



Consulting services for national integrated transport master plan study and enhance sector capacity in planning and research & development

TASK 5 – CONSOLIDATED NATIONAL TRANSPORT MASTER PLAN

“REPORT 3 – RAILWAY”



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ACRONYMS

Abbreviations	Meaning	Abbreviations	Meaning
ARCCH	Authority for Research and Conservation of Cultural Heritage	h	hour
ARU	African Rail Union	IBC	Institute Of Biodiversity Conservation
AU	African Union	IRR	Internal Rate of Return
BBO	Buy, Build, Operate	IUCN	International Union for The Conservation of Nature
BLT	Build, Lease, Transfer	KRC	Kenya Railways Corporation
BOO	Build, Own, Operate	LDO	Lease, Develop, Operate
BOOT	Build, Own, Operate, Transfer	MoT	Ministry of Transport
BOT	Build, Own, Transfer	NPV	Net Present Value
BTO	Build, Transfer, Operate	NPVc	Net Present Value of Costs
CAPEX	Capital expenditure	NPVr	Net Present Value Risk
CCCC	China Communications Construction Company	O&M	Operation and Maintenance
CDE	Chemin De Fer Djibouto-Éthiopien	O/D	Origin/Destination
CDN	Railways System Of Northern Mozambique	OPEX	Operating expenditure
CEAR	Central East African Railway	Pax	Passenger
CFM	Caminhos De Ferro De Moçambique	PIDA	Programme For Infrastructure Development In Africa
CN	Competitive Neutrality	PPP	Public Private Partnership
CoM	Council of Ministers	PSC	Public Sector Comparator
CRGE	Climate Resilient Green Economy	RAHCO	Reli Assets Holding Company Limited
CSE	Conservation Strategy of Ethiopia	RDC	Addis Ababa And Djibouti To Kisangami
DBFO	Design, Build, Finance, Operate	RR	Retained Risk
EDR	Ethio-Djibouti Railways	RVR	Rift Valley Railways Consortium
EIA	Environmental Impact Assessment	SDPRP	Sustainable Development and Poverty Reduction Program
EPA	Environmental Protection Authority	SGR	Standard Gauge Railway
EPE	Environmental Policy of Ethiopia	SPV	Special purpose vehicle
ERC	Ethiopian Railway Corporation	SWOT	Strength Weaknesses Opportunities Threats
ERTMS	European standard signalling system	TAZARA	Tanzania-Zambia Railway Authority
ETB	Ethiopian Birr	TR	Transferable Risks
ETMP	Ethiopia Transport Master Plan	TRC	Tanzania Railways Corporation
EU	European Union	TRL	Tanzania Railways Limited
FDRE	Federal Democratic Republic of Ethiopia	UIC	Unit Identification Code
GCC	Gulf Cooperation Council	UN	United Nations
GDP	Gross Domestic Product	USD	United States Dollar
GHG	Greenhouse Gas		

1 INSTITUTIONAL FRAMEWORK

1.1 INTRODUCTION

Except in the railway transport sub-sector, there are specialized federal government agencies established to regulate each transport sub-sectors, in the addition to the Ministry of Transport. In the railway sub-transport sector, however, there is no specialized government agency responsible to regulate the sub-sector. Therefore, the Ministry of Transport is fully and solely responsible for regulating the railway sector. On the other hand, there are three companies established for the construction, maintenance, and/or rail transportation services; namely, the Ethiopian Railways Corporation, the Ethio-Djibouti Standard Gauge Rail Transport Services Share Company, and the Ethio-Djibouti Railway.

The following table summarizes the main institutional responsibilities.

Table 1: Railway Institutional Responsibility Matrix

Institution / Enterprise	Main Powers & Functions Areas	Financial Source	Legal Sources Of Authority
Ministry of Transport	- Policy, Strategy, and Legal Frameworks; - Supervising ERC, EDR, & CDE,	Government Treasury	- FDRE Constitution - Proclamation No. 1097/2018, 1048/2017
Ministry of Finance	- Allocating budget for MoT and ERC. - Facilitate PPP for the sub-sector	- Government Treasury; - Foreign loans;	- FDRE Constitution, - Proclamation No. 1097/2018,
Ethiopian Railway Corporation (ERC)	Built, operate and manage railway lines throughout Ethiopia	Government Treasury	Regulation No. 141/2008;
<i>Ethio-Djibouti Standard Gauge Rail Transport Services Share Company (EDR)</i>	Operating, maintaining, and managing the Ethio-Djibuti standard gauge railway line.	Revenue from operation	- Bilateral and Shareholders' Agreement signed by the governments of Ethiopia and Djibouti - Memorandum of Association and Article of Association of EDR
<i>Old Ethio-Djibouti Railway - the Chemin de Fer Djibouto-Éthiopien (CDE),</i>	Operating, maintaining, and managing the old Ethio-Djibuti narrow gauge railway line.	<i>Old Ethio-Djibouti Railway - the Chemin de Fer Djibouto-Éthiopien (CDE),</i>	Bilateral Agreements entered by the governments of Ethiopia and Djibouti

1.2 REGULATORY INSTITUTION - MINISTRY OF TRANSPORT

Developing and administrating of railways is fully under the responsibility of the federal government. There is no state organ or agency empowered to deal with regulatory or service provision functions in the railways transport.

In line with this federal jurisdiction, the Ministry of Transport (MoT), any other transport sub-sectors, is responsible for developing the railway sub-sector's policies, strategies, and legal frameworks, as well as major development plans for national railway infrastructure. MoT is also responsible for licensing and overseeing the construction of new railway lines and provision of transport services for passengers and cargos as well as the sub-sector's major players. MoT is also responsible for economic regulation with a power and duty to ensure the transport tariffs set for passengers and goods are competitive and fair. Moreover, MoT has been entrusted by law to

carry out all regulatory functions that able ensuring the safety and security of railway transport as well as to carried out investigations when railway accidents & major incidences occur.

Ministry of Transport is also a supervisory body for all the three government owned companies currently operate in the railway sub-sector.

For carrying out the responsibilities it has on the railway sub-sector, MoT has established a special department called Railway Infrastructure & Safety Regulatory Directorate. which is headed by a director.

1.3 PUBLIC ENTERPRISES:

1.3.1 Ethiopian Railway Corporation

Ethiopian Railway Corporation has been established in 2007 as a public enterprise with mandates to construct new railway lines and to provide railway transport services. Currently, it is the owner of the under-construction rail line stretched from Awash to Mekele through Hara-Gebeya; and it has not yet engaged in providing passenger or cargo transportation services; except in the Addis Ababa light railway which has been operating by a department specially created for performing this purpose.

The new Addis Ababa-Djibouti standard gauge railway was built by the ERC, and when the line was operational, it was expected to be operated by ERC. However, before the line went into operation, the ERC handed over its authority to the Ethio-Djibouti Standard Gauge Railway Transport Services Share Company (EDR), a joint venture established by the governments of Ethiopia and Djibouti. ERC is expected to be operator on the Awash-Hara Market-Mekelle railway, which is under construction, as well as on additional rail lines to be built by it in the future.

ERC is a majority shareholder as well as a member of the Board of Directorates of EDR along with MoT, Ministry of Finance, and Djiboutian Railway enterprise. ERC is currently accountable to the Ministry of Transport.

As it be to any public enterprise, the 100% of the initial capital of ERC was paid from the government coffer; and until now, the government continues providing ERC with additional finance as an extra support/subsidiary, or/and matching funds to the foreign loans ERC has taken, and/or subsidy, since ERC hasn't yet started/abled to generate a revenue for covering its running costs as well as for matching funds.

Currently, the development of Ethiopian railway sub-sector is relying on foreign loans. Except from the small portions of the matching fund which have been contributed from government treasury, the majority funds for the construction of the Addis Ababa City Light Railways, the Addis Ababa Djibouti Standard Gauge Railway, and the Awash-Hara Gebeya-Mekelle Railway line - which is still under construction - were largely covered by foreign loans.

1.3.2 Ethio-Djibouti Standard Gauge Rail Transport Services Share Company (EDR)

EDR is responsible for the operations and maintenance of the Ethio-Djibuti standard gauge railway line and for the management of freight and passenger services between Addis Ababa and Djibouti. Unlike other public enterprises, EDR was established as a joint-ventured commercial company as per the Commercial Code of Ethiopia following the agreement made by Ethiopian and Djiboutian governments. Though Proclamation No. 1097/2018 makes it accountable to the MoT, its Shareholders' meeting is the highest organ/decision maker of the Company. Under the Shareholders' meeting, there is a Board of Directors which guides and controls the activities of the EDR.

A Chinese company, which has signed a 6-year management contract with EDR, is currently

operating and maintaining the Djibouti Railway in Addis Ababa. It is expected that EDR will take over the responsibility from the management contractor in 2 to 3 years to carry out the operation and maintenance on his own.

The Addis Ababa-Djibouti railway line was built with a foreign commercial loan and the Ministry of Finance is primarily responsible for repaying the loan. The financing of the management contract will also be covered by the government, and EDR will be required to cover the operation and maintenance costs of the railway line with his own income and, if possible, to make some profits for distribution to its shareholders.

1.3.3 The Old Ethio-Djibouti Railway - the Chemin de Fer Djibouto-Éthiopien (CDE),

CDE is established by an agreement made by the governments of Ethiopia and Djibouti to operate and manage the Addis Ababa-Djibouti Railway, a narrow-gauge railway built over a century ago. Currently, this old Addis Ababa-Djibouti railway line has been abandoned due to several safety issues and for the inefficient transport provided and is currently operating a sporadic service for a cement factory in Ethiopia.

In addition, the construction of the new line Addis Ababa – Djibouti causes additional interruptions to the old tracks. Despite the stop to the operation, the company that own and manage the railways is still active to manage the asset still own by the company that have a big historical value.

CDE is accountable to MoT; and is responsible to cover the operational costs and expenses by its own. It doesn't get its majority income from its operational activities; rather it gets its majority revenue from the rental fees it collects from the renter of its assets in Addis Ababa and Dire Dawa.

2 PRESENT SITUATION

The railway sector is administered at the federal level. Although permitted by law, no private sector is currently involved in rail transport. In other words, there is no law monopoly for the operation of railways but a de facto monopoly. The main actors of the sector are all under the control of public powers: MoT, Ethiopian Railway Corporation (ERC), Ethio-Djibouti Standard Gauge Railway Share Company (EDR). The Chemin de Fer Djibouto-Éthiopien (CDE), the old metric gauge railway, it is hardly functional, and it is on the edge of its dissolution.

Dealing with the railway construction, service, and regulation are under the Federal jurisdiction as per the Constitution. Railway Transport Administration Proclamation No. 1048/2017 is the principal law that governs and regulated the Railway Sector in Ethiopia. The Proclamation is also the legal foundation for future regulations and directives that may (and likely, will) be issued by the Council of Ministers (CoM) and by the Ministry of Transport (MoT) respectively.

Similar with other transport sectors, MoT is responsible for proposing policy, strategies and laws concerning railways as well as for preparing infrastructure master plans. In addition, MoT is given a responsibility of regulating the sector by providing licenses for all rail constructions carried out by private investors as well as registering the main actors of the sector – namely infrastructure managers and railway undertakings. This approach allows the Ethiopian transport system to pave the road to a future openness of the market to private operators.

MoT has additional responsibilities because of the temporary absence of an independent government agency responsible for the safety of the sector. The Proclamation provides the “body authorized by law to administer railway transport” to have a power and duties to carry out all the regulatory functions for ensuring the railway transport is safe and reliable. Sub-Article 43 of Article 2 of the Proclamation defines the “body authorized by law to administer railway transport” as the Ministry of Transport or another government organ as may be determined by Council of Ministers. So far, no Council of Minister’s Regulation has been enacted to determine a government organ to exercise these responsibilities. Therefore, currently, MoT, through its Railway Infrastructure & Safety Regulatory Directorate, is the only regulator of the railway transport sector.

For regulating the sector and ensuring safety of the railway transport, the Proclamation provides the following requirements:

- a) for locomotive and wagon – they shall be registered and have put in-service license to be used in Ethiopia.
- b) for railway professionals: train master, maintenance manager, trainer, examiner, train dispatcher, assessor, and a safety management system manager shall register at the national registry, have Competency License which shall be renewed every three years.
- c) for train masters: they need to have two licenses - train master competency license and supplementary train master certificate
- d) for Infrastructure Managers: they shall get a Safety Authorization by meeting the requirements
- e) for Railway Undertakings: they need to get a Safety Certificate by meeting the requirements
- f) For training, maintenance, and assessment institutions – they shall get Accreditation Certificate to engage in railway sector:

The Proclamation also requires both the infrastructure manager and railway undertaking to submit their Safety Management System and get approval for it from the regulator. The minimum content and the form Safety Management System is provided by the Proclamation. Any Construction or development activity undertaken around railway infrastructures shall obtain prior

permission from the regulator. The MoT is also authorized to appoint audit and inspection officers who perform safety audits and inspection of the proper application of the relevant laws.

The Proclamation requires all persons, whether natural or legal, that involve in - construction, maintenance and management of railway infrastructure, providing railway transport services, providing training for railway professionals, manufacturing train and other equipment used for the construction/maintenance of railway infrastructure, providing consultancy service in the railway sector - to be registered, licensed, and/or accredited by “the regulator”.

The two railway operators are currently focused on slightly different areas:

- ERC is focused on Plan & Execution of Railway line Infrastructure’s Construction; and providing of rail transport services. The latter activity is limited (operations and maintenance) to the operation of the Addis Ababa light railway line.
- EDR is responsible for the operations and maintenance of the Ethio-Djibuti standard gauge railway line and for the management of freight and passenger services between Addis Ababa and Djibouti.

The economic regulation of the sector is under the responsibility of the MoT. It has the power and duty to ensure the transport tariffs set for passengers and goods are competitive and fair. For achieving this objective, both the infrastructure manager and railway undertaking are required by law to submit to MoT their tariff proposal and the services condition for the approval. They shall not implement any tariff without a prior approval of Ministry. MoT has given a power to either approve or amend if it gets necessary.

Currently the MoT, with the new established Railway Infrastructure Development, Service and Safety Directorate is working with the support of international expertise to issue the railway regulatory framework. This framework includes, firstly, the design and organizational structure of the agency in charge of regulation and safety of railway sector, that is currently in charge to the Department itself.

The completion of the railway system's regulatory framework is a complex and time-consuming process. What has been implemented until now is the minimum level that allows a safe operational environment, while, as stated above the preparation of the acts establishing the new specialised agency is in the pipeline.

In terms of safety issues, the following items are needed to fill the gap:

- conditions under which activities undertaken around the railway infrastructure that endanger the safety of railway transport service shall be prohibited or restricted;
- conditions under which constructions and development activities undertaken around rail way infrastructures shall have permission issued by the authority;
- conditions on which authorization may be granted before undertaking other related development activities on lands adjacent to railway infrastructure or train stations;
- conditions on which construction of other infrastructures undertaken crossing or over passing or parallel to railway infrastructures;
- condition on which any excavation and construction that are undertaken near by the railway infrastructures;
- condition in which dangerous goods can be transported by train.

Further topics that need to be defined or biased belongs to different areas, like scope of the business, access to market economic regulation, training and accreditation system. The following items can be suggested:

- manner of provision of railway transport service by using a railway infrastructure of another person based on a contractual agreement entered with the infrastructure manager;

- other professions related with a railway transport to be qualified for registration in accordance with the Proclamation in force;
- determine, whether other infrastructures connected with railway infrastructure may also need a license before putting them into service
- set requirements that shall be fulfilled by to obtain accreditation certificate in the following fields: i) maintenance institutions, ii) assessment institutions which assess railway work's professionals, iii) training centres, iv) assessment institutions in the field of technical and safety capacity level of trains or one or more than one railway infrastructure parts.

Coming to the status of rail safety, the table below describes the accidents occurred in the operating period 2018-2020 on the line from Addis Ababa to Djibouti managed by EDR.

Table 2: Railway accidents on the EDR infrastructure 2018-2020

Ethio-Djibouti S.G. Railway Safety and Security Accidents and Incidents Report												
SN	Item	2018				2019				2020		Total
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	
1	Animal Hits	166	126	113	131	129	36	41	35	50	18	845
2	Theft and Vandalism	60	224	226	202	28	25	47	39	31	48	930
3	Personal injuries	0	0	2	1	3	0	1	0	3	1	11
4	Personal death	0	2	7	2	3	1	1	4	4	1	25
5	Major Train Blocking incidents	NA	NA	26	10	44	14	16	14	10	13	147
6	Train Blocking Duration (Minute)	NA	NA	9030	2580	7380	6765	2671	2164	3551	1241	35382
7	Derailment	0	0	0	0	0	1	0	0	1	0	2

Source EDR

The data set on the Addis Ababa - Djibouti route is still not very robust to make a reliable diagnosis, especially taking into account two factors: i) the company is still in a start-up phase and, ii) the number of trains running is still low, below the potential of the line. In terms of trend, however, it can be observed that some events show a decreasing trend (Theft and vandalism, Animal hits, Duration of train blocking).

Furthermore, the safety field is evolving because of the ongoing completion of the regulatory framework (see below).

In addition to safety, other themes emerge from the analysis of the sector: the strategy for low emissions and rail accessibility. Many of these problems are closely linked and, in turn, connected with the current poor performance of the railway system (see chapter 4.3).

The poor performance of the railways in terms of services provided, both passenger and freight, does not allow to fully exploit the strengths of this mode of transport.

The design requirements for the Ethiopian railway network, before the electrification of the traction power, are fully in line with the country's strategic choice to be the leading country of the low-emission strategy in Africa, through the construction of the Grand Ethiopian Renaissance Dam and the its use by railway lines. A low rate of exploitation of the potential transport capacity of the railway system¹, both for passenger and freight services, seems to weaken this perspective or at least sets the stage for a new discussion on the subject.

Another theme arising from the early years of operation period of the Addis Ababa - Djibouti link is again related to the issue of accessibility. As main passengers' stations are built in the suburb area, getting there and back to the cities represents a true challenge for railway users. Considering the scarcity of services currently provided, this makes the railway service less competitive compared with the road public transport even though fares are lower.

¹ The management contract of the line has been set to a level of about 20 trains/day on average with a maximum capacity of the critical section of 15. The current timetable of the service is far below these limits as described in Chapter 4.3

2.1 CURRENT STATUS THE RAILWAY SERVICE

Currently, the national railway infrastructure of Ethiopia can be listed as:

- Old Addis – Djibouti metric gauge railway line
- New Ethio-Djibouti electrified standard gauge railway line

The old railway Addis Ababa - Djibouti has been abandoned due several safety issues and for the inefficient transport provided and currently is operating a sporadic service for a cement factory.

In addition, the construction of the new line Addis Ababa – Djibouti causes additional interruptions to the old tracks.

Despite the stop to the operation, the company that own and manage the railways is still active to manage the asset still own by the company that have a big historical value. The railway corridor that includes the urban penetration in Addis Ababa and Dire Dawa is a valuable part of the asset and can be valorised if adequately exploited and linked with the new Ethio-Djibouti electrified standard gauge railway line.

Figure 1: Map of the current railway infrastructure



The new Ethio-Djibouti electrified standard gauge railway line is mainly located in the mountain areas between the central plateaus of Ethiopia and Djiboutian plateau, the line starts westward from SEBETA (at southwest of Addis Ababa) runs eastward through Labu, Indode, Mojo, Adama, Metehara, Awash, Mieso, Afdem, Bike, Gota, Dire Dawa to Dewele, reaches Djibouti and finally ends at Nagad. The total length is about 750 km. the line is double track in the section Sebeta – Adama and single track in the other part. This because initially was foreseen a suburban service between Adama and Sebeta. Currently this type of service is not provided. The line has been built according to Chinese standards and can be referred to National Railway Class III in China. Currently, for passenger service is operated 1 or 2 trains each day.

The active service is:

- 1 train /day: Labu – Nagad or Nagad – Labu
- 2 train /day: Labu–Dire Dawa and Nagad–Dire Dawa or Dire Dawa–Labu and Dire Dawa–Nagad

The travel time is

- about 15, 5 h between Labu and Nagad
- about 10,5 h between Labu and Dire Dawa
- about 5 h between Dire Dawa and Nagad

Addis Ababa-Djibouti railway has 19 stations, currently 5 are opened: Lebu, Adama, Dire Dawa, Ali Sabieh and Nagad for passengers’ services. The other stations will be opened step by step to provide service to passengers. Passenger flow in the year 2019 has been 93,600 passengers/ year, Freight Service has been operated during the Trial Operation: 3 pairs of trains between Mojo and Nagad. The travel time is about 20 h. Freight flows in 2019 has been 1.14 million ton/year

2.2 COMPANY CURRENTLY ACTIVE IN ETHIOPIA

Currently, three (3) companies are engaged in the Ethiopian railway sector in various missions:

- Old Narrow gauge Railway (Chemin de Fer Djibouto-Éthiopien (C.D.E.),
- Ethiopian Railways Corporation (ERC)
- Ethio-Djibouti Standard Gauge Railways (EDR)

Currently, C.D.E. operate the service basic related livelihoods and social services in 18 small stations from Dire Dawa to Gilile. The organization provide infrastructure management and transportation services in Ethiopia and Djibouti but the agreement between the two countries will end in 2023.

The Ethiopian Railways Corporation, established by the Council of Ministers Regulation No. 141/2000, is a state-owned enterprise owned by the Government of Ethiopia with the aim of

- building rail transport infrastructure;
- providing passenger and freight rail services;
- performing related activities necessary to achieve the purpose for which it was established.

The corporation has so far completed the construction of Sebeta-Dewale and put it into service. The Awash- Kombocha – Haragebeya line is under construction. In addition, the construction of Addis Ababa Light Rail Transit Service has been completed and is currently providing passengers services. In terms of operation, the corporation currently manages the Addis Ababa Light Rail Transit Service. For the Sebeta-Dewale railway line, the infrastructure management and rail transport services are being carried out by EDR.

Ethio-Djibouti Standard Gauge Railway Share Company (EDR) is an institution established to provide freight and passenger services on the new standard gauge line between Ethiopia and Djibouti.

Since its inception, the company has been providing passenger and freight services on the line through a Chinese management contractor.

All the companies work under the rules and regulation issued by the government of Ethiopia and in particularly by MOT which has establish a specific department acting as Safety Regulatory Agency.

3 SWOT ANALYSIS

The analysis of the current status of the railway service, the interviews held with the main actors of the railway sector and the analysis of the railway system in Ethiopia has led to a Swot Analysis of the railway sector:

Table 3: Railway Sector SWOT Analysis

S	W	O	T
STRENGTHS	WEAKNESSES	OPPORTUNITIES	THREATS
- Addis Djibouti railway line is along the main transport and logistic corridor of the country - Rolling stock potentially able to transport several cargo typologies - Ethiopia has successfully implemented cross border operation	- The Addis Djibouti line, in terms of capacity, is currently underused - Ethiopia is a newcomer in the electrified standard gauge railway world. For this reason, there is no wide know-how in the railway field - Loading /unloading facilities are currently low equipped	- Old railway corridor available in the urban area - Freight and passenger demand constantly growing - Ethiopia is crossed by two African railway corridors (Cairo – Johannesburg and Djibouti – Dakar)	- Shortage of foreign currency - No technical national railway standard for the development of the railway network - No clear institutional and technical framework for the involvement of the private sector

STRENGTH

Addis Djibouti railway line is along the main transport and logistic corridor of the country

Addis Ababa – Djibouti railway line has been built along the main logistic corridor of the country. It allows to intercept high passenger and freight flows.

Rolling stock potentially able to transport several cargo typologies

The available rolling stock in terms of quantity can operate all the foreseen service. Moreover, the rolling stock can operate several freight typologies and it allows to attract more demand.

Ethiopia has successfully implemented cross border operation

One of the main challenges for the development of the railway network in a country like Ethiopia, which has the goal to link new ports, is the achievement of efficient cross border operation. Ethiopia has already successfully organized and implemented such type of service and it will represent a significant bust for the development of the future railway corridor.

WEAKNESSES

The line, in terms of capacity, is currently underused

The infrastructural and operational condition currently on the line Addis Ababa – Djibouti lead to an underusage of the line capacity limiting the transport capacity of the line. This is also limiting the economic and financial revenues of the railway.

Ethiopia is a newcomer in the railway world. For this reason, there is no wide know-how in the railway field

Ethiopia is a newcomer in the railway field and obviously the railway know-how is not fully developed in the country. It leads to:

- Needs of trainings
- Lack of local supplier for equipment of spare parts

Both the above considerations impact in the increasing of foreign currency needs to support the railway development due force Ethiopia to import training, equipment and spare parts.

Moreover, the regulatory aspects and issues still need to be fully settled and implemented.

Loading /unloading facilities are low-equipped

Loading /unloading facilities are currently low-equipped. This led to delay in train departure that affects the reliability and robustness of the railway transport. Moreover, despite the rolling stock is mainly available, currently in Ethiopia railway is not linked to loading /unloading facilities able to move non-containerized cargo such us: liquid loading/unloading facilities and bulk facilities. This limits the attractivity of the railway transport.

OPPORTUNITIES

Old railway corridor available in the urban area

Despite the old railway is not anymore operational, the railway corridor has a big value. It could be integrated with the new Addis Ababa – Djibouti providing local and commuter services within the city centre that can also increase the attractivity of the long-distance passenger transport that currently is affected by the high distance between the railway station and the city centre of the two major cities (Addis and Dire Dawa).

Freight and passenger demand constantly growing

The transport demand in Ethiopia is constantly growing, particularly along the corridor of the Addis – Djibouti railway line. This should allow that the rail transport demand growth accordingly ensuring the increasing of the economic and financial revenues of the railway.

Ethiopia is crossed by two African railway corridors

Ethiopia is crossed by two African railway corridors (Cairo – Johannesburg and Djibouti – Dakar) and this offers the opportunity to integrate the Ethiopian railway network in an African context attracting flows that are not necessary connected to local market. To get this opportunity it is necessary to promote the railway integration at international level.

THREATS

Shortage of foreign currency

Shortage of foreign currency is affecting the railway network in three main aspects:

- Delay in the construction of the new railway line
- Unavailability of spare parts that affect the reliability of the railway service
- Training not provided to the staff

These three main consequences are resulting in the overall slowdown of the development of the Ethiopian railway network.

No technical national railway standard for the development of the railway network

Currently each railway line has been developed with different standards. This led to challenges related to the interoperability and to a possible increasing of the costs in terms of:

- Additional investment to ensure the interoperability between the lines
- Increase the number (and then the costs) of the spare parts and suppliers
- Provide additional study for each line in order to evaluate the interoperability challenges
- Possible risks to increase the manoeuvres and travel time (and then reduce the attractiveness of the railway) in order to ensure the movements between line with different standards
- Difficulties to develop spare parts and equipment for the local suppliers

No clear institutional and technical framework for the involvement of the private sector

Currently, the private companies that wish to be linked to the railway face the challenges related to the not clear instructional and technical framework that does not indicate clearly the role and the responsibilities, and the related costs allocation, in order to realize the railway link. This discourage the linking to the railway and limit the increasing of the traffic on the railway line.

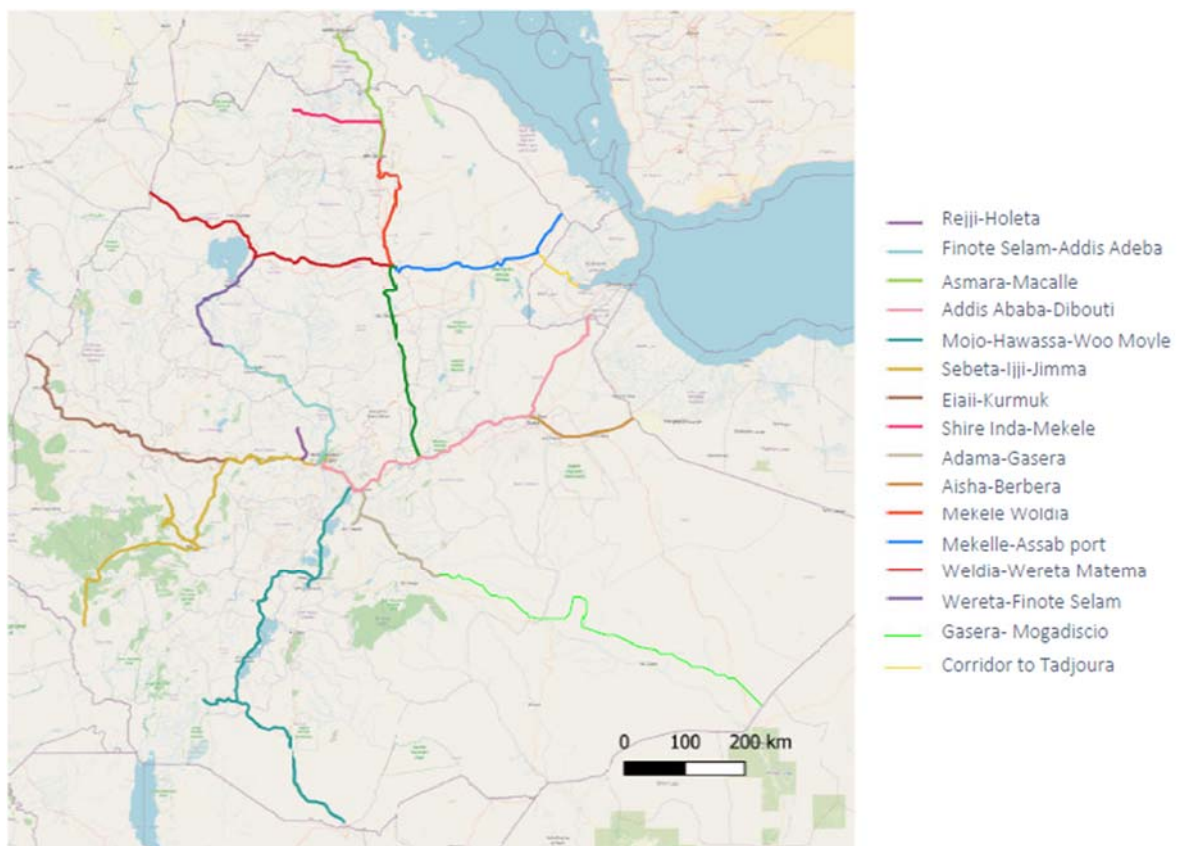
4 PLANNED INTERVENTIONS

The interventions studied in the sectorial Master Plan have been identified basing on five main principles:

- Capability to reach seaports alternative to Djibouti
- Results of previous study
- Corridor where significant flows have been identified
- Integration with African railway corridors
- Promote the economic growth of Ethiopia

Basing on the above-mentioned principles the corridors in the following picture have been identified as to be studied.

