ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

SCHOOL OF COMMERCE

ASSESSMENT OF LOGISTICS SYSTEM ENGINEERING & EVALUATION OF INTEROPERABILITY & PERFORMANCE OF RAILWAY TRANSPORT, IN THE CASE OF ETHIO –DJBOUTI RAILWAY TRANSPORT SHARE COMPANY/EDR/

Thesis submitted in partial fulfillment of the requirements for the Degree of Master of Arts/ M.A/ in Logistics and Supply Chain Management/LSCM/

BY

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APPROVEDBYBOARDOFEXAMINERS

Advisor	**Signature**	**Date**
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Declaration

I, the undersigned, declare that this thesis entitled as "ASSESSMENT OF LOGISTICS SYSTEM ENGINEERING & EVALUATION OF INTEROPERABILITY & PERFORMANCE OF RAILWAY TRANSPORT, IN THE CASE OF ETHIO –DJBOUTI RAILWAY TRANSPORT SHARE COMPANY/EDR/ "is my work and has not been presented for the award of any degree or diploma in this or any other university. All sources of materials used in the thesis have been accordingly acknowledged.

Declared by: - Mekonnen Getachew Asfaw

Signature: _____

Date: January,2022 Place of Submission: Addis Ababa University School of Commerce, Addis Ababa, Ethiopia

December, 2021

StatementofCertification

This is to certify that this thesis entitled as "ASSESSMENT OF LOGISTICS SYSTEM ENGINEERING & EVALUATION OF INTEROPERABILITY & PERFORMANCE OF RAILWAY TRANSPORT, IN THE CASE OF ETHIO –DJBOUTI RAILWAY TRANSPORT SHARE COMPANY/EDR" ,submitted in partial fulfillment of the requirements for the degree of Master of Arts in Logistics and Supply Chain Management to the School of Commerce of Addis Ababa University, done by Mekonnen Getachew Asfaw is an authentic work carried by him under our guidance.

Busha Temesgen (Ph.D) Addis Ababa, Ethiopia

Advisor's Place

Acknowledgement

I am gratified to the God for giving me the courage to finish this study. Firstly, I would like to thank my Advisor Assistant professor Busha Temesgen (Ph.D) for his constructive suggestions and useful comments. My gratitude also goes to Ethio – Djibouti railways managements and staff those who gave me the required data from sample determination and support in the collection of data.

Finally, my gratitude goes to my mom Almaz Bobale and my son Nobel Mekonnen for making me sacrifices over the past three years, by allowing me the time to conduct this master's degree program and care during my study.

I dedicate this thesis for those people who have lost their life due to the current war in the northern part of our country and ENDF who defend our country Ethiopia.

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Abbreviations and Acronyms

AVE:- Average Variance extracted
CCECC-China Civil Engineering Construction Corporation

CREC-China Railway Engineering Group Limited

CR:- Composite Reliability

EDR-Ethio-Djibouti Standard Gauge Railway Transport Share Company

EDI:- Electronic Data Interchange

ELS- Effectiveness in Logistics System

ERC-Ethiopian Railways Corporations

ERLT-1 Efficiency in Rail Logistics Transport

ERT-2 Effectiveness in Rail Transport

EMAA- Ethiopian Maritime Affairs Authority

ESLSE-Ethiopian Shipping and Logistics Service Enterprise

ERCA:- Ethiopian Revenue and Customs Authority

I:-Interoperability

IT:- Information Technology

IRT-Integration of Rail Transport Service

JV-Joint Venture

TFLP-Transport Financing in Logistics Performance

MOTL- Ministry of Transport and Logistics

PLS-Partial Least Square

SPSS-Statistical Package for social Science

SCM- Structural Equation Modeling

SQC:- Service Quality and Competence

RII-Relative Importance Index

TSI:- Technical Specification of Interoperability

ABSTRACT

Assessment of Logistics system engineering, evaluation of Interoperability and evaluation of logistics performance ,the case of Ethio – Djibouti railways transport service in terms of World Bank logistics performance index were examined. The study assesses the effects of logistics system engineering, Interoperability, efficiency, service quality & competence of logistics service, effectiveness as well as Logistics Performance of rail transport. This study was conducted to assess logistics system engineering, interoperability, rail transportation service on logistics performance using eight dimensions of the problems are assessed and evaluated. The eight dimensions used are , Interoperability, Logistics system engineering, transport financing and logistics performance, service quality and competency of logistics activity, efficiency and effectiveness; and integration of railway transport service. The operations attributed to these logistics performances are cost and speed. The study adopted more the descriptive and explanatory research design in obtaining information about the study topic. The study's population comprised of EDR/MC local, ESLSE, EMAA, MOTL and ERC staff which were selected in stratified sampling techniques approach. The study approach was both quantitative and qualitative research approach. Questionnaire survey has been conducted on a total of 52 respondents from EDR/MC local, ESLS, EMAA, MOTL representative to model the cause factors of assessment and evaluation of logistics performance using Partial Least Square (PLS) approach via Smartpls V3 software package, to assess the assessment and evaluation of logistics performance and rank the major impacts of logistics performance using Relative Importance Index (RII). In addition, a detailed archival document review was conducted to get the actual essence of assessment and evaluation of logistics performance of EDR . Based on the statistics the correlation analysis, it shows that rail transport service quality and Competence/SQC/ have statistically very extent effect on the logistics performance.

Key Words:-Interoperability, System Engineering, Logistics Performance, Efficiency and Effectiveness, Relative Importance Index, Partial Least Square-Structural Equation Modeling PLS.

CHAPTER ONE

INTRODUCTON

1.1 Background of the Study

A life-cycle orientation is required, addressing all phases to include system design, development, production, and/or construction, distribution, operation, sustaining support, and retirement and phasing-out. Characteristics of system Engineering focuses on the initial identification of system requirements**.** A better and more complete effort is required relative to the initial identification of system requirements. Relating these requirements to specific design goals, the development of appropriate design criteria, and the follow-on analysis effort to ensure the effectiveness of early decisions in the design process.(Blanchard, System Engineering) Interdisciplinary or Cross-functional approach is much essential in railway transport industry like EDR**.** An interdisciplinary effort (or team approach) is required throughout the system design and development to ensure that all design objectives are met in an effective manner.(Sewing Hyun Lee) This necessitates a complete understanding of the many different design disciplines and their interrelationships, particularly for large projects.

Efficient international railway transport depends in part on high level of interoperability among the railways. Interoperability of railways, however, is a very broad concept and its implementation requires the cooperation of many entities, large budgets and a long time, it is very important for the involved countries to define as precisely as possible the level of interoperability they intend to achieve, most likely in a gradual approach. (M.Chaberek)

This study details three main components of railway interoperability (a) unified contractual obligations vis-a-vis customers from origin to destination (or the legal interoperability) (b) common technical parameters of railways infrastructure and rolling stock (or the technical interoperability) (c) harmonized operational practices over an entire international route (or the operational interoperability).(Grazyana Karkawacka)

Logistics plays the most significant role in the supply chain operation. The council of logistics management defined logistics as part of the supply chain process that plans, implements, and controls the efficient, effective forward and revere flow and storage of goods, services, and

related information between the point of origin and the point of consumption in order to meet customers' requirements. In the whole logistics activities transportation service plays the most important and significant role over the logistics performance. Transportation ensures efficient product delivery to the final consumer and that the ultimate customer needs are served better, and the organization yields maximum returns (Shankar 2001). Rail transport is one of the most important modes of transport which plays major role in the logistics activities.

In Ethiopia rail transport has been providing service since the 1910s, granted that there was only one railway line. The Ethio-Djibouti railway line was the only rail transport the country had. While the total distance covered by the line was 781 Km, the 681 Km-stretch lies within Ethiopian territory. According to Fetiha (2018), more than 90% of the Ethiopian cargo is handled by the port of Djibouti and agreement is made on the port utilization between Ethiopia and Djibouti. Ethiopia has also signed bilateral port utilization agreements with Djibouti and Sudan and signed memorandum of understanding between Somaliland and Kenya to use port Djibouti, Sudan, Barbara and Mombasa respectively.

As cited on Fasil (2014), Railways freight and passenger transport service is vital to the Ethiopian economy. According to Fasil Rail freight has a serious advantage on freight and passenger's transportation including larger capacity, chipper transport cost, high efficiency, low carbon, suitable for bulky and heavy goods, free of climate and geographical condition comparatively. A well-operated railways logistics system could increase the competitiveness of the public and privet enterprises and attracts foreign direct investment.

1.2 Statement of the Problem

In this thesis the researcher believes that, since working closely with the railway sector, to change and improve three things, the logistics system engineering, the interoperability and if logistics performance evaluated and well integrated, the efficiency ,effectiveness and competence of EDR could be profitable and could return sovereign guaranteed debt and manages itself perfectly, then from the researcher back ground and working closely the researcher observed some logistics system engineering problems that 'the effective application of scientific and engineering application efforts to transform an operational need into a defined system configuration through the top-down iterative process of requirements analysis, functional analysis, allocation, synthesis, design optimization, test and evaluation. These gaps are detected

by not utilizing the rolling stocks except 300 flat wagons for containers loading and 50 covered wagons but the rest out of 1152 wagons of different types are not working since procured for large amount of hard currency, for instance 110 Oil-tank wagons are out of work in Diredawa for 5 years but now the oil storage depot is under construction and in near future can be in use, the other is 7 kms is not completed with last freight station in Djibouti and Negad port that takes 4 days by trucks to load all 53 wagons mounted to one locomotive, except Modjo dry port the whole line doesn't have interface with rail industrial links. I hope my study on this issue will show the solution to rectify things by developing logistics system engineering that may solve all these and several inter-related problems to make the EDR railway transport efficient and effective regardless of the fraud on trucks owners' competition.

Despite the challenging environment, after 3 years of hard work, SGTD (Societe de Gestion du Terminal a Contener de Doraleh) Doraleh container terminal team achieved the African best performing container terminal-according to container port performance Index (CPPI) review compiled by the WB and American-British firm ,HIS Marki ranking of Ports by WB. But not interfaced with EDR and this time at the fourth year of EDR operation the design was 6 times per day to transport by rail trailing 53 wagons each, each side and as is clear export is poor and one-way.

Characteristics of System Engineering.▪ Focus on the initial identification of system requirements.

A better and more complete effort is required relative to the initial identification of system requirements. Relating these requirements to specific design goals, the development of appropriate design criteria, and the follow-on analysis effort to ensure the effectiveness of early decisions in the design process are characteristics of system engineering.

Preliminary Design.- Identification of alternative system operational functions and sub-functions and maintenance functions.- The allocation of requirements from the top-level system to the various subsystems in terms of performance and effectiveness requirements and system supportability.

System optimization through evaluation of system alternatives involving reviewing the trade-offs within each system as compared with other systems.- System synthesis and definition involving putting together the proposed system in analytical form or in a physical model based

on detailed specifications., tried to contribute in this thesis the solutions to alleviate problems and integrate the operation.

Cost Effectiveness in System Engineering.-

The greatest impact on life-cycle cost and maintenance/support cost can be during the early phase of design and development. In other word, logistics and the design for supportability must be inherent within early system design and development process if the result are to be cost-effective.

The Logistics Support Analysis (LSA)

An iterative analytical process by which the logistics support necessary for a new (or modified) system is identified and evaluated

.▪ **Concurrent/ Simultaneous Engineering (CE).**

A Concept that refers to the participation of all the functional areas of the firm in the system engineering are concurrent.

▪ **Software Engineering.**- Software that is included as a mission-related component of the system and is required for the operation of that system.- Software that is required to accomplish maintenance functions on the system such as diagnostic routines and condition monitoring programs.

Software that is required to support program-oriented activities such as the software associated with various computer-based models used for design analysis for **Design for Reliability, Maintainability & Availability.**

For two or more systems to be interoperable, they must be able to exchange, interpret, and present shared data in a way that is understood by the other. This is accomplished with the establishment of syntactic interoperability, which involves adopting a common data format and common data structure protocols, followed by semantic interoperability, which involves the addition of metadata that links each data element to a controlled, shared vocabulary. Within this shared vocabulary are associated links to ontology, which is a data model that represents a set of concepts within a domain and the relationships among those concepts.

While both integration and technological interoperability involve connecting applications and facilitating data transmission, the main difference is in how the different systems communicate.

Interoperability is the real-time data exchange between different systems that speak directly to one another in the same language, instantly interpreting incoming data and presenting it as it was received while preserving its original context.

Integration refers to the process of combining multiple applications to function together as one uninterrupted system, often involving the use of middleware. Integration provides an environment in which a series of products can talk to each other in their current state while also maintaining compatibility with future versions of each product - in contrast, interoperable systems will lose their interoperability in the event of a system change or upgrade. Most industries, that do not require interoperability, exchange data as a result of data integration to operate the system of logistics.

According to Brooks (2008) trade networks demand superior logistics services and centers. Brooks (2008) also stated that, minimizing time and costs while ensuring reliable delivery of goods depend on an efficient logistics system. These rail transportation infrastructures have resulted in higher cost of transportation and delays on both the freight and passengers movement as referred to the standard.

1.3 Research Questions

The research will answer the following:

i. How system engineering related to rail transport affects the logistics performance in EDR?
ii. How the legal, technical and operational interoperability among rail transport infrastructure affects logistics performance in EDR?
iii. How to bridge the gap between engineered logistics management system and semi-engineered system in rail transport affects the logistics performance and efficiency?
iv. How the marketing in export service quality & competency of freight logistics service in rail transport affects the logistics performance?
v. How interoperability in IT system and technology in tracking and tracing in a rail transport affect the logistic performance in EDR?
vi. How interoperability in rail transport service affect the logistics effectiveness?
vii. How the national logistics strategy (2018-2028) The railway transport sector by Ministry of Transport/MoT/ is going to be evaluated if it incorporates the above?
viii. How the financial model for EDR, benchmark OpEx trend analysis is working in debt repayment schedule affects the logistics performance?

1.4 ResearchObjectives

1.4.1 General objective

Assess the lack of interoperability and not well engineered logistics system factors affecting railways transportation service in logistics performance in the EDR and to bridge the gap between un-engineered and engineered logistics system that leads to well interoperable, efficient ,effective (marketing in export) and more profitable railway transport business that enables return the huge sovereign guaranteed loan before break-even, and the infrastructure and rolling stock needs major maintenance that needs huge investment, and of course it should be mentioned as ten years strategy in transport policy by MoTL since among 44 projects published two-third of them are directly or indirectly related to railway transport system including one-third of three trillion ETB budget allocated .

1.4.2 Specific objective

The specific objective is to assess the following main factors:

i) Evaluates logistics system engineering related to rail transport affects the logistics performance in EDR.

ii) Assess the semi-integrated interoperability of rail transportation infrastructure affects logistics performance in EDR.

iii) Assess the gap to bridge to well engineered logistics system in rail transportation affects the logistics performance and efficiency, example loading of 53 flat wagons takes 4 days because the Doraleh and Negad port and the railway freight station are not connected/interfaced 7kms.

iv) Assess the marketing in export service quality & competency of freight logistics service in rail transport affects the logistics performance in EDR taking as an example only 2-5 wagons among 53 are loaded when the train return to Djibouti, export is poor on trade imbalance of 2.8/21.5 Bln Export Import ratio according to WB report and unnecessary competition between trucks and train.

v) Assess how interoperable in IT System and technological compatibility of tracking and tracing in a rail transportation affect the logistic performance in EDR.

vi) Assess the extent of integration/interoperability of rail transport service system affect the logistics performance.

vii) Evaluates the national logistics strategy (2018-2028), designed by the railway transport sector by Ministry of Transport/MoT/.

viii) Assesses the financial model in loan repayment schedule for break-even, infrastructure &

rolling stock depreciation, interest expense and foreign exchange losses from point of benchmark OpEx trend analysis.

1.5 Significance of the Study

The study is beneficial for top management in railway transport sector, employees of the company, new researchers, policy makers, management contractors, importers and exporters, investors and all stakeholders of EDR, the regulatory body and Logistics and Railway Transport Division in the Ministry of Transport. It helps the executive bodies to assess the factors affecting of rail transport on the countries logistics system engineering, lack of interoperability, logistics performance, and take a corrective action to engineer logistics system, to improve interoperability and the logistics performance level of Ethiopia. Moreover, the research provides the major determinant factors affecting the logistics activity and interoperability.

1.6 Scope of the Study

The scope of this study is mainly focused on assessment of logistics system engineering practice, the interoperability of railway transport and evaluation of logistics performance of the EDR with the aim of identifying the presence and cause of inefficiency in the EDR railway operation. Furthermore the research goes on to identify mitigation measures being implemented to reduce the presence of ineffectiveness and inefficiency that shown after 4 years the freight transport capacity according to design by /MC/JV it should be 2.5 Million Tons per year but this year 1.45 Million Tones(EDR report 2020) only and before it was 845,000 tons(EDR report 2018) and this study will evaluate freight operation performance and will indicate solutions to enhance its performance by improving its interoperability and logistics system..

1.7 Limitation of the Study

In the study the researcher use questioner for collecting data hence limitations on the respondents might replay based on their own perception and subjectivity which is not acknowledged. The study will only focus on the managers and major stakeholders of Ethio- Djibouti railways Share Company. Since the establishment of the company is not much longer, there might be shortage of sufficient information and archive data.

1.8 Definition of Terms

System Engineering:-As IEMS/International Engineering Management System/ research center definition System Engineering is an aggregation or assemblage of objects united by some form of regular interaction or interdependence: A group of diverse units combined by nature or art as to form an integral whole, and to function, operate, or move in unison and, often, in obedience to some form of control; an organic, or organized whole.

Interoperability:-*European Parliament and Council Directive 2001/16/EC* defines interoperability is the real-time data exchange between different systems that speak directly to one another in the same language, instantly interpreting incoming data and presenting it as it was received while preserving its original context.

.**Logistics: -**Council of Logistics management (1991) defined that logistics is 'part of the supply chain process that plans, implements and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.

Integration:-EU directive (2008) refers to the process of combining multiple applications to function together as one uninterrupted system, often involving the use of middleware. Integration provides an environment in which a series of products can talk to each other in their current state while also maintaining compatibility with future versions of each product - in contrast, interoperable systems will lose their interoperability in the event of a system change or upgrade. Most transport industries that do not require interoperability, exchange data as a result of data integration are not efficient and effective.

Logistics Performance: -According to Chowet al. (1994) conceptualized that logistics performance is a subset of a larger organizational performance. According to Fugate et al. (2010) the concept by highlighting that logistics performance positively impacts organizational performance.

