	 Pakistan	7,791	(2008)	102.18	22759	
28	 Egypt	6,700	(2010)	149.47	12075	
29	 Finland	5,919	(2008)	57.13	911	
30	 Chile	5,898	(2006)	128.2	2931	
31	 Austria	5,927	(2008)	14.57	1460	
32	 Belarus	5,491	(2008)	37.81	1731	
33	 Sudan	5,478	(2006)	339.81	5640	
34	 South Korea	5,242	(2009)	19.08	9348	Nationalized
35	 North Korea	5,235	(2006)	23.03	4595	
36	 Switzerland	5,223	(2011)	7.90	1523	
37	 Cuba	5,076	(2007)	21.84	2215	
38	 Turkmenistan	4,980	(2014)	153.44	1585	
39	 Algeria	4,316	(2012)	551.83	8595	
40	 Uzbekistan	4,280	(2011)	105.77	6488	
41	 Bulgaria	4,159	(2008)	26.66	1771	
42	 New Zealand	4,128	(2006)	64.64	1070	
43	 Norway	4,114	(2008)	78.71	1209	Nationalized
44	 Thailand	4,071	(2012)	126.04	16084	
45	 Democratic Republic of the Congo	4,007	(2008)	585.19	16463	
46	 Myanmar (Burma)	3,955	(2006)	171.07	12127	
47	 Serbia	3,809	(2008)	20.34	1918	
48	 Slovakia	3,658	(2010)	13.4	1486	
49	 Nigeria	3,528	(2006)	261.84	44904	
50	 Belgium	3,513	(2008)	8.69	3108	Nationalized
51	 Vietnam	3,147	(2007)	105.25	27765	
52	 Mozambique	3,116	(2008)	256.54	6604	








STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Rank	Country	Railway length (km)	Date of info.	Area (km ²) per km track	Population per km track	Nationalized or Private
53	 <u>Zimbabwe</u>	3,000	(2010)	130.25	4190	Nationalized
54	 <u>Uruguay</u>	2,993	(2006)	58.88	1121	
55	 <u>Croatia</u>	2,974	(2009)	19.03	1443	
56	 <u>Azerbaijan</u>	2,918	(2009)	29.68	3207	
57	 <u>Netherlands</u>	2,896	(2008)	14.34	5767	Nationalized
58	 <u>Bolivia</u>	2,866	(2007)	383.32	3638	
59	 <u>Bangladesh</u>	2,835	(2008)	50.79	53392	
60	 <u>Portugal</u>	2,794	(2013)	33.0	3594	Nationalized
62	 <u>Kenya</u>	2,778	(2010)	208.92	13899	
63	 <u>Angola</u>	2,761	(2006)	451.54	6911	
64	 <u>Tanzania</u>	2,722	(2006)	348.02	15866	
65	 <u>Denmark</u>	2,667	(2008)	16.16	2086	
66	 <u>Greece</u>	2,552	(2012)	51.73	4229	
67	 <u>Namibia</u>	2,382	(2006)	346.05	877	
68	 <u>Latvia</u>	2,269	(2007)	28.47	978	
69	 <u>Tunisia</u>	2,218	(2007)	73.76	4756	
70	 <u>Syria</u>	2,139	(2008)	86.57	11078	
71	 <u>Iraq</u>	2,032	(2006)	215.71	15587	
72	 <u>Peru</u>	2,020	(2008)	636.25	14585	
73	 <u>Morocco</u>	1,989	(2008)	224.51	16227	
74	 <u>Republic of Ireland</u>	1,919	(2007)	36.62	2387	Nationalized
75	 <u>Malaysia</u>	1,849	(2010)	178.40	15324	
76	 <u>Mongolia</u>	1,810	(2008)	864.15	1560	
77	 <u>Lithuania</u>	1,766	(2007)	36.98	1824	
78	 <u>Taiwan</u>	1,703	(2012)	21.25	13638	
79	 <u>Colombia</u>	1,663	(2007)	648.85	27770	
80	 <u>Georgia</u>	1,513	(2007)	46.07	2932	
81	 <u>Sri Lanka</u>	1,508	(2010)	43.51	13696	












STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Rank	Country	Railway length (km)	Date of info.	Area (km ²) per km track	Population per km track	Nationalized or Private
82	 <u>Saudi Arabia</u>	1,412	(2007)	1522.44	19219	
83	 <u>Zambia</u>	1,237	(2006)	608.42	10547	
84	 <u>Israel</u>	1,200	(2013)	17.31	6709	Nationalized
85	 <u>Slovenia</u>	1,228	(2007)	16.51	1672	
86	 <u>Moldova</u>	1,156	(2008)	29.28	3083	
87	 <u>Bosnia and Herzegovina</u>	1,103	(2007)	46.42	3484	
88	 <u>Cameroon</u>	974	(2007)	488.13	19924	
89	 <u>Ecuador</u>	966	(2006)	293.54	14810	
90	 <u>Ghana</u>	953	(2006)	250.30	25429	
91	 <u>Senegal</u>	906	(2004)	217.13	13724	
92	 <u>Botswana</u>	888	(2007)	655.10	2027	
93	 <u>Guatemala</u>	885	(2004)	123.04	16228	
94	 <u>Madagascar</u>	854	(2007)	687.40	24255	
95	 <u>Armenia</u>	869	(2012)	35.20	3863	
96	 <u>Guinea</u>	837	(2006)	293.74	11926	
97	 <u>Estonia</u>	816	(2008)	55.43	1642	
98	 <u>Gabon</u>	810	(2007)	330.45	1858	
99	 <u>Malawi</u>	797	(2007)	148.66	18696	
100	 <u>Republic of the Congo</u>	795	(2006)	430.19	5086	
101	 <u>Djibouti</u>	781	(2005)	29.71	1138	
102	 <u>Benin</u>	758	(2006)	148.58	11581	
103	 <u>Mali</u>	733	(2002)	1691.94	19805	
104	 <u>Mauritania</u>	728	(2008)	1415.80	4753	
105	 <u>Honduras</u>	699	(2006)	160.36	11753	
106	 <u>Macedonia</u>	699	(2007)	36.79	2943	
107	 <u>Ethiopia</u>	699	(2006)	1579.83	117456	
108	 <u>Cambodia</u>	650	(2003)	278.52	20609	

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Rank	Country	Railway length (km)	Date of info.	Area (km ²) per km track	Population per km track	Nationalized or Private
109	 <u>Côte d'Ivoire</u>	639	(2007)	504.64	30889	
110	 <u>Burkina Faso</u>	622	(2006)	440.84	25291	
111	 <u>Tajikistan</u>	616	(2007)	232.31	11167	
112	 <u>Fiji</u>	597	(2006)	30.61	1442	
113	 <u>Togo</u>	568	(2006)	99.97	10613	
114	 <u>El Salvador</u>	562	(2007)	37.44	10221	
115	 <u>Dominican Republic</u>	517	(2006)	94.14	18141	
116	 <u>Liberia</u>	490	(2006)	227.28	8151	
117	 <u>Philippines</u>	479	(2008)	626.30	196270	
118	 <u>Albania</u>	423	(2007)	67.96	7553	
119	 <u>Kyrgyzstan</u>	417	(2007)	479.50	12860	
120	 <u>Lebanon</u>	401	(2006)	25.94	10544	
121	 <u>Panama</u>	355	(2006)	212.45	9594	
122	 <u>Venezuela</u>	336	(2006)	2714.43	87458	
123	 <u>Eritrea</u>	306	(2006)	384.31	17170	
124	 <u>Swaziland</u>	301	(2008)	57.69	3940	
130	 <u>Costa Rica</u>	278	(2007)	183.81	16416	
131	 <u>Luxembourg</u>	274	(2007)	9.40	1826	Nationalized
132	 <u>Jamaica</u>	65	(2003)	40.41	9948	
133	 <u>Uganda</u>	1,244	(2002)	930.65	122780	
134	 <u>Jordan</u>	507	(2007)	355.94	24649	
135	 <u>Montenegro</u>	250	(2008)	55.47		
136	 <u>Singapore</u>	160.6	(2012)	3.94	28682	
137	 <u>Guyana</u>	127.2	(2001 est.)	1149.57	4197	
138	 <u>Suriname</u>	166	(2001)	986.87	3163	
139	 <u>Puerto Rico (US)</u>	17.2	(2006)	143.65	38810	
140	 <u>Sierra Leone</u>	84	(2001)	854.05	69857	