Figure 2: Railway corridors studied in the Master Plan



It is important to underline that the above picture represents the overall set of corridors studied and the result identified for each scenario is reported in the below specific chapter.

Similarly, the represented alignment should be intended as corridor alignment and not as railway line alignment. Therefore, the analysis of exact definition of the alignment is deferred to the following design stages.

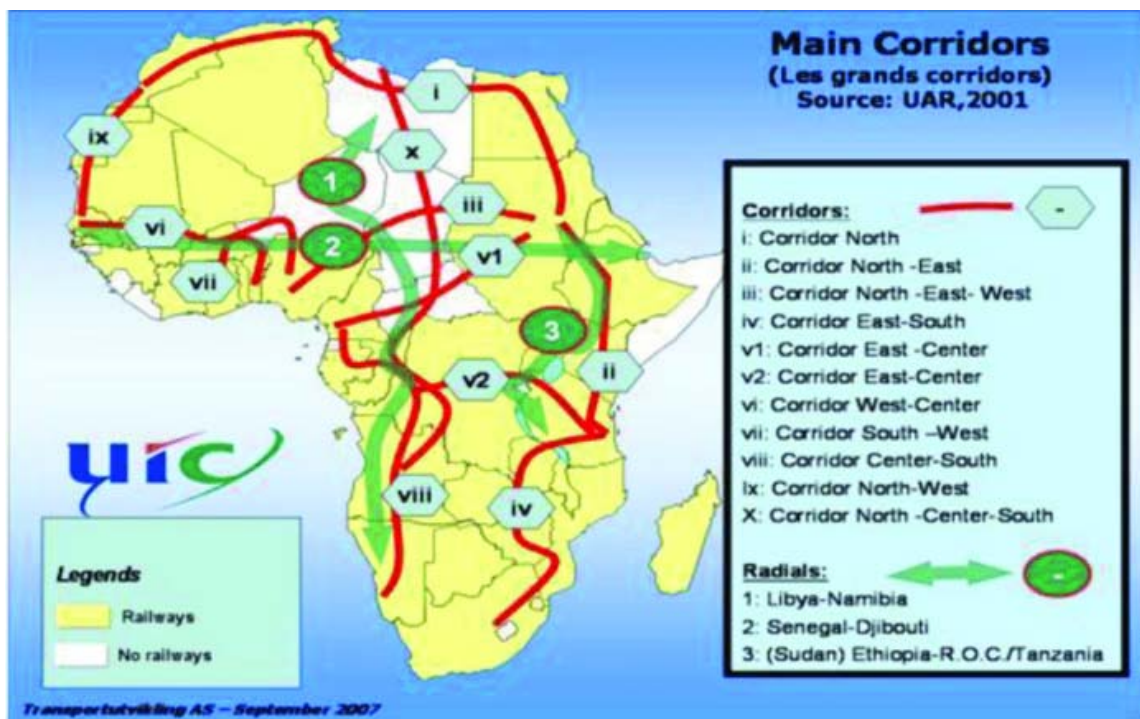
By the way, in the definition of the CAPEX costs, has been performed an analysis regarding the orographic condition of each line that could significantly affect the investments costs.

4.1 AFRICAN RAILWAY CORRIDORS

The identification of the corridors has been done also considering the integration with the African Railway corridors.

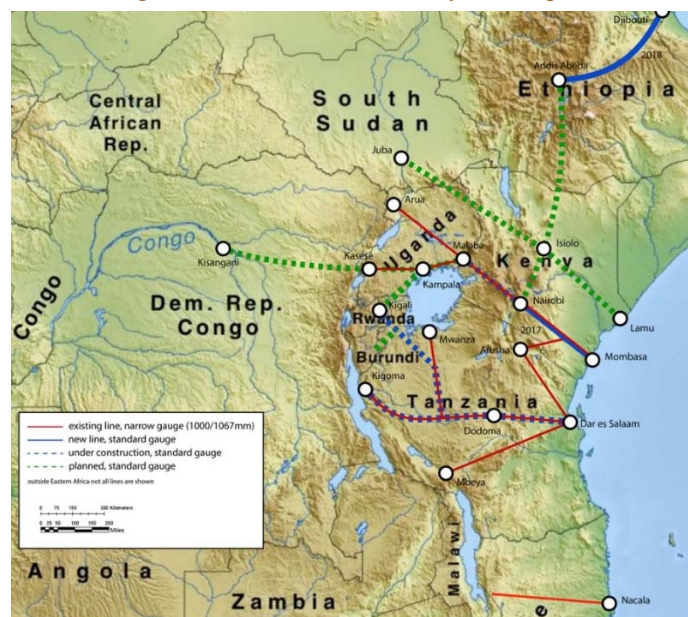
In November 2007 the African Union (AU) held a Conference on Rail Interoperability in South Africa and resolved “To this end and to facilitate interoperability of rail transport networks in Africa, standard 1 435 mm gauges should be adopted and retained for construction of new rail lines in the Continent”(Rail Development in Africa: Stakes and Prospects, Objectives and Missions of the African Rail Union (ARU); 10 – 14 April 2006, Brazzaville, Republic of Congo). It was concluded that “ The conversion to standard gauge (1 435 mm) for new railway lines should enable African railways to benefit further from the wide range of material and equipment at global level, and will contribute significantly to resolving the problem of interoperability in the future Pan-African railway network.” Ten Corridors and three Radials feature in the vision of the Union of African railways and member states are encouraged to keep these in mind for future integration whenever new lines are considered. In determining the current investment routes, it was decided to follow those identified in previous studies to ensure interoperability throughout the African continent.

Figure 3: African Railway Corridors



Additionally, in 2010, has been developed the East African Railway Master Plan. This study focused mainly on the development of the railway system in Kenya, Uganda, Tanzania, Rwanda and Burundi but also contains railway lines within third countries like Ethiopia, South Sudan and DR Congo in order to create an international corridor linking Addis Ababa and Djibouti to Kisangani (RDC). In the following picture is briefly reported the lines involved in the East African Railway Masterplan.

Figure 4: East African Railway Masterplan



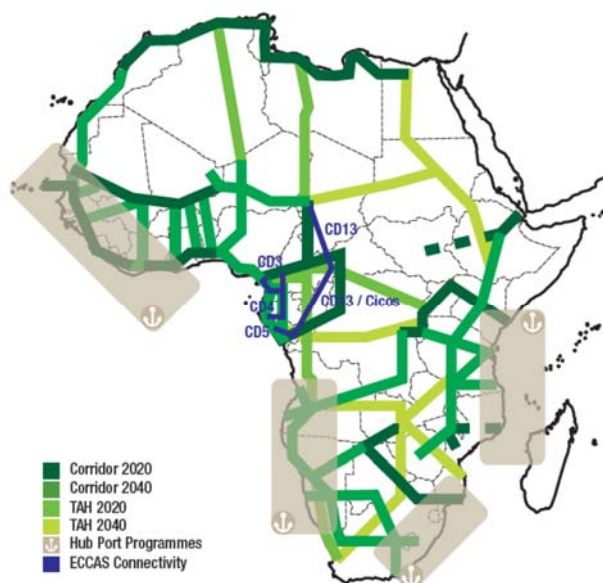
After that, Transport Sector Report and the Transport Outlook Report 2040 was developed within the Programme for Infrastructure Development in Africa (PIDA). The aim of PIDA is to strengthen the interconnection of the infrastructure in Africa.

PIDA's Transport vision is to work towards an integrated continent where the transport infrastructure and services enable the free movement of goods and passengers by improving the connectedness of African capitals and major centers with modern rail systems

Within the PIDA, ARTIN corridors have been identified. In Ethiopia two main corridors have been identified: the first cross the country from north to south and connects the Sudan to Kenya, the second cross the country from east to east linking Djibouti and South Sudan.

In the following images a summary of the ARTIN corridors is reported:

Figure 5: ARTIN Corridors



The development of the present Master Plan considers the integration of the Ethiopian Railway Network in a continental context and therefore the promotion of the integration of the railway system at international level is one of the driving forces for the identification of the corridors.

It is also true that the different considered time scenario may lead to different traffic flows evaluation and then to different implementation time scenario for the corridor but, in any case, the vision of an integrated transport system is strongly present in the study.

4.2 INTERVENTION BY SCENARIO

The identification of the intervention and the related CAPEX and OPEX are based on the flows model updated to the date of the present document. Any further model updating will be evaluated and any consequent modification in terms of corridors identification and related costs will be considered and implemented.

The identified intervention can be grouped in the following categories:

- Upgrading of the current infrastructure
- New infrastructures/lines
- Non-tangible investments

The upgrading of the current infrastructure has been evaluated basing on the analysis of the current situation and the result of the flows model. In the case where the expected flows exceed the maximum capacity of the lines, an increasing on the capacity should.

New infrastructures/lines represent the new investments needed to accommodate the expected flows. Basing on the demand growth each line could consider different investments in the different time scenarios.

Non-tangible investments represent the investments needed to enable the development of the railway sectors in Ethiopia regardless the development of the infrastructures in the country. The identification of this category of investments is based on the analysis of the present situation.

Additionally, other investments to be further studied have been identified. This category represent the investments that at the moment could not be justified due to the contingency condition but could represent a future development opportunities.

Basing on the results of the traffic model, for each scenario the following intervention has been identified:

Table 4: Railway Investments by Scenario

ACTIONS	1 - Go-Ahead Scenario			2 - Next-Generation Scenario			3 - Limits-to-Growth Scenario		
	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050
Awash - Kombolcha – Haragaria	X	X	X	X	X	X	X	X	X
Mekele – Haragaba	X	X	X	X	X	X	X	X	X
Mekelle - Assab Port Railway		X	X		X	X		X	X
Weldia - Wereta - Matema (Sudan Corridor)			X			X			X
Wereta- Finote Selam			X			X			
Mojo - Hawassa		X	X		X	X		X	X
Hawassa - Woo - Moyle		X	X			X			
Sebeta-Jimma-Bedele - Booma South Sudan Border			X			X			

ACTIONS	1 - Go-Ahead Scenario			2 - Next-Generation Scenario			3 - Limits-to-Growth Scenario		
	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050
Aisha - Berbera		X	X		X	X		X	X
Adama- Gasera			X						
Ejaji- Kurmuk			X						
Rejii - Holeta			X		X	X			
Doubling of Adama – Dewale Section									
Link rail lines (AA junction and freight sidings)	X	X	X	X	X	X	X	X	X
Signal/Interop AA- Dibouti & Awash - Haragaria	X	X	X	X	X	X	X	X	X
Addis Ababa - Djibouti Upgrade 1	X	X	X	X	X	X	X	X	X
Addis Ababa - Djibouti Upgrade 2	X	X	X	X	X	X	X	X	X
Addis Ababa - Djibouti Upgrade 3	X	X	X	X	X	X	X	X	X

4.3 INTERVENTIONS TO BE FURTHER STUDIED

The analysis carried out for the identification of the flows has identified the corridor to be developed within the time scenario of the present Masteplan.

Beside the identified corridors, other corridors deserve to be further investigated due they could have the potentiality to have significant amount of flows basing on the interaction with the other transport modes and basing on the development of the economic condition of Ethiopia.

The corridors that are suggested to be further investigated are:

- Gasera – Mogadiscio
- Finote Selam – Sebeta
- Link to Tadjoura
- Mekele – Asmara (Eritrea Border)
- Mekele - Shire

The line Gasera – Mogadiscio could link the port of Mogadiscio to the Ethiopian railway network. Despite currently the port is not attractive due to the political condition of Somalia, is an opportunity to be further studied basing on the stabilization of Somalia.

The line Finote Selam – Sebeta could represent a significant alternative to line the north-west of the country to Addis and also an alternative link to the Awash – Weldiya. Therefore, could represent a strategic investment for the development of the railway network.

The link to Tadjoura should be further investigated based on the eventual development of Tadjoura Port. It could represent a closer port for the north of Ethiopia compared to Djibouti and moreover could be specialized for specific typology of cargo.

The line Mekele - Asmara could link north of Ethiopia to the Eritrea and the port of Massawa. Therefore, is an opportunity to be further studied basing on the eventual development of Massawa port.

Differently from the other suggested line, Mekele – Shire connection has been studied and included in the flows modelling. By the way, at the moment there is significant amount of flows to justify the construction and operation of the line. Like Mekele – Asmara railway line, this corridor could be an opportunity in the future in case of new development of corridor to Eritrea or for the creation of an alternative corridor to Sudan.

5 RAIL NETWORK MODELLING

A specific model was not required for the simulation of the railway scenarios. This because the main TransCAD model used for estimating traffic on the road network also simulates in parallel traffic on the railway network (the model includes the intermodal option). The next paragraphs describe the main hypotheses and assumption considered for the distribution of traffic between the road and rail modes and the simulated scenarios.

5.1 ASSUMPTIONS ABOUT FREIGHT TRAFFIC

The assignment of freight traffic was made based on (1) a comparison between the average tariffs of the rail transport system and (2) the capacity of the intermodal terminals to handle certain quantities of traffic.

The choice of tariffs as the first discriminating element was made with the aim of simulating, at least theoretically, the first criterion that the senders (producers, distributors, shipping companies, etc.) use for their choice of the mode of transport. A base value of USD 0.038 per ton x km was used for railway tariffs, while a value of USD 0.074 per ton x km was used for road tariffs. While the first value appears to be the result of a direct survey by the Consultant, the second is a hypothesis based on average shipping rates for medium-long distances in sub-Saharan Africa (elaboration carried out by the Consultant on various sources).

Clearly the tariff itself would clearly favor the rail mode of transport over the road mode. In fact, it is known that the greater flexibility of road transport and the intrinsic advantage of being almost always door-to-door gives this transport system an aid in commercial terms over rail. The railways are therefore subject to additional “intermodal” costs, which in the model are assigned to the road-rail transfer links. These costs are the synthesis of two components: a physical component, that is the cost of loading / unloading the goods, and an additional component, merely of commercial type, which represents the ability of the railway system to appear as a “more valid alternative” to the railway system (punctuality, reliability, etc ...). It is very important to highlight that the term “more valid alternative” is referred to the subjective point of view of the shippers (that is not absolute and that can change under specific circumstances) and must not be taken into consideration as a general evaluation in terms of efficacy and/or effectiveness of one mode with respect to the other. The fictitious component is difficult to evaluate because it is affected by subjective components, which are difficult to establish in the Ethiopian reality, given that the presence of the railway is very limited and experience in this sector has not yet been accumulated. For this reason, the Consultant has adopted a cost of 5.65 USD per ton. This is a standard cost derived from previous experiences and also used in other projects in Africa developed with TransCAD.

In addition to tariffs, the capacities of the railway system and the intermodal system were also considered. In this respect, it was decided to assign more binding capacities to the intermodal, therefore capacities were assigned based on the assumed dimensions of the intermodal nodes, while a nominal capacity was assigned to railway lines. Such capacity was intentionally oversized (up to 40,000 tons per day on the main sections for the 2050 scenarios) to freely dimension the service once the potential demand has been determined. As regards the intermodal nodes, in addition to the main nodes of the network, a minimum freight intermodal capacity (30 tons/day) was assigned to all the stations of the network, assuming that a possible small shipments/parcels service would be carried out by rail.

It is important to note that the railway model is actually a semi-normative model. Many of the assumptions made by the Consultant are subjective, even if always derived from his own experience, in the absence of a consolidated experience of the railway sector in Ethiopia. This is

however consistent with the need to evaluate the impact of certain policies in a “what-if” logic. The use or not of rail transport for freight depends on a mixture between the commercial capacity of the railway sector to respond to competition from the road sector and the transport policies adopted, which may or may not favor certain sectors. Furthermore, the capacity of the railway lines themselves is important, but an even greater impact arises from the overall efficiency of the intermodal sector.

5.2 ASSUMPTIONS ABOUT PASSENGER TRAFFIC

Passenger traffic was assigned on a comparison between travel times on the road network and on the rail network. Tariffs have been analyzed, but not been taken into account in the model, assuming that the use of the train competes with the use of bus services.

Based on information collected directly by the consultant, the current average fare on the existing Addis Ababa - Djibouti line starts from a base value of 0.7 ETB / km (single seat per traveler residing in Ethiopia), while the average fare for quality bus services it is about 1 ETB / km, with fluctuations due to market conditions. However, the value of 0.7 ETB / km by rail refers to the cheapest travel class, while as regards the bus fare, the value was collected on connections not served by the railway (see the following table, referring to the Selam Bus operator).

Table 5 Selam Bus fare

From/to Addis to...	Fare (ETB)	Distance (km)	Fare / km (ETB / km)
Arba Minch	585	434	1.35
Jimma	480	352	1.36
Adigrat	825	1035	0.80
Harar	595	517	1.15
Hawassa	320	279	1.15
Mekelle	800	933	0.86
Mizan Teferi	640	568	1.13
Shire	955	943	1.01
Average			1.03

Source: <https://ticket.selambus.net/onewayvalidate>

Based on the international experience, it is assumed that bus companies will remodulate their fares in case they will need to compete with a parallel rail service. Considering that the average fare for inter-city bus services is yet said about 1 ETB per km it is realistic to admit a 30% price decrease and an alignment with rail fares

5.3 ASSIGNMENT MODEL

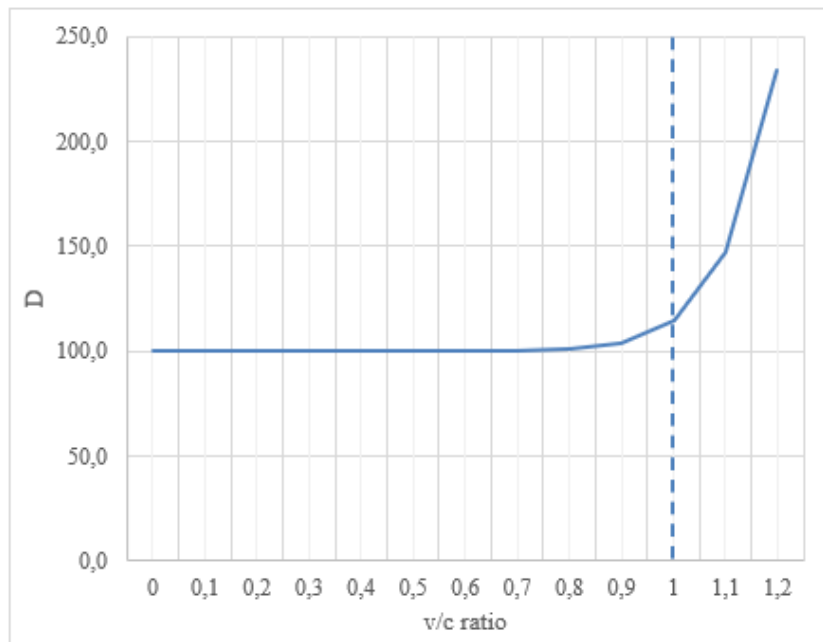
An equilibrium algorithm was chosen for the assignment of both freight and passengers. Yet said, the assignment is made in parallel both on the road and on the railway network. The model used BPR performance functions on the road links and for the specific case of the railways it was necessary to adapt a typically road cost function to the railway case. In fact, in railways a “flow curve” cannot be defined as in the road case. For roads, when the flow/capacity ratio increases, there is a gradual decrease in performance up to a situation of congestion. In the case of railways, once a capacity has been defined (which can depend on both the technical characteristics of the line and the rolling stock, but also to the characteristics of service to be implemented), there is a slight degradation in terms of performance if one remains within the limits of the service capacity and a strong deterioration if the limits of capacity are exceeded. It was therefore decided to

simulate this behaviour with a cost function of this type (i.e. a BPR):

$$D = D_0 \left[1 + \alpha \left(\frac{v}{c} \right)^\beta \right]$$

where D is the actual generalized cost on each link, D_0 is the basic generalized cost (unloaded link), v the flow, c the capacity and α and β calibration parameters. In order to simulate a rapid decrease in performance when a flow/capacity ratio of 1 is reached, values of 0.15 and 12 were taken respectively for α and β . The effect is a flow curve like the one presented in the following figure, where D_0 is conventionally assumed to 100.

Figure 6:Flow Curve



This kind of performance function was extended also to the intermodal links. It should be repeated that in our assumptions the intermodal links are the main elements that filter the demand on the railway system.

5.4 O/D MATRICES AND SCENARIOS

The O/D matrices the scenarios used for the simulation of railway traffic coincide with those already used for the road transport mode. The model, in fact, assigns in any case both on the road and on the railway network as it is intrinsically intermodal. Therefore, the following scenarios were examined:

- Limits to Growth (low growth matrices), years 2025, 2035 and 2050
- Next Generation (high growth matrices), years 2025, 2035 and 2050
- Go Ahead (high growth matrices), years 2025, 2035 and 2050

The matrices are 447 x 447 in the case of freight traffic and 439 x 439 in the case of passenger traffic. For passengers, the traffic that crosses the external border of Ethiopia has not been estimated. In this case the demand that reaches the internal centroid closest to the border point will have to be assumed as inclusive of the international passenger traffic.

The detailed results of the different scenarios are presented in the next paragraph

5.5 FORECASTED RAIL TRAFFIC FLOWS

The forecasted traffic flows on the rail network are presented inside the next tables and flow diagrams. All figures are per-day and bi-directional. Some comments:

- As yet said, the model does not assign passenger traffic on cross-border segments. This does not exclude that international passenger will not exist. International passenger traffic can be considered as assigned to o/d zone that is closest to border pass
- At year 2025 all scenarios are similar, especially as regards Next Generation and Go Ahead. Limits to Growth has lower flows due to the lower increase of the O/D matrices
- Despite the use of the same O/D matrices, at year 2050 the Go-Ahead scenario is much more favourable to the rail mode, due to the higher level of investments on rail and the surge of a “network effect” that is able to divert more traffic from the road mode.

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Table 6: Railway Flows

Link_Name	ID	Length (km)	Limits to Growth 2025		Go Ahead 2025		Next Generation 2025		Limits to Growth 2035		Go Ahead 2035		Next Generation 2035		Limits to Growth 2050		Go Ahead 2050		Next Generation 2050	
			(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)
Rail branch to Berbera	3111	187	0	0	0	0	0	0	0	2512	0	3092	0	2468	0	7504	0	18102	0	4813
Proposed rail Addis Ababa – Finote Selam	3192	54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3293	7593	2312	918
	3191	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5680	7795	5542	969
	3188	117	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5781	7750	5659	892
	3186	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6195	7731	5970	844
	3184	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6136	7619	6430	800
Railway Branch to Asmara	3182	119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NewRail	3181	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	567	11196	613	89
Rail Route 5 (Awash – Weldiya - Mekele - Shire)	3180	66	0	0	0	0	0	0	0	0	2018	102	2051	99	3805	220	5947	11456	5882	272
Proposed rail Addis Ababa – Finote Selam	3179	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6158	7587	6388	777
Rail branch to Assab	3107	75	0	0	0	0	0	0	0	2547	0	2438	0	3008	0	4870	0	12880	0	6883
Rail Route 6 (Finote Selam – Bahir Dar - Wereta -	3106	33	0	0	0	0	0	0	0	700	0	531	0	739	0	4307	0	5641	0	1399
Rail branch to Assab	3105	67	0	0	0	0	0	0	0	2547	0	2438	0	3008	0	4870	0	12880	0	6883
Rail Route 3 (Sebeta Bedele + branch to Dima)	3008	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5924	3811	5486	236
	2998	95	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12793	8614	12710	1216
Rail Route 5 (Awash - Weldiya – Mekele - Shire)	2963	25	1841	989	1427	786	1650	786	1510	3852	2291	2377	2439	3737	1383	8150	6421	21193	6341	10046
	2952	40	902	480	1310	696	1502	995	1513	844	2093	934	2140	1036	1245	3635	6143	14569	0	3507
	2949	24	0	0	0	0	0	0	1409	736	1991	822	2098	921	1196	3456	4027	14105	3824	3328
Rail Route 6 (Finote Selam – Bahir Dar - Wereta -	2944	51	0	0	0	0	0	0	0	752	0	601	0	704	0	4329	0	5897	0	1463
	2943	32	0	0	0	0	0	0	0	3014	0	2313	0	3129	0	8364	0	17744	0	7585
	2942	139	0	0	0	0	0	0	714	3232	1058	1676	1392	3315	1515	6336	4643	16444	4891	8158
	2941	51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6231	7552	5811	777
	2940	106	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6101	7465	5687	764
Rail Route 7 (Wereta - Azezo –	2939	9	0	0	0	0	0	0	0	0	0	0	0	0	0	2360	0	8288	0	76

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Link_Name	ID	Length (km)	Limits to Growth 2025		Go Ahead 2025		Next Generation 2025		Limits to Growth 2035		Go Ahead 2035		Next Generation 2035		Limits to Growth 2050		Go Ahead 2050		Next Generation 2050	
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Metema)	2938	112	0	0	0	0	0	0	0	0	0	0	0	0	1459	2360	4561	8428	4978	172
	2937	47	0	0	0	0	0	0	0	0	0	0	0	0	1881	2402	5880	8582	5869	256
Rail Route 6 (Finote Selam – Bahir Dar - Wereta -	2936	64	0	0	0	0	0	0	0	0	0	0	0	0	1935	2508	6047	6617	5924	2467
Rail Route 4 (Ejaji - Kurmuk)	2935	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5610	3580	0	0
	2934	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5118	3660	0	0
	2933	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3210	3763	0	0
	2932	114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5311	3862	0	0
	2931	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5675	3884	0	0
Rail Route 3 (Sebeta Bedele + branch to Dima)	2930	127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5525	3696	5645	156
	2929	98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	801	3510	756	76
	2928	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6250	102	5427	92
	2927	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5637	4499	5279	579
Rail Route 8 (Adama - Iteya – Gasera)	2925	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5959	112	0	0
	2924	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6286	345	0	0
	2923	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5941	524	0	0
Rail Route 2 (Mojo - Moyale + branches)	2922	98	0	0	0	0	0	0	0	0	1674	1004	0	0	0	0	0	7296	0	83
	2921	103	0	0	0	0	0	0	0	0	1674	1112	0	0	0	0	4998	7395	4930	163
	2920	81	0	0	0	0	0	0	0	0	1929	1426	0	0	0	0	5820	7660	5807	422
	2919	106	0	0	0	0	0	0	0	0	2100	1528	0	0	0	0	6158	7747	6025	505
Rail Route 3 (Sebeta Bedele + branch to Dima)	2917	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13578	8758	13260	1308
Rail Route 1 (Addis Ababa - Djibouti)	2916	14	2901	732	1876	28	1675	28	2073	3386	2756	3830	2702	3818	1882	9168	8856	18663	9208	13761
	2915	19	3383	57	2148	51	1944	51	2173	3438	3287	3887	3132	3872	1939	9280	365719	24926	362978	14689
	2914	33	2912	684	1919	640	1768	640	1902	4446	2916	4940	2743	4832	1778	13175	347658	24545	354719	18177
	2913	22	3157	9088	2273	8246	2167	8246	2184	13785	3146	14636	3076	15171	2019	38323	17583	39184	11263	45353
	2912	37	2862	9120	1806	8272	1733	8272	1767	13843	3038	14684	3020	15216	1418	38396	9382	38515	9328	45091

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Link_Name	ID	Length (km)	Limits to Growth 2025		Go Ahead 2025		Next Generation 2025		Limits to Growth 2035		Go Ahead 2035		Next Generation 2035		Limits to Growth 2050		Go Ahead 2050		Next Generation 2050	
			(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)
	2911	63	2862	9120	1806	8272	1733	8272	1767	13843	3038	14684	3020	15216	1418	38396	9382	38515	9328	45091
	2910	3	0	8835	0	8000	0	8000	0	13555	0	16326	0	13683	0	37292	0	39094	0	22763
	2908	51	0	8838	0	7980	0	7980	0	13526	0	16310	0	13644	0	37328	0	39030	0	22853
	2907	62	805	8819	873	7987	873	7987	1383	13532	1672	16336	1672	13667	1433	37356	5415	38880	5415	22946
	2906	47	805	8819	873	7996	873	7996	1383	13580	1672	16297	1672	13712	1433	37366	5415	38841	5415	23032
	2905	70	2807	8918	1962	8070	1895	8070	1949	13744	2872	16464	2880	13881	1649	39440	8824	57043	8599	25870
	2904	67	3217	8940	2196	8096	1779	8096	2144	13798	2935	16416	2812	13852	2038	39529	8882	57008	8665	25938
	2903	44	3036	8931	2095	8108	1933	8108	2133	13808	3135	16476	2965	13891	1821	39593	8894	56819	9016	26014
	2902	33	2792	8931	1988	8128	1809	8128	2060	13846	2939	16428	3010	13849	1812	39641	8759	56880	8831	26107
Rail Route 5 (Awash - Weldiya – Mekele - Shire)	2901	49	2096	979	1430	867	1400	867	1444	4428	2117	2243	2065	4630	1449	4915	6201	23536	6243	13818
	2900	52	2210	956	1344	844	1247	844	1605	4483	2168	2284	1980	4608	1245	4880	5635	23529	5648	13751
	2899	34	2028	928	1334	816	1246	816	1358	4457	2134	2281	2063	4582	1241	4870	5645	23401	5688	13687
	2898	39	2027	902	1324	784	1227	784	1348	4476	2036	2230	2134	4534	1290	4854	5545	23347	5574	13591
	2897	57	2152	954	1362	957	1345	957	1559	3827	2298	2336	2095	3779	1216	8115	5340	21116	5357	9940
	2896	21	1952	925	1503	928	1410	980	1510	3820	2287	2355	2248	3750	1424	8134	6547	20982	6419	9850
	2895	1	1925	925	1503	928	1410	980	1395	3804	1866	2348	1750	3731	1714	8137	4085	25030	3720	11502
	2894	37	810	470	1290	690	1350	990	1307	950	2087	1040	2077	1148	1524	3808	5816	14790	5875	3676
	2893	31	850	480	1285	690	1292	990	1307	899	2134	992	1879	1097	1201	3718	5392	14723	5264	3606
Rail Route 2 (Mojo - Moyale + branches)	2888	115	0	0	0	0	0	0	0	0	787	1216	0	0	0	0	2339	7488	1819	249
	2887	68	0	0	0	0	0	0	0	0	1280	96	0	0	0	0	5376	70	5213	89
Rail Route 5 (Awash - Weldiya – Mekele - Shire)	2889	52	0	0	0	0	0	0	0	0	2142	51	1988	48	4231	105	6080	83	6344	99
Rail Route 2 (Mojo - Moyale + branches)	2878	134	0	0	0	0	0	0	0	0	1918	1606	0	0	0	0	5985	7824	4653	585
Rail Route 6 (Finote Selam – Bahir Dar - Wereta -	2870	181	0	0	0	0	0	0	0	0	0	0	0	0	1925	2508	6017	6601	4861	2444
	2867	26	0	0	0	0	0	0	1030	3260	1951	1740	1969	3360	1483	6403	5849	16422	5905	8212
Rail Route 3 (Sebeta Bedele +	2873	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6671	3996	6246	310