Efficiency:-The ratio of resources utilized against the result derived (Mentzer and Konrad, 1991) the internal functioning of logistics and generally is considered best represented through some ratio of the normal level of inputs to the real level of outputs Chamberlain (1968); Van der Meulen and Spijkerman, (1985). The measure of how well the resources expended are utilized (Fugate et. al.2010).

1.9 Organization of the Study

The research comprises of five chapters. Chapter one is the introductory chapter, which provides basic information about the study, including background and statement of the research problem, research objectives and scope and limitations of the research. Chapter two presents theories and discussions related to cause factors which assesses impacts of logistics system engineering, interoperability, and efficiency, competence, effectiveness and integration management aspects of logistics system performance guide books and overview of the Partial least square –Structural Equation Modeling (PLS-SEM) approach. Chapter three covers the research methodology followed in order to achieve the objectives of the study. It presents an overview of the research design, sources of data and research instruments, research sampling and sample size determination and method of analysis. Chapter four presents analysis of the research data obtained from the questionnaire survey and archival documents were discussed accordingly. The last chapter, which is chapter five, is devoted to the author's conclusions and recommendations.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

The literature review of this study has theoretical literature review, empirical Literature review and conceptual framework review parts. The theoretical part presents the summary of theories forwarded by different scholars pertaining to the subject under study at different times. Whereas the empirical part contains summary of similar or related research findings obtained from other earlier research and conceptual review part is the sum of both theoretical and empirical review parts.

2.1 Theoretical literature

2.1.1 Logistics

Logistics is that part of the supply chain process that plans, implements and controls the efficient, effective flow and storage of goods, services and related information from the point-of-origin to the point-of-consumption in order to meet customer requirements and satisfies the requirements imposed by other stakeholders such as the government. (Cooper et al., 1997).Specifically, logistics affects trade performance of a country in terms of cost, time, reliability and predictability and customer services, which further affect overall competitiveness of the export in the international market other things being constant Arvis et.al (2007).

In the context of Ethiopia, government practiced many reforms in response to changes in the economy specifically the country issued proclamations, deregulated the transport sector, merged logistics enterprises, restructured customs Authority, contracted railway lines and established dry ports connected by railway, which are the major move in the country that gave recognition to trade logistics. (The Global Competitiveness Report, 2010)

Definition of System An aggregation or assemblage of objects united by some form of regular interaction or interdependence : A group of diverse units combined by nature or art as to form an integral whole, and to function, operate, or move in unison and, often, in obedience to some form of control ; an organic, or organized whole.

Different Systems.▪ Natural and man-made system.▪ Physical and conceptual systems. Physical systems are those made up of real components occupying space. On the other hand, conceptual systems, constitute an organization of ideas, a set of specifications and plans a series of abstract concepts, and so on.

▪ **Static and dynamic systems** Static systems include those having structure, but without activity as viewed in a relatively short period time. A dynamic system is one that combines structural with activity.

▪ **Closed and open-loop systems** A closed system is one that is relatively self-contained and does not significantly interact with its environment. Conversely, open-loop systems interact with their environment.

Endogenous vs. Exogenous Variables

▪ **Endogenous Variables.**- A variable whose value is determined by relationships included within the system.- The term endogenous is used to describe activities and events occurring within a system.

▪ **Exogenous Variables.**- A variable whose values are determined by considerations outside the system.- The term exogenous is used to describe activities and events in the environment that affect the system.

Definition and Objectives of System Engineering

▪**Definition** The effective application of scientific and engineering needing efforts to transform an operational need into a defined system configuration through the top-down iterative process of requirements analysis, functional analysis, allocation, synthesis, design optimization, test and evaluation.

▪ **Objectives of System Engineering**

1. Transformation of an operational need into an integrated system design solution through concurrent consideration of all life-cycle needs.

2. Ensure the compatibility, interoperability, and integration of all functions and physical interfaces and ensure that system definition and design reflect the requirements of all system elements.3. Characterize and manage technical risks.(Blanchard, System Engineering)

2.1.2 Interoperability

The creation of a single railway market in the EU and the introduction of competition between railway operators on the railway infrastructure is not possible without establishing interoperable railway system of European countries. The uninterrupted or continuous train traffic throughout the European railway network requires compliance characteristics of the infrastructure and vehicles and efficient interconnection of the information and communication system infrastructure managers and operators on the network. From this compliance and interconnection

depends on the efficiency and competitiveness of railways in the transport market. In doing so, interoperability refers not only to the harmonization of technical capacity between the elements of the railway system, but this concept also includes the legal and of organizational harmonization according to TSI/ Technical Specification of Interoperability

Logistics is very strongly linked to the concept of integration. Integration is a fundamental process of economic co-operation within countries and regions, an objective and a tool for cooperation within the European Union. Logistics cannot be operated in efficient way without integrated activities across all levels and across all components of logistics systems[5]. A rail transport is an important part of the European logistics system. It is co-responsible for the physical implementation of EU rules on free movement of goods and services. Rail transport is a component of the internal market in logistics services. The process of standardization, interoperability and finally the integration is a direct result of the provisions included in the Treaty on European Union (TEU) establishing the European Community (in particular Article. 71 and 156), which aim is to enable the Union citizens, entrepreneurs and regional and local authorities to participate in total benefits of establishing an area without internal borders. The tasks of interoperability, are specified in art. 155 of the TEU. Furthermore, on 12 December 1997 was signed the Kyoto Protocol, where the European Union committed itself to reducing greenhouse gas emissions in the closest future. Transport is a major emitter of these gases. Railway transport has the essential advantage at that aspect and the interoperability of rail is a way to increase this advantage.

2.1.3 Evaluation between Rail transport system and Logistics performance

Ethiopia is one of the land locked country in east Africa. In this sense, the rail transport and logistics network are the back bone of the country's economy. Efficient Rail freight transportation is critical to countries economic development (IJEDR, 2018). IJEDR (2018) states ,the availability of rail transport infrastructure and services affects national and global development patterns and can be a boost or barrier to economic growth.

According to IJEDR (2018) an important lesson from successful railways is the focus on improving operational efficiency and taking a holistic view of logistics from the perspectives of passengers, freight forwarders, and third-party logistics providers (3Pls) IJEDR (2018). Doing so requires an understanding of the drivers of logistics performance for specific segments of the economy. As it is cited on the journal, various studies show that reliability of service, price, travel time, flexibility of

service, and control and security are critical. Bernard, (2019) for rail to be part of a holistic logistics service, rail organizations must cultivate a reputation for efficient, competitive, and reliable services.

Several literatures have explained rail transport modal as useful, cost effective, time management, efficient, and play a great effect to logistics performance and economic developments. The explanations clarify that the integration is primarily an intermodal facility where the modes of rail, road and shipping converge to facilitate the loading and unloading of cargo from ships onto and from road and rail trucks. According to Foolchand, (2006), the efficiency of operations determines the adequacy of infrastructure that is provided. Its successful demand the technological improvement in shipping especially through containerization, revolutionized ship design, cargo handling equipment, intermodal facilities, road and rail transport, port design, port investments and inland transportation. Efficient intermodal facilities mean that larger vessels can call only at a few ports known as hub ports where large volumes of containers would be consolidated by land transport, barges and small feeder vessels. Dedicated rail and road terminal facilities in the vicinity of the quayside are required to facilitate the efficient transfer of goods to and from ships.

1.2.4 Strategy and Railways transportation services:

Strategy emphasizes on making the country logistics service and processes effective, efficient and integrated. This is one of the key issues in the process of transforming the country's logistics service providers to deliver complete and well-integrated service to exporters and importers by establishing an efficient and effective logistics system, transforming EDR, EMAA and ESLSE's service delivery system and its structure, strengthen the capability of logistics service providers and enhance transport capacity.(FDRE National Logistics strategy /2018-2028/)

Train as one of modes of transport has various advantages compared to other modes. In addition to the large carrying capacity, train is also more energy efficient and environmentally friendly as well as safer than other land vehicles. Train is a choice of mode which may address various current issues related to transportation encountered by the government of Ethiopia, namely, among other things, (i) many damaged roads; (ii) traffic jam due to the increasing volume of traffic; and (iii) increase of fuel price leading to the increase of transportation costs.

Inter-modal competition; Air, water and road (trucks and cars) transport are all potential alternatives to the use of the railway. The extent of substitutability between these modes of transport, and hence the level of inter-modal competition railway services face, depends on the geographic, demographic and economic features of different countries and the availability of these different modes. It also varies considerably between freight and passenger services.

Generally, rail can offer faster and better service in suburban markets where road congestion is significant and parking at destination is costly. High-speed rail (HSR) services occupy a natural market starting at distances (~150 km) where their speed dominates the ready availability and flexibility of autos, but below distances (~800 km), where airplanes‟ higher speed eventually takes over. In addition, rail services can generate significant social benefits, such as lower highway or air congestion, reduced emissions of pollutants and greenhouse gases, higher land use density, easier access to city centers and lower accident rates. As a result, because market forces will normally not internalize those benefits, governments can intervene either directly through financial support, or indirectly through regulation, to influence the pattern of services that the market would otherwise provide. It is important to highlight that substitutes for the rail mode – in

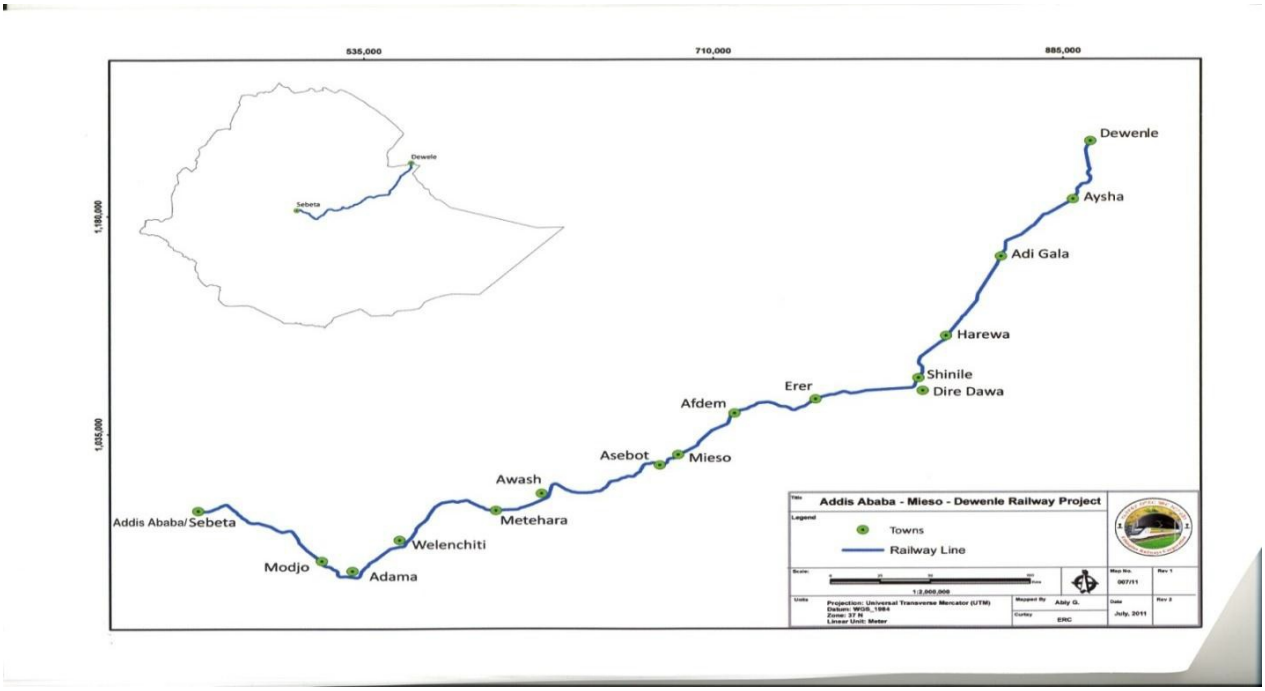
particular road transport, but also airlines – often do not face efficient usage and capacity charges for a number of policy and political reasons and this affects, and distorts, inter-modal competition.

The regulator of railway industry in Ethiopia is the government, namely the Ethiopian Railways Corporation under the Ministry of Transportation. This corporation was established on 28 November 2007 by Regulation 141/2007 of the council of ministers of the Federal Democratic Republic of Ethiopia which expressly separates the regulator from the operator. The corporation has various mandates to develop railways infrastructure and provide passenger and freight transportation service in Ethiopia.

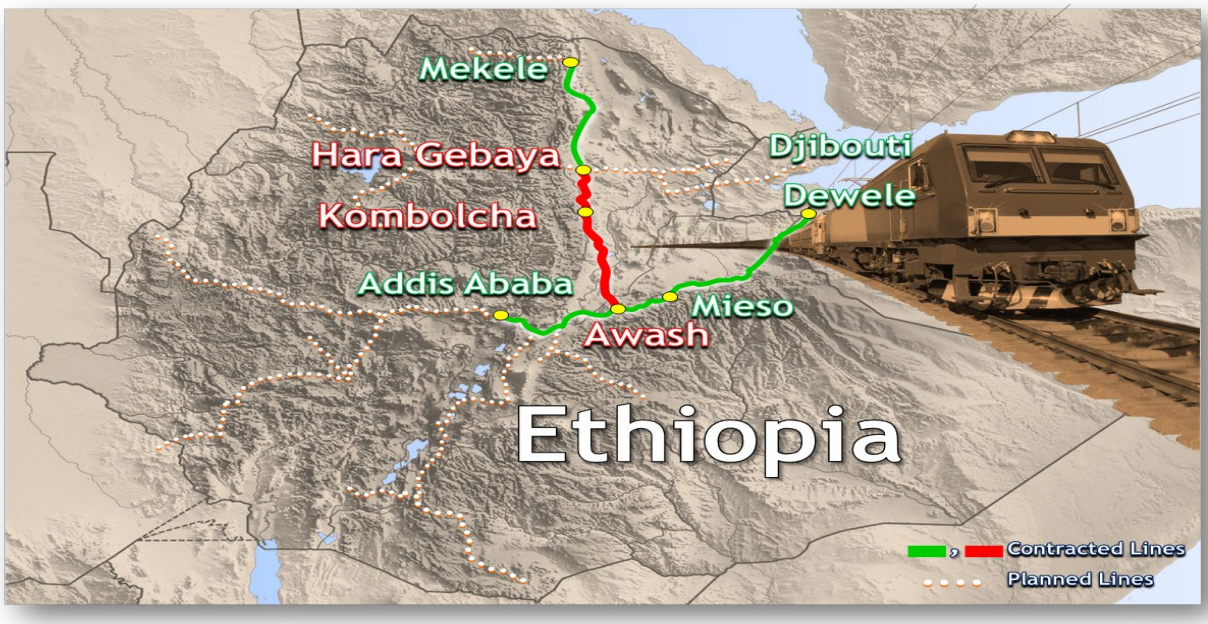
EDR was established for the purpose of Operating and maintaining the (Addis Ababa – Djibouti Standard Gauge Railway) Line (including the maintenance and renewal of all the Line infrastructure and equipment) and operating freight and passenger transport services on the Line. Following the decisions of the Board of Directors, EDR had commenced the Operation and Maintenance activities of the Railway after a general takeover agreement between the EDR and the respective Railway Company ERC. In the general takeover agreement that had been signed on December 31, 2017 between the parties, it had been declared that the two state Railway Companies would hand over the completed railway infrastructure and the Rolling Stocks on or before March 31, 2018.

(Regassa,Getu2020)

Figure1Map ofEthio–Djibouti Railways



Source: Ethiopian Railways Corporation (ERC)



Source: Ethiopian Railways Corporation (ERC)

Based on the annual report of EDR (2018), the general conditions of facilities in Addis Ababa – Djibouti Railway includes Permanent way (Track), bridges, culverts, tunnels, and buildings and structures (indoor water and power supply).

i. **Permanent Way(Track):**The main line in Ethiopia is 670.7 km long and the station line is 60.8 km; the main line in Djibouti is 81 km long and the station line is 22.5 km (including the port branches).

ii. **Bridges, culverts and tunnels:** The number of 854- hole bridges and culverts in the Ethiopian territory is174 and 1215, plus a 100m open cut tunnel; there are 18 bridgeswith89holes and 120 culverts in Djibouti;

iii. **Buildings and structures:** There are 189 buildings totally 33,626m^2 at the SEBETA-MIESO station yard and 46 buildings totally 15,290 m^2 at the MIESO-NAGAD station yard.

iv. **Traction power supply system:** Traction power supply and contact system are converted to1, 797.6 kilometers. There are 18 traction substations and 3 sub-section stations at the Ethiopian section, and 3 traction substations at the Djibouti section. The construction length of the contact system line is 114.72 km for double line segment and 636.98 km for single line segment.

v. **Communication information system:** It includes wireless train dispatching system, digital dispatching system, transmission system, switch access system, passenger ticket system, etc , totally 727.85 km long communication lines along the railway.

2.1.5 Relationship among Logistics system Engineering, Interoperability, performance of rail transport operation and 10 years Ethiopian logistics Strategy (2018-2028)

The FDRE national logistics strategy(2018-2028) which was published recently states several solutions and provides systemic logistics solutions to enhance logistics performance based on global institutional reports and contains many important points in Ethiopian logistics and supply chain industry but must add and interoperable rail transport system engineering and its components interoperability, and therefore should be evaluated its logistics performance in times of monopoly by ESLSE the transport and logistics performance that enable the huge loan taken from foreign banks return as per ten years break-even time and be profitable, effective, efficient and well integrated to be self reliant company.