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Rank	Country	Railway length (km)	Date of info.	Area (km ²) per km track	Population per km track	Nationalized or Private
141	 <u>Afghanistan</u>	75	(2011)	8696.40	418827	
142	 <u>Nepal</u>	59	(2006)	2494.59	484491	
143	 <u>Saint Kitts and Nevis</u>	58	(2006)	5.22	1040	
144	 <u>Paraguay</u>	38	(2006)	11298.67	173056	
145	 <u>Brunei</u>	13	(2001 est.)	443.46	30692	
146	 <u>Liechtenstein</u>	9.5	(2006)	17.78	4017	
147	 <u>Nauru</u>	3.9	(2001)	4.20	2000	
148	<u>Western Sahara</u>	5	(2008)	53200.00	106200	
149	 <u>Laos</u>	3.5	(2005)	59200.00	1557550	
150	 <u>Lesotho</u>	1.6	(1995)	10118.33	723667	
151	 <u>Monaco</u>	1.7	(2012)	1.18	20588	
152	 <u>Vatican City</u>	1.27	(2001 est.)	0.52	969	

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Addis Ababa-Semera-Djibouti Road Corridor

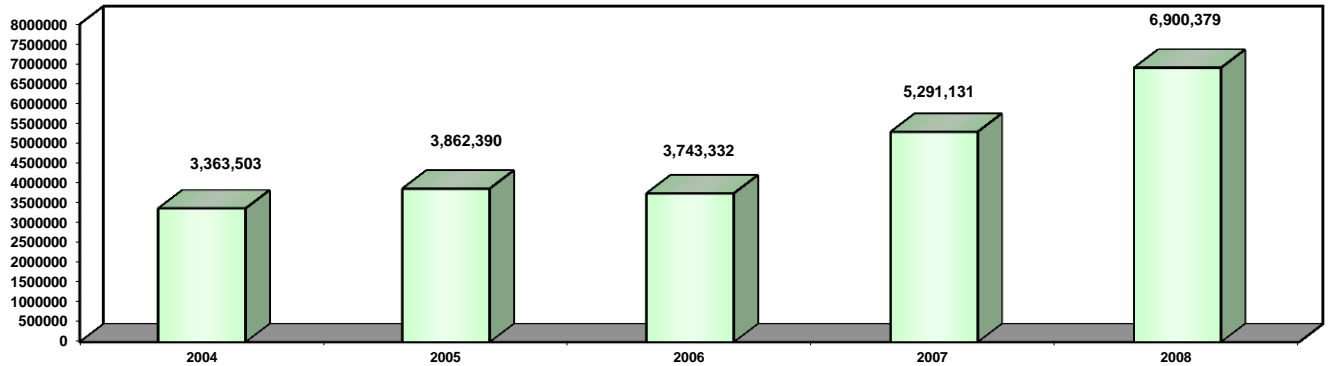
Road Profile	Within Ethiopia					Within Republic of Djibouti		
	AA	Modjo	Awash	Semera	Dobi	Dikhil	Djibouti	
Section length	98	149	355	85	29	59	159	
Total Km	98	223	531	663	692	750	909	
Standards	7m +2 ± 1.5m		7m +2 ± 1.5m	7m +2 ± 1.5m				
Surface	Asphalt Concrete					ST	AC	AC
Present Condition	Very Good						Very Good	
Schedule Improvement	—	—	—	—	—		—	
Topography	Hilly 5%, Rollong 56%, Flat 39%							
Average Speed of HT/AT*	44 Km/hr							
Trip Time	21 hr							
2007 Traffic in veh/day	15,217	2,444	1,204	1,072	1,031 (776)			