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Link_Name	ID	Length (km)	Limits to Growth 2025		Go Ahead 2025		Next Generation 2025		Limits to Growth 2035		Go Ahead 2035		Next Generation 2035		Limits to Growth 2050		Go Ahead 2050		Next Generation 2050	
			(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)	(pax/day)	(tons/day)
branch to Dima)	2874	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6146	4348	6246	496
Rail Route 2 (Mojo - Moyale + branches)	2877	18	0	0	0	0	0	0	0	0	2073	128	1910	54	0	0	1380	108	1319	89
	2876	92	0	0	0	0	0	0	0	0	1903	1836	2034	131	0	0	6065	8012	5825	761
	2918	89	0	0	0	0	0	0	0	0	1914	1874	1801	201	0	0	5524	8128	5765	848
Rail Route 5 (Awash - Weldiya – Mekele - Shire)	2891	104	1020	520	1260	699	1277	999	1305	793	1949	880	2078	976	1141	3536	5980	14352	0	3417
Rail Route 8 (Adama - Iteya – Gasera)	2880	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5538	102	0	0
	2879	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6217	694	0	0
	2881	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6653	1001	0	0
Rail Route 1 (Addis Ababa – Djibouti)	2883	24	2974	1347	1963	1308	1915	1308	1942	2048	2959	2300	2851	2128	1793	8336	358840	17993	360060	10563
	2882	3	2862	9120	1806	8272	1733	8272	1767	13843	3038	14684	3020	15216	1418	38396	15780	39190	9328	45324
Rail Route 5 (Awash - Weldiya – Mekele - Shire)	2884	72	2096	979	1430	867	1400	867	1444	4428	2117	2243	2065	4630	1449	4915	6201	23536	6243	13818
Rail Route 4 (Ejaji - Kurmuk)	2872	77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3494	0	0
Rail Route 3 (Sebeta Bedele + branch to Dima)	2875	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	603	352	0	182
Rail Route 7 (Wereta - Azezo – Metema)	2871	75	0	0	0	0	0	0	0	0	0	0	0	0	2035	2424	6360	8659	6314	339
Rail Route 6 (Finote Selam – Bahir Dar - Wereta -	2869	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6168	7500	6064	819
Rail Route 5 (Awash - Weldiya – Mekele - Shire)	2890	94	0	0	0	0	0	0	0	0	2018	102	2051	99	3805	220	6382	256	6347	182
	2868	1	1952	925	1503	28	1410	28	1510	3820	2287	2355	2248	3750	1424	8134	7589	25152	7605	11572
Rail Route 1 (Addis Ababa – Djibouti)	2909	37	0	8835	0	8000	0	8000	0	13555	0	16326	0	13683	0	37292	0	39094	0	22763
	2885	30	3219	9523	1937	8675	1770	8675	1958	17715	2920	18358	3109	18217	1743	43244	8731	74963	9273	38086
	2728	9	0	8806	0	7974	0	7974	0	13555	0	16326	0	13683	0	37238	0	39046	0	22664
Rail link Holeta - Reji (cement factories)	3233	22	0	0	0	0	0	0	0	6961	0	7910	0	7890	0	11348	0	12077	0	12385
	3234	47	0	0	0	0	0	0	0	6961	0	7910	0	7890	0	11348	0	12077	0	12385

Figure 7: Railway Flows – Limit to Growth 2025

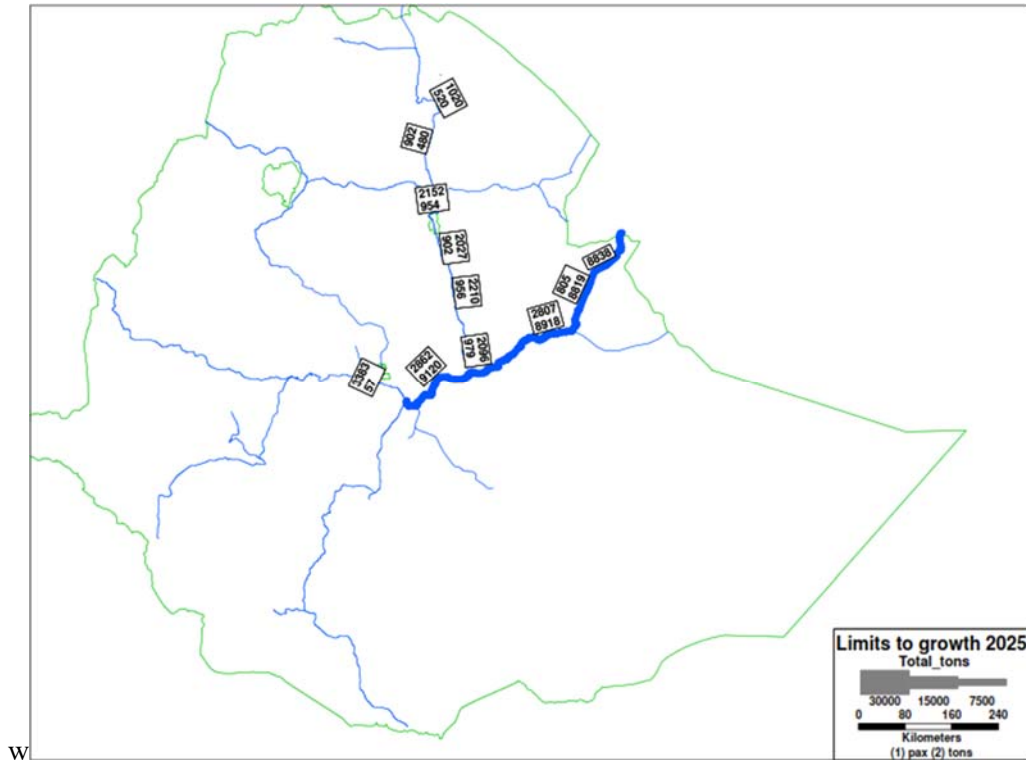


Figure 8: Railway Flows – Limit to Growth 2035

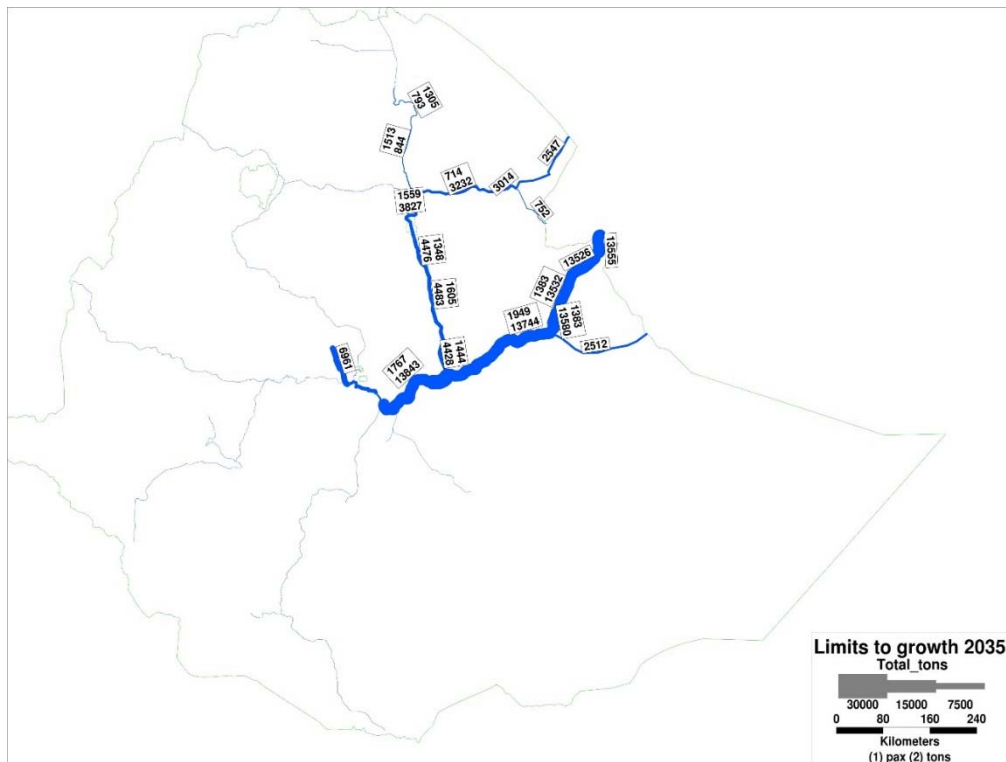


Figure 9: Railway Flows – Limit to Growth 2050

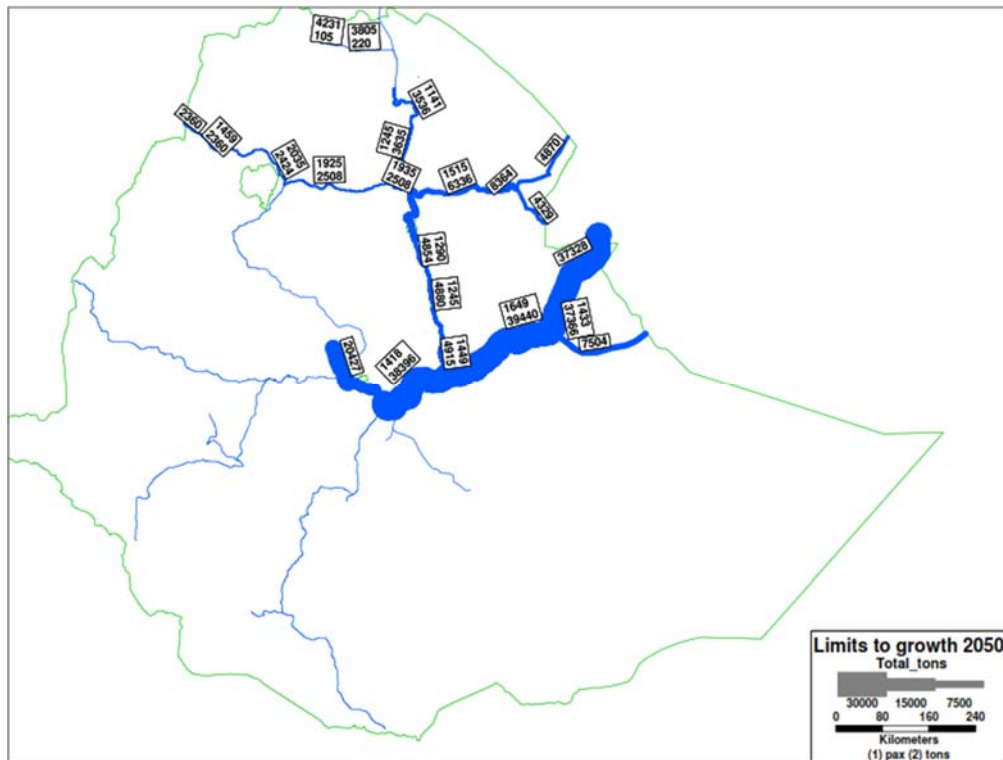


Figure 10: Railway Flows – Go Ahead 2025

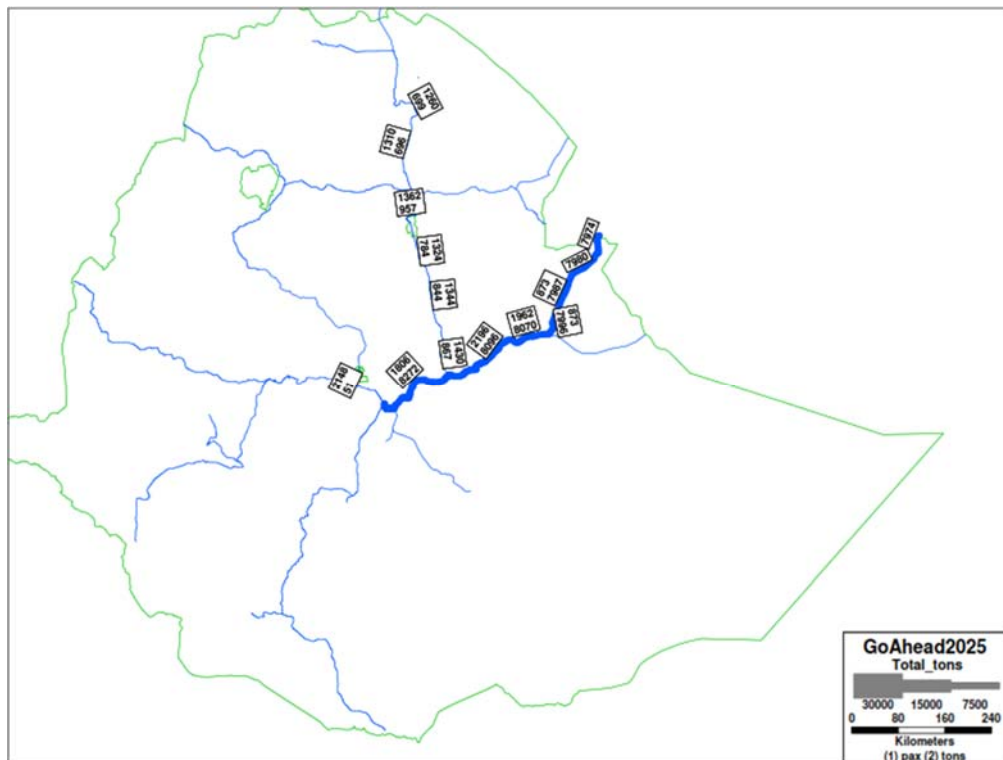


Figure 11: Railway Flows – Go Ahead 2035

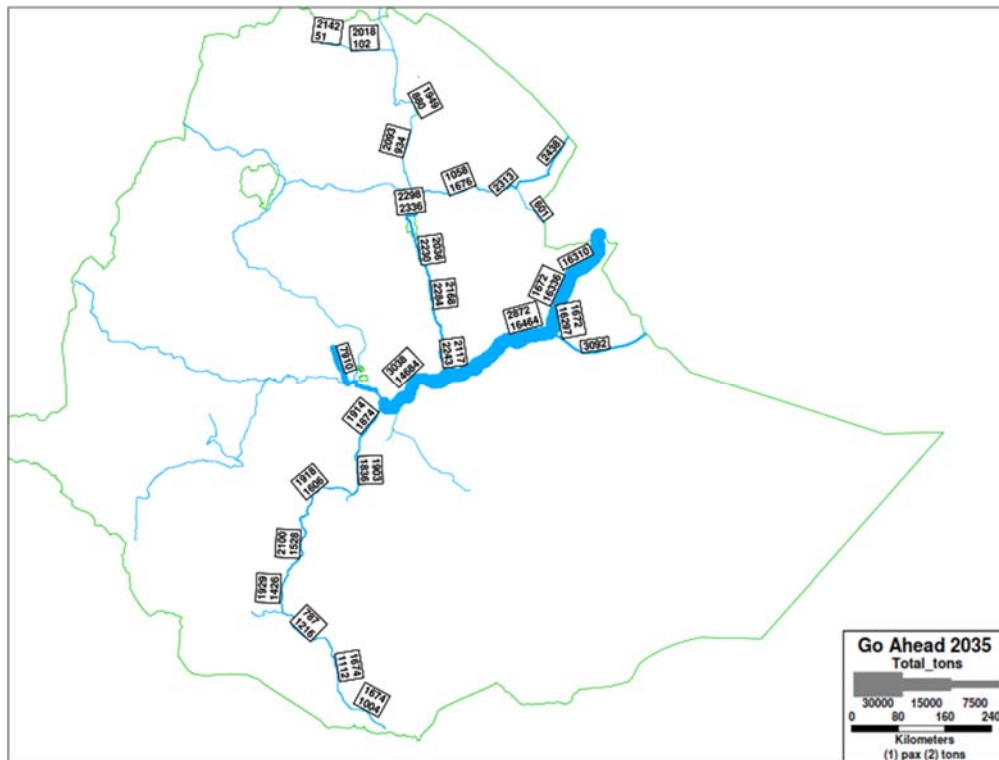


Figure 12: Railway Flows – Next Gen 2050

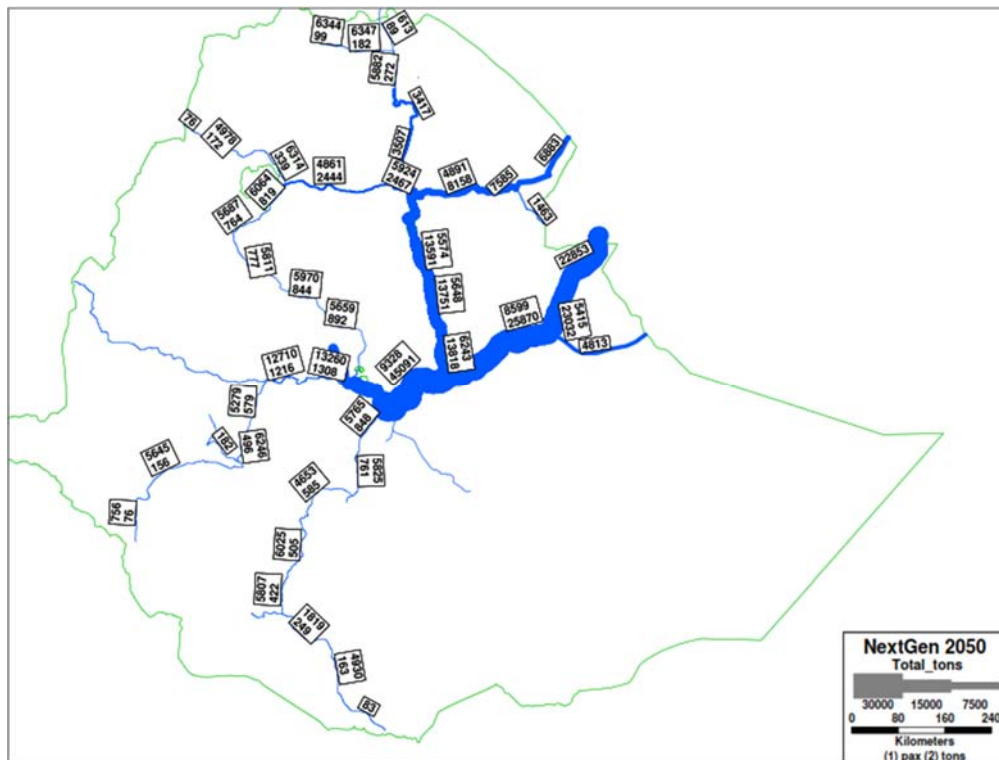


Figure 13: Railway Flows – Next Gen 2025

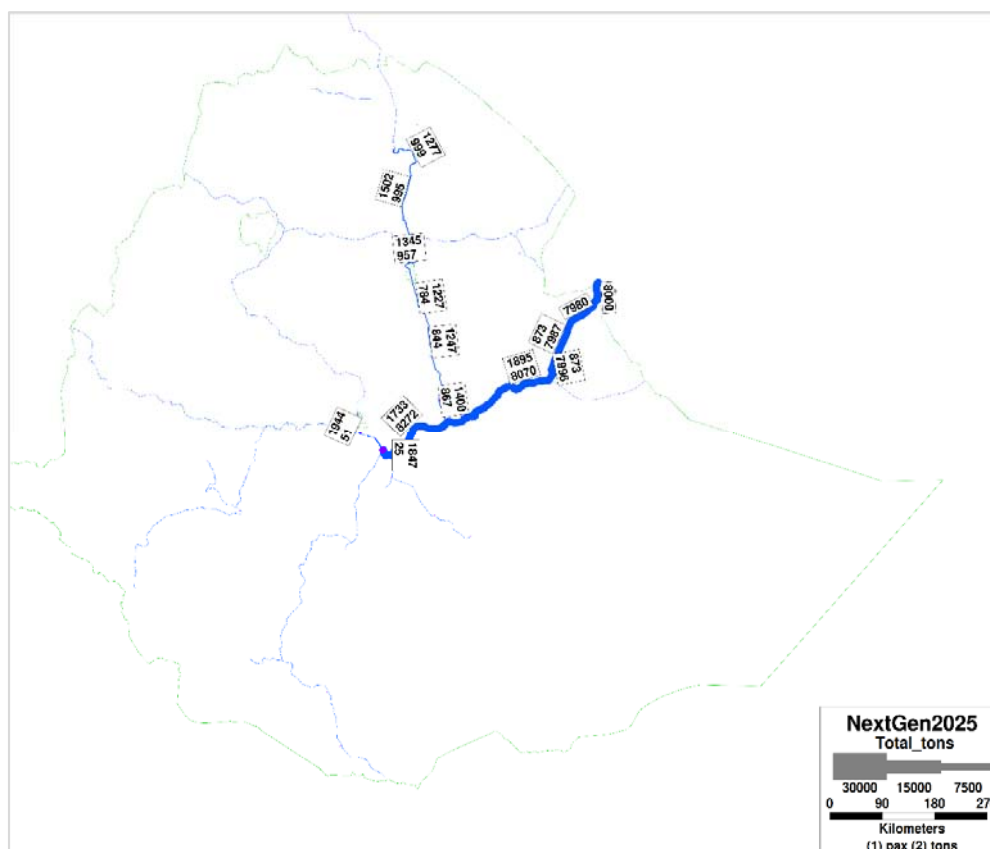


Figure 14: Railway Flows – Next Gen 2035

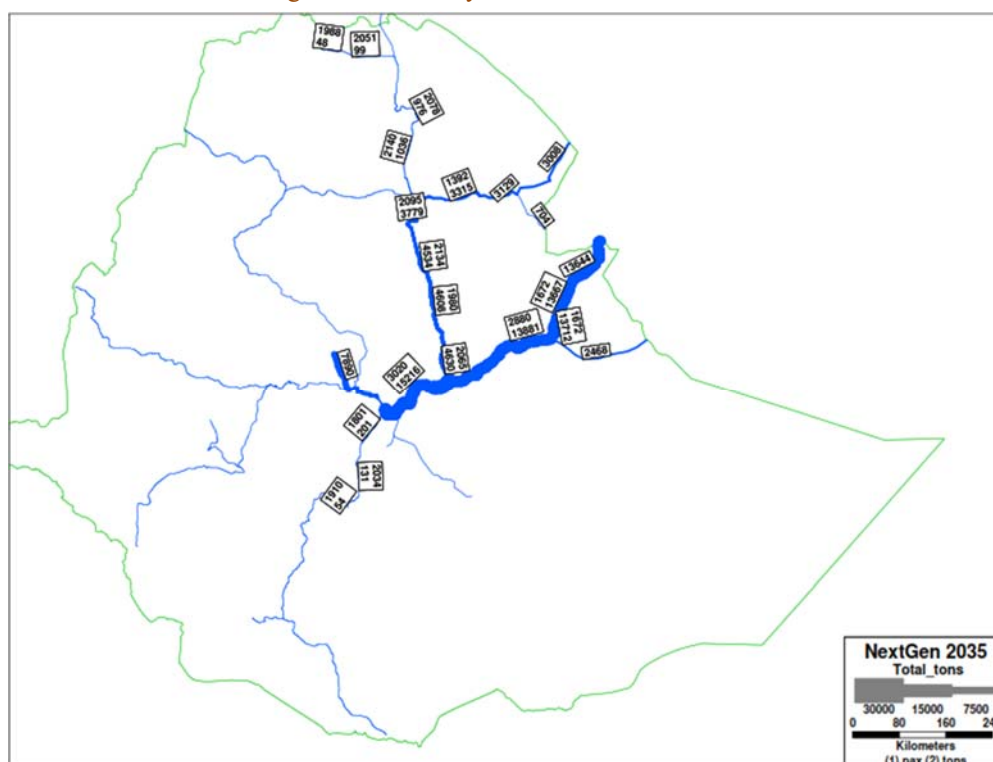
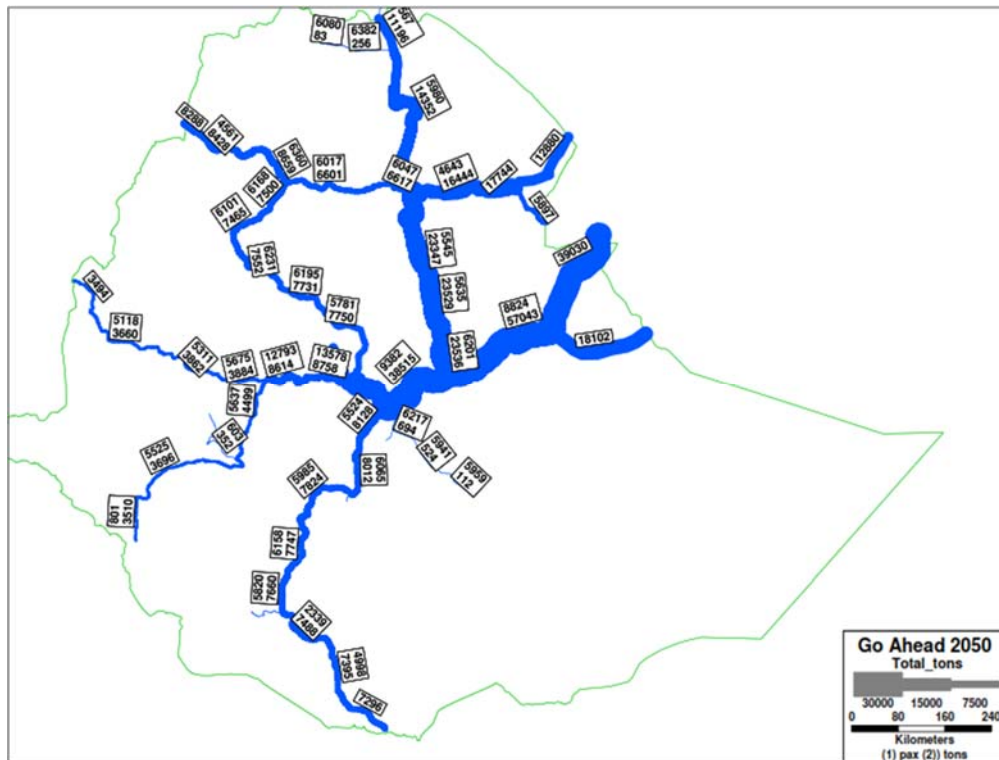


Figure 15: Railway Flows – Go Ahead 2050



6 CURRENT NETWORK UPGRADING ACTIONS BY SCENARIO

Ongoing Project

Currently in Ethiopia, two railway line is under construction:

Table 7: Railway Ongoing investments

N.	Project	The owner of the project	The location of the project	Time to complete	The assigned capital [M ETB]	Current Status
1	Awash - Kombolcha – Haragebeya	Government	Amhara and Afar region	2021	7.084	under construction
2	Mekele – Haragebeya		Amhara Afar and Tigra	Not Defined, Expected about 2025	25.768	56% Constructed ceased due to budget

Current Network Upgrading

Basing on the SWOT analysis reported above and the idea that the projects under implementation described in the previous chapter are parts of an ambitious plan that needs to be supported to reach the final aim, the Consultant has individuated the interventions required. The interventions are complementary to the projects foreseen in the 10 and 5 years plan and aim to allow a more efficient implementation of that projects.

Basing on the scenarios, the foreseen current network upgrading intervention are:

Table 8: Railway current infrastructure upgrading

ACTIONS	1 - Go-Ahead Scenario			2 - Next-Generation Scenario			3 - Limits-to-Growth Scenario		
	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050
Signal/Interop AA- Dibouti & Awash - Haragaria	x	x	x	x	x	x	x	x	x
Addis Ababa - Djibouti Upgrade 1	x	x	x	x	x	x	x	x	x
Addis Ababa - Djibouti Upgrade 2	x	x	x	x	x	x	x	x	x
Addis Ababa - Djibouti Upgrade 3	x	x	x	x	x	x	x	x	x
Doubling of the Adama – Dewale section	x	x	x	x	x	x	x	x	x

The proposed projects focus on the short – medium term is summarized in the following table

Signalling Interoperability

The Awash – Kombolcha line is equipped with European standard signalling system (ERTMS L1) and this may lead to interoperability challenges with the Sebeta – Dewale currently equipped with Chinese standard signalling system. Moreover, the section Kombolcha- Mekelle- Shire is foreseen to be equipped with Chinese signalling systems. In order to run seamlessly service between the lines it is necessary to promote the interoperability between the two systems.