Rolling Stocks Takeover Status

The total rolling stocks purchased by ERC and presented to EDR as kind contribution during the formation of EDR a represented in the table below:

Table 2.1 Total rolling stock purchased by ERC

No.	Item	Qty/Units
1	**Freight Electric Locomotives**	**32**
1.1	Spare Parts for Freight Electric Locomotives	1Set
2	**Passenger Electric Locomotives**	**3**
2.1	Spare Parts for Passenger Electric Locomotives	1Set
3	**Freight Wagons**	**1100**
3.1	Box Wagon	220
3.2	Uncovered Wagon	20
3.3	Covered Wagon	110
3.4	Hopper Uncovered Wagon	20
3.5	Hopper Covered Wagon	20
3.6	Flat Wagon	550
3.7	Refrigerated Wagon	10
3.8	Tank Wagon	110
3.9	Centre beam Wagon	20
3.10	Bi-Level Wagon	20
3.11	Spare Parts for Freight Wagons	1Set
4	Passenger Coaches	30
4.1	Hard Seat Coach	20
4.2	Hard Sleeper Coach	4
4.3	Soft Berth Coach	4
4.4	Dinner Coach	2

4.5	Spare Parts for Passenger Coaches	*1*
5	Diesel Shunting Locomotives	6
5.1	Spare Parts for Diesel Shunting Locomotives	*1*
6	**Simulator**	**1**
6.1	Spare Parts for Simulator	*1*
7	**Training Package**	**1Set**

Source: Ethio-Djibouti Railway report(EDR2019)

The following Rolling Stocks had been taken over from ERC as of December31,2019:

Table2.2 the rolling stock that had been taken over from ERC

No.	Item	TotalQty
1	Freight Electric Locomotives	32
2	Passenger Electric Locomotives	3
3	Diesel Shunting Locomotives	6
4	Passenger Coaches	30
5	Freight Wagons	
5.1	Flat Wagons	330
5.2	Box Cars	110
5.3	Tank Wagons	20
	Total taken-over Rolling Stocks until 2019	***531***
	Balance of Freight Wagons planned to be taken over in the next year	***640***

Source:Ethio-Djibouti Railway report(EDR2019)

The Government as the owner of railway infrastructure and facilities, delegates the management and maintenance of infrastructure and facilities to EDR as the operator. For the maintenance performed by

the operator, the Government pays an amount of budget referred to as the infrastructure maintenance operation. In addition, the Government also pays subsidies for passenger transportation by the operator through the budget for public service obligation. The main freight revenue has been from container transportation from Djibouti port to Modjo dry port and vice versa. The major customer of container transportation is Ethiopian Shipping and Logistic Service Enterprise and Fertilizer transportation with Ethiopian Agricultural Business Corporation, wheat transportation with Ethiopian Trade Business Corporation and steel pipe transportation with Hengxin Shipping Co.LTD and other small customers (EDR, 2018).

2.1.4 Operational performance

Slack and Lewis (2011) categorized good performance objectives in the five groups of efficiency, effectiveness, competence, financing and Integration. For the purpose of this study effects of rail transport Operations performance objectives will be discussed.

2.1.4.1 Efficiency

The efficiency of logistics support is determined by both the efficiency of logistics processes and the efficiency of logistics systems. The logistics systems are necessary to implement any of the logistics process. The logistics process contains many activities and sub-processes, such as warehousing, storage, picking stocks, and more. It is hard to imagine the logistics process without transport. It is usually the most important part of the logistics process, due to its costs, lead time and need to ensure the safety of transported resources. Since the transport process is almost constant component of the logistics processes, it is obvious that transport systems are components of logistics systems in the individual national economies, and within the cooperating countries. Within so expanded economic systems, it is impossible to have efficient transport services and the efficient logistics service without standardization at various levels, both the transport processes and transport system. Standardization as a tool of rationalizing the logistics service found its deeper understanding in most transport modes such as shipping, aviation, and trucking.

The least standardization process occurred in rail transport. At this moment, rail transportation system functioning in Europe is very far from the features that allow determining it as an interoperable one. Despite of adoption the three packages of rights and principles of railway operation in the EU, rail transport is still regulated by domestic law of individual countries where operate more than 20 signaling systems, several systems of traction power supply, five widths of tracks and five standards for axle load on the track and gauge rolling stock and civil engineering. There are significant differences between national regulations and technical specifications used on the railways. The source of these differences is individual in each country-specific techniques and solutions of local domestic industry. This situation prevents the smooth passage of trains throughout the Community. Closure of the national railway management, over the decades resulted in a very close business relationship between the national railway industry and the national railways, closing the market for the supply of railway equipment and subsystems against the competition. In order to improve their competitiveness, it is necessary to open up the national markets for the Community market. Already, these few examples provide a knowledge about wide-ranging disaggregation of European railways, and give sufficient justification to take up the work on interoperability of the European railways.(Pagell and Krause, 2004).

2.1.4.2 Effectiveness

Effectiveness is the capability of producing a desired result or the ability to produce desired output. When something is deemed effective, it means it has an intended or expected outcome, or produces a deep vivid impression.

In Logistics effectiveness, infrastructure is important in attracting domestic and international investors in setting up and expands their business activities (Zuraimi et al., 2012). The efficiency of infrastructure enables country to achieve large economies of scales, reducing the average time shipments spent at sea and in ports (Brooks & Stone,2010). In the context of Ethiopia, the logistics infrastructures have been improving gradually. Each operation is related to quality as an efficient objective owning a major impact on customer fulfillment or discontent.

2.1.4.3. Competence

1)The main assumptions of the current approach to Competence and interoperability in the Directive 2008/57/EC reflects, the policy of the European Parliament and the Council in the field of the rail system interoperability within the Community. The procedure for adopting EU directives ensures a political consensus for the solutions because Directive adopted by the

European Commission and the Council had to be passed by the European Parliament. To determine the technical and organizational conditions needed to meet in order to guarantee interoperability, the railway system is divided into subsystems, which requirements are determined and presented in the TSIs (Technical Specifications for Interoperability). The trans-European rail system is divided into: Structural subsystem: infrastructure; energy, control, the rolling stock.

2) Operational subsystem: rail traffic, maintenance (procedures, associated equipment, logistics centers for maintenance work and reserves allowing the mandatory corrective and preventive maintenance to ensure the interoperability of the rail system and the required performance), telematics applications for passenger and freight. According to Annex 1 to Directive 2008/57/EC, this subsystem comprises two elements: applications for passenger services, including systems providing information before and during the journey, reservation and payment systems, luggage management and management of connections between trains and other modes of transport, applications for freight services, including information systems (monitoring of freight and trains in real time) ,marshalling and allocation systems, reservation, payment and invoicing systems, management of connections with other modes of transport and preparation of electronic documents.

- interoperability constituents - for each subsystem or part of subsystem is proposed list of constituents and aspects relating to interoperability at the time of drafting the relevant TSI and
- Interfaces, constituting the relationship between the individual subsystems.

Technical Specifications for Interoperability (TSI) are the main platform of the regulatory rules. TSI are the European legislations rules which override the national acts of the particular scopes. The European standards draw on the TSI. Only on the basis of the TSI and European standards national railway legislation can be created.(M.Andersson & Banomyong, 2010).

2.1.4.5 Financing

Financing represents the process of providing funds for business activities , making purchases ,or investing. Financial institutions, such as banks, are in the business of providing capital to business, consumers and investors to help them achieve goals (Yu etal. 2015).

Here financing is mentioned in that EDR is formed by bilateral agreement by the 75% Ethiopian

government and 25% Djibouti Government out of 500Million USD Operation Investment including Rolling stock ownership but Djibouti contributes no penny for this huge investment. ERC report(2017)

2.1.4.6.Integration

Integration of rail systems is able to provide additional benefits - synergistic effects, impossible to achieve without interoperable actions. Integration is the goal to achieve; it is a certain ideal, which is virtually unattainable in a sustainable manner, due to continuous process of technical and organizational innovation, creating ever new ways of deepening the integration process. Therefore, in practice, we can talk rather about the process of synchronization, coordination, standardization, or the consistency. The aim is to ensure interoperability. "Interoperability" means the ability of the rail system to ensure the safe and uninterrupted movement of trains which accomplish the required levels of railway lines performance. This ability depends on the legal, technical and operational conditions which have to be provided to meet the essential requirements[6]. Interoperability in turn means a state of technical - technological, organizational and legal system that will provide the necessary capacity of the railway system and the conditions for the safe and uninterrupted movement of trains, according to the needs. In practice, it means that the interoperable rolling stock will be able to navigate the interoperable rail infrastructure of the individual countries without having to stop at the borders in order to exchange locomotives or drivers and without taking any activities by drivers.(Chaberek Kawasacka)

2.1.5 Logistics performance

Logistics performance is defined as, analysis of both effectiveness and efficiency in accomplishing a given task‟ (Mentzer and Konrad, 1991). Other scholar refers LP as a metric used to quantify the efficiency and or effectiveness of an action (Neely,Gregory,&Platts,2005).

Researchers have found it difficult to define LP because organizations have multiple and frequently conflicting goals (Chow, Heaver, and Henriksson, 1993). As mentioned earlier that LP plays a vital role in achieving the organizational goals (MPRA 2014). The evaluation is based on how well goal is met (Mentzer and Konrad, 1991) and to what extend the overall productivity and performance would reflect LP (Stabler, 1992). Consequently, LP helps the fulfillment of the organization’s objectives and strategy (Braz, Scavarda, and Martins, 2011) as well as satisfying the customers (Kayakutlu and Buyukozkan, 2011).Logistics is that part of the supply chain process that plans, implements and controls the efficient, effective flow and storage of goods, services and related information from the point-of-origin to the point-of-consumption in order to meet customer requirements and satisfies the requirements imposed by other stake holders such as the government. (Cooper et al.,1997)

2.1.5 Logistics performance index (LPI)

According to OECD,(2015)the World Bank international bench marking tool focusing specifically on measuring the trade and transport facilitation friendliness of a country and which help to identify key barriers for improvement.

There is ample evidence that appropriately designed liberalization and introduction of competition in these sectors can improve efficiency (including timeliness), reduce costs and expand service access to users OECD, (2006).Frequency with which shipments reach consignee within scheduled or expected time (1= low to 5=high) in Ethiopia was reported at 2.37 in 2016, according to the World Bank collection of development indicators, compiled from officially recognized sources. (WBTE).

2.2 Empirical literature

Getu(2020) assessed the explanatory variable rail way quality and competency of logistics service in railways transport has positive relationship with railway transport and logistics performance cost. The coefficient showed that one percent increase in quality and competency of logistics service will increase cost of rail transport and logistics performance by 54.6 percent. It is evident that at 99% confidence levels that statistically significant (t-ratio 0.000).This imply that, improving railways transport service quality and competency significantly reduce transport cost, increase safety and reliability, facilitate import and export trade and increase foreign direct investment.

As cited by Fekadu et al, (2013) the logistics performance of Ethiopia is characterized by lack of coordination in the supply chain, lack of coordination in the areas of inventory planning and warehouse management, less attention on customer satisfaction, inadequate vehicles in delivery of goods to customer, lack of coordination with transporters and lack of information sharing as well as using information technology across the supply chain. (Fekadu*et al*.2013)

According to Fasil (2014) the examined the important quality indicator of rail freight transportation are Safety of cargoes during transportation, Regularity of cargo arrival, Just-in-time delivery, Security of carriages, Proper maintenance of the cargos and Availability of cargo handling equipment at loading points. Based on his descriptive statistical analysis most important quality indicators are Safety of cargoes during transportation found that the respondents' overall expectation on a scale of 1 to 5 is 4.6069. The study realize that respondents expect a lot from the delivery of goods without losing, delivery of goods without contaminating and delivery of goods without damaging dimensions.

Natnael 2015) assessed the freight transport and transportation infrastructures along the China-Djibouti-Addis Ababa (Ethiopia) trade route via Modjo dry port and discussed the logistics system of Ethiopia is characterized by poor logistics management system and poor transportation infrastructures. From the research it was found out that for containerized goods it is better to consider a variety of modes in combination so that the respective advantages/benefits of each mode are better exploited thus the Intermodal transportation ("Multimodal") have most significant positive impacts over the freight transport i.e. Considering other alternatives beyond the current Shipping→Trucking system of freight transport to Shipping→Rail→Truckingand Shipping → Pipeline → Trucking (Oil transport). The research stated that the state owned ESLSE being the only "multimodal" transport operator (MTO)should work together with different private stake holders in addressing the issues of customer's complaint and for the common benefit of the nation is expected rather than monopolizing the ongoing "multimodal" freight transport logistics service.

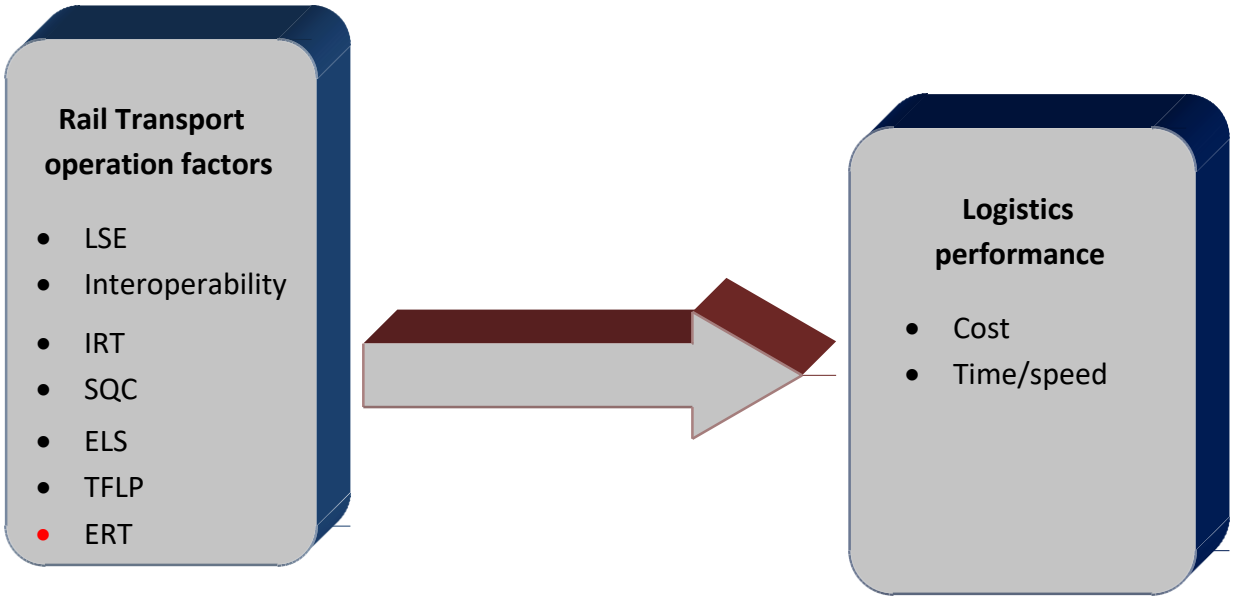
Debora (2017) assessed logistics performance of the Ethiopian Electric Power Corporation. The aim of the study is to increase Ethiopian Electric Power Corporation understanding of their current logistics performance and measuring the logistics performance index in terms quality, productivity, and cost and cycle time. Descriptive analysis method issued to describe the data. The study states that high logistics costs observed in warehouse cost and damage goods and discussed order entry and order processing time has too long.

As cited by Debela (2013), the customs process check points for export goods due to the network problem, the software ASYCUDA ++ the authority uses is not working properly and trucks wait up to 8 hours until the checking is finished by manual system communicating head office staff through telephone. By improving the network system and minimizing the check points, it is possible to lower the cost due to unnecessary delays.

2.3 ConceptualFramework

Based on the theoretical framework presented in the previous section, this part highlight show the research is conceptualized. According to Miles and Huberman (1994, p18) ―Conceptual framework explains, either graphically or in a narrative form, the main things to be studied, the key factors, concepts or variables and the presumed relationship among them. The conceptual framework of the study below shows factors affecting rail transportation service in logistics performance.

Independent variable *Dependent variable*



Source: Adopted from World Bank & slack2016

Literature Gap

The World Bank Logistics Performance Indicator (LPI 2016) places Ethiopia ranked number 126among 160 countries, with an overall score of 2.3768 on a scale from 1 to 5(1=low to 5=high).Since Ethiopia occupied such position on the 2016 LPI, there is a need to identify all the indicators presented in the report and to study the effect that may represent logistical constraints in operations of rail transportation. The researcher assessed the factors affecting of rail transportation service on the logistics performance in terms of World Bank LPI.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Description of the Study Area

The study area mainly focused on the assessment of logistics system engineering practice and interoperability of rail transportation service in logistics performance in terms of logistics performance index. An analysis was made on eight independent variables interoperability, service quality and competence, logistics system engineering, transport financing and logistics performance, efficiency and effectiveness and integration of rail transportation service. The analysis is based on primary data from questionnaires of the staff and additional information from interview with managements of EDR, ESLSE, MOTL, ERC and EMAA. The findings from this analysis were discussed in more detail in the research.

3.2 Research Approach

The study approaches are both quantitative and qualitative research approach. The researcher distributed questionnaires to rail transport service providers (management and employees) of EDR, ESLSE, MoTL and EMAA. The approach will provide complete understanding in assessing the effect of logistics system engineering and interoperability of rail transport on logistics performance.

3.3 Research Design

Depending on the objectives descriptive and explanatory methods are used, the descriptive research method helps to describe the research quantitative findings using major statistical measures such as mean and standard deviation. Quantitative questionnaires distributed to internal management and experts of EDR/MC, ESLSE and EMAA. One of the goals of the study is to determine the relationship between dependent and independent variables in a population. A detailed analysis is required to gain an understanding of the topic and to explain the information in a logical manner using Smart PLS –SEM model.

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Introduction

This section describes the procedures undertaken to achieve the research objectives. The procedures adopted, including all the information relevant to the data collection and where those data were obtained are discussed. In addition, data and information sources, research instruments, sample size and method of analysis are presented.

The strategy followed in carrying out the research was started with problem identification which has been done through unstructured literature review, formal and informal discussions with professionals in the sector and archival study; and then the research design was formulated.

Following this approach, information sources were determined based on the formulated research design.

Research Sampling and Sample size

The research populations are the railway transport operators, regulatory bodies repetitive and employer of Addis- Djibouti railway transport companies and stakeholder regulators. In this research non probabilistic purposeful sampling method used for questionnaire survey due to the nature of the research questions requiring familiarity, the need for obtaining valid information from the actual respondents and the fact operator involvement in railway transport service providers are less to address the key professionals' engagement in the research.

Sample size determination is done using G-Power software. G-Power version three (Buchner et al, 1997) is a program that allows high-precision power and sample size analyses. It computes power values for given sample sizes, effect sizes, and alpha levels (post hoc power analyses), sample sizes for given effect sizes, alpha levels, and power values (a priori power analyses), and alpha and beta values for

given sample sizes, effect sizes, and compromise power analyses (Joseph and Gardner,2007).

Effect size, α error probability, Power (1-β err prob.) and Number of predictors are an input for the program to calculate the sample size. The test family selected for this research is t-test of Linear multiple regression. Effect size is a way of quantifying the difference between two or more groups and effect size determination is critical point which is based on how it is anticipated by the researcher.

Large effect size results to small sample size and to the reverse small effect size of the difference may be negligible in PLS algorithm which is not reliable in True effect. (Joseph and Gardner,2007). Due to this, in this research standardized medium effect size isusedi.e.0.5fort-statistical test, alpha=0.05 and power=0.8.