Note:- *HT:- Heavy Truck *AT:- Articulated Truck

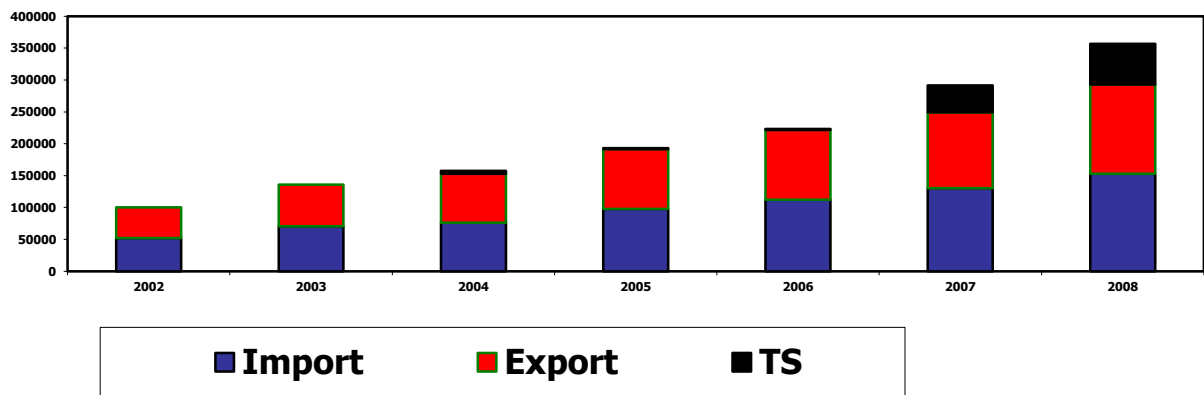
(a)



Figure C-2: a) Addis Ababa - Djibouti Road corridor and (b) Port of Djibouti Layout



(a)



(b)

Figure C- 3: (a) Total Volume of Djibouti Port chart and (b) container throughput(TEU) of Djibouti Port

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table C-2: Ethiopian Railway Sector Human Resource Development Plan (2012 -2020)

Overall Human Resource Requirement Plan (2012/13 – 20014/15 EC and 2015/16 – 2019/20)								
No	Education Level		Number of Professionals and Technicians Required					2015/16 -
			Ration	2012/13	2013/14	2014/15	Total	
	Total No of HR			14,240	22,584	55,296	92,120	434,020
1	PhD			-	-	-	-	-
2	MSc/MA	ERC	0.25	119	188	461	806	3,617
		Sector	0.75	356	565	1,382	2,417	10,850
	Total			475	753	1,843	3,222	14,467
3	BSc/BA	ERC	0.25	475	753	1,843	3,071	14,467
		Sector	0.75	1,424	2,258	5,530	9,212	43,402
	Total			1,899	3,011	7,373	12,283	57,869
4	TVET	ERC	0.25	2,967	4,705	11,520	19,192	90,421
		Sector	0.75	8,900	14,115	34,560	57,575	271,263
	Total			11,867	18,820	46,080	76,767	361,683
	Grand			14,240	22,584	55,296	92,271	434,020
	Proportion of TVET							
4	Level V	ERC	2%	59	94	230	384	1,808
			8%	237	376	922	1,535.33	7,234
			20%	593	941	2,304	3,838.33	18,084
			30%	890	1,412	3,456	5,757.50	27,126
			40%	1,187	1,882	4,608	7,676.67	36,168
			100%	2,967	4,705	11,520	19,192	90,421
4b	Level V	Sector	2%	178	282	691	1,151.2	5,425
			8%	712	1,129	2,765	4,606	21,701
			20%	1,780	2,823	6,912	11,515	54,253
			30%	2,670	4,235	10,368	17,272	81,379
			40%	3,560	5,646	13,824	23,030	108,505
			100%	8,900	14,115	34,560	57,575	271,263