Moreover, the rail link between the Sebeta – Dewale ad Awash – Kombolcha railway line is already in the finalization phase. If the signalling interoperability will not be ensured, there is two possible operational scenarios:

- Switch of the traction locomotive;
- Equip the locomotive with two different signalling system and create a transition area where the locomotive can switch between the two signalling systems.

These operations will lead to an increasing of the Opex costs and travel time for the passenger and goods. Moreover, the maintenance of two different system for two different lines may lead

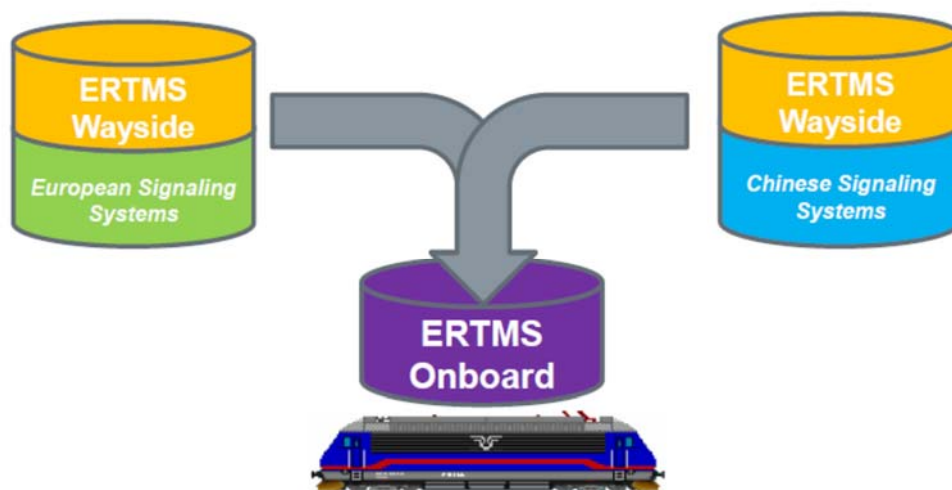
to a not optimized spare parts purchasing and stock. Moreover, it will force to provide different training for the train crew staff basing on the line limiting the interchangeability of the train drivers between the lines.

In order to avoid the cost increasing, it is suggested to create an interoperable signalling system that allow the seamlessly operation of the trains along the rail network implementing an ERTMS system.

A standardized and homogeneous ATP System have to be set by ERC for the eight routes to reduce the implementation Costs and to ensure the Operational Safety.

ERTMS is a standardized ATP System design as an overlay System to be easily installed on top of any existing Signaling Systems and Vehicle's types, it means that is no necessary to completely replace the current Chinese signalling system but is possible to install only the wayside equipment in order to realize the full signalling interoperability of the lines

Figure 16: Signalling Scheme



e
Implementing the standard UIC 405-1R in the single-track section has been evaluated that the line has a capacity of 15 trains/ day in the most critical section (between Bike and Dire Dawa).

Table 9: Sebeta – Dewale estimated capacity

From	To	Section length [km]	Estimated Capacity	Current Capacity
Adama	Feto	40,62	25	7
Feto	Metehara	63,938	17	4
Metehara	Awash	28,978	34	9
Awash	Sirba Kunkur	33,6	30	8
Sirba Kunkur	Mieso	43,46	24	6
Mieso	Bike	67,41	16	4
Bike	Dire Dawa	70,372	15	4
Dire Dawa	Arawa	48,066	22	6
Arawa	Adigala	62,014	17	5
Adigala	Aysha	50,6	21	6
Aysha	Dewale	40,438	25	7

Unfortunately, the current condition of the line is far from the ideal one:

- The average operational speed (about 50 km/h) is below the planned average speed (about 80 km /h); this because the line is not fully fenced and there are several illegal line crossings that lead to speed reduction in order to ensure the safety of the operation
- The line is not operated during the night time and this reduced the available window for the operation

Under this condition, implementing the standard UIC 405-1R has been evaluated that the capacity of the line is reduced to 4 or 5 trains /day.

Basing on the above consideration, three step of upgrading has been individuated for the Sebete – Dewale railway line:

Addis Ababa – Djibouti Upgrading 1

The aim of the step one is to increase the Speed the Safety and Capacity of the line provind the opportunity to run trains 24 hours /day.

In order to reach this goal, it is necessary to strength power availability, purchasing shunt reactors. Moreover, in order to speed up the time for the inspection of freight cargo and passenger it would be suggested the implementation of dedicated scan that can support in this activity

According to the expected improvement, the capacity of the line can be increased up to 12 trains/day.

Addis Ababa – Djibouti Upgrading 2

The aim of the step two is to increase the Safety and Capacity of the line implement fence along all the line and installing a reliable and efficient level crossing system to increase the operational speed and avoid the risk of run over. Currently, the operation on the line is limited by intrusion on the track that has led to minor accident.

According to the expected improvement, the capacity of the line can be increased up to 16 trains/day.

Addis Ababa – Djibouti Upgrading 3

The aim of the step three is to increase the Capacity of the line implement new sidings in order to increase the capacity achieving a maximum length of 25/30 km the single-track sections. It is important to underline that the increasing of the capacity through the increasing of the number of loop along the line may line to a minor reduction of he commercial speed along the line. According to the expected improvement, the capacity of the line can be increased up to 26 trains/day.

Doubling of Adama – Dewale Section

The results of the model have underlined that starting from 2025 will be necessary the doubling of the entire Addis – Djibouti railway corridors because of the high level of flows expected on the line. This will not limit the 3 upgrading of the current infrastructure already foreseen and required to optimize the circulation on the railway.

Therefore, the doubling of the single-track section is recommended. This will allow not only to maximize the flows on Addis - Djibouti line but also to optimize the circulation on the linked corridors (Awash – Weldya, Mojo – Moyale).

7 NEW INFRASTRUCTURE ACTIONS BY SCENARIO

The identification of the intervention and the related CAPEX and OPEX are based on the flows model updated to the date of the present document. Any further model updating will be evaluated and any consequent modification in terms of corridors identification and related costs will be considered and implemented.

For the ongoing project, the investments will only include the estimated costs for the finalization and eventual upgrading during the years.

Table 10: Railway New Infrastructure Action by Scenario

ACTIONS	1 - Go-Ahead Scenario			2 - Next-Generation Scenario			3 - Limits-to-Growth Scenario		
	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050	Short Term 2025	Medium Term 2035	Long Term 2050
Awash - Kombolcha – Haragaria	x	x	x	x	x	x	x	x	x
Mekele – Haragaba	x	x	x	x	x	x	x	x	x
Mekelle - Assab Port Railway		x	x		x	x		x	x
Weldia - Wereta - Matema (Sudan Corridor)			x			x			x
Wereta- Finote Selam			x			x			
Mojo - Hawassa		x	x		x	x		x	x
Hawassa - Woo - Moyle		x	x			x			
Sebeta-Jimma-Bedele - Booma South Sudan Border			x			x			
Aisha - Berbera		x	x		x	x		x	x
Adama- Gasera			x						
Ejaji- Kurmuk			x						
Rejii - Holeta			x		x	x			
Doubling of Adama – Dewale Section									

For the details about the CAPEX and OPEX for each scenario please refer to the following paragraph.

8 NON-TANGIBLE ACTIONS BY SCENARIO

The Railway sectorial masterplan is not only focused on infrastructure investments but include also suggested non-tangible investments. These investments should be considered as the base for developing all the infrastructure investments foreseen in each scenario.

Basing on this, the implementation of this investments should be considered as priority action:

Table 11: Railway non-tangible actions by scenario

N.	Project	The owner of the project	Scenario	Time to complete	Estimated Budget [M USD]
1	Establishing the Ethiopian Railway Handbook for design, construction and operation	ERC /MOT	All	8 Months	1.5

Ethiopia has already developed a significant experience in cross border operations due to the only standard gauge electrified railway is operating between two countries, Ethiopia and Djibouti. The challenges related to the cross-border operations have been faced and solved, by the way, the ambitious plan for the railway network development should consider the need to have seamless cross border operations that could not limit the capabilities of the railway to serve international shipping.

To achieve the goal of seamless cross border operations two main issues should be taken into consideration: technical interoperability and operational constraints.

Technical interoperability is represented by all the factors that may limit the capability of a train to operate on a different network. The challenge related to technical interoperability has been faced in another context always in the same way: defining a common standard to be fulfilled.

In Europe, the technical interoperability between several countries and rail networks has been faced implementing the TSI, Technical Specification for Interoperability. The TSI aims to facilitate the transition from the old integrated national railway systems which were governed mostly by national rules to the shared European railway area governed mostly by common EU rules.

The TSI refer to the harmonization of both technical aspects and regulatory framework among the European countries.

Similar to the European experience, Gulf Cooperation Council (GCC) is currently on the Gulf Railway Project (also known as the GCC Railway Project) – one of the largest contemporary cross-border rail networks in the world. The GCC Railway is intended to connect all the six GCC nations with a railway track running through key cities of each of these nations.

A pan-GCC rail network also means that each GCC country would be working individually on its railway infrastructure.

To support the development of the GCC rail network a common set of standards has been developed.

The present Ethiopia Railway Masterplan has identified an ambitious network development that should be supported by the development of Ethiopian national standards. Anyway, these standards should be developed focusing only on the Ethiopian context but aiming to minimize any future challenge related to the integration of the Ethiopian network on the international East African rail corridors.

Based on the above, along with the identified infrastructure investments, has been also identified the implementation of a non-tangible investment: the Ethiopian Railway Handbook.

The aim of the Handbook should be the identification of a national standard for the design, construction, operation and maintenance of the railway system within the Ethiopian regulatory framework.

The expected benefits of the implementations of the Ethiopian national standards are not only the development of the railway network in an efficient, safe and cost-effective manner but also the facilitation of the involvement of the private sector in the development.

Furthermore, the development of a national railway handbook could lead to increased participation of the private section in the railway development because it will be possible to invest within a defined technical framework at least at the national level.

9 ACTIONS EVALUATION (CAPEX AND OPEX ESTIMATION)

In this chapter a first analysis of the costs is provided to evaluate the differences between the possible scenarios. In the current situation, characterized by high uncertainty about the international and national economic perspectives linked to the depth and duration of the damages determined by the Covid 19 pandemic, the do-minimum scenario assumes a peculiar character, the one of a worst-case scenario, where it is planned to do the minimum because the general economic situation, both for the private and for the public sector, doesn't allow to do more. Building a worst-case scenario has the advantage to concentrate on the key elements that could help to take the right decisions to face tough times. The costs evaluation is performed for passenger's train services and freight's train services for each investment.

9.1 ASSUMPTIONS

The aim of this chapter is to fix all the input data and assumptions made to perform the following analysis.

9.1.1 Rolling stock

Currently, the usable Ethiopian fleet is composed by:

Table 12: Current Ethiopian fleet

Item	Qty/ Units
Freight Electric Locomotives	32
Passenger Electric Locomotives	3
Freight Wagons	1100
Passenger Coaches	32

This fleet was evaluated suitable for the following simulations and also for future scenarios. In the event of the need to purchase new locomotives, wagons and coaches, the prices are estimated for each type of vehicle. These prices are averages of current market prices of products.

Table 13: Rolling Stock unit cost

Vehicles Cost	[\$]
Locomotive	6 000 000
Passenger train coach	1 000 000
Freight train wagon	120 000

For each scenario is evaluated the quantity of spare parts necessities, based on the train-km. To insert this value in the operational cost the cost per 1000km is in the following table:

Table 14: Rolling stock spare parts unit cost

Spare parts Cost	[\$]/1000[km]
Locomotive	500
Coach	100
Wagon	30

In parametric way has been also possible to estimate the number of hours of maintenance for the rolling stock basing on the following table:

Table 15: Rolling stock Hours of maintenance

Hours of maintenance	[h]/1000[km]
Locomotive	10
Coach	1.5
Wagon	1.5

The following table shows some characteristics of the freight train and the passenger train. Specifically, an estimated average energy consumption, average travel speed, capacity, and the estimated kilometers each train must travel daily.

Table 16: Rolling stock consumption and capacity

Train characteristic	Energy consumption [kWh/train*km]	Average Operating speed [km/h]	Train run [km]	Capacity [Ton / Seats]
Freight train	89	50	700	1 600
Passenger train	15	100	1400	500

Based on the traffic flows and the quantity of goods to be carried it is assumed that the train composition is as follows:

Table 17: Train Composition

Train Composition	Freight train	Passenger train
Locomotive	1	1
Coach	-	7
Wagon	40	-

9.1.2 Unit Costs

The evaluation of the costs developed in this document started from the unit costs according to the Ethiopian Railway Job Grading and Salary Structure, as reported in the following table:

Table 18: Crew Yearly Cost

Annual Salary	[\$ /year]
Driver	1938
Train Chief/Conductor	1 100
Rolling stock maintenance worker	1190

Has been assumed that the following staff will be on board of the trains:

Table 19: Crew Composition

	Passenger Trains Number	Freight Trains Number
Driver	1	1
Train Chief/Conductor	5	1

Traffic management personnel cost takes into account the personnel present in the various infrastructure sections (stations, workstations, level crossings, etc). In this first phase this value has been estimated as 872 \$/km. The administrative personnel cost value is approximately the 20% of all the personnel costs.

The price for energy is estimated 0.06 \$/kWh.

Revenues has been calculated basing on average international benchmark best practice and the expected tariff is reported in the table below

Table 20 Railway Estimated Revenues

	Revenues	
Freight	0.05	\$/ton*km
Passenger	0.02	\$/pax*km

Investment cost for Rolling Stock for Addis Abeba – Djibouti corridor has considered the rolling stock currently available and in particular:

9.1.3 Infrastructure Investment

In terms of rail lines, we could set up 3 different levels of service based on the infrastructure configuration:

- **SINGLE TRACK** with Crossing points every 50 km with capacity 20 trains/day

- **SINGLE TRACK** with Crossing Points every 25 km with capacity 35 trains/day
- **DOUBLE TRACK** with capacity 150 trains/day

A different investment cost was assumed based on the level of service needed for each scenario and time horizon. The investment per km for each configuration was estimated as:

- SINGLE TRACK 5 million \$/km
- SINGLE TRACK 6 million \$/km
- DOUBLE TRACK 9 million \$/km

The following table summarizes the results:

Table 21: Railway Infrastructure investment by scenario

Line	1 - Limits-to-Growth Scenario			2 - Next-Generation Scenario			3 - Go-Ahead Scenario		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Addis - Djibouti	1.028	0	0	1.028	0	0	1.028	0	0
Awash - Kombolcha – Haragaria	358	0	0	7	351	0	7	351	0
Mekele – Haragaba	638	198	0	638	198	0	638	198	0
Mekelle - Assab Port Railway	0	1.567	313	0	1.567	313	0	1.567	313
Weldia - Wereta - Matema (Sudan Corridor)	0	0	3.084	0	0	3.084	0	0	3.084
Wereta- Finote Selam	0	0	0	0	0	1.296	0	0	1.296
Mojo - Hawassa	0	0	0	0	995	199	0	995	199
Hawassa - Woo - Moyle	0	0	0	0	0	4.232	0	4.232	0
Sebeta-Jimma-Bedele - Booma South Sudan Border	0	0	0	0	0	4.834	0	0	4.834
Aisha - Berbera	0	934	0	0	934	0	0	934	187
Adama- Gasera	0	0	0	0	0	0	0	0	1.479
Ejaji- Kurmuk	0	0	0	0	0	0	0	0	2.760
Rejii - Holeta	0	0	0	0	0	511	0	0	511
TOTAL [\$]	2.023	2.699	3.397	1.672	4.045	14.469	1.672	8.277	14.663

9.1.4 Infrastructure maintenance costs

For the assessment of the infrastructure maintenance costs it has been assumed that the annual costs for the infrastructure maintenance is 3% of the investment costs. This value includes the periodic maintenance (about 1.8% of investment costs) and the annual current maintenance (about 1.2% of investment costs).

Table 22: Infrastructure maintenance cost by scenario

	1 - Limits-to-Growth Scenario			2 - Next-Generation Scenario			3 - Go-Ahead Scenario		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Addis - Djibouti	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520
Awash - Kombolcha – Haragaria	6.323.400	0	0	0	0	0	0	0	0
Mekele – Haragaba	2.962.664	3.555.197	3.555.197	2.962.664	3.555.197	3.555.197	2.962.664	3.555.197	3.555.197
Mekelle - Assab Port Railway	0	4.701.177	5.641.413	0	4.701.177	5.641.413	0	4.701.177	5.641.413
Weldia - Wereta – Matema (Sudan Corridor)	0	0	9.251.460	0	0	9.251.460	0	0	9.251.460
Wereta- Finote Selam	0	0	0	0	0	3.886.502	0	0	3.886.502
Mojo - Hawassa	0	0	0	0	2.984.232	3.581.078	0	2.984.232	3.581.078
Hawassa - Woo - Moyle	0	0	0	0	0	12.697.020	0	12.697.020	12.697.020
Sebeta-Jimma-Bedele – Booma South Sudan Border	0	0	0	0	0	14.501.972	0	0	14.501.972
Aisha - Berbera	0	2.803.182	2.803.182	0	2.803.182	2.803.182	0	2.803.182	3.363.818
Adama- Gasera	0	0	0	0	0	0	0	0	4.437.180
Ejaji- Kurmuk	0	0	0	0	0	0	0	0	18.082.520

9.2 CAPEX

Basing on the identified flows on the network and the assumptions before listed, the expected investments for infrastructure and rolling stock can be summarized in the following tables:

Table 23: Railway Infrastructure Investment by scenario

Line	1 - Limits-to-Growth Scenario			2 - Next-Generation Scenario			3 - Go-Ahead Scenario		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Addis - Djibouti	1.028	0	0	1.028	0	0	1.028	0	0
Awash - Kombolcha – Haragaria	358	0	0	7	351	0	7	351	0
Mekele – Haragaba	638	198	0	638	198	0	638	198	0
Mekelle - Assab Port Railway	0	1.567	313	0	1.567	313	0	1.567	313
Weldia - Wereta - Matema (Sudan Corridor)	0	0	3.084	0	0	3.084	0	0	3.084
Wereta- Finote Selam	0	0	0	0	0	1.296	0	0	1.296
Mojo - Hawassa	0	0	0	0	995	199	0	995	199
Hawassa - Woo - Moyle	0	0	0	0	0	4.232	0	4.232	0
Sebeta-Jimma-Bedele - Booma South Sudan Border	0	0	0	0	0	4.834	0	0	4.834
Aisha - Berbera	0	934	0	0	934	0	0	934	187
Adama- Gasera	0	0	0	0	0	0	0	0	1.479
Ejaji- Kurmuk	0	0	0	0	0	0	0	0	2.760
Rejii - Holeta	0	0	0	0	0	511	0	0	511
TOTAL [\$]	2.023	2.699	3.397	1.672	4.045	14.469	1.672	8.277	14.663

Table 24:rolling stock investment by scenario

	Rolling Stock Investment								
	1 - Limits-to-Growth Scenario			2 - Next-Generation Scenario			3 - Go-Ahead Scenario		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Addis - Djibouti	273	114	103	149	239	926	149	338	413
Awash - Kombolcha – Haragaria	60	39	0	53	53	152	53	7	382
Mekele – Haragaba	53	0	0	53	0	7	53	0	145
Mekelle - Assab Port Railway	0	53	0	0	99	145	0	53	237
Weldia - Wereta - Matema (Sudan Corridor)	0	0	14	0	0	80	0	0	264
Wereta- Finote Selam	0	0	0	0	0	67	0	0	113
Mojo - Hawassa	0	0	0	0	53	7	0	53	53
Hawassa - Woo - Moyle	0	0	0	0	0	80	0	60	257
Sebeta-Jimma-Bedele - Booma South Sudan Border	0	0	0	0	0	108	0	0	246
Aisha - Berbera	0	46	0	0	46	0	0	46	138
Adama- Gasera	0	0	0	0	0	0	0	0	67
Ejaji- Kurmuk	0	0	0	0	0	0	0	0	119
Rejii - Holeta	0	0	0	0	0	60	0	0	60
TOTAL [\$]	386	252	116	255	489	1.630	255	556	2.492

Table 25:Total Investment by scenario

	TOTAL INVESTMENT								
	1 - Limits-to-Growth Scenario			2 - Next-Generation Scenario			3 - Go-Ahead Scenario		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Addis - Djibouti	1301	114	103	1176	239	926	1176	338	413
Awash - Kombolcha – Haragaria	417	39	0	59	404	152	59	358	382
Mekele – Haragaba	690	198	0	690	198	7	690	198	145
Mekelle - Assab Port Railway	0	1620	313	0	1666	458	0	1620	550
Weldia - Wereta - Matema (Sudan Corridor)	0	0	3098	0	0	3164	0	0	3348
Wereta- Finote Selam	0	0	0	0	0	1362	0	0	1408
Mojo - Hawassa	0	0	0	0	1048	206	0	1048	252
Hawassa - Woo - Moyle	0	0	0	0	0	4313	0	4292	257
Sebeta-Jimma-Bedele-Booma South Sudan Border	0	0	0	0	0	4942	0	0	5080
Aisha - Berbera	0	980	0	0	980	0	0	980	325
Adama- Gasera	0	0	0	0	0	0	0	0	1546
Ejaji- Kurmuk	0	0	0	0	0	0	0	0	2879
Rejii - Holeta	0	0	0	0	0	571	0	0	571
TOTAL [\$]	2.409	2.951	3.514	1.926	4.534	16.099	1.926	8.833	17.155

9.3 OPEX

Basing on the identified flows on the network and the assumptions before listed, the expected yearly OPEX for each scenario is summarized in the following table:

Table 26: Yearly OPEX by scenario

Line	OPEX								
	1 - Limits-to-Growth Scenario			2 - Next-Generation Scenario			3 - Go-Ahead Scenario		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Addis - Djibouti	86.370.283	95.947.713	108.056.500	84.810.529	95.819.324	135.338.278	84.810.529	99.337.178	123.688.370
Awash - Kombolcha – Haragaria	8.184.270	9.553.196	9.485.237	6.728.787	9.902.620	15.927.666	6.745.128	8.899.023	21.006.759
Mekele – Haragaba	3.347.292	4.506.020	4.471.213	3.396.011	4.739.815	5.878.576	3.360.449	4.663.057	9.692.484
Mekelle - Assab Port Railway	0	6.465.231	7.561.072	0	6.712.337	13.502.891	0	6.168.547	13.564.919
Weldia - Wereta - Matema (Sudan Corridor)	0	0	11.065.701	0	0	14.819.353	0	0	19.695.358
Wereta- Finote Selam	0	0	0	0	0	6.105.153	0	0	8.274.487
Mojo - Hawassa	0	0	0	0	3.768.756	5.494.268	0	4.208.399	7.373.772
Hawassa - Woo - Moyle	0	0	0	0	0	17.669.502	0	16.255.733	24.627.505
Sebeta-Jimma-Bedele - Booma South Sudan Border	0	0	0	0	0	22.597.270	0	0	27.295.300
Aisha - Berbera	0	3.669.101	3.669.101	0	3.657.361	4.283.072	0	3.823.861	8.389.580
Adama- Gasera	0	0	0	0	0	0	0	0	6.985.139
Ejaji- Kurmuk	0	0	0	0	0	0	0	0	23.798.054
Rejii - Holeta	0	0	0	0	0	19.906.788	0	0	20.851.293
TOTAL [\$ /Year]	97.901.845	120.141.261	144.308.825	94.935.327	124.600.213	261.522.817	94.916.106	143.355.798	315.243.022

For the details about the performed calculation please refer to the following paragraphs.

9.3.1 Sebete - Dewale

Table 27: Sebete Dewale Cost Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	195	219	341	193	238	381	193	256	377
Infrastructure Investments [M\$]	1.028	0	0	1.028	0	0	1.028	0	0
Daily Pax*km	21.122.718	27.139.624	35.824.765	22.701.853	27.105.196	39.521.646	22.701.853	27.589.464	39.098.188
Daily Pax train*km	42.245	54.279	71.650	45.404	54.210	79.043	45.404	55.179	78.196
Daily Ton*km	26.710.398	27.542.921	27.542.921	24.076.032	27.486.619	43.040.489	24.076.032	29.477.560	35.294.700
Daily Freight train*km	16.694	17.214	17.214	15.048	17.179	26.900	15.048	18.423	22.059
Number of Passenger Locomotives	37	47	62	39	47	68	39	48	68
Number of Coaches	259	329	434	273	329	476	273	336	476
Number of Freight Locomotives	29	30	30	26	30	47	26	32	38
Number of Wagons	1160	1200	1200	1040	1200	1880	1040	1280	1520
Rolling Stock Investments [M\$]	273	114	103	149	239	926	149	338	413
TOTAL INVESTMENT COSTS [M\$]	1.301	114	103	1.176	239	926	1.176	338	413
Pax locos spare parts [M\$/year]	6,8	8,7	11,5	7,3	8,7	12,6	7,3	8,8	12,5
Freight locos spare parts [M\$/year]	2,7	2,8	2,8	2,4	2,7	4,3	2,4	2,9	3,5
Coaches spare parts [M\$/year]	9,5	12,2	16,0	10,2	12,1	17,7	10,2	12,4	17,5
Wagons spare parts [M\$/year]	6,4	6,6	6,6	5,8	6,6	10,3	5,8	7,1	8,5
Total Spare parts [M\$/year]	25,3	30,2	36,9	25,6	30,2	45,0	25,6	31,2	42,0
Pax locos maintenance [h/year]	135.185,4	173.693,6	229.278,5	145.291,9	173.473,3	252.938,5	145.291,9	176.572,6	250.228,4
Freight locos maintenance [h/year]	53.420,8	55.085,8	55.085,8	48.152,1	54.973,2	86.081,0	48.152,1	58.955,1	70.589,4
Coaches maintenance [h/year]	141.944,7	182.378,3	240.742,4	152.556,5	182.146,9	265.585,5	152.556,5	185.401,2	262.739,8
Wagons maintenance [h/year]	320.524,8	330.515,1	330.515,1	288.912,4	329.839,4	516.485,9	288.912,4	353.730,7	423.536,4
Total maintenance [h/year]	651.076	741.673	855.622	634.913	740.433	1.121.091	634.913	774.660	1.007.094
Total RSS Staff	391	446	514	382	445	674	382	466	605
Total RS staff maintenance cost [€/year]	280.046	319.014	368.027	273.094	318.481	482.213	273.094	333.203	433.180
Total rolling stock maintenance cost [\$ /year]	25.583.829	30.526.839	37.246.040	25.893.968	30.480.722	45.468.603	25.893.968	31.544.282	42.460.786
Number of Pax Driver	130	167	220	140	167	243	140	170	241
Number of Freight Driver	103	106	106	93	106	166	93	113	136
Pax Train chief/conductor	464	596	787	499	596	869	499	606	859
Freight Train Chief	73	76	76	66	76	118	66	81	97
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	1.044.486	1.270.947	1.585.232	1.074.001	1.269.111	1.881.542	1.074.001	1.307.515	1.784.984
Pax Energy Consumption [kWh/year]	202.778.094	260.540.388	343.917.744	217.937.793	260.209.880	379.407.802	217.937.793	264.858.852	375.342.609
Freight Energy Consumption [kWh/year]	475.445.081	490.263.998	490.263.998	428.553.363	489.261.810	766.120.702	428.553.363	524.700.576	628.245.657
Total energy consumption cost [\$]	40.693.391	45.048.263	50.050.905	38.789.469	44.968.301	68.731.710	38.789.469	47.373.566	60.215.296
Traffic Management Kilometric Cost [€/km*year]	872	872	872	872	872	872	872	872	872
TRAFFIC MANAGEMENT PERSONEL COST[\$ /year]	584.293	584.293	584.293	584.293	584.293	584.293	584.293	584.293	584.293
ADMINISTRATIVE PERSONEL COST [\$ /year]	381.765	434.851	507.510	386.277	434.377	589.610	386.277	445.002	560.491
INFRASTRUCTURE MAINTENANCE COST [€/year]	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520	18.082.520
OPERATIONAL COST [\$]	86.370.283	95.947.713	108.056.500	84.810.529	95.819.324	135.338.278	84.810.529	99.337.178	123.688.370