Table 1. Standardised effect sizes for common statistical tests, alpha=0.05, power=0.8

Statistical test (symbol for effect size)	Small effect	Medium effect	Large effect
Student's t-test (*d*)	0.20	0.50	0.80
ANOVA fixed effects one way (*f*)	0.10	0.25	0.40
Chi-square goodness of fit (*w*)	0.10	0.30	0.50

Figure 4 Standardized effect sizes for common statistical tests (Joseph and Gardner,2007)

Inserting Effect size, α error probability, and Number of predictors as an input for the program as shown in the above figure and to improve the sample size the Power(1-βerr prob) taken as 99%. The Sample size of was 54 obtained from the program.

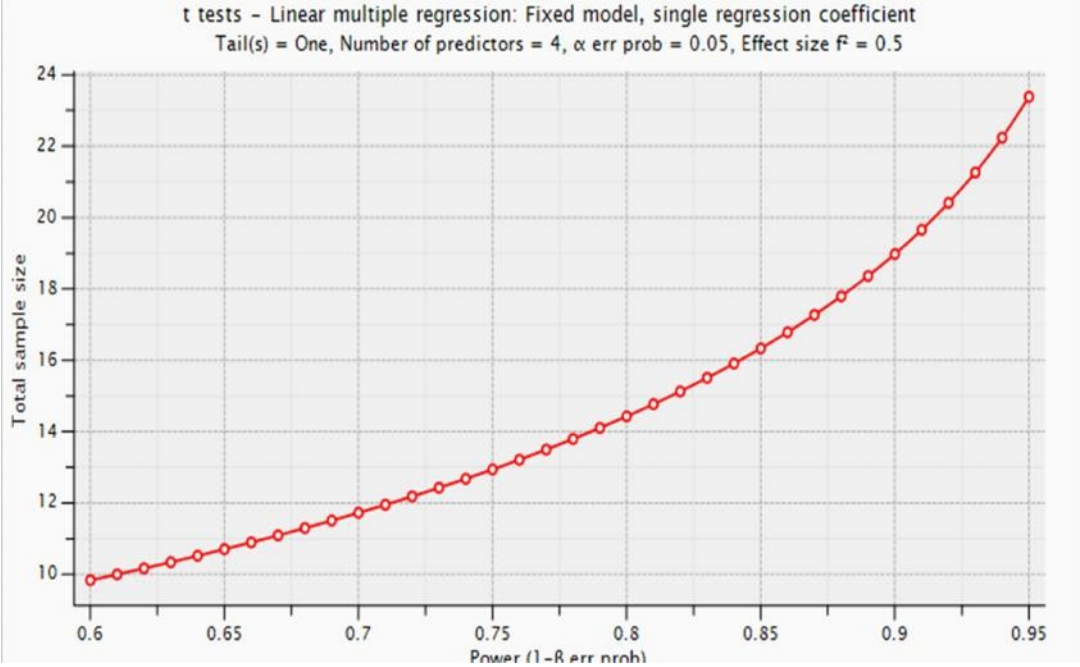

Figure 5 Sample size from G-power Software

DataCollection

PrimaryData

The source of the primary data was collected through distributing an open ended questionnaire through email and in person. The primary objective of the survey was assessing the presence or absence of performance failure. The Second objective was to identify the main cause factors of evaluating logistics performance if the Addis – Djibouti railway transport company EDR faced lagging efficiency, competence and effectiveness during its implementation to reach break-even and return sovereign guaranteed loan.

3.4.1 Secondary Data

The secondary data was gathered through reviewing related literatures for questionnaire designing and archival documents such as management contract agreements, minutes of meeting, transport operators technical proposal, management contractor's financial proposal, employer's requirement, Final evaluation report of the feasibility study, annual audits and progress reports of management contractors/MC/

and operation report of the EDR were studied to actual operation data and these were included with the survey result in the Analysis and Discussion chapter.

Method ofAnalysis

The results of the questionnaires were analyzed using statistical techniques and the results used to form the basis for recommendations as well as areas for further research. The methods of analysis used in analyzing the data were: Importance Index (RII) and PLS-SEM based Cause factors modeling. This was followed by thorough discussions in order to draw a conclusion and to forward recommendations based on the findings of the study.

Relative Importance Index(RII)

Relative important index method is adopted to establish the relative importance of major impacts of logistics system engineering, interoperability and freight logistics performance in Addis-Djibouti railway EDR. Rating scale is one of the most common formats for questioning respondents on their views or opinions of an event or attribute. In this research, a five point (1= Very Small Extent (VSE),2= Small Extent (SE) , 3= Moderately Extent (M), 4 = Great Extent (GE) and 5 = Very Great Extent (GE) Likert scale was used to assess the degree of impact of assessment of logistics system engineering, interoperability and evaluation of logistics performance. It is used to calculate the importance index for each factor that is used to determine the relative ranking.

$$RII=\sum \frac{W}{A\ N} \quad \text{.....Equation 1}$$

Where:

-

w = weighting given to each impact by the respondents and ranges from 1 to 5 where '1' is very small extent ' and '5' is very great extent,

A=highest weight(i.e.5inthiscase),and
N = total number of respondents.

PLS Structural Equation Modeling(PLS-SEM)

Introduction to the PLS-SEM Software

This section describes the procedures undertaken to achieve the research objectives. The procedures adopted, including all the information relevant to the data collection and where those data were obtained are discussed. In addition, data and information sources, research instruments, sample size and method of analysis are presented.

The strategy followed in carrying out the research was started with problem identification which has been done through unstructured literature review, formal and informal discussions with professionals in the sector and archival study; and then the research design was formulated.

Following this approach, information sources were determined based on the formulated research design.

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study.PLS Structural Equation Modeling(PLS-SEM)

WhyPLS?

The advantages of PLS include ability to model multiple dependents as well as multiple independents; robustness in the face of data noise and missing data; and creating independent latent variables directly on the basis of cross-products involving the response variable(s), making for stronger predictions.

PLS is a soft modeling approach to SEM with no assumptions about data distribution (Vinzi et al., 2010). Thus, PLS-SEM becomes a good alternative to Covariance based SEM when the following situations are encountered (Bacon, 1999; Hwang et al., 2010; Wong,2010):

1. The Sample size is small.
2. Applications have little available theory.
3. Predictive accuracy is paramount.

PLS may be implemented as a regression model, predicting one or more dependents from a set of one or more independents; or it can be implemented as a path model, handling causal paths relating predictors as well as paths relating the predictors to the response variable(s). PLS is implemented as regression model by SPSS and by SAS's PROC PLS. Smart PLS is the most prevalent implementation as a path model(Garson,2016).

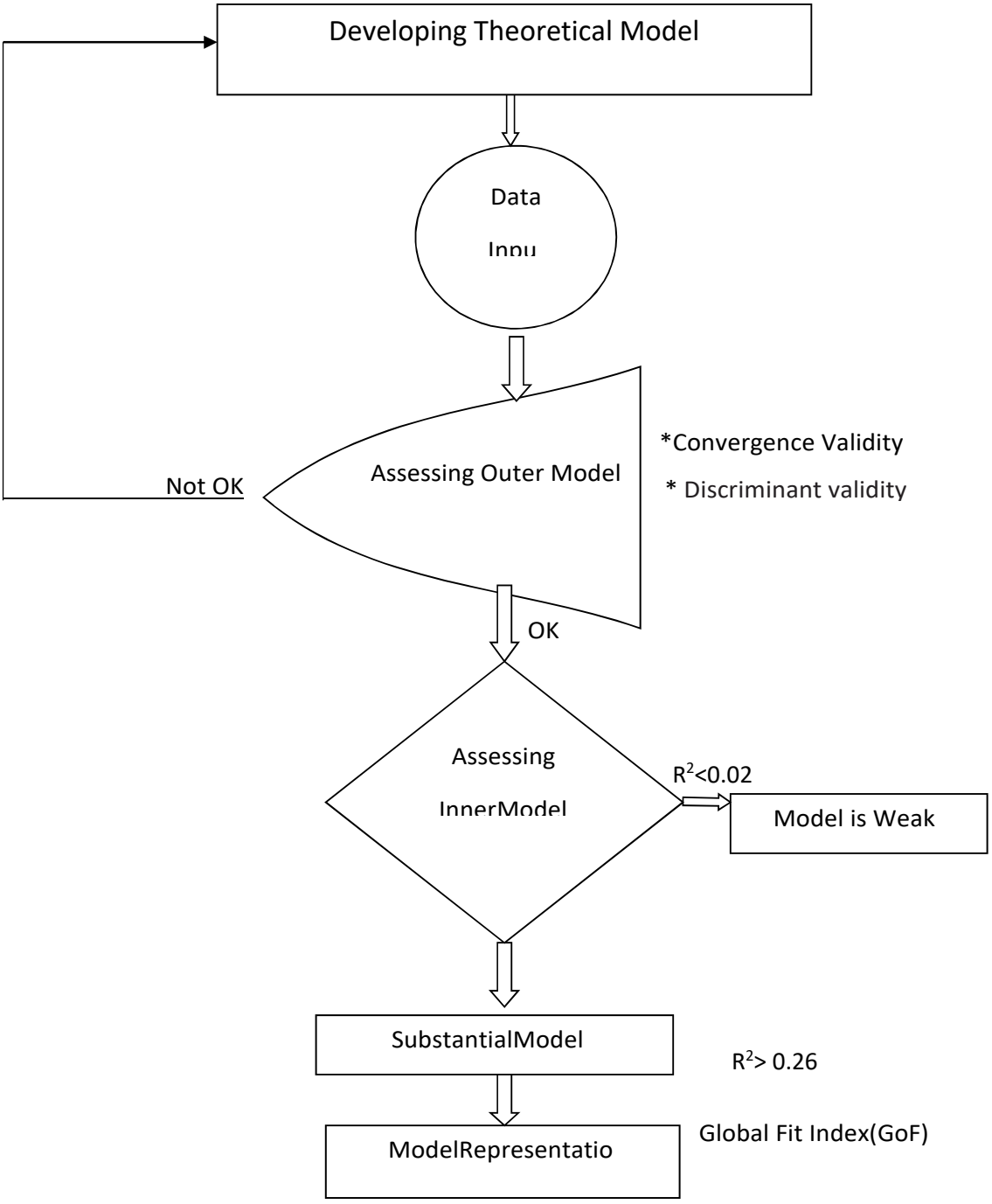

Figure 6 Schematic Diagram of PLS-SEM Analysis

The PLS algorithm aims at estimating the values of latent variables; it is essentially a sequence of regressions in terms of weigh vectors. The weight vectors are obtained when convergence satisfies fixed point equations. The basic PLS algorithm, as suggested by Lohmöller (1989), includes the following two stages: Stage 1 is the iterative estimation of latent variable scores, consisting of a 4-step iterative procedure that is repeated until convergence is obtained or the maximum number of iterations is reached. Stage 2 is the estimation of the path coefficients; this is how smart PLS software works

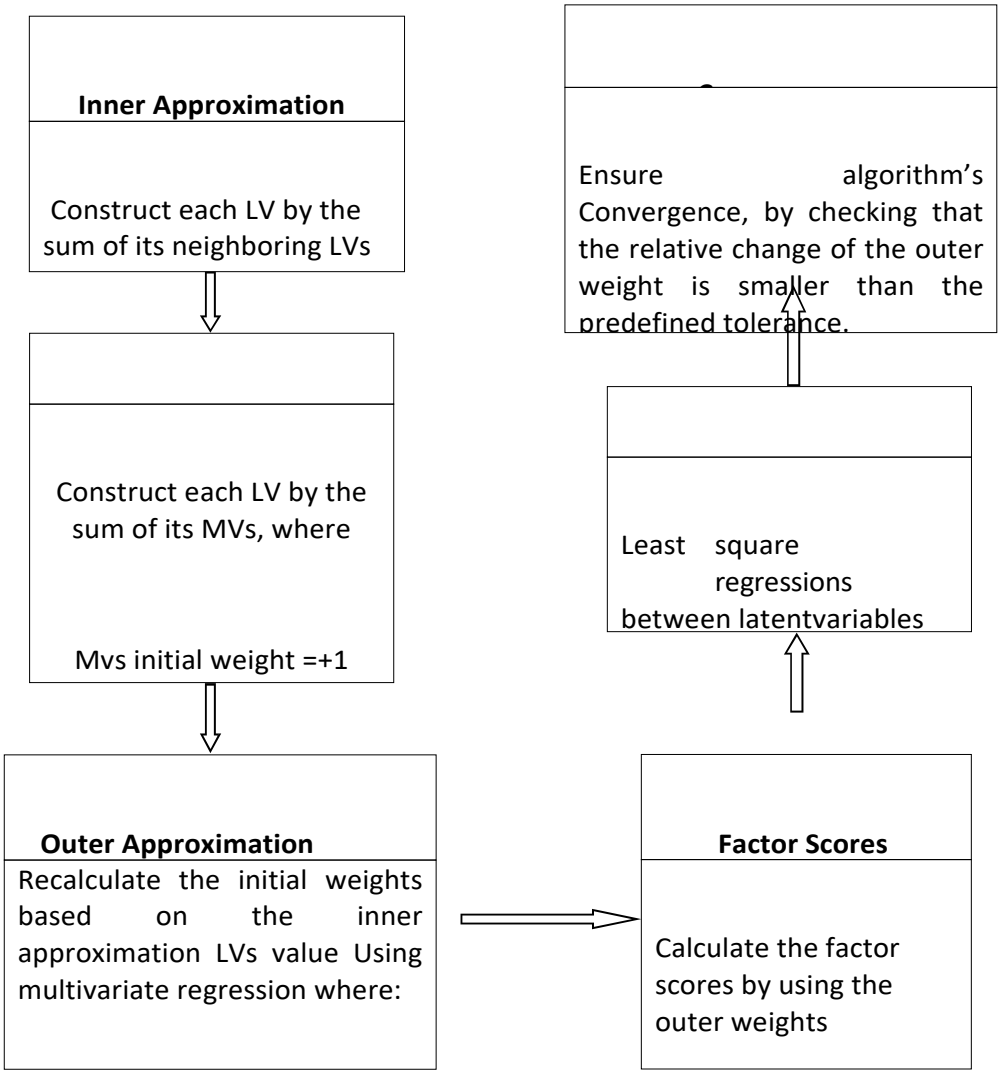

Figure 7 The Flow chart for PLS algorithm

PLS ProceduralMethods

Develop Theoretical Model and Data Input

A complete theoretical model for evaluation is developed based on 24 factors affecting logistics system engineering, interoperability and logistics performance. Theoretical model defines the causal relationships between the factors of logistics system engineering & interoperability to assess their effect on logistics performance or service quality and competence. In this two independent models for logistics performance evaluation were formulated. This model is drawn in Smart-PLS V3 software for simulation process. Input data to this model was done through note pad (*.txt) file format which contains the respondent's input from the questionnaire survey.

Evaluation of OuterModel

Evaluation of the outer model (measurement model) is to examine the reliability and validity of the constructs of the model (Hulland, 1999). It determines how well the indicators (specific questions) load on the theoretically defined constructs. This can be carried out in two stages as follows:

A) Convergent validity of the measures (Hulland, 1999).

B) Discriminant validity of the research instruments (Gefen,Straub&Boudreau,2000)

A) Convergent validity ofconstructs

Convergent validity is the measure of the internal consistency. It is estimated to ensure that the items assumed to measure each latent variable measures them and not measuring another latent variable (Fornell & Larcker, 1981; Hulland,1999).

Convergent validity of the construct can be determined by calculating individual item reliability, Cronbach's alpha, Composite reliability (CR) and Average Variance Extracted (AVE) as suggested by (Aibinu, Ling & Ofori,2011)..

Individual Item Reliability is the extent to which measurements of the latent variables measured with multiple-item scale reflects mostly the true score of the latent variables relative to the error.

It is assessed by calculating standardized loadings of each variable where items with loadings of less than 0.4 should be dropped (Hulland, 1999) while (Chin, 1998) suggested that item with loading lower than 0.5 should be dropped.

Cronbach's Alpha is the coefficient of reliability (or consistency). It measures how well a set of items (or variables) measures a single one dimensional latent construct. (Litwin, 1995) suggested that value of Cronbach alpha should be higher than 0.7.

Composite Reliability (CR) measure is used to check how well a construct is measured by its assigned indicators. However, the interpretation of composite reliability score and Cronbach's Alpha is same. (Chin, 1998; Hair, Ringle, & Sarstedt,2011)suggested0.7as a benchmark for 'modest' composite reliability.

Average Variance Extracted (AVE) test is used to assess internal consistency of the construct by measuring the amount of variance that a latent variable captures from its measurement items relative to the amount of variance due to measurement errors (Fornell & Larcker,1981).

A basic assumption is that the average covariance among indicators has to be positive. Barclay, Thompson, and Higgins (1995) and Hair et al., (2011) stated that AVE should be higher than 0.5. This means that at least 50% of measurement variance is captured by the latent variables.

B) Discriminant validity ofconstructs

Discriminant validity indicates the extent to which a given construct is different from other constructs (Hulland, 1999). It is tested through analysis of average variance extracted by using the criteria that a construct should share more variance with its measures than it shares with other constructs in the model (Fornell & Larcker, 1981). This is examined by comparing the AVE of construct shared on it and other constructs. For valid discriminant of construct, AVE shared on it should be higher than variance shared with other constructs (Chin, 1998).

Evaluation of InnerModel

Inner model (structural model) evaluation is carried out to assess the relationship between exogenous and endogenous latent variables in respect of variance accounted (Hulland, 1999).

It also determines the explanatory power of the model by evaluating squared multiple correlations (R^2) and path co-efficient (β) values, where R^2 indicates the percentage of a construct's variance in the model, whilst the path coefficients indicate the strengths of relationships between constructs (Chin, 1998).

Accordingto(Cohen,1988;Cohen,Cohen,West,&Aiken,2003)R^2ofendogenouscan be assessed as great extent =0.26, moderate =0.13 and small extent=0.02 while for path co efficient assessment, β value of all structural paths is compared, highest β value indicates that effect of the construct is most significant and lowest value shows the lowest effect of construct on endogenous latent variable

Performance of Model

Performance of the developed model was assessed with two-step process as (i) outer model evaluation to examine the reliability and validity of the construct, and (ii) inner model evaluation to assess the relationship between exogenous and endogenous latent variables (independent latent variables and dependent variable) in respect of variance accounted for (Hulland, 1999).

Datacoding

While analyzing the questioner the author has coded factors (research variables). The coding is according the sequential arrangement on the questioner. First, the group of variables (exogenous latent variables) has been coded taking the first letter of the group name e.g. LSE: Logistics system engineering and LSE1 Stands for the first lickert scaled question under LSE.