Note:-

- ✓ TVET stands for Technical and Vocational Education and Training
- ✓ For TVET, Levels I; II and III indicates Technicians involved in actual craftsman work

For TVET, Levels IV and V indicates Foremen, Supervisors and Managerial level jobs

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

Table C-3: (a):Ethiopian Freight Export by AAU (000' Metric Tons)

Products	Base 2010	Total Export								Railway Share			
		2011	2012	2013	2014	2015	2020	2025	2030	2015	2020	2025	2030
Coffee	320	368	403	460	526	601	1,160	2,041	3,592	240	464	816	1,437
Oil Seeds	355	408	447	511	608	724	1,398	2,460	4,330	290	559	984	1,732
Pulses	417	479	548	678	872	1,121	2,163	3,807	6,701	448	865	1,523	2,680
Cotton	42	48	56	64	73	84	163	286	503	34	65	114	201
Sugar	-	-	-	75	225	600	1,158	2,038	3,587	240	463	815	1,435
Cement	-	-	-	63	188	313	604	1,063	1,871	125	242	425	748
Other Agri.	92	106	122	140	161	185	357	628	1,105	74	143	251	442
Livestock	54	87	157	233	291	353	681	1,199	2,110	141	273	480	844
Others	231	319	470	563	544	382	737	1,298	2,284	153	295	519	913
Total	1,511	1,816	2,202	2,787	3,488	4,363	8,421	14,820	26,084	1,745	3,368	5,928	10,433

Table C- 3:(b): Annual Ethiopian Freight Import by AAU (Thousand Metric Tons Units)

Products	Base 2010	Total Import								Railway Share			
		2011	2012	2013	2014	2015	2020	2025	2030	2015	2020	2025	2030
Petroleum	2031	2275	254 8	2853	3196	3579	6,299	10,14 1	16,32 8	1,432	2,520	4,057	6,531
Food Aid	500	500	500	500	500	500	880	1,417	2,281	200	352	567	912
Fertilizer	526	589	659	738	827	926	1,630	2,624	4,225	370	652	1,050	1,690
Cement	940	500	500				0	0	0	-	-	-	-
Gen.	3,23	3,88	4,66	5,59	6,716	8079	14,21	22,89	36,85		5,688		
Cargo	9	7	4	7			9	3	7	3,232		9,157	14,743
Total	7,236	7,751	6,323	9,688	11,239	13,084	23,028	37,075	59,690	5,234	9,211	14,830	23,876

STUDY ON INTEGRATION OF ETHIOPIA RAILWAY NETWORK WITH REGIONAL COUNTRIES (Especially with Djibouti)