9.3.2 Awash – Kombolcha

Table 28: Awash Kombolcha Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	5	6	9	4	7	23	4	6	31
Infrastructure Investments [M\$]	358	0	0	7	351	0	7	351	0
Daily Pax*km	728.386	518.634	469.890	473.644	738.484	2.071.342	486.488	762.039	2.067.162
Daily Pax train*km	1.457	1.037	940	947	1.477	4.143	973	1.524	4.134
Daily Ton*km	334.478	1.498.050	1.498.050	301.966	1.528.103	4.446.403	300.868	802.211	8.007.743
Daily Freight train*km	209	936	936	189	955	2.779	188	501	5.005
Number of Passenger Locomotives	2	1	1	1	2	4	1	2	4
Number of Coaches	14	7	7	7	14	28	7	14	28
Number of Freight Locomotives	1	2	2	1	2	5	1	1	9
Number of Wagons	40	80	80	40	80	200	40	40	360
Rolling Stock Investments [M\$]	60	39	0	53	53	152	53	7	382
TOTAL INVESTMENT COSTS [M\$]	417	39	0	59	404	152	59	358	382
Pax locos spare parts [M\$/year]	0,2	0,2	0,2	0,2	0,2	0,7	0,2	0,2	0,7
Freight locos spare parts [M\$/year]	0,0	0,1	0,1	0,0	0,2	0,4	0,0	0,1	0,8
Coaches spare parts [M\$/year]	0,3	0,2	0,2	0,2	0,3	0,9	0,2	0,3	0,9
Wagons spare parts [M\$/year]	0,1	0,4	0,4	0,1	0,4	1,1	0,1	0,2	1,9
Total Spare parts [M\$/year]	0,7	0,9	0,9	0,5	1,1	3,1	0,5	0,9	4,3
Pax locos maintenance [h/year]	4.661,7	3.319,3	3.007,3	3.031,3	4.726,3	13.256,6	3.113,5	4.877,0	13.229,8
Freight locos maintenance [h/year]	669,0	2.996,1	2.996,1	603,9	3.056,2	8.892,8	601,7	1.604,4	16.015,5
Coaches maintenance [h/year]	4.894,8	3.485,2	3.157,7	3.182,9	4.962,6	13.919,4	3.269,2	5.120,9	13.891,3
Wagons maintenance [h/year]	4.013,7	17.976,6	17.976,6	3.623,6	18.337,2	53.356,8	3.610,4	9.626,5	96.092,9
Total maintenance [h/year]	14.239	27.777	27.138	10.442	31.082	89.426	10.595	21.229	139.230
Total RSS Staff	9	17	16	6	19	54	6	13	84
Total RS staff maintenance cost [€/year]	6.125	11.948	11.673	4.491	13.369	38.464	4.557	9.131	59.887
Total rolling stock maintenance cost [\$ /year]	679.248	919.595	881.885	470.918	1.100.080	3.141.032	480.475	867.129	4.370.099
Number of Pax Driver	4	3	3	3	5	13	3	5	13
Number of Freight Driver	1	6	6	1	6	17	1	3	31
Pax Train chief/conductor	16	11	10	10	16	46	11	17	45
Freight Train Chief	1	4	4	1	4	12	1	2	22
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	29.866	34.479	32.715	20.306	42.749	121.587	20.760	35.989	158.785
Pax Energy Consumption [kWh/year]	6.992.504	4.978.882	4.510.940	4.546.979	7.089.449	19.884.881	4.670.285	7.315.570	19.844.753
Freight Energy Consumption [kWh/year]	5.953.712	26.665.297	26.665.297	5.374.989	27.200.238	79.145.976	5.355.449	14.279.360	142.537.821
Total energy consumption cost [\$]	776.773	1.898.651	1.870.574	595.318	2.057.381	5.941.851	601.544	1.295.696	9.742.954
Traffic Management Kilometric Cost [€/km*year]	872	872	872	872	872	872	872	872	872
TRAFFIC MANAGEMENT PERSONEL COST[\$ /year]	306.488	306.488	306.488	306.488	306.488	306.488	306.488	306.488	306.488
ADMINISTRATIVE PERSONEL COST [\$ /year]	68.496	70.583	70.175	66.257	72.521	93.308	66.361	70.322	105.032
INFRASTRUCTURE MAINTENANCE COST [€/year]	6.323.400	6.323.400	6.323.400	5.269.500	6.323.400	6.323.400	5.269.500	6.323.400	6.323.400
OPERATIONAL COST [\$]	8.184.270	9.553.196	9.485.237	6.728.787	9.902.620	15.927.666	6.745.128	8.899.023	21.006.759

9.3.3 Mekele – Haragebeya

Table 29: Mekele Haragebeya Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	4	5	8	4	7	19	3	6	26
Infrastructure Investments [M\$]	638	198	0	638	198	0	638	198	0
Daily Pax*km	82.411	282.157	257.192	101.544	418.689	634.763	88.259	416.994	1.133.850
Daily Pax train*km	165	564	514	203	837	1.270	177	834	2.268
Daily Ton*km	44.090	245.593	245.593	59.528	276.019	862.589	47.594	223.916	3.046.410
Daily Freight train*km	28	153	153	37	173	539	30	140	1.904
Number of Passenger Locomotives	1	1	1	1	1	2	1	1	2
Number of Coaches	7	7	7	7	7	14	7	7	14
Number of Freight Locomotives	1	1	1	1	1	1	1	1	4
Number of Wagons	40	40	40	40	40	40	40	40	160
Rolling Stock Investments [M\$]	53	0	0	53	0	7	53	0	145
TOTAL INVESTMENT COSTS [M\$]	690	198	0	690	198	7	690	198	145
Pax locos spare parts [M\$/year]	0,0	0,1	0,1	0,0	0,1	0,2	0,0	0,1	0,4
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,3
Coaches spare parts [M\$/year]	0,0	0,1	0,1	0,0	0,2	0,3	0,0	0,2	0,5
Wagons spare parts [M\$/year]	0,0	0,1	0,1	0,0	0,1	0,2	0,0	0,1	0,7
Total Spare parts [M\$/year]	0,1	0,3	0,3	0,1	0,4	0,8	0,1	0,4	1,9
Pax locos maintenance [h/year]	527,4	1.805,8	1.646,0	649,9	2.679,6	4.062,5	564,9	2.668,8	7.256,6
Freight locos maintenance [h/year]	88,2	491,2	491,2	119,1	552,0	1.725,2	95,2	447,8	6.092,8
Coaches' maintenance [h/year]	553,8	1.896,1	1.728,3	682,4	2.813,6	4.265,6	593,1	2.802,2	7.619,5
Wagons maintenance [h/year]	529,1	2.947,1	2.947,1	714,3	3.312,2	10.351,1	571,1	2.687,0	36.556,9
Total maintenance [h/year]	1.698	7.140	6.813	2.166	9.357	20.404	1.824	8.606	57.526
Total RSS Staff	1	4	4	1	6	12	1	5	35
Total RS staff maintenance cost [€/year]	731	3.071	2.930	932	4.025	8.776	785	3.702	24.743
Total rolling stock maintenance cost [\$ /year]	79.013	303.270	283.955	99.157	419.425	789.555	84.750	400.084	1.931.320
Number of Pax Driver	1	2	2	1	3	4	1	3	7
Number of Freight Driver	0	1	1	0	1	3	0	1	12
Pax Train chief/conductor	2	6	6	2	9	14	2	9	25
Freight Train Chief	0	1	1	0	1	2	0	1	8
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	3.445	12.786	11.883	4.299	18.046	32.016	3.693	17.438	72.980
Pax Energy Consumption [kWh/year]	791.143	2.708.712	2.469.042	974.825	4.019.418	6.093.726	847.290	4.003.138	10.884.961
Freight Energy Consumption [kWh/year]	784.796	4.371.563	4.371.563	1.059.598	4.913.144	15.354.092	847.169	3.985.710	54.226.093
Total energy consumption cost [\$]	94.556	424.816	410.436	122.065	535.954	1.286.869	101.667	479.331	3.906.663
Traffic Management Kilometric Cost [€/km*year]	872	872	872	872	872	872	872	872	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	172.316	172.316	172.316	172.316	172.316	172.316	172.316	172.316	172.316
ADMINISTRATIVE PERSONEL COST [\$ /year]	35.298	37.635	37.426	35.509	38.877	42.622	35.359	38.691	54.008
INFRASTRUCTURE MAINTENANCE COST [€/year]	2.962.664	3.555.197	3.555.197	2.962.664	3.555.197	3.555.197	2.962.664	3.555.197	3.555.197
OPERATIONAL COST [\$]	3.347.292	4.506.020	4.471.213	3.396.011	4.739.815	5.878.576	3.360.449	4.663.057	9.692.484

9.3.4 Mekele - Assab Port Railway

Table 30:Mekele Assab Cost Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	3	7	0	5	23	0	3	20
Infrastructure Investments [M\$]	0	1.567	313	0	1.567	313	0	1.567	313
Daily Pax*km	0	99.487	211.096	0	193.958	681.500	0	147.419	646.944
Daily Pax train*km	0	199	422	0	388	1.363	0	295	1.294
Daily Ton*km	0	908.544	908.544	0	989.364	4.610.704	0	653.951	4.687.889
Daily Freight train*km	0	568	568	0	618	2.882	0	409	2.930
Number of Passenger Locomotives	0	1	1	0	1	2	0	1	2
Number of Coaches	0	7	7	0	7	14	0	7	14
Number of Freight Locomotives	0	1	1	0	2	5	0	1	6
Number of Wagons	0	40	40	0	80	200	0	40	240
Rolling Stock Investments [M\$]	0	53	0	0	99	145	0	53	237
TOTAL INVESTMENT COSTS [M\$]	0	1.620	313	0	1.666	458	0	1.620	550
Pax locos spare parts [M\$/year]	0,0	0,0	0,1	0,0	0,1	0,2	0,0	0,0	0,2
Freight locos spare parts [M\$/year]	0,0	0,1	0,1	0,0	0,1	0,5	0,0	0,1	0,5
Coaches' spare parts [M\$/year]	0,0	0,0	0,1	0,0	0,1	0,3	0,0	0,1	0,3
Wagons spare parts [M\$/year]	0,0	0,2	0,2	0,0	0,2	1,1	0,0	0,2	1,1
Total Spare parts [M\$/year]	0,0	0,4	0,5	0,0	0,5	2,1	0,0	0,3	2,1
Pax locos maintenance [h/year]	0,0	636,7	1.351,0	0,0	1.241,3	4.361,6	0,0	943,5	4.140,4
Freight locos maintenance [h/year]	0,0	1.817,1	1.817,1	0,0	1.978,7	9.221,4	0,0	1.307,9	9.375,8
Coaches' maintenance [h/year]	0,0	668,6	1.418,6	0,0	1.303,4	4.579,7	0,0	990,7	4.347,5
Wagons maintenance [h/year]	0,0	10.902,5	10.902,5	0,0	11.872,4	55.328,4	0,0	7.847,4	56.254,7
Total maintenance [h/year]	0	14.025	15.489	0	16.396	73.491	0	11.089	74.118
Total RSS Staff	0	8	9	0	10	44	0	7	45
Total RS staff maintenance cost [€/year]	0	6.033	6.662	0	7.052	31.611	0	4.770	31.880
Total rolling stock maintenance cost [\$ /year]	0	391.344	477.689	0	492.396	2.122.642	0	340.331	2.122.616
Number of Pax Driver	0	1	1	0	1	4	0	1	4
Number of Freight Driver	0	3	3	0	4	18	0	3	18
Pax Train chief/conductor	0	2	5	0	4	15	0	3	14
Freight Train Chief	0	2	2	0	3	13	0	2	13
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	13.129	17.167	0	17.395	73.016	0	12.193	72.575
Pax Energy Consumption [kWh/year]	0	955.075	2.026.526	0	1.861.996	6.542.401	0	1.415.224	6.210.666
Freight Energy Consumption [kWh/year]	0	16.172.088	16.172.088	0	17.610.678	82.070.524	0	11.640.330	83.444.416
Total energy consumption cost [\$]	0	1.027.630	1.091.917	0	1.168.360	5.316.775	0	783.333	5.379.305
Traffic Management Kilometric Cost [€/km*year]	0	872	872	0	872	872	0	872	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	0	273.433	273.433	0	273.433	273.433	0	273.433	273.433
ADMINISTRATIVE PERSONEL COST [\$ /year]	0	58.519	59.453	0	59.576	75.612	0	58.079	75.578
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	4.701.177	5.641.413	0	4.701.177	5.641.413	0	4.701.177	5.641.413
OPERATIONAL COST [\$]	0	6.465.231	7.561.072	0	6.712.337	13.502.891	0	6.168.547	13.564.919

9.3.5 Weldia - Wereta - Matema (Sudan Corridor)

Table 31: Sudan Corridor Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	7	0	0	17	0	0	22
Infrastructure Investments [M\$]	0	0	3.084	0	0	3.084	0	0	3.084
Daily Pax*km	0	0	915.332	0	0	2.719.063	0	0	2.892.106
Daily Pax train*km	0	0	1.831	0	0	5.438	0	0	5.784
Daily Ton*km	0	0	0	0	0	867.691	0	0	4.113.742
Daily Freight train*km	0	0	0	0	0	542	0	0	2.571
Number of Passenger Locomotives	0	0	2	0	0	5	0	0	5
Number of Coaches	0	0	14	0	0	35	0	0	35
Number of Freight Locomotives	0	0	0	0	0	1	0	0	5
Number of Wagons	0	0	0	0	0	40	0	0	200
Rolling Stock Investments [M\$]	0	0	14	0	0	80	0	0	264
TOTAL INVESTMENT COSTS [M\$]	0	0	3.098	0	0	3.164	0	0	3.348
Pax locos spare parts [M\$/year]	0,0	0,0	0,3	0,0	0,0	0,9	0,0	0,0	0,9
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,4
Coaches' spare parts [M\$/year]	0,0	0,0	0,4	0,0	0,0	1,2	0,0	0,0	1,3
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,2	0,0	0,0	1,0
Total Spare parts [M\$/year]	0,0	0,0	0,7	0,0	0,0	2,4	0,0	0,0	3,6
Pax locos maintenance [h/year]	0,0	0,0	5.858,1	0,0	0,0	17.402,0	0,0	0,0	18.509,5
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	1.735,4	0,0	0,0	8.227,5
Coaches' maintenance [h/year]	0,0	0,0	6.151,0	0,0	0,0	18.272,1	0,0	0,0	19.435,0
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	10.412,3	0,0	0,0	49.364,9
Total maintenance [h/year]	0	0	12.009	0	0	47.822	0	0	95.537
Total RSS Staff	0	0	7	0	0	29	0	0	57
Total RS staff maintenance cost [€/year]	0	0	5.165	0	0	20.569	0	0	41.093
Total rolling stock maintenance cost [\$/year]	0	0	708.140	0	0	2.403.824	0	0	3.660.903
Number of Pax Driver	0	0	6	0	0	17	0	0	18
Number of Freight Driver	0	0	0	0	0	3	0	0	16
Pax Train chief/conductor	0	0	20	0	0	60	0	0	64
Freight Train Chief	0	0	0	0	0	2	0	0	11
Driver Salary [\$/year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$/year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	0	33.123	0	0	107.493	0	0	147.799
Pax Energy Consumption [kWh/year]	0	0	8.787.187	0	0	26.103.002	0	0	27.764.217
Freight Energy Consumption [kWh/year]	0	0	0	0	0	15.444.893	0	0	73.224.608
Total energy consumption cost [€]	0	0	527.231	0	0	2.492.874	0	0	6.059.330
Traffic Management Kilometric Cost [€/km*year]	0	0	872	0	0	872	0	0	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	0	0	448.408	0	0	448.408	0	0	448.408
ADMINISTRATIVE PERSONEL COST [\$/year]	0	0	97.339	0	0	115.294	0	0	127.460
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	9.251.460	0	0	9.251.460	0	0	9.251.460
OPERATIONAL COST [€]	0	0	11.065.701	0	0	14.819.353	0	0	19.695.358

9.3.7 Wereta – Finote Selam

Table 32: Wereta Finote Selam Costs

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	0	0	0	13	0	0	17
Infrastructure Investments [M\$]	0	0	0	0	0	1.296	0	0	1.296
Daily Pax*km	0	0	0	0	0	1.256.300	0	0	1.327.862
Daily Pax train*km	0	0	0	0	0	2.513	0	0	2.656
Daily Ton*km	0	0	0	0	0	168.841	0	0	1.618.306
Daily Freight train*km	0	0	0	0	0	106	0	0	1.011
Number of Passenger Locomotives	0	0	0	0	0	3	0	0	3
Number of Coaches	0	0	0	0	0	21	0	0	21
Number of Freight Locomotives	0	0	0	0	0	1	0	0	2
Number of Wagons	0	0	0	0	0	40	0	0	80
Rolling Stock Investments [M\$]	0	0	0	0	0	67	0	0	113
TOTAL INVESTMENT COSTS [M\$]	0	0	0	0	0	1.362	0	0	1.408
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,4
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,6	0,0	0,0	0,6
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4
Total Spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	1,0	0,0	0,0	1,6
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	8.040,3	0,0	0,0	8.498,3
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	337,7	0,0	0,0	3.236,6
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	8.442,3	0,0	0,0	8.923,2
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	2.026,1	0,0	0,0	19.419,7
Total maintenance [h/year]	0	0	0	0	0	18.846	0	0	40.078
Total RSS Staff	0	0	0	0	0	11	0	0	24
Total RS staff maintenance cost [€/year]	0	0	0	0	0	8.106	0	0	17.239
Total rolling stock maintenance cost [\$/year]	0	0	0	0	0	1.030.351	0	0	1.587.261
Number of Pax Driver	0	0	0	0	0	8	0	0	8
Number of Freight Driver	0	0	0	0	0	1	0	0	6
Pax Train chief/conductor	0	0	0	0	0	28	0	0	29
Freight Train Chief	0	0	0	0	0	0	0	0	4
Driver Salary [\$/year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$/year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	0	0	0	0	47.232	0	0	65.023
Pax Energy Consumption [kWh/year]	0	0	0	0	0	12.060.483	0	0	12.747.480
Freight Energy Consumption [kWh/year]	0	0	0	0	0	3.005.373	0	0	28.805.854
Total energy consumption cost [€]	0	0	0	0	0	903.951	0	0	2.493.200
Traffic Management Kilometric Cost [€/km*year]	0	0	0	0	0	872	0	0	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	0	0	0	0	0	188.374	0	0	188.374
ADMINISTRATIVE PERSONEL COST [\$/year]	0	0	0	0	0	48.743	0	0	54.127
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	0	0	0	3.886.502	0	0	3.886.502
OPERATIONAL COST [€]	0	0	0	0	0	6.105.153	0	0	8.274.487

9.3.9 Mojo – Hawassa

Table 33: Mojo Hawassa Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	0	0	4	12	0	5	17
Infrastructure Investments [M\$]	0	0	0	0	995	199	0	995	199
Daily Pax*km	0	0	0	0	381.653	1.072.275	0	382.646	1.073.911
Daily Pax train*km	0	0	0	0	763	2.145	0	765	2.148
Daily Ton*km	0	0	0	0	30.915	147.039	0	337.859	1.461.794
Daily Freight train*km	0	0	0	0	19	92	0	211	914
Number of Passenger Locomotives	0	0	0	0	1	2	0	1	2
Number of Coaches	0	0	0	0	7	14	0	7	14
Number of Freight Locomotives	0	0	0	0	1	1	0	1	2
Number of Wagons	0	0	0	0	40	40	0	40	80
Rolling Stock Investments [M\$]	0	0	0	0	53	7	0	53	53
TOTAL INVESTMENT COSTS [M\$]	0	0	0	0	1.048	206	0	1.048	252
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,1	0,3	0,0	0,1	0,3
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,2	0,5	0,0	0,2	0,5
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,4
Total Spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,3	0,9	0,0	0,4	1,3
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	2.442,6	6.862,6	0,0	2.448,9	6.873,0
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	61,8	294,1	0,0	675,7	2.923,6
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	2.564,7	7.205,7	0,0	2.571,4	7.216,7
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	371,0	1.764,5	0,0	4.054,3	17.541,5
Total maintenance [h/year]	0	0	0	0	5.440	16.127	0	9.750	34.555
Total RSS Staff	0	0	0	0	3	10	0	6	21
Total RS staff maintenance cost [€/year]	0	0	0	0	2.340	6.937	0	4.194	14.863
Total rolling stock maintenance cost [\$ /year]	0	0	0	0	305.960	880.437	0	412.938	1.336.637
Number of Pax Driver	0	0	0	0	2	7	0	2	7
Number of Freight Driver	0	0	0	0	0	1	0	1	6
Pax Train chief/conductor	0	0	0	0	8	24	0	8	24
Freight Train Chief	0	0	0	0	0	0	0	1	4
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	0	0	0	14.135	40.344	0	17.390	54.192
Pax Energy Consumption [kWh/year]	0	0	0	0	3.663.867	10.293.839	0	3.673.399	10.309.549
Freight Energy Consumption [kWh/year]	0	0	0	0	550.281	2.617.293	0	6.013.891	26.019.935
Total energy consumption cost [\$]	0	0	0	0	252.849	774.668	0	581.237	2.179.769
Traffic Management Kilometric Cost [€/km*year]	0	0	0	0	872	872	0	872	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	0	0	0	0	173.571	173.571	0	173.571	173.571
ADMINISTRATIVE PERSONEL COST [\$ /year]	0	0	0	0	38.009	44.170	0	39.031	48.525
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	0	0	2.984.232	3.581.078	0	2.984.232	3.581.078
OPERATIONAL COST [\$]	0	0	0	0	3.768.756	5.494.268	0	4.208.399	7.373.772

9.3.11 Hawassa - Woo – Moyle

Table 34 Hawassa – Moyale Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	0	0	0	12	0	5	17
Infrastructure Investments [M\$]	0	0	0	0	0	4.232	0	4.232	0
Daily Pax*km	0	0	0	0	0	2.805.617	0	1.150.075	3.077.349
Daily Pax train*km	0	0	0	0	0	5.611	0	2.300	6.155
Daily Ton*km	0	0	0	0	0	225.807	0	852.207	4.833.668
Daily Freight train*km	0	0	0	0	0	141	0	533	3.021
Number of Passenger Locomotives	0	0	0	0	0	5	0	2	6
Number of Coaches	0	0	0	0	0	35	0	14	42
Number of Freight Locomotives	0	0	0	0	0	1	0	1	6
Number of Wagons	0	0	0	0	0	40	0	40	240
Rolling Stock Investments [M\$]	0	0	0	0	0	80	0	60	257
TOTAL INVESTMENT COSTS [M\$]	0	0	0	0	0	4.313	0	4.292	257
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,9	0,0	0,4	1,0
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,5
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	1,3	0,0	0,5	1,4
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,2	1,2
Total Spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	2,2	0,0	1,2	4,0
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	17.956,0	0,0	7.360,5	19.695,0
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	451,6	0,0	1.704,4	9.667,3
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	18.853,7	0,0	7.728,5	20.679,8
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	2.709,7	0,0	10.226,5	58.004,0
Total maintenance [h/year]	0	0	0	0	0	39.971	0	27.020	108.046
Total RSS Staff	0	0	0	0	0	24	0	16	65
Total RS staff maintenance cost [€/year]	0	0	0	0	0	17.193	0	11.622	46.474
Total rolling stock maintenance cost [\$/year]	0	0	0	0	0	2.248.681	0	1.184.630	4.053.325
Number of Pax Driver	0	0	0	0	0	17	0	7	19
Number of Freight Driver	0	0	0	0	0	1	0	3	19
Pax Train chief/conductor	0	0	0	0	0	62	0	25	68
Freight Train Chief	0	0	0	0	0	1	0	2	13
Driver Salary [\$/year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$/year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$/year]	0	0	0	0	0	103.894	0	50.555	162.052
Pax Energy Consumption [kWh/year]	0	0	0	0	0	26.933.928	0	11.040.719	29.542.553
Freight Energy Consumption [kWh/year]	0	0	0	0	0	4.019.371	0	15.169.292	86.039.283
Total energy consumption cost [\$/year]	0	0	0	0	0	1.857.198	0	1.572.601	6.934.910
Traffic Management Kilometric Cost [€/km*year]	0	0	0	0	0	872	0	872	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	0	0	0	0	0	615.410	0	615.410	615.410
ADMINISTRATIVE PERSONEL COST [\$/year]	0	0	0	0	0	147.299	0	135.517	164.787
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	0	0	0	12.697.020	0	12.697.020	12.697.020
OPERATIONAL COST [\$/year]	0	0	0	0	0	17.669.502	0	16.255.733	24.627.505

9.3.13 Sebete-Jimma-Bede - Booma South Sudan Border

Table 35: Sebete Bedele Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	0	0	0	27	0	0	33
Infrastructure Investments [M\$]	0	0	0	0	0	4.834	0	0	4.834
Daily Pax*km	0	0	0	0	0	4.802.610	0	0	4.994.097
Daily Pax train*km	0	0	0	0	0	9.605	0	0	9.988
Daily Ton*km	0	0	0	0	0	389.440	0	0	3.492.833
Daily Freight train*km	0	0	0	0	0	243	0	0	2.183
Number of Passenger Locomotives	0	0	0	0	0	9	0	0	9
Number of Coaches	0	0	0	0	0	63	0	0	63
Number of Freight Locomotives	0	0	0	0	0	1	0	0	4
Number of Wagons	0	0	0	0	0	40	0	0	160
Rolling Stock Investments [M\$]	0	0	0	0	0	108	0	0	246
TOTAL INVESTMENT COSTS [M\$]	0	0	0	0	0	4.942	0	0	5.080
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	1,5	0,0	0,0	1,6
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,3
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	2,2	0,0	0,0	2,2
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0	0,8
Total Spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	3,8	0,0	0,0	5,0
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	30.736,7	0,0	0,0	31.962,2
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	778,9	0,0	0,0	6.985,7
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	32.273,5	0,0	0,0	33.560,3
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	4.673,3	0,0	0,0	41.914,0
Total maintenance [h/year]	0	0	0	0	0	68.462	0	0	114.422
Total RSS Staff	0	0	0	0	0	41	0	0	69
Total RS staff maintenance cost [€/year]	0	0	0	0	0	29.448	0	0	49.216
Total rolling stock maintenance cost [\$/year]	0	0	0	0	0	3.850.262	0	0	5.072.246
Number of Pax Driver	0	0	0	0	0	30	0	0	31
Number of Freight Driver	0	0	0	0	0	1	0	0	13
Pax Train chief/conductor	0	0	0	0	0	106	0	0	110
Freight Train Chief	0	0	0	0	0	1	0	0	10
Driver Salary [\$/year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$/year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$/]	0	0	0	0	0	177.874	0	0	217.350
Pax Energy Consumption [kWh/year]	0	0	0	0	0	46.105.057	0	0	47.943.334
Freight Energy Consumption [kWh/year]	0	0	0	0	0	6.932.027	0	0	62.172.419
Total energy consumption cost [\$/]	0	0	0	0	0	3.182.225	0	0	6.606.945
Traffic Management Kilometric Cost [€/km*year]	0	0	0	0	0	872	0	0	872
TRAFFIC MANAGEMENT PERSONEL COST [\$/year]	0	0	0	0	0	702.894	0	0	702.894
ADMINISTRATIVE PERSONEL COST [\$/year]	0	0	0	0	0	182.043	0	0	193.892
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	0	0	0	14.501.972	0	0	14.501.972
OPERATIONAL COST [\$/]	0	0	0	0	0	22.597.270	0	0	27.295.300

9.3.15 Aisha – Berbera

Table 36:Aisha Berbera Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	2	5	0	2	3	0	2	11
Infrastructure Investments [M\$]	0	934	0	0	934	0	0	934	187
Daily Pax*km	0	0	0	0	0	0	0	0	0
Daily Pax train*km	0	0	0	0	0	0	0	0	0
Daily Ton*km	0	469.439	469.439	0	461.217	899.448	0	577.829	3.382.880
Daily Freight train*km	0	293	293	0	288	562	0	361	2.114
Number of Passenger Locomotives	0	0	0	0	0	0	0	0	0
Number of Coaches	0	0	0	0	0	0	0	0	0
Number of Freight Locomotives	0	1	1	0	1	1	0	1	4
Number of Wagons	0	40	40	0	40	40	0	40	160
Rolling Stock Investments [M\$]	0	46	0	0	46	0	0	46	138
TOTAL INVESTMENT COSTS [M\$]	0	980	0	0	980	0	0	980	325
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,1	0,3
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wagons spare parts [M\$/year]	0,0	0,1	0,1	0,0	0,1	0,2	0,0	0,1	0,8
Total Spare parts [M\$/year]	0,0	0,2	0,2	0,0	0,2	0,3	0,0	0,2	1,2
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Freight locos maintenance [h/year]	0,0	938,9	938,9	0,0	922,4	1.798,9	0,0	1.155,7	6.765,8
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Wagons maintenance [h/year]	0,0	5.633,3	5.633,3	0,0	5.534,6	10.793,4	0,0	6.934,0	40.594,6
Total maintenance [h/year]	0	6.572	6.572	0	6.457	12.592	0	8.090	47.360
Total RSS Staff	0	4	4	0	4	8	0	5	28
Total RS staff maintenance cost [€/year]	0	2.827	2.827	0	2.777	5.416	0	3.480	20.371
Total rolling stock maintenance cost [\$ /year]	0	162.436	162.436	0	159.591	311.228	0	199.941	1.170.550
Number of Pax Driver	0	0	0	0	0	0	0	0	0
Number of Freight Driver	0	2	2	0	2	3	0	2	13
Pax Train chief/conductor	0	0	0	0	0	0	0	0	0
Freight Train Chief	0	1	1	0	1	2	0	2	9
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	4.923	4.923	0	4.837	9.433	0	6.060	35.478
Pax Energy Consumption [kWh/year]	0	0	0	0	0	0	0	0	0
Freight Energy Consumption [kWh/year]	0	8.356.023	8.356.023	0	8.209.660	16.010.167	0	10.285.360	60.215.259
Total energy consumption cost [\$]	0	501.361	501.361	0	492.580	960.610	0	617.122	3.612.916
Traffic Management Kilometric Cost [€/km*year]	0	872	872	0	872	872	0	872	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	0	163.040	163.040	0	163.040	163.040	0	163.040	163.040
ADMINISTRATIVE PERSONEL COST [\$ /year]	0	34.158	34.158	0	34.131	35.578	0	34.516	43.778
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	2.803.182	2.803.182	0	2.803.182	2.803.182	0	2.803.182	3.363.818
OPERATIONAL COST [\$]	0	3.669.101	3.669.101	0	3.657.361	4.283.072	0	3.823.861	8.389.580