3.4 Population and Sample Size

The research populations are the railway transport operators, regulatory bodies repetitive and employer of Addis- Djibouti railway transport companies and stakeholder regulators. In this research non probabilistic purposeful sampling method used for questionnaire survey due to the nature of the research questions requiring familiarity, the need for obtaining valid information from the actual respondents and the fact operator involvement in railway transport service providers are less to address the key professionals' engagement in the research.

Due to geographical and resource constraints, the researcher targeted the EDR head office and management contractors' local staffs, EMAA management, ESLSE management which found in Addis Ababa city and Modjo dry port staff; as of June 2021 human resource and capacity building performance audit report, the number of EDR and MC local staffs composition and the same for management and some staff of ESLSE. MoTL and EMAA.

Key informant interview: Open ended checklists prepared and used to gather qualitative data from managers, department heads and key staffs of EDR, ESLSE and EMAA and JV/MC.

3.4.1 Sampling Size

Due to geographical and resource constraints, the researcher targeted the EDR head office and management contractors' local staffs which found in Addis Ababa city; as of June 2021 human resource and capacity building performance audit report, the number of EDR and MC local staffs composition and the same for management and some staff of ESLSE and EMAA.

Key informant interview: Open ended checklists prepared and used to gather qualitative data from managers, department heads and key staffs of EDR, ESLSE, ERC, MOTL and EMAA.

3.4.2 Sampling techniques

To make the sample size optimum and assure the degree of efficiency, representativeness, reliability and flexibility the researcher use stratified random sampling method to distribute closed ended questionnaire by calculating the strata of each position respondent's through making disproportionate stratified sampling due to the fact that the number of some position in the organizational structures are smaller or larger over the other which have significant effect on the study result at the end. On the other hand, for open ended interview questionnaires, judgmental sampling method designed to use due to the fact that the number of higher officials are small in number and the researcher does not consider trainees as part of the population size due to less work experience.

Balanced data collected and used, which enables to reach at valid conclusion. In addition, disproportionate stratified sampling will apply to enabling to balance the number of respondents across each sample size.

On the other hand, the disproportionate stratified sampling will apply to take an appropriate number of EDR respondents to evaluate the capability of administering contract administration conditions over the MC's operation and maintenance and capacity building performance.

3.5 Data Sources and Types

The study used both primary and secondary data sources. The primary data was collected from the Company's experts and managements using questionnaire. The questionnaire contained two parts. The first part is designed to collect respondents‟ background information and respondents‟ general information. The second part is structured questions designed to measure each dimension and with the five-point Likert scale. Likert-type scale rate from 1=very small extent, 2= small extent, 3=Moderate, 4= great extent, 5= very great extent. This helped to make questions interesting to respondents and, thereby, enhance their cooperation, ultimately to ensure maximum response rate. In addition, key informant checklists were used to gather relevant data from project manager's key staffs. Secondary data collected from the company's reports and EDR manuals, brochure and journals. These data helped to assess the effect of rail transport service delivery (operation) on logistics performance of the country.

3.6 Data Collection Procedures

The primary data is collected in the field based on the existing and reality condition. This data collection is conducted by questionnaire survey and key informant interview. The secondary data is data which is collected to support the primary data and as comparison to other studies. The secondary data in this research is obtained from the organizations associated with the research object such as EDR, MC (CCECC-CREC JV), ESLSE, EMAA and transport and Logistics ministry/MoTL/. Other sources will be articles and websites.

Questionnaire: The questionnaire in this study is prepared by the researcher. The questionnaire for sample survey is composed of close end questions as well as open end questions so that the closed ended questions assist to collect factual data from the options give whereas the open ended questions helped to find the respondent's opinions at length.

3.7 DataAnalysis

The researcher carried out quantitative and qualitative analysis. The quantitative analysis involved the use of descriptive and inferential statistics. There are several software packages for the analysis of quantitative data some of which are broader in scope and user friendly liked the Partial Least Square (PLS-SEM) Structural Equation Modeling software. Smart PLS may obviously not be the best but its user-friendly nature and the mastery we have of PLS automatically makes it better for us. There may be spreadsheet packages that are better than the PLS-SEM, but PLS is widely in use now also.

3.8 Ethical Consideration

Data collected on a voluntarily basis, all information received was treated as strictly confidential and the participants and their biographical information will remain anonymous. Research involving people must be developed ethically; particularly this includes the responsibility of the researcher to protect the privacy of the individuals that participate in the study. This privacy protection must extend to all people's, regardless of age, religion and race.

CHAPTER FOUR

4. ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the contents of the findings on "Assessments of Logistics System Engineering, Evaluation of Interoperability and Performance of Railway Transport, the case of EDR". The questionnaire used to assess Logistics System Engineering and Evaluate of Interoperability and Performance of Railway Transport in the case of Ethio-Djibouti Railway S.C using Partial least square Structural Equation Modeling (PLS-SEM) for, to rank the major impacts of logistics system engineering, interoperability in Addis- Djibouti railway logistics transport performance and assess mitigation measures being used to avoid the occurrence of inefficiency and ineffectiveness for future rail way transport operations.

The questionnaire survey was conducted being inclusive of key professionals from major stake holders of the railway, shipping and logistic sector. These are the EDR(The Ethio-Djibouti Railway Transport Standard Gauge share Company/the survey company/),the Ethiopian Shipping & Logistics service Enterprise(ESLSE), the Ethiopian Maritime Affairs Agency/EMAA/, Ministry of Transport and Logistics/ MOTL, Ethiopian Railway Corporation /ERC/and the management contractors (CREC and CCECC/JV) and EDR.

4.2 Analysis of Questionnaire Response

To perform a comprehensive study on assessment of the presence, causal factors and impacts of cost and time over run Addis-Djibouti railway project a total of 52 respondents were selected after Pilot study was conducted and the questionnaire get advancement; those of 52 respondents were comprised of railway engineers, logistics experts, operations managers, contract administrators and top managers.

Among out of those 50 respondents 52 questioners were collected giving a response rate of 88.24% and from 50 questioners which were collected 2 questioners were found to be invalid due to lack of full information given by the

respondents. Therefore, valid response rate of 82.35% is obtained. On the basis of these 28 questioners analysis was conducted to determine the presence of the operation and model the causal factors that attribute for logistics performance.

Table 3 Questionnaire response rate

Respondents Category	Questioner Distributed	Questioner Received	Percentage Collected	Valid Response	Valid Response Rate
EDR	30	29	96.67 %	28	96.55 %
ESLSE	10	10	100%	9	90%
EMAA	5	4	80%	4	80%
MOTL	5	3	60%	3	60%
ERC	2	2	100%	2	100%
Total	52	48	87.33 %	46	85.31 %

Respondents Academic Background and WorkExperience

The purpose of section one was to know the educational and professional capability of respondents under this survey.

The survey result shows that among 28 of EDR respondents all of them hold MSc/MA/MBA. degree and 1only 1 respondent have BSc. degree which is 91.67 % of them hold second degree. From ESLSE 6 of them were with MSc/MA/MBA degree and the rest 4 were with BSc. (i.e. 40% of the ESLSE respondents). The EMAA respondents have 2 Msc. and 2 BSc. Whereas the MOTL respondents have all MSc/MBA holders. ERC respondents are both M.Sc. holders.

4.3 PLS Assessment of the questionnaire for Logistic Performance

4.3.1 Model Development

In order to assess the most influential factor for Logistic Performance in terms of Logistics System Engineering and Evaluation of Interoperability, reflective construct was adopted. A hierarchal model based on groups and items identified in Table1 showing relation to endogenous latent variable i.e. Logistic Performance.

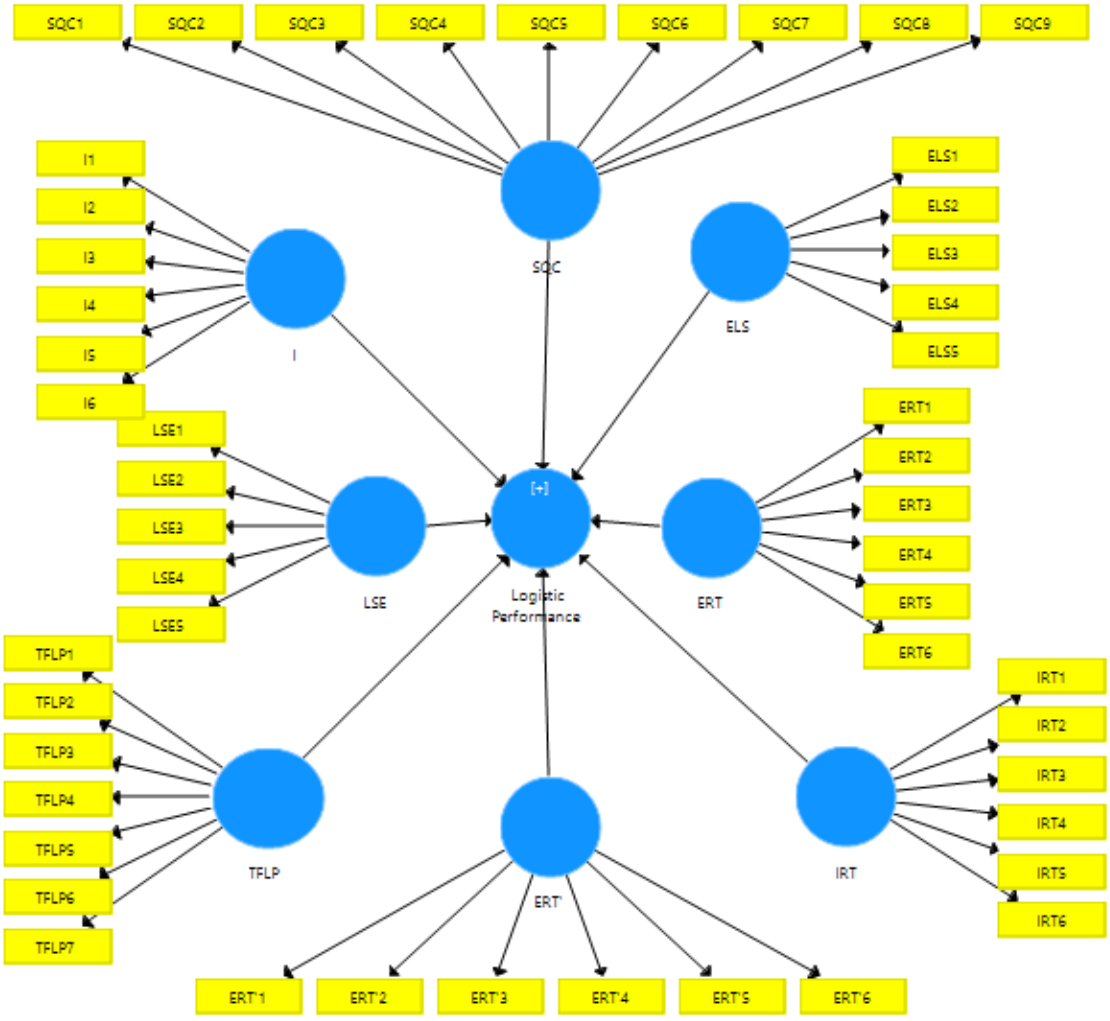

Figure 4.1 Theoretical Model of Logistic Performance Assessment in Smart Pls

In the above theoretical model, the items represented in yellow are indicators of the model which are the factors affecting logistic performance and the data was drawn from the conducted survey. The middle circles named such as LSE,TFLP, ERT, I, ELS, SQC, IRT and ERT' are exogenous latent variables which are group/ constructs of the indicators and the main latent variable to be assessed is logistic performance which in the model represented as endogenous latent variable.

4.3.2 PLS Algorithm Results for Logistic Performance Assessment

The first step for successful model was linking the indicators and latent variables together, and then the path modeling procedure can be carried out. The statistical software application Smart-PLS 3.0 was used to compute the PLS path model with second-order construct, and assess the strength of each factor affecting logistic performance through the developed model. While the results differ little for the alternative weighting schemes, path weighting is the recommended approach. This weighting scheme provides the highest R^2 value for endogenous latent variables and is generally applicable for all kinds of PLS path model specifications and estimations. Moreover, when the path model includes higher-order constructs (often called second-order models), PLS path model is preferable. The indicators of the developed model are correlated and interchangeable.

In the PLS-SEM diagram there are two types of numbers: the number in the circle which shows how much the variance of the latent variable is being explained by the other latent variables; and numbers on the arrows, these are called the path coefficients, they explain how strong the effect of one variable is on another variable. The weights of different path coefficients enable the ranking of their relative statistical importance. The results of the first iteration shown asfollows

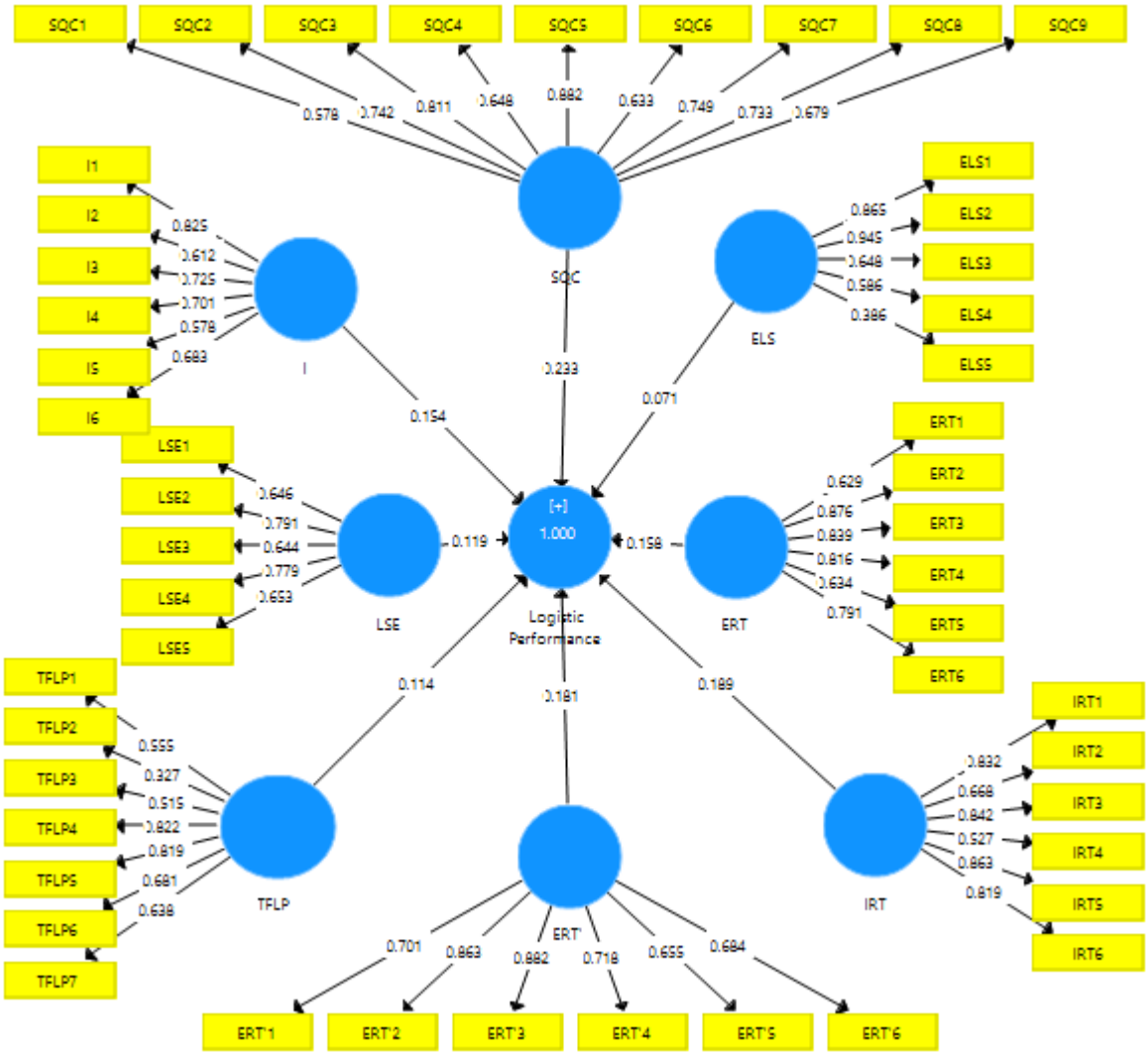

Figure 4.1 Results of PLS Algorithm for Logistic Performance Assessment (Iteration 1)

The PLS algorithm sequence ensures that reliability and validity of measures of constructs are ascertained before attempting to draw conclusions about the nature of the relationships between constructs (Aibinu et al., 2011). To ensure reliability and validity of the measures, first the measurement model assessment is done and then the structural model assessment follows.

4.3.21 Measurement Model Assessment

I. Individual item reliability and convergent validity:

To evaluate individual item reliability, the standardized loadings (or simple correlation) should be reviewed, and perhaps dropped since they would add very little explanatory power to the model were assessed.

Construct	Item	Loading	Alpha	CR	AVE
LSE	LSE1	0.646	0.754	0.831	0.498
	LSE2	0.791			
	LSE3	0.644			
	LSE4	0.779			
	LSE5	0.653			
TFLP	TFLP1	0.555	0.738	0.822	0.414
	TFLP2	0.327			
	TFLP3	0.515			
	TFLP4	0.822			
	TFLP5	0.819			
	TFLP6	0.681			
	TFLP7	0.638			
I	I1	0.825	0.780	0.845	0.479
	I2	0.612			
	I3	0.725			
	I4	0.701			
	I5	0.578			
	I6	0.683			
	SQC1	0.578			

SQC	SQC2	0.742	0.884	0.906	0.522
	SQC3	0.811			
	SQC4	0.648			
	SQC5	0.882			
	SQC6	0.633			
	SQC7	0.749			
	SQC8	0.733			
	SQC9	0.679			
ELS	ELS1	0.865	0.833	0.828	0.510
	ELS2	0.945			
	ELS3	0.648			
	ELS4	0.586			
	ELS5	0.386			
ERT	ERT1	0.629	0.860	0.896	0.593
	ERT2	0.876			
	ERT3	0.839			
	ERT4	0.816			
	ERT5	0.634			
	ERT6	0.791			
IRT	IRT1	0.832	0.853	0.894	0.590
	IRT2	0.668			
	IRT3	0.842			
	IRT4	0.527			
	IRT5	0.863			
	IRT6	0.819			
	ERT'1	0.701	0.846	0.887	0.571

ERT'	ERT'2	0.863			
	ERT'3	0.882			
	ERT'4	0.718			
	ERT'5	0.655			
	ERT'6	0.684			

Table 4.1 Individual factor reliability and convergent validity of outer Model (Iteration 1)

A common threshold for reliability is that the items with outer loading higher than 0.7 should be considered highly satisfactory (Hulland, 1999; Henseler *et al.*, 2009; Gotz *et al*., 2010) and for items with loading between 0.4 to 0.7 practical potential significance should be assessed prior to elimination. If an indicator's reliability is low and eliminating this indicator goes along with a substantial increase of composite reliability, it makes sense to discard this indicator (Henseler *et al*.,2009)

Composite Reliability scores (CR), Cronbach's alpha and Average Variance Extracted (AVE) tests were used to determine the convergent validity of measured constructs with cut-off value for AVE, CR and Cronbach's Alpha were 0.5, 0.7 and 0.7, respectively.