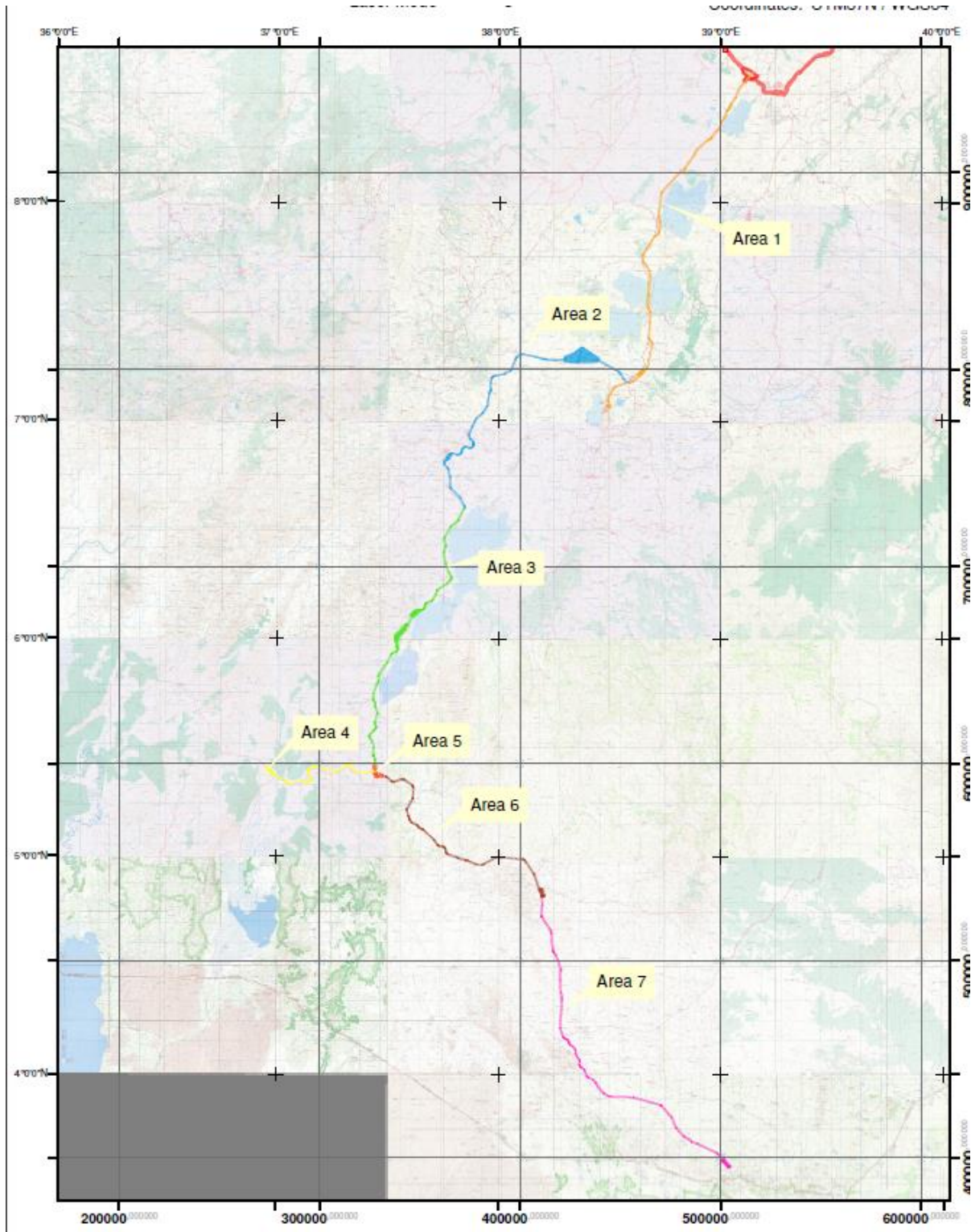


Figure C-4: Map of Route Alignment Area 1 (Gelan/Mojo) to Area 7 (Moy)