9.3.16 Adama- Gasera

Table 37: Adama Gasera Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	0	0	0	0	0	0	14
Infrastructure Investments [M\$]	0	0	0	0	0	0	0	0	1.479
Daily Pax*km	0	0	0	0	0	0	0	0	1.514.498
Daily Pax train*km	0	0	0	0	0	0	0	0	3.029
Daily Ton*km	0	0	0	0	0	0	0	0	124.929
Daily Freight train*km	0	0	0	0	0	0	0	0	78
Number of Passenger Locomotives	0	0	0	0	0	0	0	0	3
Number of Coaches	0	0	0	0	0	0	0	0	21
Number of Freight Locomotives	0	0	0	0	0	0	0	0	1
Number of Wagons	0	0	0	0	0	0	0	0	40
Rolling Stock Investments [M\$]	0	0	0	0	0	0	0	0	67
TOTAL INVESTMENT COSTS [M\$]	0	0	0	0	0	0	0	0	1.546
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,7
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total Spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1,2
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	9.692,8
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	249,9
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	10.177,4
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	1.499,1
Total maintenance [h/year]	0	0	0	0	0	0	0	0	21.619
Total RSS Staff	0	0	0	0	0	0	0	0	13
Total RS staff maintenance cost [€/year]	0	0	0	0	0	0	0	0	9.299
Total rolling stock maintenance cost [\$ /year]	0	0	0	0	0	0	0	0	1.214.909
Number of Pax Driver	0	0	0	0	0	0	0	0	9
Number of Freight Driver	0	0	0	0	0	0	0	0	0
Pax Train chief/conductor	0	0	0	0	0	0	0	0	33
Freight Train Chief	0	0	0	0	0	0	0	0	0
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	0	0	0	0	0	0	0	56.115
Pax Energy Consumption [kWh/year]	0	0	0	0	0	0	0	0	14.539.180
Freight Energy Consumption [kWh/year]	0	0	0	0	0	0	0	0	2.223.731
Total energy consumption cost [\$]	0	0	0	0	0	0	0	0	1.005.775
Traffic Management Kilometric Cost [€/km*year]	0	0	0	0	0	0	0	0	872
TRAFFIC MANAGEMENT PERSONEL COST[\$ /year]	0	0	0	0	0	0	0	0	215.065
ADMINISTRATIVE PERSONEL COST [\$ /year]	0	0	0	0	0	0	0	0	56.096
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	0	0	0	0	0	0	4.437.180
OPERATIONAL COST [\$]	0	0	0	0	0	0	0	0	6.985.139

9.3.17 Ejaji- Kurmuk

Table 38:Ejaji Kurmuk Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	0	0	0	0	0	0	14
Infrastructure Investments [M\$]	0	0	0	0	0	0	0	0	2.760
Daily Pax*km	0	0	0	0	0	0	0	0	1.997.487
Daily Pax train*km	0	0	0	0	0	0	0	0	3.995
Daily Ton*km	0	0	0	0	0	0	0	0	1.715.276
Daily Freight train*km	0	0	0	0	0	0	0	0	1.072
Number of Passenger Locomotives	0	0	0	0	0	0	0	0	4
Number of Coaches	0	0	0	0	0	0	0	0	28
Number of Freight Locomotives	0	0	0	0	0	0	0	0	2
Number of Wagons	0	0	0	0	0	0	0	0	80
Rolling Stock Investments [M\$]	0	0	0	0	0	0	0	0	119
TOTAL INVESTMENT COSTS [M\$]	0	0	0	0	0	0	0	0	2.879
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,6
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,9
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,4
Total Spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,1
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	12.783,9
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3.430,6
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	13.423,1
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	20.583,3
Total maintenance [h/year]	0	0	0	0	0	0	0	0	50.221
Total RSS Staff	0	0	0	0	0	0	0	0	30
Total RS staff maintenance cost [€/year]	0	0	0	0	0	0	0	0	21.601
Total rolling stock maintenance cost [\$ /year]	0	0	0	0	0	0	0	0	2.138.865
Number of Pax Driver	0	0	0	0	0	0	0	0	12
Number of Freight Driver	0	0	0	0	0	0	0	0	7
Pax Train chief/conductor	0	0	0	0	0	0	0	0	44
Freight Train Chief	0	0	0	0	0	0	0	0	5
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	0	0	0	0	0	0	0	90.271
Pax Energy Consumption [kWh/year]	0	0	0	0	0	0	0	0	19.175.879
Freight Energy Consumption [kWh/year]	0	0	0	0	0	0	0	0	30.531.906
Total energy consumption cost [\$]	0	0	0	0	0	0	0	0	2.982.467
Traffic Management Kilometric Cost [€/km*year]	0	0	0	0	0	0	0	0	872
TRAFFIC MANAGEMENT PERSONEL COST[\$/year]	0	0	0	0	0	0	0	0	401.296
ADMINISTRATIVE PERSONEL COST [\$]	0	0	0	0	0	0	0	0	102.634
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	0	0	0	0	0	0	18.082.520
OPERATIONAL COST [\$]	0	0	0	0	0	0	0	0	23.798.054

9.3.18 Rejii - Holeta

Table 39: Reji Holeta Costs Summary

	Limit to Growth			Next Generation 2025			Go Ahead		
	2025	2035	2050	2025	2035	2050	2025	2035	2050
Max services on the line	0	0	0	0	0	27	0	0	33
Infrastructure Investments [M\$]	0	0	0	0	0	511	0	0	511
Daily Pax*km	0	0	0	0	0	1.130.282	0	0	1.157.389
Daily Pax train*km	0	0	0	0	0	2.261	0	0	2.315
Daily Ton*km	0	0	0	0	0	111.494	0	0	746.532
Daily Freight train*km	0	0	0	0	0	70	0	0	467
Number of Passenger Locomotives	0	0	0	0	0	2	0	0	2
Number of Coaches	0	0	0	0	0	14	0	0	14
Number of Freight Locomotives	0	0	0	0	0	1	0	0	1
Number of Wagons	0	0	0	0	0	40	0	0	40
Rolling Stock Investments [M\$]	0	0	0	0	0	60	0	0	60
TOTAL INVESTMENT COSTS [M\$]	0	0	0	0	0	571	0	0	571
Pax locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,4	0,0	0,0	0,4
Freight locos spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,1
Coaches' spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,5	0,0	0,0	0,5
Wagons spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,2
Total Spare parts [M\$/year]	0,0	0,0	0,0	0,0	0,0	0,9	0,0	0,0	1,1
Pax locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	7.233,8	0,0	0,0	7.407,3
Freight locos maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	223,0	0,0	0,0	1.493,1
Coaches' maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	7.595,5	0,0	0,0	7.777,7
Wagons maintenance [h/year]	0,0	0,0	0,0	0,0	0,0	1.337,9	0,0	0,0	8.958,4
Total maintenance [h/year]	0	0	0	0	0	16.390	0	0	25.636
Total RSS Staff	0	0	0	0	0	10	0	0	15
Total RS staff maintenance cost [€/year]	0	0	0	0	0	7.050	0	0	11.027
Total rolling stock maintenance cost [\$ /year]	0	0	0	0	0	913.015	0	0	1.153.722
Number of Pax Driver	0	0	0	0	0	7	0	0	7
Number of Freight Driver	0	0	0	0	0	0	0	0	3
Pax Train chief/conductor	0	0	0	0	0	25	0	0	25
Freight Train Chief	0	0	0	0	0	0	0	0	2
Driver Salary [\$ /year]	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938	1.938
Train chief salary [\$ /year]	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Total on-board crew cost [\$]	0	0	0	0	0	42.070	0	0	49.711
Pax Energy Consumption [kWh/year]	0	0	0	0	0	10.850.711	0	0	11.110.932
Freight Energy Consumption [kWh/year]	0	0	0	0	0	1.984.592	0	0	13.288.268
Total energy consumption cost [\$]	0	0	0	0	0	770.118	0	0	1.463.952
Traffic Management Kilometric Cost [€/km*year]	0	0	0	0	0	872	0	0	872
TRAFFIC MANAGEMENT PERSONEL COST[\$ /year]	0	0	0	0	0	74.367	0	0	74.367
ADMINISTRATIVE PERSONEL COST [\$]	0	0	0	0	0	24.697	0	0	27.021
INFRASTRUCTURE MAINTENANCE COST [€/year]	0	0	0	0	0	18.082.520	0	0	18.082.520
OPERATIONAL COST [\$]	0	0	0	0	0	19.906.788	0	0	20.851.293

10 PROJECT PRIORITIZATION

The prioritization of the investments has been performed considering the investments evaluated in paragraph Capex and the flows described in the paragraph RAIL NETWORK MODELLING.

The rank has been developed basing on the “evaluated utility” as described in the document “Implementation Strategy” that will be further submitted.

The result is summarized in the following table:

Table 40: Railway Investments Rank

Line/investment	Infrastructural investment (Million \$)	Rolling stock investment (Million \$)	Total Investment (Million \$)	Pax-Km (000 units/year)	Ton-km (000 units/year)	Traffic units (000 units/year)	Cost effectiveness (000 traffic units/year per \$ of investment)	Ranking
Addis - Djibouti	1028	899	1927	14.270.839	12.882.565	27.153.404	14,09258407	1
Awash - Kombolcha – Haragaria	358	441	799	754.514	2.922.826	3.677.340	4,601506751	2
Mekele – Haragaba	835	198	1033	413.855	1.111.940	1.525.795	1,477415947	3
Mekelle - Assab Port Railway	1880	290	2170	236.135	1.711.079	1.947.214	0,89727124	6
Weldia - Wereta – Matema (Sudanorridor)	3084	264	3348	1.055.619	1.501.516	2.557.135	0,763775157	7
Wereta- Finote Selam	1296	113	1408	484.670	590.682	1.075.352	0,763732895	8
Mojo - Hawassa	1194	106	1299	391.978	533.555	925.532	0,712291742	9
Hawassa - Woo - Moyle	4232	317	4549	1.123.233	1.764.289	2.887.521	0,634706525	10
Sebeta-Jimma-Bedele–Booma South Sudan Border	4834	246	5080	1.822.845	1.274.884	3.097.729	0,609843198	11
Aisha - Berbera	1121	184	1305	0	1.234.751	1.234.751	0,945971751	5
Adama- Gasera	1479	67	1546	552.792	45.599	598.391	0,387162569	13
Ejaji- Kurmuk	2760	119	2879	729.083	626.076	1.355.158	0,470675153	12
Rejii- Holeta	511	60	571	422.447	272.484	694.931	1,216786373	4

The results shows that the priority is given to the finalization of the ongoing investments and the upgrading of the Sebeta – Dewale line, where the majority of the flows are transported.

After these, the rank promotes the line that maximize the flows on Addis – Djibouti corridor: Reji – Holeta that bring on the current network a significant amount of flows.

Following, the lines creating new connections to the Red Sea ports (Assab, Berbera and Port Sudan).

11 TRANSPORT MODES INTEGRATION

The railway transport is strongly affected by the integration with other transport modes; particularly for what is defined “the last mile” transportation both for passengers and freight transport.

The movements of people and goods from stations to final destination could be achieved only integrating railway with other transport modes.

In details, the movements of freight are heavily affected by the capacity of the freight terminal to load/unload the trains and to manage the overall logistic chain linked to the rail transport. Similarly, the attractiveness of the passenger transport is linked to the capacity to link the passenger station to the road network allowing people to reach the final destination using public or private transport modes.

In the light of that, the development of the railway sectorial masterplan has been carried out approaching holistically to the transport sectors considering the interaction and the mutual relation between several transport modes.

The transport modes integration is a key factor to increase the attractiveness of a transport mode optimizing the logistic chain and reduce the transport cost. Therefore, to successfully implement the result of the master plan should be consider as a vital factor. Additionally, the improvement of the transport mode integration lead to increase energy efficiency and optimize the use of resources.

The transport integration should not be only considered only under the infrastructure point of view. Transport integration affects several levels and requires consideration of the following:

- Interchanging
- Connecting
- Information
- Payment
- Policy

Interchanging, regardless if we refer to freight or passenger transport, should allow to switch transport mode with little lag time. the creation of a interchanged mode result in a more convenient transport. Similarly, a **traveler connecting** from one mode to the other means planning and designing the easies, safe and most connection. Ease of connection greatly improve user satisfaction; increase transport patronage and transport sustainability.

The successful of the integration is also related to **providing connecting information**. Ready access to reliable and timely service information is transport modes integration.

Similar, a simple, connected **payment system**, is a vital factor for the success of the transport modes integration. A complex payment system may lead the final customer to consider the several transport modes as silo and to not feel the integration.

The successful of the transport mode integration if also based on **policy, planning, pricing and operation across** modes, to enable seamless connected journeys.

The provided masterplan is entirely focus on providing integrated transport modes planning.

By the way, it represents only a first step of long journey that should be walked in all the following steps, starting from the design of each identified intervention in all the transport mode.

11.1 RAIL – INTERMODAL TERMINAL INTEGRATION

The integration between the railway network and the logistic chain should be performed through the implementation of intermodal terminals.

If we consider the railway like a house, the intermodal terminal are the doors of the house. For this reason, the modelling of the railway network has been performed jointly with the modelling of the intermodal terminals. The capacity in terms of tons and trains/day that is possible to carry with the railway is directly limited by the loading capacity of the freight terminal rather than the railway infrastructure capacity.

In the different time scenarios, the increasing of the freight flows is often related to the upgrading of the freight terminal capacity more than the growing of the flows on the network.

The terminals are in turn integrated with the road sector because only considering the integration between the roads and the terminals is possible to achieve the last mile transportation.

Therefore, the creation of the integrated terminals where several transport systems are linked is vital for the development of an integrated logistic chain.

11.2 RAIL – PASSENGER SERVICE INTEGRATION

In the last decades, increasing problems resulting from the growing mobility and travel elongation of the suburban area inhabitants have forced to search for solutions that would help sustainable transport development. Good practices have led for integration of rail with bus systems and urban system in general in order to optimize the use of both transport modes.

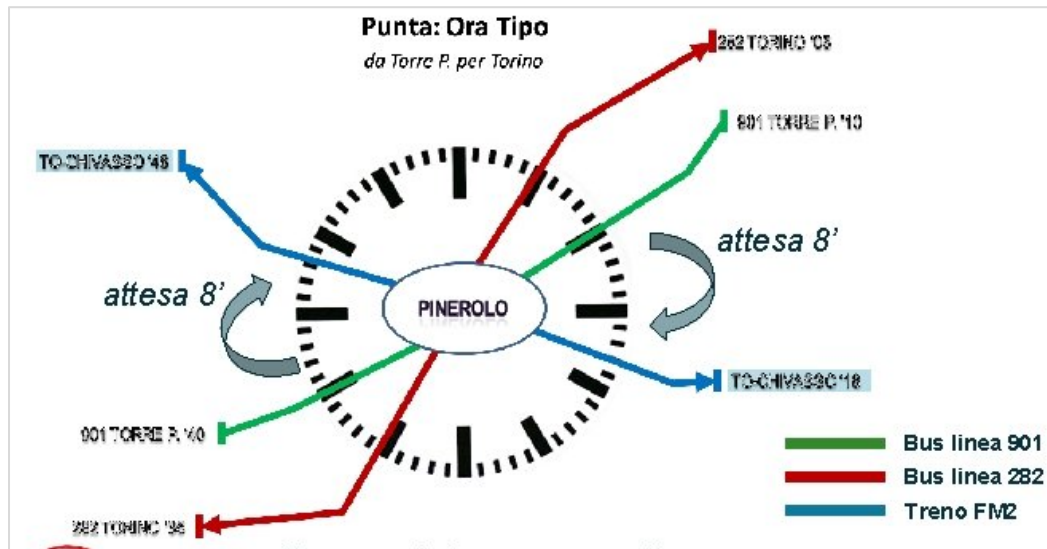
Integrated railway – public transport passenger transport system consists of many factors affecting the result of the integration. The integrations should be analyzed passenger point of view because the key element in railway integrated passenger transport is the passenger, that is the final customer, who requires the transport from one place to another. A basic condition for accomplishing the integrated transport is create and offer the complete travel which provides not only transport, but also other complementary services.

Good way to promote the integration of passenger service between the railway system and other transport modes (including other railway itself) is to maximize the overall transport service quality for passengers. Great benefit for the passenger service integration coming from the elimination waiting time in stations or terminals, where passengers can change transport mode. It would also influence transport accessibility in some region.

Nowadays, the most advanced technologies implemented to promote the passenger’s railway integration are:

- Integrated Station Layout
- New station (or the upgrading of the existing stations) designed not only looking to the railway service but including and integrating all the other transport system. The integration could involve private or public transport mode, like tramway, public bus, commuter and urban rail. An integrated layout promotes the interchanging and the connectivity between the transport modes
- Implementation of Integrated scheduled service
- Scheduled service is a form of train timetable in which train departures from the same station occur at fixed minutes every hour. It was originally implemented to promote the passenger connectivity between long distance and local trains. In this way, each passenger has a suitable time frame to move from long distance train and local train in the station. This concept is also applied to an integrated hub where each transport system departs at fixed minutes every hour. The departure time could be fixed allowing the passenger interchanging.

Figure 17 Example of Scheduled services in Pinerolo railway station



- Integrated Passenger Information System
- The creation of the integrated stations and schedule requires to be supported by an integrated information to the passenger. The implementation to an integrated passenger information system allows to promptly inform the passengers not only about the status and the schedule of the mode they are using but also about the schedule of all the other integrated transport systems.
- Integrated Fare System
- All the above-mentioned action needs also to be supported to an integrated fare system that will eliminate obstacles for passenger in changing transport mode and optimize the travel. The most common way is the creation of fare zone where each passenger can use equally and without specific challenge all the transport systems.

12 POSSIBLE FINANCING OPTIONS

In this paragraph will be review the main challenges faced to define the optimal financing options. By “optimal” we mean a financing option that satisfies the project objective considering the returns of the private sector and the constraints/objectives of the public sector:

- public sector comparator and VfM
- institutional framework to attract private party (concession, PPP, contracting out etc)

Regardless of the type of project, it is important to underline that if there is a desire to attract domestic or foreign investors, or if a particular infrastructure belonging to the public sector is subsequently privatized, then the respect of the rule of law is a founding block to assure increased access to foreign investments and will also encourage lenders to lend in the country’s projects. The reason relies on the risks associated to an investment and the mark up on returns that investors will require.

12.1 PUBLIC SECTOR COMPARATOR AND VFM

The most valuable financial option available to finance the project can be distinguishing between:

- project financed with budgetary resources and
- project requiring the involvement of the private parties.

Budgetary resources

The verification of the correct budgetary appropriation procedure is fundamental for a positive outcome of project implementation. In fact, very often uncertainty about budgetary appropriation for a given project creates delays in project implementation and uncertainty is often translated into price increase. Moreover, investments costs should be carefully analyse of each project in order to assess whether the budgetary allocation is sufficient or not. This, to avoid starting a project evaluation and bidding process without a satisfactory financing coverage, and thus creating delays and difficulties in the realization of the project. Project should be implemented only with a full financing coverage including contingencies items.

An assessment of financial sustainability of the project should define the equilibrium tariff level which will be necessary, given the demand, to satisfy the project needs without further recourse to public funds.

Project requiring the involvement of the private parties

Infrastructure developments in several part of the world are facing difficulties due to restricted budgetary funds and therefore there is a growing demand to attract private capital to accelerate infrastructure project delivery. Recourse to private capital is also looked for in order to exploit the competence and efficiency of the private sector to deliver infrastructure works in time and within “ex ante” costs. Public Private Partnerships were developed to respond to those needs: the public sector from developer and provider of infrastructure works becomes purchaser of infrastructure services. The private party becomes developer, financier and operator of the infrastructure projects.

The involvement of the private party requires an attractive institutional and legislative framework which should guarantee a smooth execution of the project and protect the return to the private investors and the repayment of the loans incurred for the proper execution of the project.

As we mentioned the reason for the public authorities to involve the private sector are principally:

- Budgetary deficits, so the project cannot be completed without private funds;
- Budgetary restrictions which prevent funding investment projects due to compliance with

fiscal procedures obligations (for instance deficit/GDP rules).

- Gain from the efficiency of the private sector in order to deliver infrastructure projects in time and within project budget

However, before looking at the various model under which the private party could be involved in a major infrastructure project, should be considered that there is value for money in attracting the private sector.

The Value for Money approach is a technique developed and used in the UK and several public administrations worldwide where the public authorities compares the procurement of a particular investment from using budgetary resources, or by looking at the private sector.

The methodology used is called Public Sector Comparator (PSC):

The Public Sector Comparator (Value for Money Assessment Guide, HM Treasury 2006) could be defined as a hypothetical capital expenditure, cost adjusted for a risk component in the event that a given public work is implemented by the Public Administration.

For a PSC calculation it is necessary to quantify the various cash flows during the project cycle (construction and operation).

The main component of the PSC are the following:

- Raw PSC: includes capital costs and operational costs, direct and indirect, of the construction, maintenance and operation of the infrastructure.
- Competitive Neutrality (CN): cancellation of any competitive advantage for the Public Administration in implementing a project under traditional public procurement.
- Transferable risks (TR): all project risks during construction and operation, transferable to the private sector.
- Retained risk (RR): all project risk which cannot be transferred to the private sector (for instance: Changing law)

$$\text{PSC} = \text{RAW PSC} + \text{CN} + \text{TR} + \text{RR}$$

The sum of net present value of costs (NPVc) and net present value risk (NPVr) determines the PSC or the true cost of construction work for the public sector. This value should be compared with the NPV of the costs and risks obtained by the private sector. To conduct this exercise it is necessary not only to assess the risk but to give them a probability of occurrence. Moreover it is essential to quantify the correct discount rate that the Public Sector is willing to use as discount factor in the NPV calculation.

It is also required to identify the risk eligible to be transferred to the private sector and the one that could be retained by the public sector:

- Main risks to be transferred to the private sector
- Increase construction costs;
- Delay in completion;
- Maintenance risk;
- Increase in operational costs
- Performance risks
- Main risk to be retained by the public sector:
- Regulatory risk
- Inflation
- Change in law
- Exchange and interest rate
- Project variation if requested by the public sector

12.2 INSTITUTIONAL FRAMEWORK TO ATTRACT PRIVATE PARTY (CONCESSION, PPP, CONTRACTING OUT ETC)

There are several various frameworks under which the private party can become involved in the delivery of an infrastructure project but notably there are two main categories of models:

- the BOT or DBFO model and
- the Unbundled type of models.

The possible framework are:

- BOT: (build, operate and transfer). Agent build, operate and finance a concession which is then transferred to the public sector; also DBFO (Design, Build, Finance, Operate)
- BOOT: (build, own, operate, transfer). Contrary to BOT the project is privatized and then exploited till transfer to the public sector;
- BOO: (build, own, operate). Similar to boot, but allow for renegotiation of transfer terms;
- BTO: (build, transfer, operate). Private sector design, build, finance the project but ownership is transferred at the end of construction. Project is leased back to private sector for operation;
- BBO: (buy, build, operate). Private sector buy an infrastructure, improves and operates it;
- BLT: (build, lease, transfer). Project financing and leasing techniques to implement projects.
- LDO: (lease, develop, operate). Long term lease of the private sector on a public asset, which is developed and operated by the private sector. Profit sharing mechanisms between private and public sector;
- Unbundled models: alternatives to traditional BOT and based on separation of project functions and risks on each participant to the project.

The BOT or DBFO model

The typical BOT (Build Operate and Transfer) or DBFO (Design, build, finance and operate) is based on a legal contract called Concession. The concession is a contract between the Granting or Awarding entity (public entity, such as the State or a municipality) and the private party which form a concessionaire. Under the concession agreement the concessionaire undertakes to design, build and operate and maintain the infrastructure for a certain period of time (usually 30 years) and transfer it back in good conditions to the Granting or Awarding entity. Under this scheme the private sector forms usually a consortium of companies interested in building the infrastructure and have the necessary competence and financial strength to implement the project. In the case of a rail project one can think at a structure where the concessionaire is a construction company, an operating company, a rolling stock supplier, a signalling company, etc. The concessionaire will develop a financial model which will explain the financial viability conditions necessary to implement the project, the required equity to debt ratio, the expected IRR of the project and of the equity, the project NPV. The concession agreement is a complex document as it will govern the relationship between the public granting Authority and the private concessionaire in term of obligations of the parties, the possible renegotiation of the contract, the indemnification in case of withdrawal of the concession when the debt is still outstanding. The following fig. 8 gives an indication of the contractual relationships around a BOT model. The BOT financing hinges on a series of contractual obligations and guarantees in order for the SPV to implement the project.

Embedded in the BOT model is the risk sharing between the private and the public sector. This applies particularly when public grants or subsidies are required to allow an adequate financial return to the private investors. The advantage of this type of model is that the private party can make a quotation of capital expenditures including the design of the project that can reflect the life cycle of the project and therefore maximizing the maintenance efficiency of the infrastructure. The drawback of this model is that without a strong and appropriate monitoring,

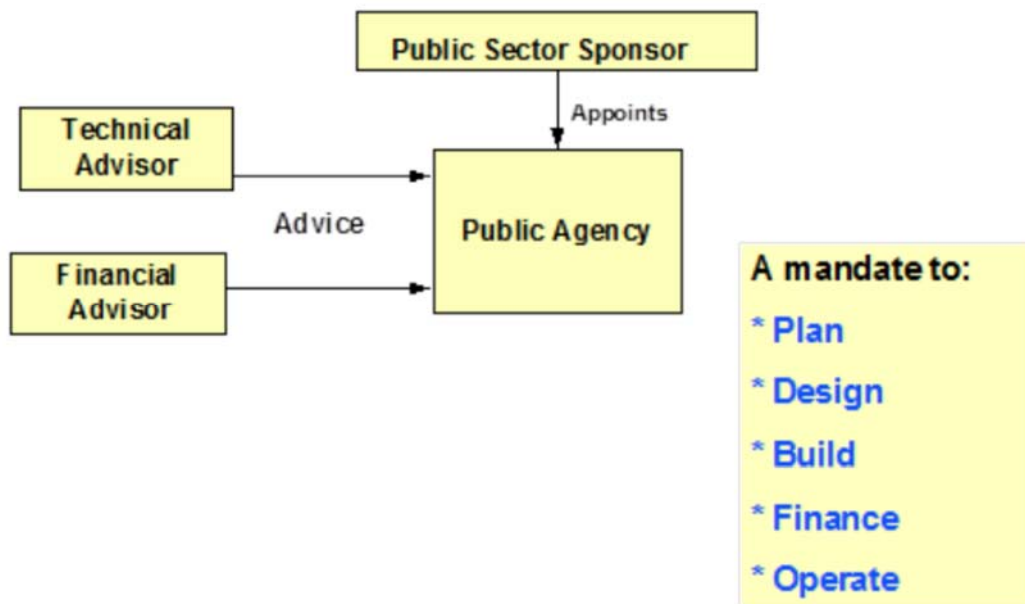
the risk sharing mechanism may not be optimal and therefore the concentration of several risk under one single agent (the concessionaire) tends to increase the infrastructure price causing the necessity of a higher tariff, or a higher availability payment or greater subsidies to be paid by consumers or the public sector. To summarize infrastructure prices tend to increase due to:

- Concessions which tend to be long
- High tariff for a long time
- Increased risk of renegotiation
- Asymmetry in contract revisions
- Rigid price policy for long periods
- Undesired transfer from the public to the private sector

The unbundled model

The unbundled model tends to solve some of the inconsistencies of the BOT model. In particular the aggregation of risks under a single agent, without transparency tends to inflate construction and O&M costs. The basic idea is to share risk and to reduce construction and operating costs by running separate contracts. The idea is based on the possibility of using the capital market, namely securitization techniques, to finance infrastructure projects.

Figure 18: unbundled model



As can be seen in the following figures Government should form an infrastructure agency. The agency, with the assistance of legal, technical and financial advisers, should tender separately the construction, the operation & maintenance and the financing of the project.

Figure 19: Paying Construction

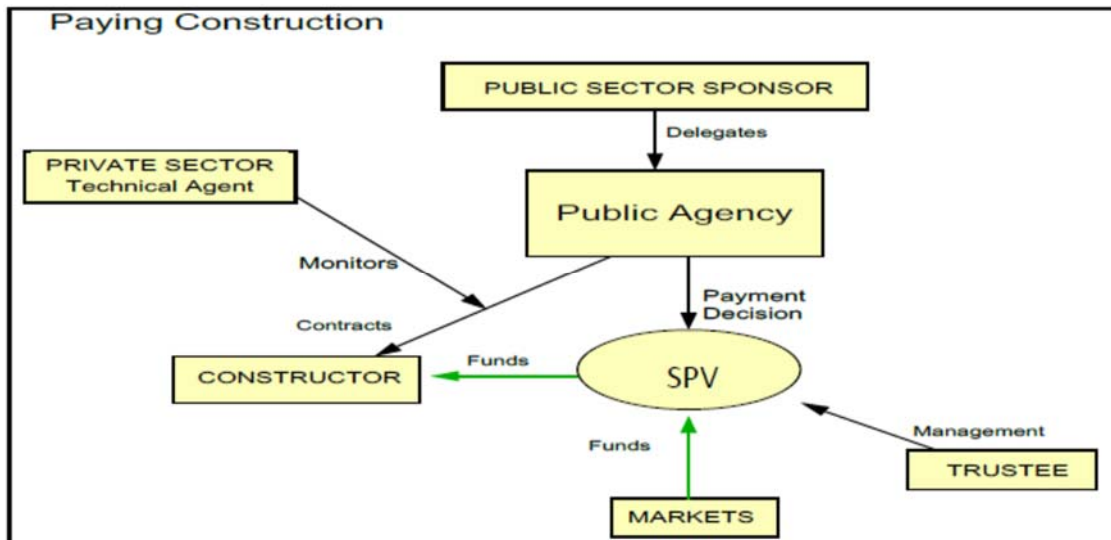
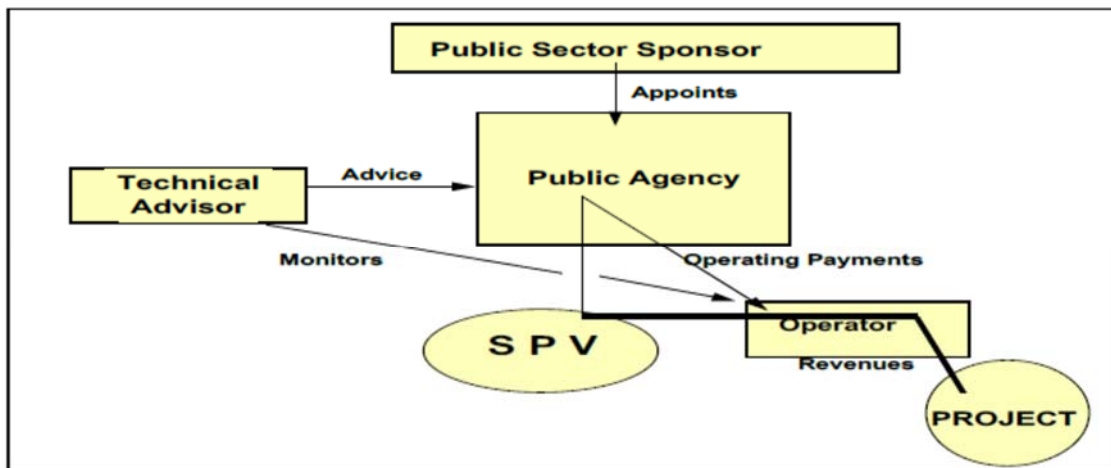


Figure 20: Special Purpose Vehicle - SPV



The main features of the unbundled scheme is the recourse to an open ended financial SPV who should raise money from the capital market by granting the financial SPV all the cash flow and contractual rights deriving from the construction and operation of the project. The financial SPV will end when all its liabilities will be paid. In this structure the role of the trustee is of paramount importance, as he becomes the depositary of the infrastructure rights and represent the lenders from the capital markets. By disaggregating (unbundling) the project, each party will bear his own industrial risk which presumably will be lower than what is currently applied under a BOT scheme where the risk are all aggregated. The life cycle efficiency can be obtained in designing the various tenders by the agency and its advisers. The advantage of this scheme is to arrive at a better definition and pricing of the risks with consequent reduction of the infrastructure cost. To summarize the main benefits deriving by using an unbundled approach:

- A more efficient allocation of risks
- A favourable framework to mitigate subjective risks of political and regulatory nature
- Contracts are less likely to be inflated
- Contracts have less renegotiating risks

- Price policy is more flexible:
- contracts with shorter maturities
- SPV may absorb price changes
- Underestimation of revenues and windfall profits benefit the infrastructure users
- Intergenerational cost distribution is more attainable
- SPV appropriate to assure full transparency in subsidies
- SPV neutrality favours a reduction in social resistance to pay for the services
- Participation of local companies is favoured
- Financing in local currency is more attainable

Suggested Business Improvements

Ethiopia is strongly committed to develop as fast as possible the rail national network. To support the development is vital an effective raising of the financial resources or an adequate management of it.