Initeration1,the outer loading of all construct items are above the cutoff point 0.4 except the TFLP 2 and ELS 5 with low outer loading of 0.327 and 0.368 respectively and the values of Average Variance Extracted (AVE) for LSE, I and TFLP construct are below the acceptable limit. The second iteration done as follows taking in to account the concepts stated above and low outer loading in Iteration 1.

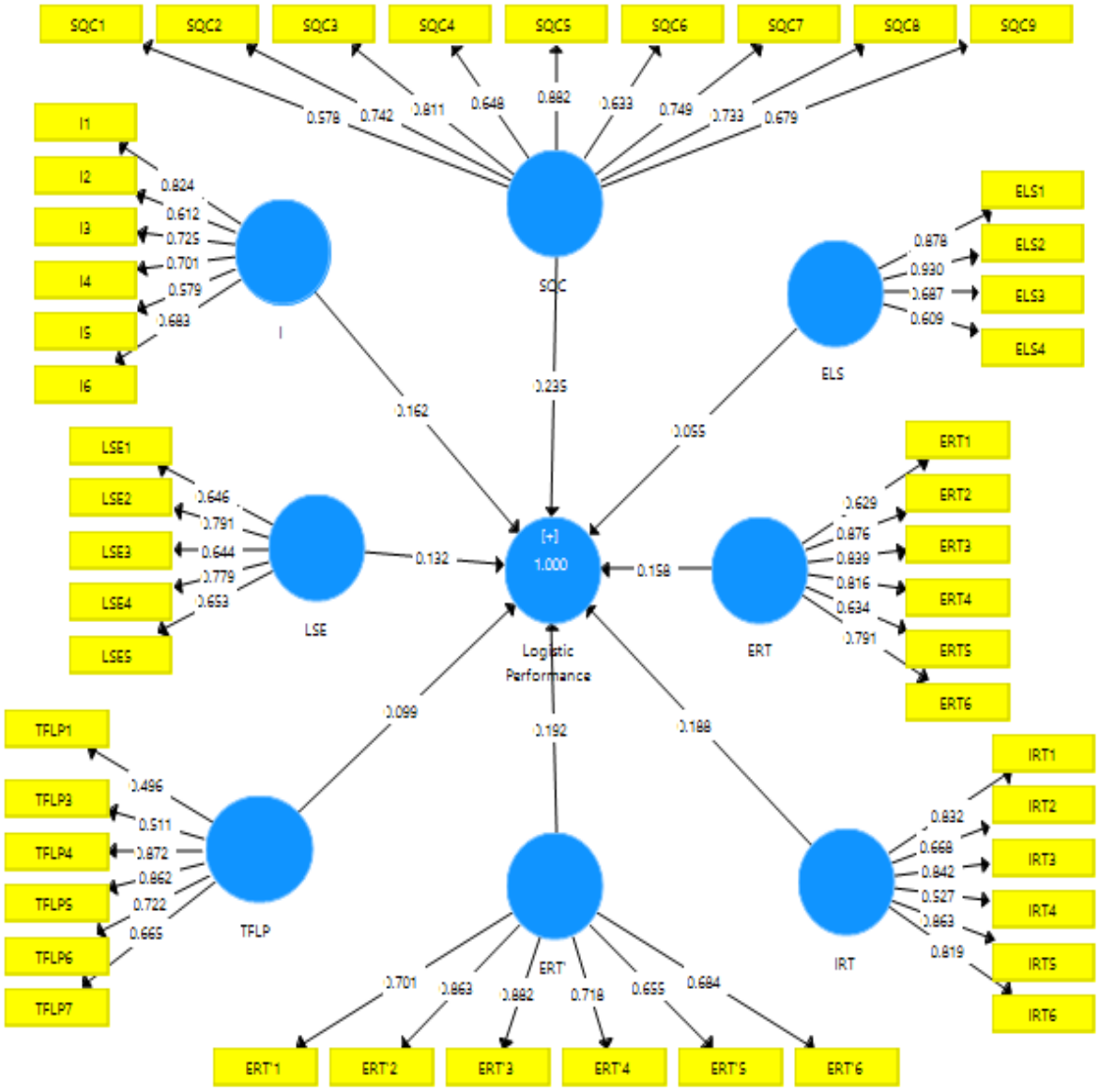

Figure 4.2 Results of PLS Algorithm for Logistic Performance Assessment (Iteration 2)

Construct	Item	Loading	Alpha	CR	AVE
LSE	LSE1	0.646	0.754	0.831	0.498
	LSE2	0.791			
	LSE3	0.644			
	LSE4	0.779			
	LSE5	0.653			
TFLP	TFLP1	0.496	0.780	0.849	0.496
	TFLP2	Omitted			
	TFLP3	0.511			
	TFLP4	0.872			
	TFLP5	0.862			
	TFLP6	0.722			
	TFLP7	0.665			
I	I1	0.824	0.780	0.845	0.479
	I2	0.612			
	I3	0.725			
	I4	0.701			
	I5	0.579			
	I6	0.683			
SQC	SQC1	0.578	0.884	0.906	0.522
	SQC2	0.742			
	SQC3	0.811			
	SQC4	0.648			
	SQC5	0.882			
	SQC6	0.633			
	SQC7	0.749			
	SQC8	0.733			

	SQC9	0.679			
ELS	ELS1	0.878	0.817	0.864	0.620
	ELS2	0.930			
	ELS3	0.687			
	ELS4	0.609			
	ELS5	Omitted			
ERT	ERT1	0.629	0.860	0.896	0.593
	ERT2	0.876			
	ERT3	0.839			
	ERT4	0.816			
	ERT5	0.634			
	ERT6	0.791			
IRT	IRT1	0.832	0.853	0.894	0.590
	IRT2	0.668			
	IRT3	0.842			
	IRT4	0.527			
	IRT5	0.863			
	IRT6	0.819			
ERT’	ERT’1	0.701	0.846	0.887	0.571
	ERT’2	0.863			
	ERT’3	0.882			
	ERT’4	0.718			
	ERT’5	0.655			
	ERT’6	0.684			

Table 4.2 Individual factor reliability and convergent validity of outer Model (Iteration2)
Indicators with lowest loading value i.e. TFLP2and ELS5 omitted resulting increasing AVE of TFLP construct from 0.414 to 0.496 and ELS construct from 0.510 to 0.620.Even though the outer loading omitted in the second iteration, effects of the omission is not satisfactory in bringing acceptable AVE value. So, third iteration should be done to enhance reliability and validity of for LSE, I and TFLP construct in terms of AVE

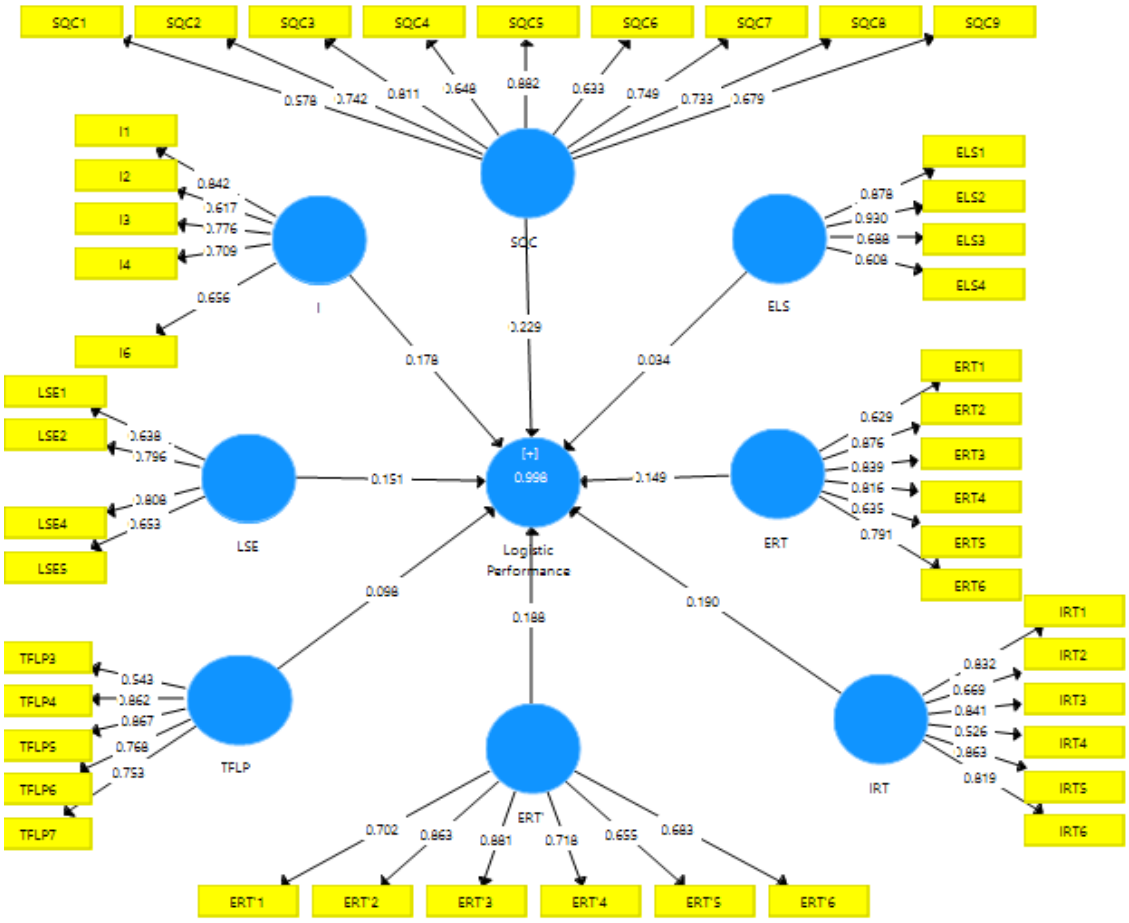

Figure4.3 Results of PLS Algorithm for Logistic Performance Assessment (Iteration 3)

In the third iterative process, According to Henseler *et al*. (2009) indicators with low loading relatively in the construct selected for omission for significant change on Average Variance Extracted(AVE).

Construct	Item	Loading	Alpha	CR	AVE
LSE	LSE1	0.638	0.706	0.817	0.530
	LSE2	0.796			
	LSE3	Omitted			
	LSE4	0.808			
	LSE5	0.653			
TFLP	TFLP1	Omitted	0.817	0.875	0.590
	TFLP2	Omitted			
	TFLP3	0.543			
	TFLP4	0.862			
	TFLP5	0.867			
	TFLP6	0.768			
	TFLP7	0.753			
I	I1	0.842	0.771	0.845	0.525
	I2	0.617			
	I3	0.776			
	I4	0.709			
	I5	Omitted			
	I6	0.656			
SQC	SQC1	0.578	0.884	0.906	0.522
	SQC2	0.742			
	SQC3	0.811			
	SQC4	0.648			

	SQC5	0.882			
	SQC6	0.633			
	SQC7	0.749			
	SQC8	0.733			
	SQC9	0.679			
ELS	ELS1	0.878	0.817	0.864	0.620
	ELS2	0.930			
	ELS3	0.688			
	ELS4	0.608			
	ELS5	Omitted			
ERT	ERT1	0.629	0.860	0.896	0.593
	ERT2	0.876			
	ERT3	0.839			
	ERT4	0.816			
	ERT5	0.635			
	ERT6	0.791			
IRT	IRT1	0.832	0.853	0.894	0.590
	IRT2	0.669			
	IRT3	0.841			
	IRT4	0.526			
	IRT5	0.863			
	IRT6	0.819			

Table 4.3 Individual factor reliability and convergent validity of outer Model (Iteration3)

As shown in Table 4.3, the omission of additional three items/indicators i.e. LSE3, I5 and TFLP1 brought a substantial change in the AVE value of their construct making above the cutoff point 0.5. In this iteration, the value AVE, CR and Alpha as well as all outer loadings are acceptable. The measurement model was considered satisfactory with the evidence of adequate reliability and validity.

II. Discriminant validity ofconstructs

Discriminant validity indicates the extent to which a given construct is different from other constructs (Hulland, 1999). This can be examined by comparing the AVE of construct shared on it and other constructs.

Table 4.4 Correlation matrix (Discriminant Validity of constructs)

	ELS	ERT	ERT'	IRT	I	LSE	SQC	TFLP
ELS	0.787							
ERT	0.305	0.770						
ERT'	0.571	0.631	0.756					
IRT	0.355	0.772	0.840	0.768				
I	0.418	0.621	0.742	0.782	0.725			
LSE	0.510	0.476	0.688	0.735	0.698	0.728		
SQC	0.518	0.523	0.601	0.605	0.722	0.741	0.723	
TFLP	0.357	0.230	0.455	0.259	0.472	0.484	0.526	0.768

As shown in Table4.4 the correlation matrix of all constructs were above 0.7 i.e. the cut-off point for this test. Therefore, the measurement model gets valid in terms of dicriminant validity

4.3.2.2 Structural Model Assessment for Logistic Performance

Structural model can be assessed by testing the explained variance on endogenous latent variable (R^2)and path co-efficient also termed as beta (β) values of each path.

According to Cohen (1988) R^2 of endogenous can be assessed as substantial = 0.26, moderate = 0.13 and weak = 0.02. From Figure 4.5 R^2 of the endogenous latent variable is 0.998 which is higher than the cut-off value and hence the model lies at

high satisfactory level. In assessing the path coefficient, beta value of all structural paths is compared, higher the path co-efficient the significant effect on endogenous latent variable.

As shown in Figure 4.5 SQC have the highest path co-efficient i.e. 0.229. This means the service quality &competences of logistics service (SQC) have large effect on logistic performance.