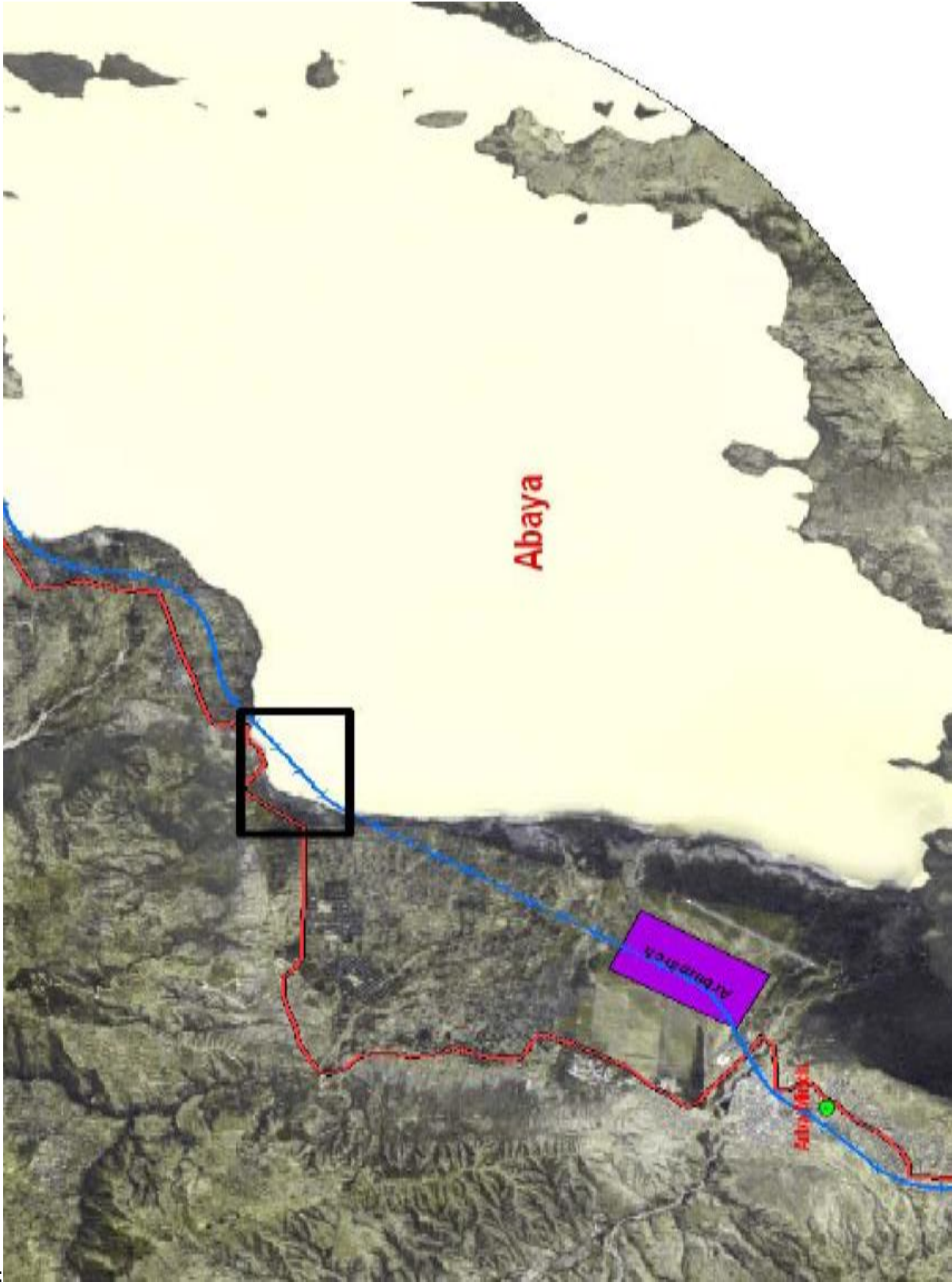


Figure C-5: Alignment Passing Over Lake Abaya to Avoid High Terrain North of Arba Minch