Although it is quite evident the business potential of the new line Addis Ababa - Djibouti, according to the Consultant experience, it seems no possible to generate a free cash flow from operation enough to repay interests and capital of loan obtained for the construction of the line.

Moreover, for the other under -construction railway lines, the expected operational revenues are below the Addis Ababa – Djibouti so the development of the railway sector may be affected by the lack of funds to be fully developed.

Freight transport is forecasted to be the main source of revenues of the line but can be convenient to develop ancillary business to increase the revenues of the railway sector and to keep competitive and easy to use freight rail transport within the Ethiopian logistic chain. In synthesis:

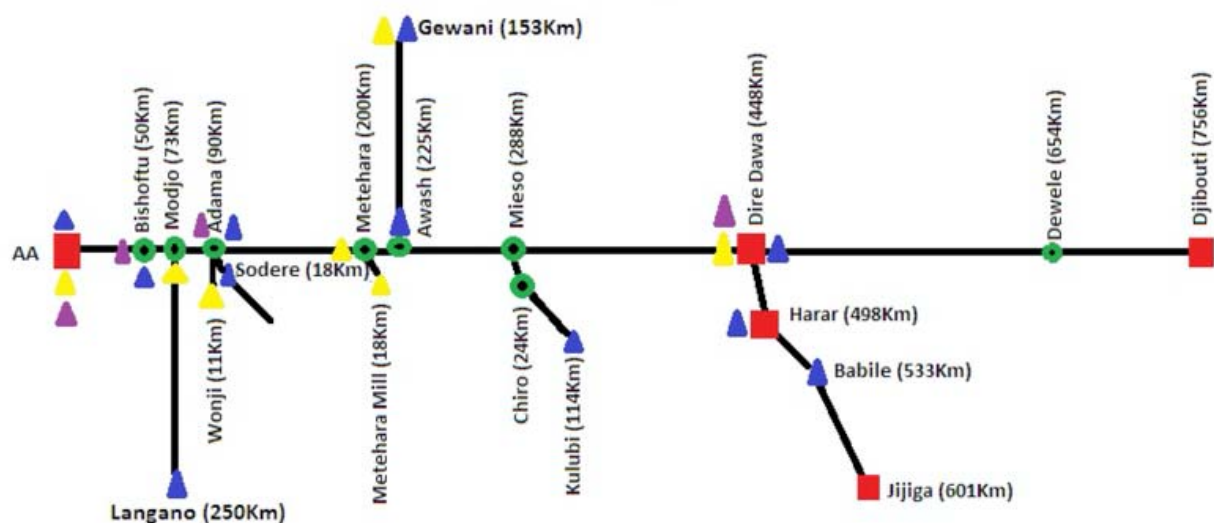
- the exploitation of present and future assets is the critical strategic lever to obtain a major role in the complementary business. To define the possible assets usage and improvement, undertaking of an assessment of their potential is necessary.
- to exploit this potential on the complementary business at maximum, it may be very important to define the right industrial partners to involve.
- also, to create the ancillary businesses, i.e. those that are not functional to support the transport business, but that may imply an increase of revenues, the exploitation of the assets is the key lever to create consistent business models and attract financial partners or give them in concession.

It is critical to assess as soon as possible the need of infrastructural intervention to enhance competitiveness of freight rail transport and to figure out the potential businesses to increase forecasted revenues.

Basing on the above consideration, several businesses have been analysed. The following variables have been evaluated on the basis of the knowledge of the business and the brief analysis of the existing structures. The variables 'Degree of Local Competition', 'Information technology specific requests', 'Degree of specific competencies' and 'Cost structure: Capital intensity' have been evaluated on the inverse scale. It means that the higher is the degree of local competition the lower is the assessment of the variable. As well as the higher is the need of specific information technology knowledge to run the business the lower is the rate assessed since it is less attractive. All the assessments need to be better definite through specific analysis on the field and on the competitive environment.

From the experience of the Consultant, it has been derived the following chart showing the locations where the most important potential business sources are located.

Figure 21: Major Locations Along Addis-Djibouti Corridor for possible Non-core Railway Business



Legend

■ Regional Capital
 ● Major Stations
 ▲ Touristic/Resort Area
 ▲ Production Site
 ▲ Industrial Park

The data collection provided some inputs to determine a very first assessment of some of the potential ancillary business.

Ancillary Businesses

Ancillary businesses are related to activity that are not usually linked to the railway transport but are usually involved in the railway business due from one side provide the required revenues to support the development of the railway sector and from the other side support the railway undertaken to secure the cargo. These types of businesses are usually provided jointly with other companies (private or public).

Table 41 Railway Possible Business Partner

Business	Possible Partners
Live Animal Transport	-
Bus Shuttle Services	Tour Operators, Bus Companies
Cabling	Ethiotelecom
Warehousing	Importers, Exporters, Logistic Operators, UN agencies, Industrial parks
Dry Bulk Storage	Importers, Exporters, Logistic Operators, UN agencies

Following, for each business is reported an introductive picture describing:

- Business idea description
- Business model description
- A first analysis of the location more attractive for the business along the Addis – Djibouti corridor (green for the most attractive areas, red for the less attractive areas)

Figure 22: Live Animal Transport

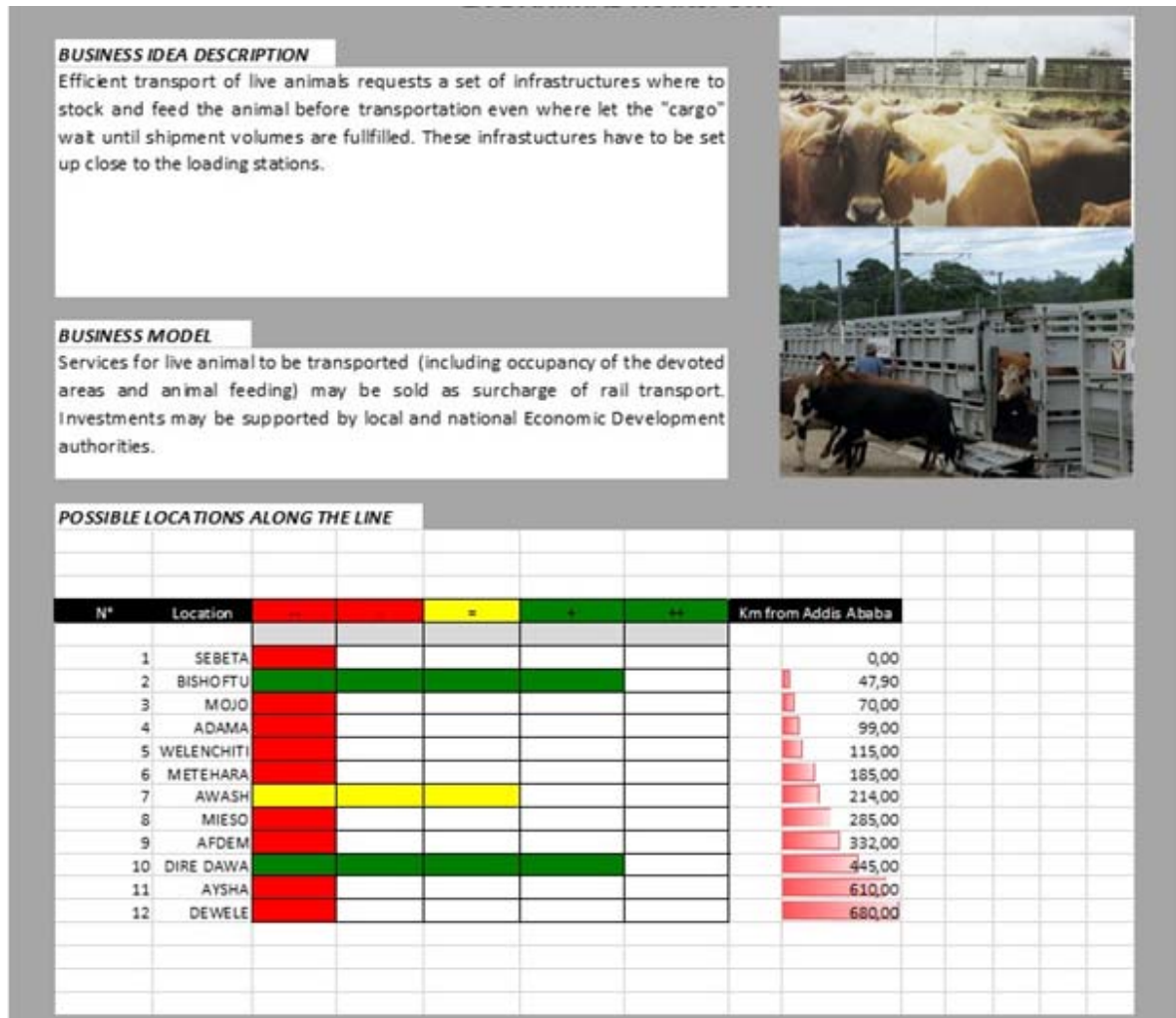


Figure 23: Bus Shuttle Services

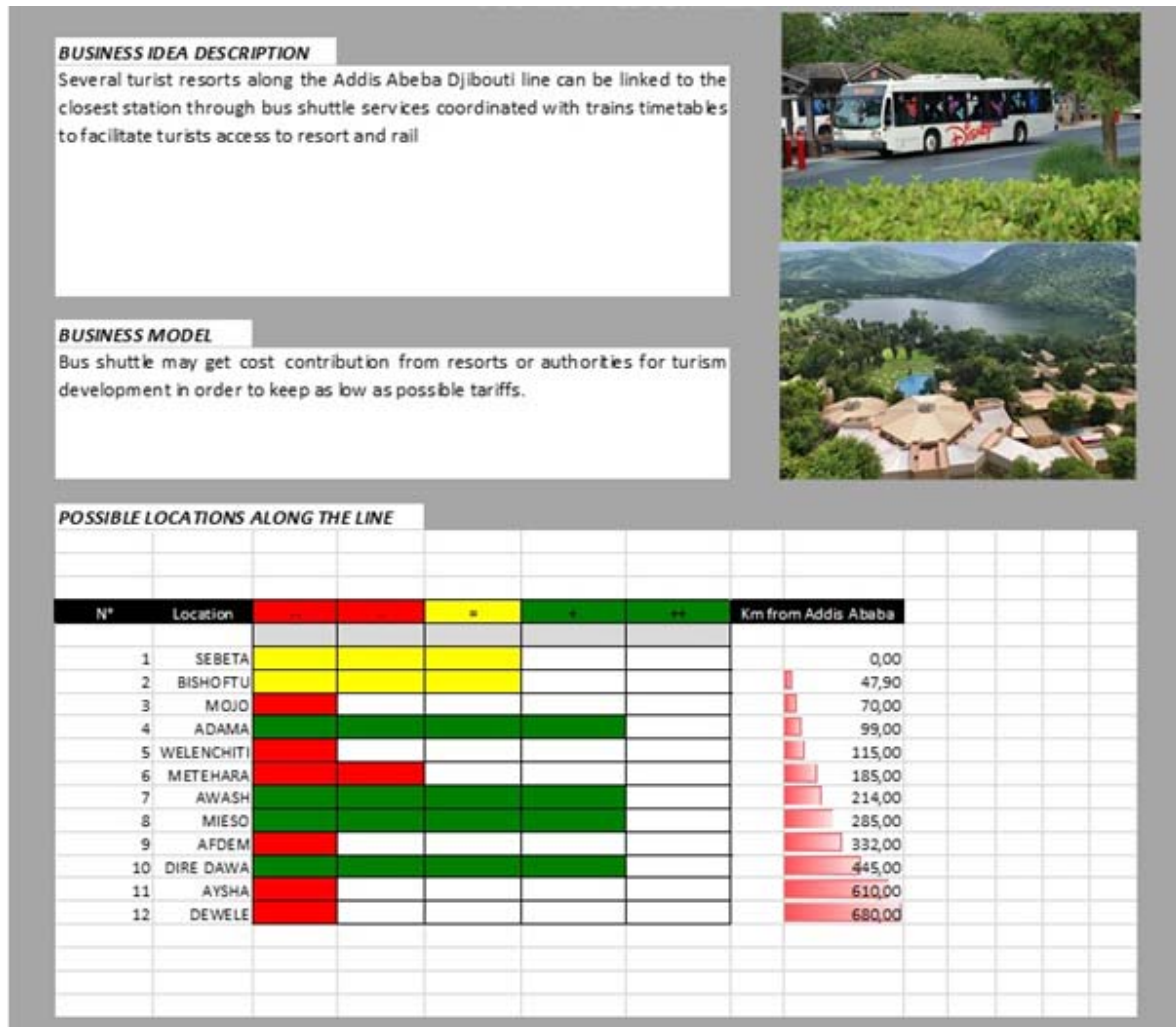


Figure 24: Cabling Along Rail Track



Figure 25: Warehousing for Mass Markets Goods

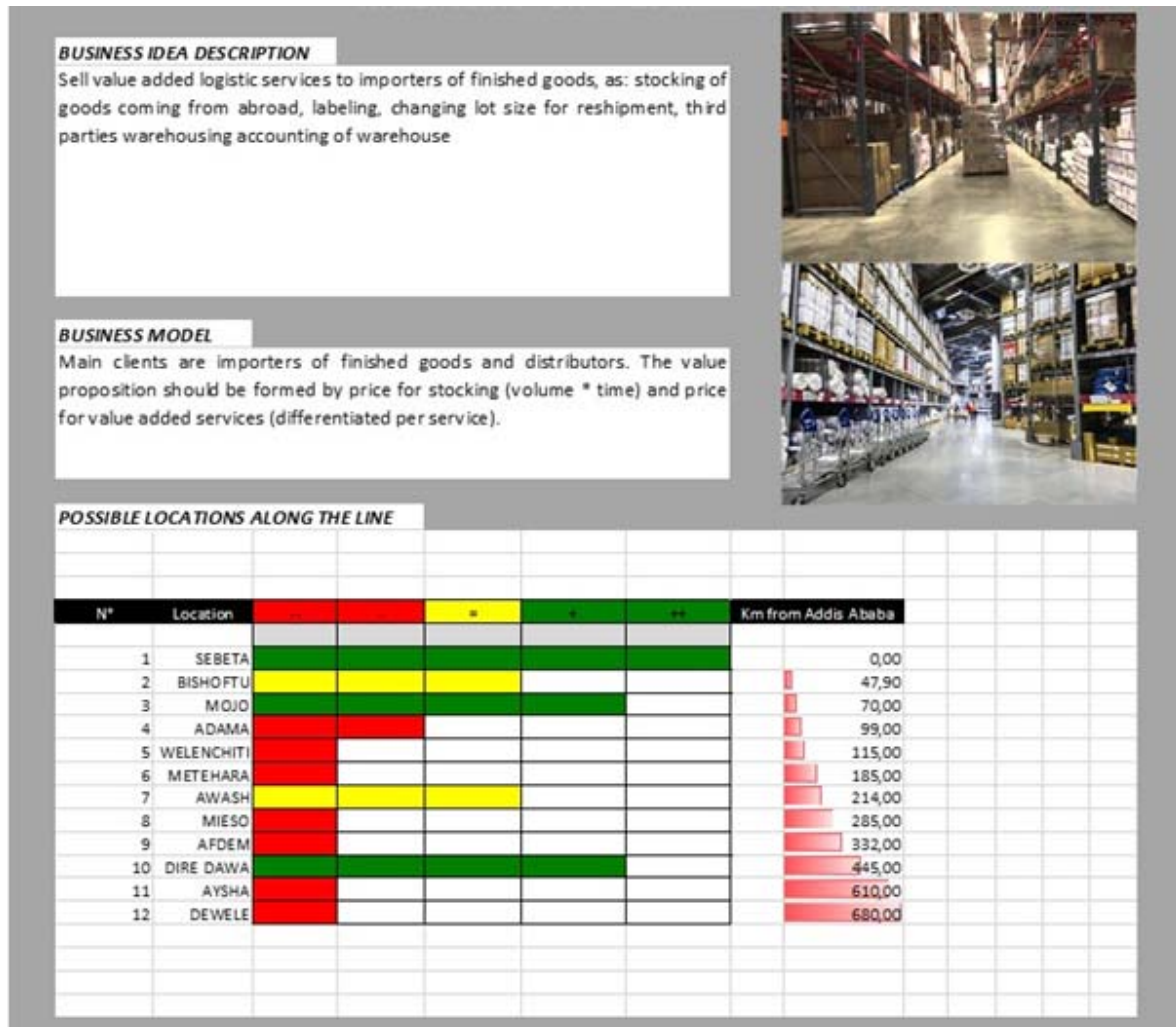
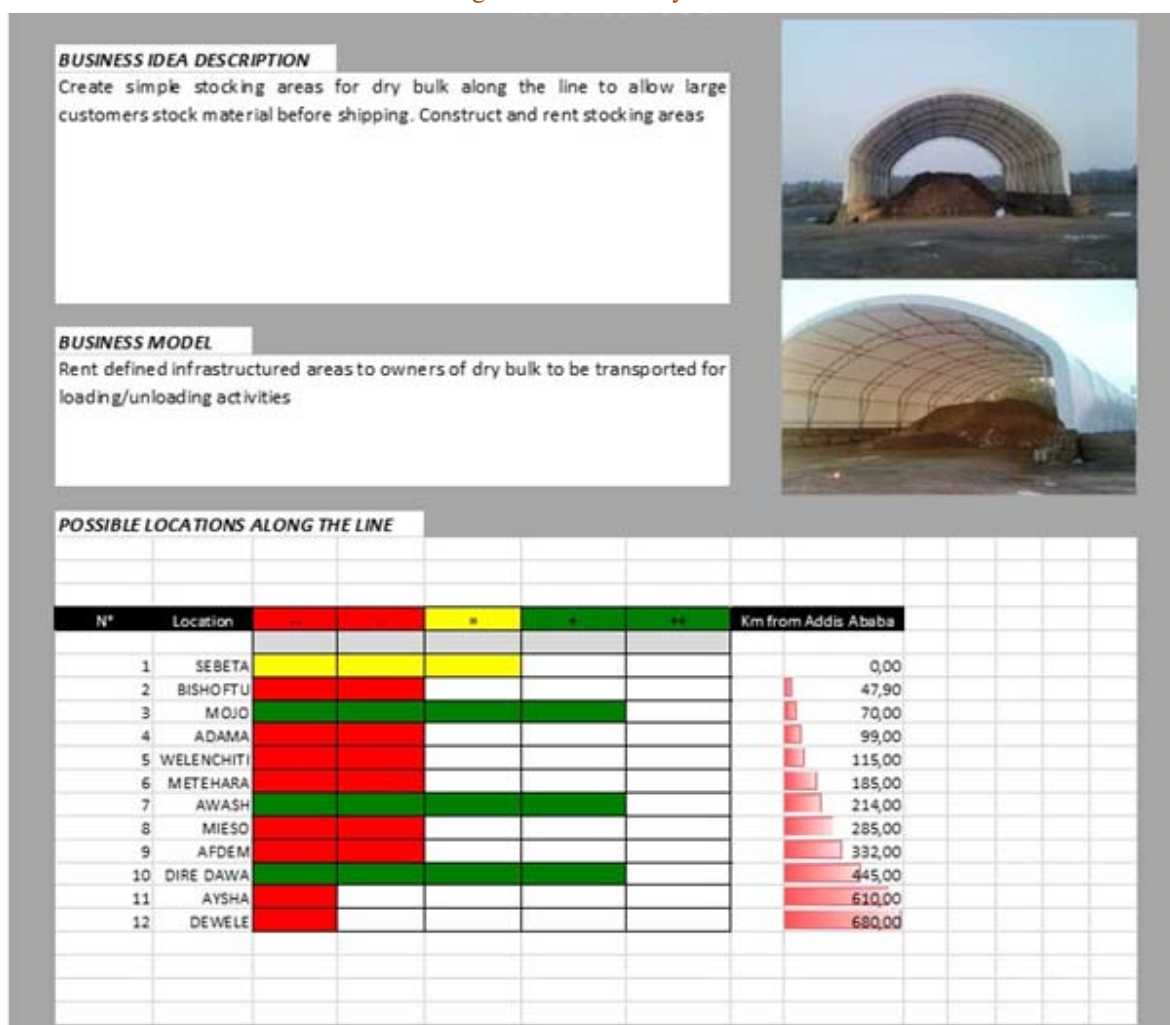


Figure 26: Stock Dry Bulk



Additional Rail Businesses

Additional rail businesses are related to the activities linked to the railway business and could be expanded in order to increase the revenues, to secure the cargo and to bring the private sector closer to the railway activities.

Following, for each business is reported an introductive picture describing:

- Business idea description
- Business model description
- A first analysis of the location more attractive for the business along the Addis – Djibouti corridor (green for the most attractive areas, red for the less attractive areas)

Figure 27: Rail Service Consortia

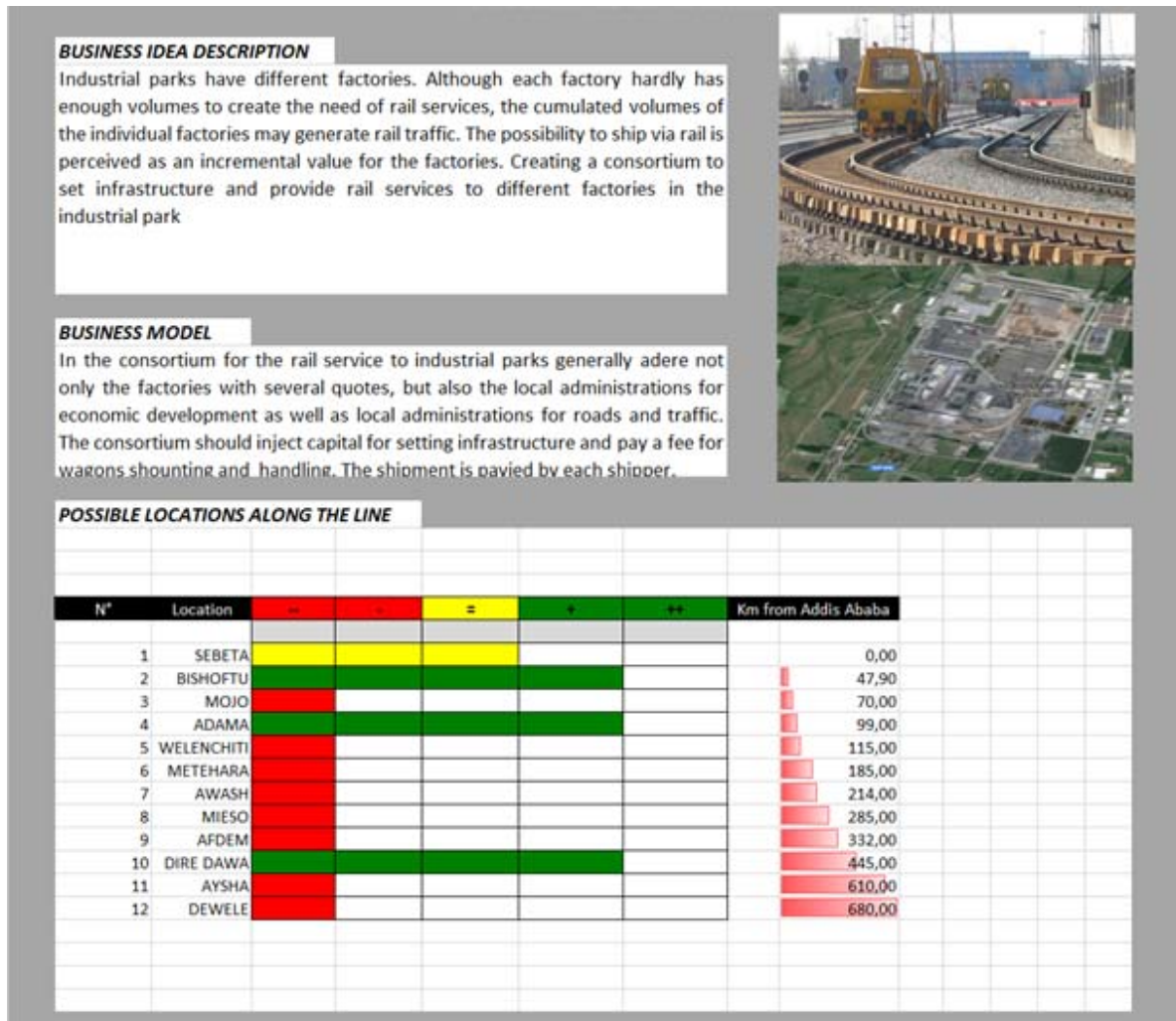
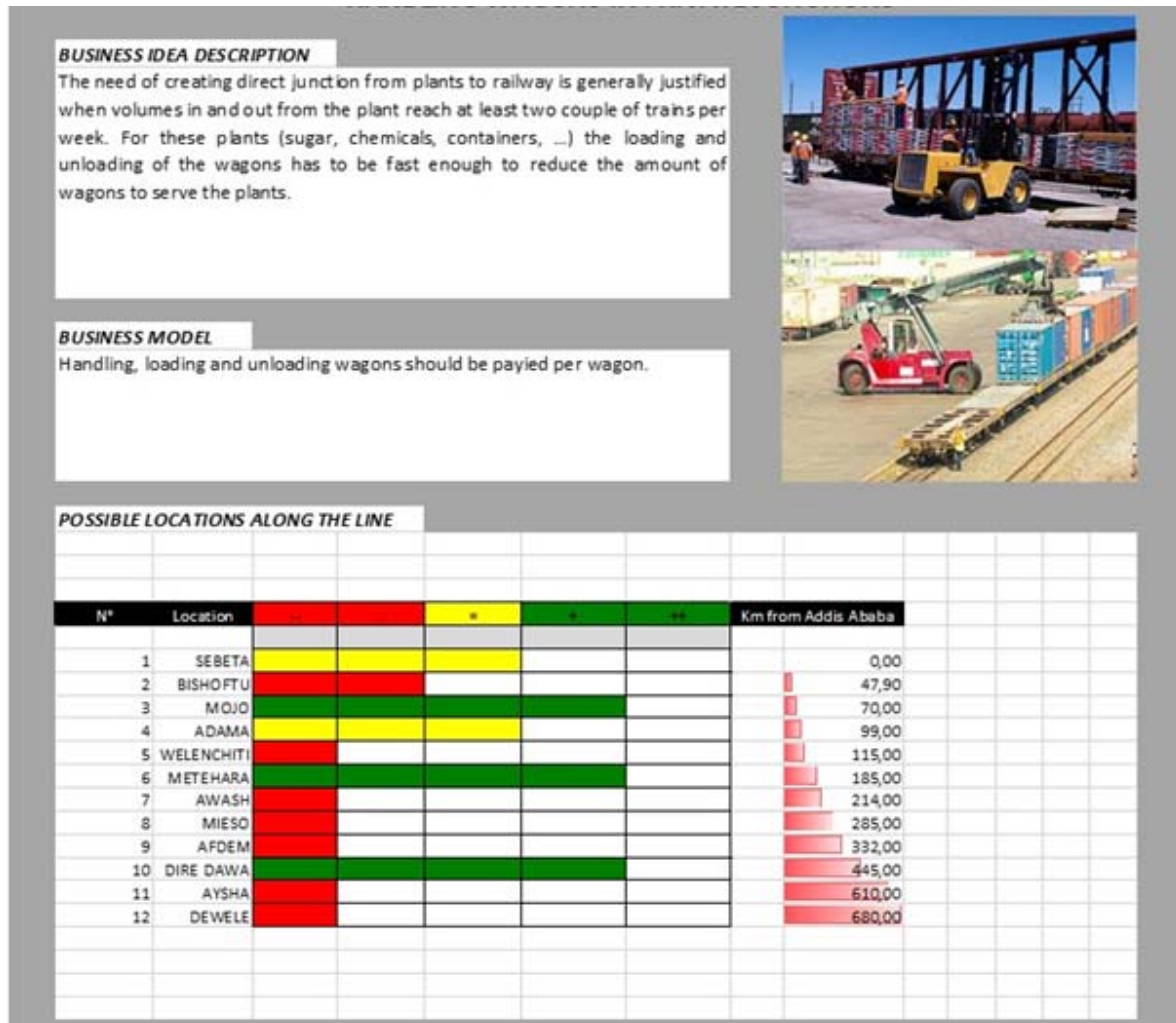


Figure 28: Handling Wagons in Private Junctions



During the interview held, other possible additional businesses have been underlined and, in particular, the possible link to the Awash oil storage and a cement factory near Dire Dawa. These two specific cases have not been considered because the analysis of a possible link is already ongoing.