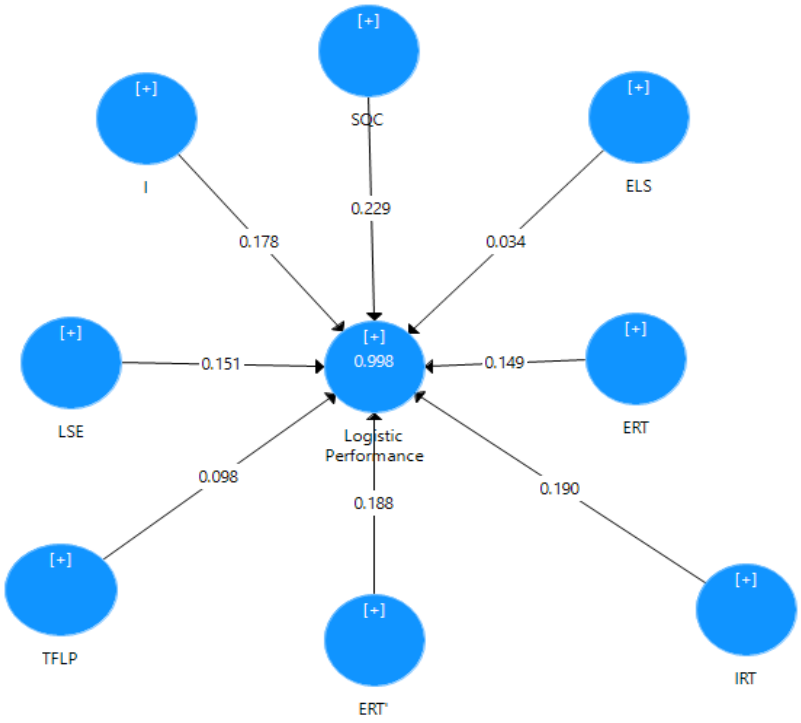

Figure 4.5 Logistic Performance Structural Model Results

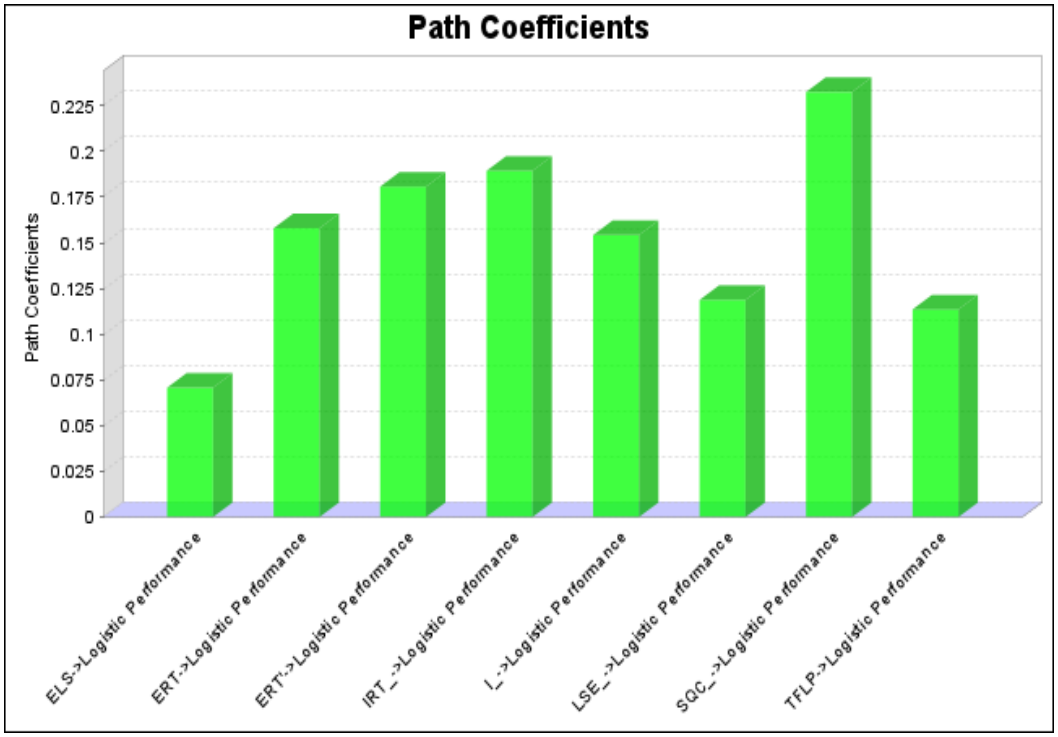

Figure 4.6 Path Coefficient results of Iteration 1

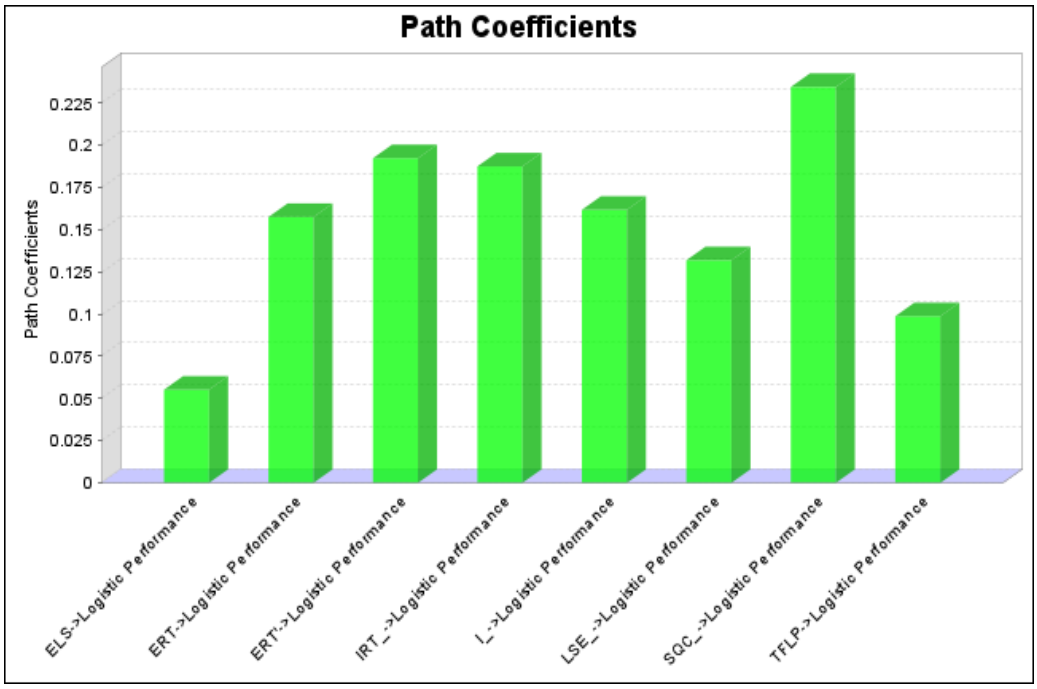

Figure 4.7 Path Coefficient results of Iteration 2

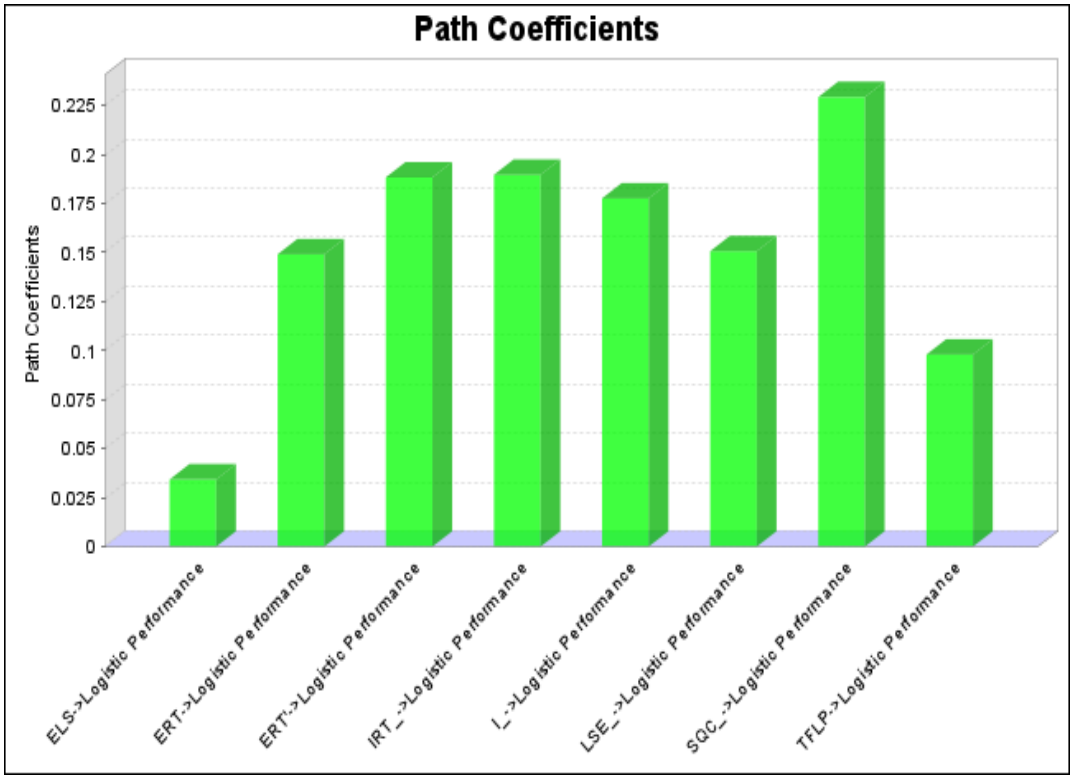

Figure 4.8 Path Coefficient results of Iteration 3

The second major construct affecting logistic performance is IRT with path co-efficient of 0.190. Further, the significance of the path co-efficient was tested by calculating t-value using non-parametric bootstrap procedure with Smart PLS software.

Bootstrapping

The boot strap technique provides an estimate of the shape, spread, and bias of the sampling distribution of a specific statistic. Bootstrapping treats the observed sample as if it represents the population. The procedure creates a large, pre -specified number of bootstrap samples (e.g., 5,00 used in this research).Each bootstrap sample should have the same number of cases as the original sample.

Bootstrap samples are created by randomly drawing cases with replacement from the original sample. The PLS results for all bootstrap samples provide the mean value and standard error for each path model coefficient. This information permits a student's t-test to be performed for the significance of path model relationships (Henseler*etal*.,2009).

For all the paths, a two tail t-test was used. The exact p values (probability value) associated with the t values of each path coefficient were also estimated. Table 4.5 shows that all the paths retrieved t-value higher than minimum cut-off value i.e., 2.58 at significance level = 5% (Hair *et al*., 2011)

	T Statistics	**P Values**	**Inference**
ELS-> Logistic Performance	1.242	0.215	Insignificant
ERT > Logistic Performance	4.432	0.000	Significant
ERT' > Logistic Performance	6.613	0.000	Significant
IRT > Logistic Performance	6.132	0.000	Significant
I > Logistic Performance	8.626	0.000	Significant
LSE> Logistic Performance	5.756	0.000	Significant
SQC> Logistic Performance	6.567	0.000	Significant
TFLP> Logistic Performance	3.533	0.000	Significant

Table 4.5 Model bootstrapping path results

The above table implies that all the construct have significant effect on logistic performance except ELS. SQC, IRT and ERT' are the most influential constructs on logistic performance in descending order.

4.3.3 Overall Measurement Model Assessment (ModelValidation)

Global Fit measure (GoF) for PLS path modeling, defined as the geometric mean of the average communality and average R2 (for endogenous constructs) was used to assessoverallmodelfitnessandexplainingpowerofmodel.TheGoFindexisbounded between 0 and 1. Wetzels *et al*. (2009) suggest using 0.50 as the cut off value for communality (Fornel and Larcker, 1981) and different effect sizes of R2 (Cohen, 1988 cited by Akter *et al*., 2011b) to determine GoFsmall (0.10), GoFmedium (0.25) and GoFlarge (0.36) leading to achieve GoFsmall = 0.1, GoFmedium = 0.25, GoFlarge=0.36 as cut-off values for global validation of PLS model as adopted by Akter *et al*., 2011). Following equation used by (Akterb*et al*., 2011) was adopted to calculate GoF:

$$GoF = \sqrt{\overline{AVE}\ X\ \overline{R^2}}$$ Equation2

Using the Above equation, the Global Fit Model for logistics performance PLS Model and Interoperability PLS Model calculated as follows

GoF for the PLS Model

R^2= 0.998

AVE average= AVE of the eight latent variables/8

$$= 0.530+0.\overline{590+0.525+0}.522+0.620+0.593+0.590/8= 0.496$$

$GoF_{LSE} = \sqrt{0.496 * 0.998}=0.704$

From the above calculations, we can say the model was highly satisfactory having a largely exceeded GoF than the cut off point for global validation of PLS model.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The results obtained in the analysis of the questionnaire survey, PLS modeling of logistics system engineering, interoperability and logistics performance and the Archival findings have been discussed and presented in the previous Chapters in detail. Therefore, from the results of the analysis of desk study and respondents' responses the following major conclusions have been drawn:

Effectiveness and efficiency in logistics system factors (ELS)are the very great extent (AVE 0.620)construct or group of factors causing for lesser efficiency and effectiveness.

Following Effectiveness in logistics factors (ELS), Effectiveness of rail transport (ERT/ AVE 0.593/) are affects Logistics Performance factors (ERT) are the second significant construct second to ELS. Thirdly, Transport financing and logistics performance factors (TFLP) and Integration of transport services (IRT) are equally affected logistics performance (AVE 0.59).

As discussed in the previous chapters this study was conducted to assess logistics system engineering, interoperability, rail transportation service on logistics performance using eight dimensions of the problems are assessed and evaluated. The eight dimensions used are, Interoperability, Logistics system engineering, transport financing and logistics performance, service quality and competency of logistics activity, efficiency and effectiveness; and integration of railway transport service. The operations attributed to these logistics performances are cost and speed. The study adopted more the descriptive and explanatory research design in obtaining information about the study topic. The study's population comprised of EDR/MC local, ESLSE,EMAA, MOTL and ERC staff which were selected in stratified sampling techniques approach. The data was collected using questionnaire and interview using descriptive and inferential statics of explanatory analysis. The findings obtained are summarized below as per the study's specific objectives.

From the previous chapter, based on the statics the correlation analysis, it show that rail transport service have statistically significant effect on the logistics performance cost. It is evident that at 95%

confidence level that the independent variables of customs; competence and quality of logistics service; that all the construct have significant effect on logistic performance except ELS. SQC, IRT and ERT' are the most influential constructs on logistic performance in descending order.

From the department of LSCM I can understand the railway industry integrates all courses of Business logistics, Global Logistics, Humanitarian logistics, Custom clearance and freight forwarding, Industrial operation Management, supply chain Management, Business Leadership, Supply Chain Modeling all in one.

5.2 .RECOMMENDATION

Based on the results of the study, for consideration from the study of the research paper; the following major recommendations are forwarded to the Company and other researchers;

Recommendation to the Company(EDR)

- EDR is advised to have well developed and finalized legal, technical and operational interoperability packages and to contract agreements with bilateral agreements.
- Improved performance evaluation by KPI and better coordination among stakeholders is in need.
- EDR should finalize and be IT connected in technical interoperability issues and apply same software with ESLSE, EMAA and other stakeholders in the multimodal of operations.
- Security ensuring works such as giving awareness about projects for residents along railway projects and better coordination with public security government bodies should be taken to an emphasis points.
- Supports for Djibouti government regarding interface to Negad port of 7 kms container terminal during machines and equipment are wasted to loading and unloading time can be cut from 4 days to hours applying gantry cranes and rich-stackers.
- As it was indicated on the World Bank study, improving human resources are a key factor when it comes to competence and quality of logistics services. In order to achieving logistics excellence in EDR, it requires continuous improvement in service equality and competency of logistics services.

- In Technological Interoperability, even though EDR's applying the Chinese' freight Transport system which is IT based Technology installed along the line, they need to implement further IT and EDI e-system in areas of tracking and tracing logistics activities. Logistics players were highly depending on the information technology (IT) and electronic data interchange (Ali et al.,2008). Raus et al (2009) highlight that the usage of IT and EDI could prevent criminal activities, informal payments and improve cost efficiency. Therefore, I strongly recommend EDR to implement new information system in e-payment and e-ticketing services Schedule reviews should be always on desk tasks, works which are not inter sequential can be done independently, reviewing contractors progress should be done in well enhanced manner.
- Empowering Logistics and supply chain Managers for better leadership and Assigning the right professionals to the right task position is the last recommendation

Recommendation to furtherstudies

The author would like to suggest future research to be carried out on: Comparative study of Logistics System Engineering, Interoperability and Logistics performance on Ethiopia's railway transport. It is believed that they will contribute a better towards railway freight transport industry and to the country's transport development as a whole.

1. By adopting these recommendations, EDR can improve rail transportation service delivery for its customers, becoming the efficient, reliable and effective rail transport service provider in Ethiopia and improve the logistics performance level of the country in the global economy scale.
2. Ministry of Transport will enhance the logistics performance by applying the 10 years Logistics strategy (2012-20122 EC) in that strives for its implementation in the remaining years and rectify collecting transport modes companies in one organization, since among 44 projects in the strategy about 30 directly or indirectly connected to the railway transport system and must be system engineered, interoperable and integrated to increase the efficiency of logistics performance.

3.Financial model should be revised for break-even and debt return, rolling stock and infrastructure depreciation, interest expense and foreign losses EDR to be run by local staff and return loan.

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Structured Questionnaire
Addis Ababa University
Master of logistics and supply chain management

Dear respondent,

This questionnaire is designed to collect information from Rail transport service providers and stakeholders and aimed to analyze **"Assessments of Logistics System Engineering and Evaluation of Interoperability and Performance of Railway Transport, the case of EDR"**as a research subject for the partial fulfillment of the requirements of Master in logistics and supply chain management (LSCM). ***Your response would have been used only for academic purpose and kept confidential.***

General Instructions

- There is no need of writing your name
- Where answer options are available please circle in the appropriate number for part I and tick (√) for your response to each statements of part II.
- Please answer ALL the questions.

Thank you for taking your time to share the insight with me.

Yours faithfully,

Mekonnen Getachew Asfaw
Addis Ababa University School of Commerce
Tel: +251939290069 Email: nobilamak@gmail.com

Part One: Respondent characteristics***:***

1. **Sex**: 1. Male ☐ 2. Female ☐

2. **Age**: 1. 20-30 ☐ 2. 31-40 ☐ 3. 41-50 ☐ 4. 51-60 ☐ 5. Above 60 ☐

3. **Educational status:**
   1. Certificate ☐ 2. Diploma/TVET ☐ Degree 4. ☐ aster and above ☐

4. **Position:**
   1. Director/chief officer ☐ Section manager ☐ 3. Team leader ☐ 4 .Exper ☐
   5.Others ☐

5. **Average monthly income level in Birr:**

☐ ☐

1. Below 4000 ☐ 2. 4001-6000 ☐ 3. 6001-8000 ☐ 4. 8001-12000 5. Above12000

6. How long have you been working in the railways company?

1. 1-5 Years ☐ 2. 6-10 years ☐ 3. 11yearsand above ☐

7. Organization you are working for

1 Ethiopian Railway Corporation (ERC) ☐

2. China Civil Engineering Construction Corporation (CCECC) ☐
3..Ethio-Djibouti Standard Gauge Rail Transport Share Company (EDR) ☐

4.Ethiopian Shipping Lines and Logistics Service Enterprise/(ESLSE) ☐

5.Ethiopian Maritime Affairs Authority(EMAA) ☐

6 China Railway Engineering Corporation (CREC) ☐

8.Academic background _____

1. Ph.D ☐ 2. Masters ☐ 3. Bachelor ☐ 4 .Diploma ☐ 5.Cirtificate ☐
2. Railway ☐ 2. Civil ☐ 3. Mechanical ☐ 4 .Electrical ☐ 5.Logistics ☐

Part two: Effect of rail transportation service on logistics performance

questions: In determining the extent to which your organization affect logistics and rail transport performance,interoperability ,efficiency, effectiveness, financing and integration please indicate to what extent your organization practices the following on a scale of 1 – 5 (where**; 1=very small extent, 2= small extent, 3=Moderate, 4= great extent, 5= very great extent)**

7. SECTION B: How the gap in logistics system engineering in rail transport service affectthe logistics and rail transport performance in EDR?

To what extent does the gap in logistics system engineering in your organization affect the logistics and rail transport performance and rail transport efficiency?	1	2	3	4	5
1. Systems in rail transport increased utilization of computerized and automated communication systems “ASYCUDA++”					
2. The logistics System engineering team or functional unit is independently organized to Coordinate activities of systems to allow the customers to get efficient services					

3. Border logistics systems department and functional unit is adequately staffed with skilled personnel & facilities to deliver fast and quality services					
4. Clearly articulated systems guideline is in place to secure all necessary documents from customer before starting all process					
5. Designed systems in rail transport service promote cross-border cooperation in monitoring and clearing cargo					
Any other (Please specify) ……					

8. SECTION C: How rail transport financing affects the logistics performance in EDR

How rail transport financing affects logistics performance?	1	2	3	4	5
1. Rail transportinfrastructure improves import & export in thedomestic freight yards needs huge financing and budget.					
2. Rail transport improves sufficient hinterland connection for intermodal transports and access to finance.					
3. Adequate number of rolling stocks are available to support the rail transport operation such as locomotives, wagons,etc					
4. Rail transport infrastructures are well equipped with the necessary equipment and facilities such asrailway communication signaling, mechanical and electrical equipment, IT system and other with adequate financing.					
5. Rail transport infrastructure is accessibleto sufficient fright yards and dry ports and allocated maintenance budget.					
6. Rail transport hassufficient link roads to access train station and interfaced by rail link with industries financing.					
7. Rail transports are equipped with sufficient electric energy supply for the service with contributed finance by both parties/countries.					
Any other (Please specify					

9. SECTION D: How the lack of interoperability in rail transport affects the logistics performance?

How the ease of arranging interoperability in rail transport affects the logistics performance?	1	2	3	4	5
1. Rail transport easy interoperable services at increasingly competitive prices &reduces service barriers in the logistics sector.					
2. Rail transport interoperability enhances reduced costs of passengers and cargo transport to support logistics activities as compared to other modes.					
3. Rail transport competitive interoperability based price facilitates the movement of passengers & cargos within the country.					