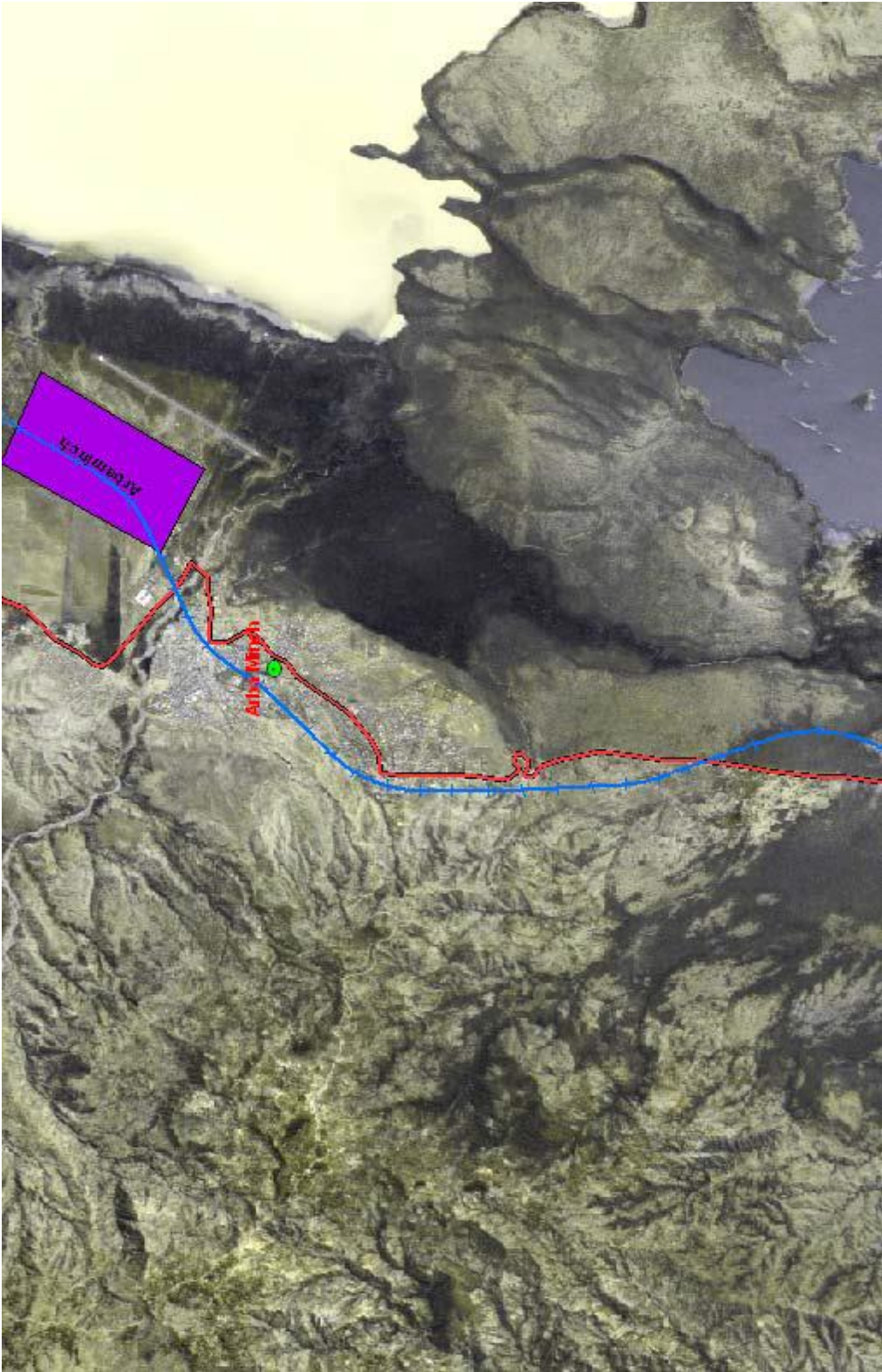


Figure C-6:Alignment Passing Through the Forest Area South of Arba Minch

DECLARATION

I hereby declare that the work which is being presented in this thesis entitled “**Study on Integration of Ethiopia Railway Network with Regional Countries (Especially with Djibouti)**” is original work of my own, has not been presented for a degree in any other university; and that all sources of material used for the thesis have been duly acknowledged.

Amen Gudeta (Beli)
(Candidate)

Signature

Date

Submitted to: **Addis Ababa University, Addis Ababa Institute of Technology, 2015**