13 RAILWAY NETWORK IN EAST AFRICA

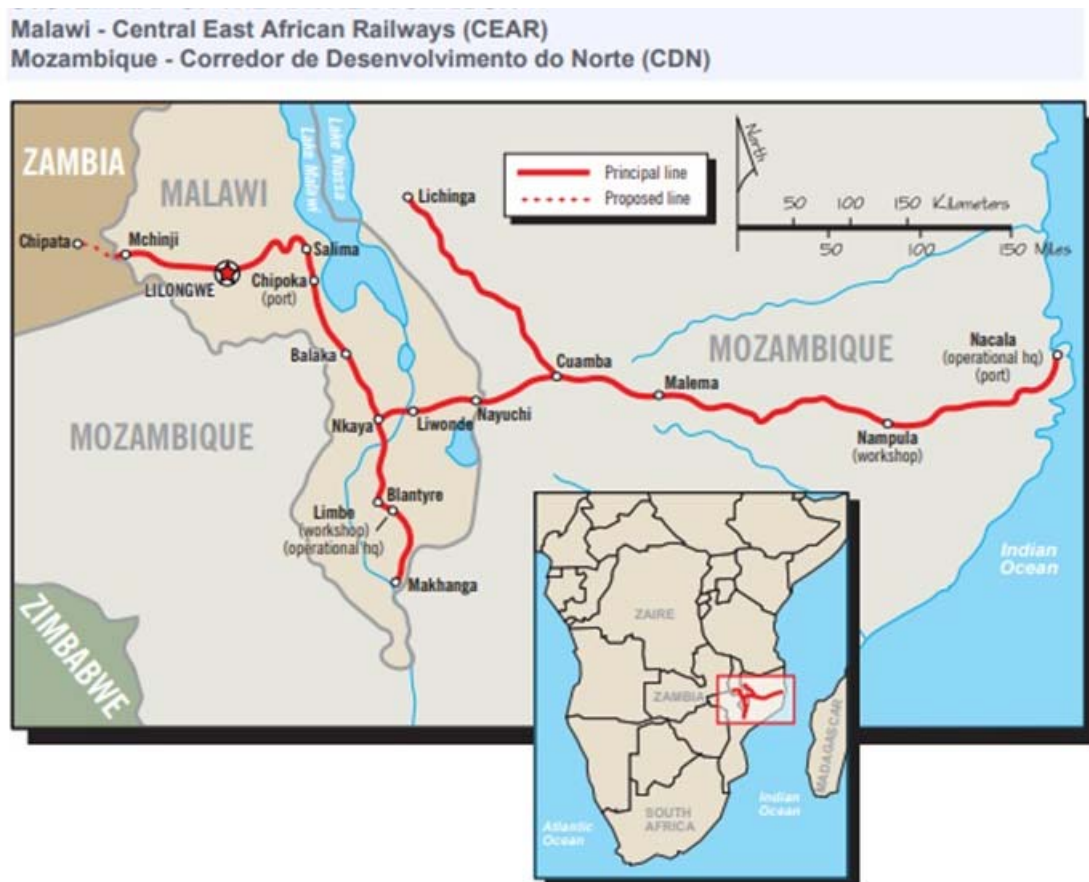
In the following chapter, a brief description of the lessons of experience from other experiences with rail concessioning in Sub-Saharan Africa in relation to the implementation of the new standard gauge electrified network.

13.1 MALAWI

Malawi has 787 km Cape Gauge long railway network linked to Beira via a southern connection to the Sena line in Mozambique. The Malawi Railways was managed by the Malawi Government until privatization on 1st December 1999.

In December 1999, Central East Africa Railways (CEAR) took over the 20-year concession on the Malawi Railways, renewable in 5-year tranche. In 12th September 2008 CEAR sold their interests in CDN to Mozambican investor group INSITEC. The Nacala Corridor which includes CEAR will now be managed and operated entirely by Mozambican investors. The concession to operate the Railways System of Northern Mozambique (CDN) was granted on 10th January 2005 is valid for 15 years and renewable for a further 15 years. The Port of Nacala is the terminal of the CDN, the most recent addition to the railway system. It connects the Nacala Development Corridor and links to the Central East African Railway (CEAR) of Malawi. The project includes the rehabilitation of the 77 km section of the line between Cuamba and the border with Malawi at Entre Lagos, infrastructure improvements for Malawi to improve drainage and reduce line interruptions during the annual rains, as well as refurbish the Port of Nacala (source: <http://rrdc.com>)

Figure 29: System Map of the Nacala Corridor



On the 787 km long rail network in Malawi is annually transported about 220.000 (2008) tons of cargo, principally Containers, Maize, Fuels, Fertilizer, Cement, Tobacco and Sugar. The amount of transported cargo is not stable and has significant fluctuation, for example in 2000 the total amount was more than 500.000 tons.

Originally, the terms of concession for the CEAR was:

- 5 percent of gross revenues (with a minimum of \$0.5 million p.a.) plus \$0.5 million initial payment;
- \$0.9 million p.a. for five years for the rollingstock (18 locomotives and 410 wagons)
- operate two passenger services for the first five years of the concession, for which a payment of \$150,000 has been made by the Government, effectively netted off against the concession fee. There-after, the payment and service offered will be by negotiation

13.2 TANZANIA

Source <https://dlca.logcluster.org/>

The railway system in Tanzania has a total track length of 3,676 km with two separate networks. One is run by Tanzania-Zambia Railway Authority (TAZARA), which maintains and operates a 1,067 mm gauge of 975 km network in the Southern part of the country, more precisely the line from Dar es Salaam to Kapiri Mposhi in Zambia. Tanzania Railways Limited (TRL) operates over 2,706 km of tracks (1,000 mm gauge) in the Central and Northern parts of Tanzania, including Tanzania's railway links to Kenya and Uganda. TRL is fully owned by the government.

Railways in Tanzania were first built in 1893, when the first rail track was laid at the port of Tanga. Then, construction of railway lines continued to other places in the country. The railway services were operated by Tanzania Railways Corporation (TRC), established in 1977 after the collapse of the former East African Community. In 2007, TRC was renamed to be TRL.

TAZARA is a bi-national railway, linking the Southern Africa Regional transport network to Eastern Africa's seaport of Dar es Salaam, offering both freight and passengers transportation services between and within Tanzania and Zambia. The construction of TAZARA railway network was completed in 1975 and started commercial operations in 1976.

TRL network is managed by Reli Assets Holding Company Limited (RAHCO). RAHCO was established under the Railway Act No. 4 of 2002 and became operational in September 2007 principally as Landlord of railways infrastructure on behalf of the Government.

In 2017, RAHCO issue a tender for the realization of the first phase of Central Corridor of the East Africa Railway Network, which consists of several railway projects. Central Corridor Line connects the landlocked great lake (Victoria Lake) countries Burundi and Rwanda to the port of Dar Es Salaam. It is an alternative transport route to the Northern Corridor. The corridor covers the following railway sections:

- Isaka (Tanzania) – Kigali (Rwanda)
- Keza (Tanzania) – Muangoti (Burundi)
- Dar Es Salaam (Tanzania) – Mwanza (Tanzania)

There are 4 part of the Central Railway Corridor:

- Dar Es Salam – Isaka
- Isaka – Mwanza
- Isaka – Kigali (Rwanda)
- Isaka – Kigoma (Burundi)

First two parts consist the Dar Es Salaam – Mwanza Railway Project which is divided into 5 big phases:

- Dar Es Salaam – Morogoro (207 km)
- Morogoro - Makutupora (344 km)
- Makutupora – Tabora (294 km)
- Tabora – Isaka (130 km)
- Isaka – Mwanza (249 km)

The Contract signed between RAHCO and the construction JV foreseen an electrified standard gauge railway line with contract type FIDIC Plant and Design-Build (Yellow Book).

In 2020, The Ministry of Finance of Tanzania has obtained a term loan of USD 1.46 billion to fund the construction of the Standard Gauge Railway (SGR) project to Makutupora. Standard Chartered Bank Tanzania acted as a global coordinator of the loan while the biggest component of financing comes from the Export Credit Agencies of Denmark and Sweden.

The 550km long railway section (phase 1 and phase 2) is part of the overall SGR project that will stretch for 1,219 km, connecting Dar es Salaam to Mwanza on Lake Victoria for an overall budget of USD 7.5 billion. (<https://www.tanzaniainvest.com/>)

13.3 KENYA

Rail operations in Kenya are managed by the Kenya Railways Corporation (KRC). KRC has a concession with two operators for the management of the narrow 1 metre gauge network: the Rift Valley Railways/RVR and, in some parts, the Magadi Rail.

In 2014, the Government of Kenya received a grant from the People’s Republic of China for the construction of a standard gauge railway (SGR) line together with rolling stock. The line will run from Mombasa to Malaba from where it is anticipated that Uganda will extend the link to Kampala and Rwanda to Kigali

Figure 30: Kenya Railway Network



The project cost of the first phase of the SGR from Mombasa to Nairobi was 90% financed by the Export-Import Bank of China. The remainder of the project cost was funded by the Kenyan government. The \$3.23 billion financing from Exim was finalised in May 2014. Exim advanced the loan amount in two subsidized loans of US\$1.63 billion each. One of the loans was a foreign aid loan provided on a concessional basis (very low interest rate) while the other was a below market rate preferential export buyer's credit. A condition imposed by the Kenyan government for the financing was 40% of the total project costs or about 130 billion Kenyan shillings would be spent on local supplies including sand, cement, electric cables, galvanised iron and steel.

A condition by Exim Bank for the loan was to have an operator acceptable to the bank for the initial phase of operations, which led the Kenyan government to reject a planned international tender.

Basing on the loan conditions, the operations of the SGR line are contracted to China Communications Construction Company (CCCC) for the first 5 years of operation, starting from 2017 (opening of commercial operation). Many of the employees working for the SGR are Kenyans.

In 2018 the railway handled more than 1,6 million passengers and 5 million tons of freight.

In 2019 has started the operation on the Nairobi-Naivasha section.

Despite the high volume carried out on the line, the management of the line is facing several challenges related to the integration between the Chinese and the local staff and the know-how transfer. For the drivers, most of the gadgets are still in Chinese making it hard for locals to read and understand. Anyway, Transport Cabinet Secretary James Macharia announced in 2020 that the percentage of Chinese workers will reduce yearly, with the peak in 2027 when SGR will be run 100 per cent by Kenyans.

13.4 UGANDA

The country has about 1,350 kms of rail lines and most of it had not been operational for over 20 years. Repairs have been completed on the Tororo-Gulu line and still ongoing on the Gulu Pakwach Line. A railroad originating at Mombasa on the Indian Ocean connects with Tororo, where it branches westward to Jinja, Kampala, and Kasese and northward to Mbale, Soroti, Lira, Gulu, and Pakwach. Uganda's important road and rail links to Mombasa serve its transport needs and also those of its neighbors like Rwanda, Burundi, and parts of D.R. Congo and South Sudan.

The Rift Valley Railways Consortium (RVR) is a consortium that was established to manage the railways of Kenya -Uganda. The consortium won the bid for private management of the century-old Uganda Railway in 2005.

Uganda has also planned to build a new standard gauge railway line.

The construction, is expected to be financed by the government of Uganda, using borrowed money from the Exim Bank of China.

Unfortunately, due the delay of the construction of the Naivasha–Kisumu–Malaba section in Kenya, that should connect Uganda to Mombasa port, the loan has not yet been finalized and the construction has not yet started.

In 2018, the EastAfrican (a weekly newspaper published in Kenya) reported that Uganda may scale back on starting major infrastructure projects, in an effort to reduce its fiscal deficit in the run-up to joining the East African Monetary Union in 2024.

After failing to secure the Chinese funding for a new standard-gauge line, Uganda Railways Corporation decided in 2019 to refurbish century-old rail network to boost bulk cargo transportation. The rehabilitation will be carried out in phases over several years and cost at least 241 million €. To finance the rehabilitation, the European Union has given a grant of 21.5 million €.

13.5 MOZAMBIQUE

Portos e Caminhos de Ferro de Moçambique (CFM) is the parastatal authority that oversees the railway system of Mozambique and its connected ports.

The Mozambique Ports and Railways Administration (CFM) was created in 1931. The railway system was developed in order to be connected with the three main ports of Maputo, Beira and Nacala, mainly to provide a fast, safe and efficient transit transportation service for mineral and agriculture exports from South Africa, Zimbabwe and Malawi, and for some national traffic from landlocked provinces. The main railway network is about 2,500 km long, distributed in three

systems in the South, Central and North, each with 1,067 mm gauge (Cape gauge) that is compatible with neighboring railways networks.

Figure 31: Mozambique Railway Network



Since the early 90s the Government and CFM are allowing private sector participation in the management of specific Terminals of port business.

In 1998, CFM set the new mission that among various aspects highlights the involvement of the Private Sector – domestic and foreign – in the operation and development of railways and port system, via concessions.

In this way, CFM has investments in 22 companies, including 15 of the railway and port sector and the remaining subdivided by tourism, hiring of railway equipment, road infrastructure and building materials businesses.

In this sense, for fulfilment of the mission related to the involvement of private sector in concessions for the operation of railway and port business, criteria and principles of partnership, in particular, which involve the following:

- Internationally acknowledged experience, with know-how and total mastery of specific Technologies in the transport, logistics and distribution sector;
- Solid financial capacity that is able to create critical mass and continue to inject capital or mobilize them from external sources to continue the investment program;
- Willingness to guarantee the involvement of the national business;
- Ability to induce high returns on past and future investments, i.e., selected partners should add value to the value the CFM already holds or held.

Even though the concessioning system has led to the involvement of several transport players, the Standard gauge ambition in Mozambique has been stop after some study performed in 2012.

14 ENVIRONMENTAL ISSUES

The overarching objective of the whole exercise of undertaking the Ethiopian Transport Master Plan (ETMP) is to contribute to the country’s sustainable development.

14.1 TRANSPORT AND ENVIRONMENT

Transport infrastructures, like other development projects, pose impacts on the environment in different ways and levels. That is, depending on the mode, they have impacts on the air, soil, water, vegetation and wildlife.

In the process of achieving their primary objectives, transport projects contribute several benefits (positive impacts) that foster development at different levels mainly in the form of: creating/enhancing accessibility and mobility, creating employment opportunity, and contributing to induced development.

However, beside its benefits, the transport sector has also posed detrimental impacts especially on the environment. That is, the construction or upgrading of transport infrastructures involves impacting the physical, biological and socio-economic environments regardless of the extent of the impacts. Each of the impacts associated with road works may be positive or negative, short- or long-term, localized or widespread, etc. The risks to the physical environment include: soil erosion in the longitudinal and transverse directions in the road route/corridor; slope instability when the road cuts through mountainous areas; decreased water quality due to both pollutants and sediment loads linked to soil erosion; soil and water pollution from hazardous wastes such as used oil and lubricants; and decreased air quality due to emissions from construction machinery and traffic volume (there are also stationary sources of emissions). The risks to biological environment include: loss of natural vegetation and of wildlife habitat due to land clearing, and the impact of road activity on wildlife migration patterns (due to ecosystem fragmentation). The risks to the socio-economic environment include: loss of fertile land and cash (perennial) crops, loss of residential houses, loss of business, etc.

As construction of transport infrastructures impact the environment, the environmental impacts in turn affect communities, including their health and livelihoods. That is, decreased water and air quality affects households’ environmental health. Loss of properties like land, crops, residential houses and other businesses affects the livelihoods of communities.

During the operation phase of transport system, the performance of the system could also be related to environment. That is, the status of transport system performance and quality affects the environment; for example, in the form of air pollution (possible emissions from vehicles, aircrafts, vessels, railway locomotives etc.); and soil and water pollution from spillages of fusels due to accidents. Wildlife resources could also be affected mainly in the form of accidental killing of animals by vehicles or trains.

14.2 LEGAL AND POLICY FRAMEWORK

In Ethiopia, several legal documents and provisions have been issued to ensure environmental sustainability. The legal documents have been issued at different levels ranging from the Constitution of the Federal Democratic Republic of Ethiopia (FDRE) to sectoral guidelines and manuals.

On this basis, the following sections present the major legal and policy provisions related to environment and relevant to the Transport Sector within the overall legal framework of the country.

14.3 CROSS-SECTORAL ENVIRONMENTAL LEGISLATIONS

14.3.1 The Constitution

The Constitution of the Federal Democratic Republic Ethiopia (FDRE), issued in August 1995, forms the fundamental basis for enactment of specific legislative instruments governing environmental protection matters at national level. The Constitution has several provisions which have direct policy, legal and institutional relevance for appropriate implementation of environmental protection and rehabilitation action plans targeted to avoid mitigate or compensate the adverse effects of development actions.

The Constitution thus contains a number of articles which are relevant to social and economic issues/objectives (such as, rights of women, children, labour & employment), environmental matters in connection with development projects in general, and the prominent Articles relevant for the proposed Subproject include the following:

- Article 44 states that all person have the right for a clean and healthy environment;
- Article 92, which sets out national policy principles and objectives, includes the following significant environmental objectives:
- 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;

14.3.2 Conservation Strategy of Ethiopia

The CSE is an important policy document, which views environmental management from several perspectives. In particular, it recognizes the importance of incorporating environmental factors into development activities from the outset, so that planners may take into account environmental protection as an essential component of economic, social and cultural development. The Conservation Strategy of Ethiopia (CSE) takes a holistic view of natural, human-made and cultural resources, and their use and abuse. It seeks to integrate into a coherent whole existing and future federal and regional government planning in all sectors that impinge on the environment, including agriculture, forestry, wildlife, fisheries, soils, water, minerals, energy, urban planning and cultural heritage conservation. A sound partnership has been sought between planners, decision makers and the Ethiopian people to manage Ethiopia's natural resources for the Ethiopian people and their children. Most sections, groups and classes of people have been consulted and have participated in the formulation of this strategy. The policy-making phase encompassed broad ranging discussions and a full debate at both federal and regional levels in order to arrive at a consensus

14.4 CROSS SECTORAL NATIONAL ENVIRONMENTAL POLICIES

14.4.1 Environmental Policy of Ethiopia

The Environmental Policy of Ethiopia (EPE) was approved by the Council of Ministers in April 1997. Its conceptual framework was based on the findings and recommendations of the National Conservation Strategy of Ethiopia. This policy document, along with CSE was developed with the assistance from the International Union for the Conservation of Nature (IUCN). EPE includes 9 policy objectives, 19 guiding principles, 10 sectorial and 10 cross-sectorial policies.

The EPE supports Constitutional Rights through its guiding principles. The overall policy goal is 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 sectorial environmental policies are; Soil husbandry and sustainable agriculture, Forest woodland and tree resources, Genetic species and ecosystem bio-diversity, Water, Energy, Mineral resources, Human settlement, urban environment and environmental health, Pollution from industrial waste and hazardous materials, Atmospheric pollution and climatic change, and Cultural and natural heritage.

The cross-sectorial environmental policies cover the following main areas/theme, such as, Population and the environment, Community participation and the environment, Tenure and access rights to land and natural resources, Land use plans, Social and gender issues, Environmental economics, Information systems, Research, Environmental impact assessment and Environmental education and awareness.

The implementation of transport infrastructures and operation of the system has a direct relation and impact on the sectoral environmental policies stipulated in the EPE.

Environmental Impact Assessment (EIA) policies are included in the cross-sector environmental policies. The EIA policies emphasize the early recognition of environmental issues in project planning, public participation, mitigation and environmental management and capacity building at all levels of administration. The policy establishes the Environmental Protection Authority (EPA) as the body to harmonize Sector Development Plans and to implement an environmental management program for the country. It also imparts political and popular support to the sustainable use of natural, human-made and cultural resources at the federal, regional, zonal, woreda and community levels.

The Environmental Policy of Ethiopia (EPE) and the 2002 Sustainable Development and Poverty Reduction Program (SDPRP) attribute the prevalence of poverty in part to low growth and low productivity of agriculture and to the populace's dependence on agriculture and natural resources. The EPE states that agriculture is the main source of variability and stagnation in economic growth (1997). As one of the most dependent countries on foreign aid, limited fiscal resources impact Ethiopia's ability to address these issues (ICNL, 2011). At the same time, as the current government of Ethiopia has only been in place since 1995, Ethiopia faces not only the economic development challenges of any low-income country, but also the challenge of creating a new government institutional structure so that it can best serve its citizens' needs. The manner in which environmental issues are addressed in the coming years will have a significant influence on the well-being of the Ethiopian people, and on surrounding nations whose ecosystems are “dynamically interlinked” with Ethiopia (McKee, 2007). In this context, the development of strong institutions and networks is a necessity to address environmental degradation and management of natural resources.

14.4.2 National and Regional Conservation Strategies

Since the early 1990s, the Federal Government has undertaken a number of initiatives to develop regional, national and sectoral strategies to ensure better environmental conservation and protection. Paramount amongst these was CSE, approved by the council of ministers, which provided a strategic framework for integrating environmental planning into new and existing policies, programs and projects. The CSE is an important strategy document which views environmental management from several perspectives. The CSE itself provides a comprehensive and rational approach to environmental management in a very broad sense, covering national and regional strategies, sectoral and cross-sectoral strategy, action plans and programs, as well as providing the basis for development of appropriate institutional and legal frameworks for implementation.

The plan comprehensively presented the exiting situation within the country and gave a plan of priority actions on the short and medium term. In particular, it recognizes the importance of

incorporating environmental factors into development activities from the outset, so that planners may take into account environmental protection as an essential component of economic, social and cultural development.

14.4.3 Policy on Biodiversity Conservation and Research and Development

One of the priority areas of national action towards the effective conservation, rational development and sustainable utilization of genetic resources is a national commitment to set out an appropriate government policy and subsequent action. To this end, the national policy on Biodiversity Conservation and Development is formulated based on the rationale that the conservation of biodiversity is one of the conditions of the overall socio-economic development and sustainable environmental management goals. Hence, because of its vital importance in the socio-economic wellbeing of the Ethiopia people, the conservation, proper management and the use of biodiversity need to be supported by policy, legislation and national capacity building. Based on that policy initiative, national biodiversity strategy and action plan was prepared by the Institute of Biodiversity Conservation (IBC) in 2007 to translate the policy objective in to action.

14.4.4 Cultural Policy of Ethiopia

Article 51/3 of the constitution of the FDRE declares that the Federal Government 'shall establish and implement national standards and basic policy criteria for the protection and preservation of cultural and historical heritage'. Based on this, the Council of Ministers of FDRE endorsed the cultural policy of Ethiopia in October 1997 and subsequently issued the Research and Conservation of Cultural Heritage Proclamation (Pro. No. 209/2000).

Protection and conservation of cultural heritage from manmade and natural hazards is one of the goals of the Authority for Research and Conservation of Cultural Heritage. Article 42 of the same proclamation states under “Reserved Area” that the Authority has the power of issuing building permission for any work to be carried out in an area declared reserve by the Council of Ministers. There is also an article that states the removal of any cultural ruins is to be carried out under strict supervision of the responsible authority, ARCCH in this case.

14.4.5 Ethiopia’s Green Development Initiatives

Building on the positive development of recent years, Ethiopia aims to achieve middle-income countries status by 2025 while developing a green economy. To this end, boosting agricultural productivity and strengthening the industrial base will be essential to reach to the intended goal.

Following the conventional development path would, among other adverse effects, result in a sharp increase in greenhouse gas (GHG) emissions and unsustainable use of natural resources. To avoid such negative effects, the government has developed a strategy to build a climate-resilient green economy (CRGE). The CRGE initiative follows a sectoral approach and aims at overcoming the challenges of developing a green economy. This strategy focuses on four pillars (including renewable and clean sources of power) that will support Ethiopia’s developing green economy. These are:

- Adoption of agricultural and land use efficiency measures.
- Increased GHG sequestration in forestry, i.e., protecting and re-establishing forests for their economic and ecosystem services including using them as carbon stocks.
- Deployment of renewable and clean power generation.
- Use of appropriate and advanced technologies in industry, transport, and buildings.

It is believed that establishing these pillars within the relevant parts of the economic development plan will prevent the economy from being locked into an unsustainable pathway and can help to attract the investment required for their development.

14.5 ENVIRONMENTALLY SENSITIVE AREAS IN ETHIOPIA

Simien Mountains National Park

This national park of 17,900ha occupies a broad undulating plateau of open grassy plains, and includes a wide altitudinal range between 1900m and 4624m, the highest peak in Ethiopia. The World Heritage Site covers an area of 22,000ha. The park was set up primarily to conserve the resident population of Walia ibex *Capra walie*, the spectacular scenery and principal catchment area of the Mayshasha River. Vegetation is a complex of Afro-alpine woodlands, heath forest and montane moorland, with high levels of plant endemism.

Abijatta-Shalla Lakes National Park

Over half of this park of 88,700 ha consists of lakes, including the shallow Lake Abijatta (19,600ha) and 260m deep Lake Shalla (43,200ha). The latter is an important wetland. Over 300 bird species occur, including lesser flamingo and a large breeding colony of threatened great white pelicans. Vegetation consists mainly of *Acacia* and *Ficus savanna*, with small areas of riverine forest; some lakes are edged with a nearly continuous bank of reeds.

Awash National Park

This is a 75,600-ha park completely surrounded by the Awash West Wildlife Reserve, and is located at the foot of the Shoa escarpment on the eastern edge of the Rift Valley where this opens out into the Danakil plains. The plains are traversed by the Awash River, and most of the area is covered by open, semi-arid savanna. In the south-west is a dormant volcano. Mount Fantalle (2005m), and hot springs surrounded by palm forest exist. Large herds of ungulates use the area, and threatened mammals include Grevy's zebra *Equus grevyi*, Swayne's hartebeest *Alcelaphus buselaphus swaynei*, leopard and cheetah. Lion occur, and the park also supports the Somali wild ass.

Babile Elephant Sanctuary

Covering an area of 698,200ha, this sanctuary was established in 1970 and was formerly known as Harar Elephant Sanctuary. Part has been proposed as a World Heritage site covering 650,000, 400km west of Addis Ababa between 1000m and 1788m above sea level. Semi-arid *xerophilous* woodlands are inhabited by elephant, possibly a distinct subspecies *Loxodonta africana orleansi*.

Bale Mountains National Park

This is a high, rugged, once-glaciated mountain area of 247,100ha completely surrounded by Bale Wildlife Reserve, at elevations up to 4317m. It is an important water catchment area for four major rivers, and includes a high-altitude plateau dotted with permanent lakes. The park's main purpose is to provide a refuge for mountain nyala *Tragelaphus buxtonii*, and to preserve the area's outstanding natural beauty. The vegetation is extremely varied, ranging from Afro-alpine moorland at high altitudes

(the largest area in Africa) through ericaceous moorlands and *juniper-Hagenia* forest to grassland and marshes.

Kuni-Muktar Mountain Nyala Sanctuary (IUCN Category II)

Montane dry evergreen forest, dominated by *Juniperus/Podocarpus*, high altitude grassland and heath. Important for the conservation of Mountain Nyala and Menelik's Bushbuck.

Mago National Park

Part of the Omo-Tama-Mago complex of contiguous protected areas, Mago National Park covers an area of 216,200 ha. Much of the park is a flat valley floor where open broadleaf savanna

predominates, whilst thorn bush growing on the dryer valley floor merges into riverine forest in the south. The park was created mainly to conserve the large numbers of plains wildlife in the area, and is particularly important for buffalo and *Beisa oryx*. Endangered mammals include elephant, leopard and African wild dog. Access is difficult, and recent information on the status of the area is scarce.

Nechisar National Park

Covering 51,400 ha this park primarily comprises grassy plains transected by several rivers, areas of rocky ridges and Lake Haro Robi. Some savanna woodland and lakeshore riverine forest occurs, as does highland forest in the east. The area was set up because of its prolific wildlife.

Omo National Park

Part of the Omo-Tama-Mago complex of contiguous protected areas, Omo covers an area of 406,800ha. The park is dominated by three open grassy plains, separated by rocky ridges and drained by tributaries of the Omo. The vegetation is mainly Acacia scrub savanna. The park was set up to preserve this extensive area of wilderness and the prolific plains wildlife, especially common eland and elephant. There are large herds of buffalo, and giraffe, leopard, lion and African wild dog occur.

Senkelle Swayne's Hartebeest Sanctuary

This 5400ha area consists mainly of open grassland with some Acacia stands, and was set up to save the most viable population of the endemic and endangered Swayne's hartebeest *Alcelaphus buselaphus swaynei*, which numbered over 2000 in 1989.

Yabello Sanctuary

Established in 1985, this sanctuary covers 253,700ha about 550km south of Addis Ababa. Altitudes range from 1430m to 1800m. Situated in the savanna of the south-east highlands, it was established to protect Swayne's hartebeest *Alcelaphus buselaphus swaynei*.

Yangudi-Rassa National Park

This is a low-lying area of 473,100ha located between Gewane and Mille Sardo wildlife reserves and Afdem-Gewane Controlled Hunting Area. Most of the area is flat, and covered with open grassland, savanna and riverine forest. It was set up primarily to conserve a population of Somali wild ass. Other mammals include Grevy's zebra, cheetah and leopard.