4. Theless cost of loaded and empty container cargo as compared with other modes of transport are interoperable.					
5. Rail transportation service price stimulates multi-modal (intermodal) transport activities interoperable.					
6. Rail transport interoperability is competitive in comparison with other modes of transport in the market (road & Air).					
Any other (Please specify					

10. SECTION E: How service quality &competences of logistics service in rail transport affect logistics performance in EDR?

How service quality &competences of logistics service in rail transport affect logistics performance in EDR?	1	2	3	4	5
1. There is enough skill and expertise in the company to operate Rail transport systems as transport operator.					
2. The company uses proper queue management system to serve customers at the reception to minimize waiting time.					
3. Rail transportation service quotations are delivered to customers in standard time.					
4. Customers are informed in time in case of any supplementary work related to any change on schedule.					
5. In the company employees respond to customer enquiries in time.					
6. The company ensures that maintenances and line check up are made in time to ensure safety and security.					
7. Competency of rail transport allows increased scale of logistics service providers.					
8. Rail transport logistics service competency encourages integration of logistics services for import & export trade.					
9. Rail transport logistics service introduces modern supply chain management techniques such as increasing the reliability in online ticketing system & Targeting a new market niche.					
Any other (Please specify)					

11. SECTION F: How the limitations in effectiveness in a rail transport affect the logistic performance in EDR?

How effective logistics system in a rail transport enhances the logistic performance in EDR?	1	2	3	4	5
1. Rail transport improved information and communications technologies (ICT) to support logistics activities.					
2. Rail transportation service implemented utilization of tracking and monitoring systems.					
3. Rail transport introduces online systems (internet) for real time clearance monitoring.					
4. Rail transport introduces e-government services and e-signatures for government approvals.					
5. Rail transport service introduced public information platforms for sharing trade and logistics data.					
Any other (Please specify)					

12. SECTION G: How efficient the rail transport service affect the logistics performance?

How efficient the rail transport service affect the logistics performance?	1	2	3	4	5
1. Rail transport service simplify operations which cause delays in transportation and leads to good efficiency;					
2. Rail transport service decrease variability of transport and handling times impacts efficiency.					
3. Rail transport service decrease waiting times in border crossings may enhance efficiency.					
4. Rail transportation services shorten operations required for border crossings.					
5. Rail transportation services improve management of handling perishable goods operations in freight yards.					
6. Rail transport service increase efficiency of logistics performance by novel management practices.					
Any other (Please specify)					

13. SECTION H: How Integration of rail transports service affect the logistics performance?

How integration of rail transport service affect the logistics performance?	1	2	3	4	5
1. Rail transport minimized the transportation cost per unit in import and export process are integrated and attractive to customers					
2. Rail transport is cheaper than other modes of transport					
3. The capital investment into rail transport add more value to the logistics integrated activities					
4. Rail transport Maintenance cost maximize the logistics					

service cost					
5. Rail transport minimize the overall total inventory cost like holding, ordering and stock out					
6. Rail transport reduced loading and unloading cost as well as loss and damage cost					
Any other (Please specify)					

14. SECTION I: How effective of rail transport service affect the logistics performance?

How effectiveness of rail transport service affect the logistics performance?	1	2	3	4	5
1. EDR shorten time to deliver freight cargos and passengers effectively					
2. Rail transport improve time of loading and unloading in freight yards effectively using cranes					
3. rail transport reduced lead time (time between order and delivery) in import and export logistics activities					
4. Trains arrive in the stations at the needed time by the customer is effective					
5. The train traveling time increased level of incidence of cargo damage occurrence					
6. Reducing Train travel time improves safety and security of cargos and passengers are effective					
Any other (Please specify)					

3.3Please write additional contributing cause factors for gap in logistics system engineering. (if any)

_____
_____
_____
_____
_____

3.4 Please write additional contributing cause factors for lack of interoperability. (if any)

_____
_____
_____
_____

Appendix I

Data for assessment of Logistics system engineering and Transport Financing

LSE1	LSE2	LSE3	LSE4	LSE5	TFLP1	TFLP2	TFLP3	TFLP4	TFLP5	TFLP6	TFLP7
3	3	3	4	3	3	3	3	3	3	3	3
4	3	3	4	4	4	5	2	3	2	3	3
4	3	3	4	4	4	4	3	3	2	3	3
4	3	4	5	5	4	5	4	2	1	2	2
3	3	3	4	4	3	4	4	3	3	4	4
3	3	3	3	2	5	4	5	4	3	3	3
3	3	3	3	4	4	3	4	4	3	3	3
5	4	5	4	4	3	4	5	5	4	4	4
3	4	4	4	4	3	4	4	4	4	4	5
4	4	4	3	4	5	4	4	4	4	3	4
5	3	3	4	4	4	4	5	4	2	2	3
5	4	2	4	2	4	4	2	2	3	2	3
1	2	2	3	2	4	4	3	4	4	3	3
5	5	4	4	5	4	5	4	5	5	5	4
3	4	2	3	5	3	3	5	3	4	3	3
1	4	3	5	5	3	2	4	5	5	5	5
1	3	2	2	1	2	3	4	3	2	1	4
5	5	3	3	1	5	2	3	5	4	4	3
3	3	4	3	3	4	3	2	3	3	3	3
3	4	5	3	3	5	5	4	4	5	4	4
3	2	2	1	1	2	2	3	2	2	3	2
3	3	2	4	3	4	4	2	4	3	3	3
2	1	2	2	3	2	3	1	3	1	3	3
4	3	4	3	3	3	4	4	3	4	3	2
4	3	3	3	4	4	4	3	4	3	3	3
4	3	4	3	3	4	3	3	4	4	3	3
3	3	3	4	3	3	3	3	3	3	3	3
4	3	3	4	4	4	5	2	3	2	3	3
4	3	3	4	4	4	4	3	3	2	3	3
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5	4	5	4	4	3	4	5	5	4	4	4
3	4	4	4	4	3	4	4	4	4	4	5
4	4	4	3	4	5	4	4	4	4	3	4
5	3	3	4	4	4	4	5	4	2	2	3

5	4	2	4	2	4	4	2	2	3	2	3
1	2	2	3	2	4	4	3	4	4	3	3
5	5	4	4	5	4	5	4	5	5	5	4
3	4	2	3	5	3	3	5	3	4	3	3
1	4	3	5	5	3	2	4	5	5	5	5
1	3	2	2	1	2	3	4	3	2	1	4
5	5	3	3	1	5	2	3	5	4	4	3
3	3	4	3	3	4	3	2	3	3	3	3
3	4	5	3	3	5	5	4	4	5	4	4
3	2	2	1	1	2	2	3	2	2	3	2
3	3	2	4	3	4	4	2	4	3	3	3
2	1	2	2	3	2	3	1	3	1	3	3
4	3	4	3	3	3	4	4	3	4	3	2
4	3	3	3	4	4	4	3	4	3	3	3
4	3	4	3	3	4	3	3	4	4	3	3

Appendix 2

Data for Assessment of Interoperability and Service Quality & Competence

I1	I2	I3	I4	I5	I6	SQC1	SQC2	SQC3	SQC4	SQC5	SQC6	SQC7	SQC8	SQC9
3	4	3	3	2	2	3	4	4	4	4	4	3	3	3
3	4	4	4	3	4	4	3	4	4	4	4	4	4	4
3	2	3	4	3	4	4	3	4	4	4	4	3	4	4
3	4	4	5	4	4	3	4	4	5	5	2	3	4	2
4	4	4	4	4	4	3	4	4	4	4	4	4	4	3
3	4	4	5	4	3	4	3	3	2	3	3	4	4	3
3	3	4	4	3	4	3	3	3	3		4	4	4	3
4	4	4	4	5	5	3	3	4	3	3	4	4	4	4
4	5	5	4	4	3	5	5	5	5	5	5	5	5	5
4	4	4	5	4	4	3	4	4	4	3	3	4	5	2
4	4	4	4	4	4	4	3	4	4	4	4	4	4	4
3	5	5	5	4	5	4	2	2	2	3	5	5	5	2
4	4	4	4	4	3	3	2	3	3	3	4	3	3	2
5	5	4	5	5	5	5	4	4	4	5	5	5	5	4
2	4	3	3	5	3	3	3	3	4	2	3	3	5	3
3	1	4	4	3	4	3	2	4	5	4	4	3	5	5
3	4	4	4	1	3	3	2	3	3	3	4	4	4	4
5	5	5	5	4	4	4	4	4	4	4	5	4	4	1
3	3	3	4	3	3	3	3	3	3	3	3	4	4	3
4	5	5	3	2	2	1	3	4	3	3	4	4	3	3

1	1	1	4	3	4	2	1	1	2	1	3	2	2	1
4	4	4	3	4	3	3	4	4	4	4	3	3	3	4
1	3	2	2	3	1	4	2	2	3	1	2	1	3	1
4	5	2	5	4	3	3	3	4	3	3	4	4	3	1
4	3	4	3	4	3	4	4	3	3	3	4	4	4	4
3	4	4	4	4	4	4	5	5	5	5	4	4	5	5
3	4	3	3	2	2	3	4	4	4	4	4	3	3	3
3	4	4	4	3	4	4	3	4	4	4	4	4	4	4
3	2	3	4	3	4	4	3	4	4	4	4	3	4	4
3	4	4	5	4	4	3	4	4	5	5	2	3	4	2
4	4	4	4	4	4	3	4	4	4	4	4	4	4	3
3	4	4	5	4	3	4	3	3	2	3	3	4	4	3
3	3	4	4	3	4	3	3	3	3		4	4	4	3
4	4	4	4	5	5	3	3	4	3	3	4	4	4	4
4	5	5	4	4	3	5	5	5	5	5	5	5	5	5
4	4	4	5	4	4	3	4	4	4	3	3	4	5	2
4	4	4	4	4	4	4	3	4	4	4	4	4	4	4
3	5	5	5	4	5	4	2	2	2	3	5	5	5	2
4	4	4	4	4	3	3	2	3	3	3	4	3	3	2
5	5	4	5	5	5	5	4	4	4	5	5	5	5	4
2	4	3	3	5	3	3	3	3	4	2	3	3	5	3
3	1	4	4	3	4	3	2	4	5	4	4	3	5	5
3	4	4	4	1	3	3	2	3	3	3	4	4	4	4
5	5	5	5	4	4	4	4	4	4	4	5	4	4	1
3	3	3	4	3	3	3	3	3	3	3	3	4	4	3
4	5	5	3	2	2	1	3	4	3	3	4	4	3	3
1	1	1	4	3	4	2	1	1	2	1	3	2	2	1
4	4	4	3	4	3	3	4	4	4	4	3	3	3	4
1	3	2	2	3	1	4	2	2	3	1	2	1	3	1
4	5	2	5	4	3	3	3	4	3	3	4	4	3	1
4	3	4	3	4	3	4	4	3	3	3	4	4	4	4
3	4	4	4	4	4	4	5	5	5	5	4	4	5	5

Appendix 3

Data for Assessment of

ELS2	ELS3	ELS4	ELS5	ERT1	ERT2	ERT3	ERT4	ERT5	ERT6
3	4	3	4	3	3	3	3	3	3
4	2	2	3	4	3	4	3	2	4
4	2	2	3	4	3	4	4	2	3
3	3	1	3	3	4	4	4	2	3
3	3	3	3	4	4	4	4	3	3
3	3	3	2	3	3	3	4	4	4
3	3	2	3	3	3	3	3	3	3
4	4	3	4	4	3	4	4	3	4
3	4	2	2	4	4	4	4	4	4
4	4	3	3	4	3	3	3	4	4
4	3	3	3	5	5	5	5	5	5
5	4	4	2	3	4	4	4	5	5
2	1	1	2	4	4	5	5	5	3
4	3	3	3	5	4	5	5	5	4
3	2	2	1	2	3	5	4	4	3
5	4	4	5	4	3	4	4	3	4
4	5	2	5	3	4	5	1	4	4
3	3	2	3	4	4	4	4	4	3
3	3	2	3	3	3	2	3	3	3
3	4	4	4	1	2	2	1	2	2
3	3	2	3	2	3	3	3	3	2
3	4	4	3	4	4	5	4	4	5
1	2	3	4	4	1	2	1	3	1
2	1	1	1	5	4	4	4	2	2
3	3	3	3	4	4	4	5	3	4
4	4	4	4	3	3	3	3	3	3
3	4	3	4	3	3	3	3	3	3
4	2	2	3	4	3	4	3	2	4
4	2	2	3	4	3	4	4	2	3
3	3	1	3	3	4	4	4	2	3
3	3	3	3	4	4	4	4	3	3
3	3	3	2	3	3	3	4	4	4
3	3	2	3	3	3	3	3	3	3
4	4	3	4	4	3	4	4	3	4
3	4	2	2	4	4	4	4	4	4
4	4	3	3	4	3	3	3	4	4
4	3	3	3	5	5	5	5	5	5

5	4	4	2	3	4	4	4	5	5
2	1	1	2	4	4	5	5	5	3
4	3	3	3	5	4	5	5	5	4
3	2	2	1	2	3	5	4	4	3
5	4	4	5	4	3	4	4	3	4
4	5	2	5	3	4	5	1	4	4
3	3	2	3	4	4	4	4	4	3
3	3	2	3	3	3	2	3	3	3
3	4	4	4	1	2	2	1	2	2
3	3	2	3	2	3	3	3	3	2
3	4	4	3	4	4	5	4	4	5
1	2	3	4	4	1	2	1	3	1
2	1	1	1	5	4	4	4	2	2
3	3	3	3	4	4	4	5	3	4
4	4	4	4	3	3	3	3	3	3

Appendix 4

Data for Assessment of Effectiveness of Logistics System and Effectiveness of Logistics System

ELS1	ELS2	ELS3	ELS4	ELS5	ERT1	ERT2	ERT3	ERT4	ERT5	ERT6
4	3	4	3	4	3	3	3	3	3	3
4	4	2	2	3	4	3	4	3	2	4
4	4	2	2	3	4	3	4	4	2	3
2	3	3	1	3	3	4	4	4	2	3
3	3	3	3	3	4	4	4	4	3	3
2	3	3	3	2	3	3	3	4	4	4
3	3	3	2	3	3	3	3	3	3	3
4	4	4	3	4	4	3	4	4	3	4
3	3	4	2	2	4	4	4	4	4	4
3	4	4	3	3	4	3	3	3	4	4
4	4	3	3	3	5	5	5	5	5	5
4	5	4	4	2	3	4	4	4	5	5
2	2	1	1	2	4	4	5	5	5	3
4	4	3	3	3	5	4	5	5	5	4
3	3	2	2	1	2	3	5	4	4	3
5	5	4	4	5	4	3	4	4	3	4
4	4	5	2	5	3	4	5	1	4	4
5	3	3	2	3	4	4	4	4	4	3
3	3	3	2	3	3	3	2	3	3	3
3	3	4	4	4	1	2	2	1	2	2

3	3	3	2	3	2	3	3	3	3	2
3	3	4	4	3	4	4	5	4	4	5
2	1	2	3	4	4	1	2	1	3	1
2	2	1	1	1	5	4	4	4	2	2
4	3	3	3	3	4	4	4	5	3	4
4	4	4	4	4	3	3	3	3	3	3
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2	3	3	3	2	3	3	3	4	4	4
3	3	3	2	3	3	3	3	3	3	3
4	4	4	3	4	4	3	4	4	3	4
3	3	4	2	2	4	4	4	4	4	4
3	4	4	3	3	4	3	3	3	4	4
4	4	3	3	3	5	5	5	5	5	5
4	5	4	4	2	3	4	4	4	5	5
2	2	1	1	2	4	4	5	5	5	3
4	4	3	3	3	5	4	5	5	5	4
3	3	2	2	1	2	3	5	4	4	3
5	5	4	4	5	4	3	4	4	3	4
4	4	5	2	5	3	4	5	1	4	4
5	3	3	2	3	4	4	4	4	4	3
3	3	3	2	3	3	3	2	3	3	3
3	3	4	4	4	1	2	2	1	2	2
3	3	3	2	3	2	3	3	3	3	2
3	3	4	4	3	4	4	5	4	4	5
2	1	2	3	4	4	1	2	1	3	1
2	2	1	1	1	5	4	4	4	2	2
4	3	3	3	3	4	4	4	5	3	4
4	4	4	4	4	3	3	3	3	3	3

Appendix 5

Data for Assessment of Integration of Railway Transport

IRT1	IRT2	IRT3	IRT4	IRT5	IRT6	ERT'1	ERT'2	ERT'3
3	3	3	3	3	3	3	3	3
4	5	5	3	4	4	4	4	4
4	5	5	3	4	4	4	4	4
4	5	4	3	4	4	5	4	4
4	4	3	3	4	3	4	3	4
4	4	4	2	3	3	4	4	3
3	4	4	4	3	3	4	4	3
4	4	5	4	4	3	3	4	5
4	5	4	3	4	3	4	3	3
4	2	4	4	3	4	4	4	3
5	5	4	4	4	4	4	4	4
5	5	5	5	5	5	4	5	5
4	3	5	5	4	4	4	4	4
5	5	5	4	5	5	5	5	5
4	3	4	4	3	3	4	4	3
4	3	4	4	4	4	5	5	5
4	5	1	1	4	1	5	5	3
4	5	4	4	4	4	3	4	4
4	3	3	3	3	3	3	3	3
2	3	3	3	3	3	4	4	4
3	2	3	2	2	3	2	2	2
3	4	4	3	3	4	3	4	4
1	2	1	3	2	2	2	2	1
5	5	4	2	4	4	4	3	4
4	5	4	3	3	4	4	4	4
3	3	4	4	3	3	3	4	4
3	3	3	3	3	3	3	3	3
4	5	5	3	4	4	4	4	4
4	5	5	3	4	4	4	4	4
4	5	4	3	4	4	5	4	4
4	4	3	3	4	3	4	3	4
4	4	4	2	3	3	4	4	3
3	4	4	4	3	3	4	4	3
4	4	5	4	4	3	3	4	5
4	5	4	3	4	3	4	3	3
4	2	4	4	3	4	4	4	3
5	5	4	4	4	4	4	4	4

5	5	5	5	5	5	4	5	5
4	3	5	5	4	4	4	4	4
5	5	5	4	5	5	5	5	5
4	3	4	4	3	3	4	4	3
4	3	4	4	4	4	5	5	5
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4	5	4	4	4	4	3	4	4
4	3	3	3	3	3	3	3	3
2	3	3	3	3	3	4	4	4
3	2	3	2	2	3	2	2	2
3	4	4	3	3	4	3	4	4
1	2	1	3	2	2	2	2	1
5	5	4	2	4	4	4	3	4
4	5	4	3	3	4	4	4	4
3	3	4	4	3	3	a	4	4