MODELING AND ANALYSIS OF THE DRY PORT TRANSPORT LOGISTICS PERFORMANCE: A CASE OF MODJO DRY PORT

A THESIS SUBMITTED FOR M.SC. IN INDUSTRIAL ENGINEERING AND LOGISTIC MANAGEMENT

BY

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HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA

MARCH, 2023

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A THESIS SUBMITTED TO THE DEPARTMENT OF INDUSTRIAL ENGINEERING, FACULTY OF MANUFACTURING, INSTITUTE OF TECHNOLOGY, HAWASSA UNIVERSITY

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ADVISORS' APPROVAL SHEET

This is to certify that the thesis entitled "**Modeling and Analysis of the Dry Port Transport Logistics Performance: A Case of Modjo Dry Port**" submitted in partial fulfillment of the requirements for the degree of **Master's** with specialization in **Industrial Engineering and Logistic Management**, the Graduate Program of **the Department of Industrial Engineering**, and has been carried out by **Hunduma Bersisa** (ID. No. **GPIELMR/0007/112**), under our supervision. Therefore, we recommend that the student has fulfilled the requirements and hence hereby can submit the thesis to the department.

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DECLARATION

I hereby declare that this M.Sc. thesis entitled "**Modeling and Analysis of the Dry Port Transport Logistics Performance: A Case of Modjo Dry Port**" is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged.

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Signature: __________________

Place and Date of Submission: __________________________

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List of Acronyms/Abbreviations

ASYCUDA	Automated System for Customs Data
CCTV	Closed Circuit Television
CFS	Container Freight Station
EC	Electronic Commerce
EDI	Electronic Data Interchange
ESLSE	Ethiopian Shipping and Logistics Service Enterprise
FEU	Forty feet Equivalent unit
GIS	Geographical Information System
GPS	Global Positioning System
ICT	Information and Communication Technologies
ITS	Intelligent Transport Systems
ITT	Inter-terminal Transport
KPI	Key Performance Indicators
LCL	Less than Containers Loads
LLDC	Land Locked Developed Countries
LPI	Logistics Performance Index
MDP	Modjo Dry Port
RFID	Radio frequency identification
SPSS	Statistical Package for Social Sciences
TEU	Twenty feet Equivalent unit
TOS	Terminal Operating System
UNCTAD	Unit Nation Conference on Trade and Development
WB	World Bank

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Abstract

To encourage the country's economic development, import/export trade is a better and more cost-effective way are using dry ports. Dry Ports are the specific sites to which imports and exports can be consigned for inspection by customs and which can be specified as the origin or destination of goods in transit accompanied by documentation such as the combined transport bill of lading or multi-modal transport document.

However, the management of trucks, loading and unloading time, processing of custom duties, port machinery productivity and dwelling time, etc. were the problems at MDP. the research problems in addition were delays at checking points, temporary storage and transport cost at inter-terminal.

Therefore, this research was conducted with a model and analysis of Modjo dry port transport logistics performance to overcome the factor affecting the efficiency and effective of the transport logistics in the port. To overcome the problems, primary data collection methods (Site survey: observation, data record, questionary and interview) took place with the help of the company's workers cooperation whose answers questionary properly 117 of 146 considered in the research. The secondary data source (Text books, articles, journals, theses, and company documents) was used for preliminary identifying the problems and validating the study after the results were analyzed. The raw data collected through different tools in the research were analyzed with the help of SPSS, Excel, and QM for windows software packages. The analyzed data was shown by percentage, mean, table, chart and graphs and the results were shown by graphical and mathematical models.

After the results obtained were analyzed and discussed, the research questions; the model of the transport logistics performance, and the performance of its operations were answered. In these results, different performance indicators and their attributes were modeled from the existing model with modifications, in terms of checking points (in-gates) an additional in-gate and two other reach stackers at temporary storage will be necessary to be assigned, and the terminal transports should be directly delivering the cargo through CFS to the customers for cost and time optimization.

Key words: checking point, CFS, Dry port, Transport logistics, Performance, Terminal operating system.

CHAPTER ONE

INTRODUCTION

In this section, the background of the study, problem statement, objective, research questions, scope and justification and at the end of this section organization of the study were discussed.

1.1. Background of the Study

The economies of Ethiopia and Djibouti depend on imports into and exports out of Ethiopia. These depend, in turn, on an efficient transport logistics system along the entire length of the Djibouti-Ethiopia transport and transit corridor.

To support the country's economic development, import/export trade better and more cost-effective ways using dry ports. Dry Ports are the specific sites to which imports and exports can be consigned for inspection by customs and which can be specified as the origin or destination of goods in transit accompanied by documentation such as the combined transport bill of lading or multi-modal transport document (Tigabu, 2020).

Dry port aims to reach localized trading in hinterland areas to minimize transportation costs which are 40% of all logistics costs (Topolšek et al., 2018), and to improve logistic performance in the region. It's playing a major role not only in delivering products through containers but also in supporting economic activities and improving logistics competitiveness (Miraj et al., 2021).

Inland terminal and/or hinterland accessibility are driven by transport costs, alternative transport modes, capacity and quality of inland connections and transport service quality, in addition to an integration on the main land transport networks (Hervás-Peralta et al., 2019).

According to UNCTAD (2018), ESLSE's port and terminal facilities are points of destination for Ethiopia's imports and points of consolidation for exports, where goods are loaded and unloaded and customs formalities are completed. Goods are temporarily stored there, placed into or taken out of containers, made ready for transport, and dispatched to their final destinations.

Because, it was generally built to provide and deliver the following services; receiving and delivering cargoes, cargo loading and unloading, stuffing and unstuffing of container goods, temporary storage for import and export cargoes, container cleaning and maintaining, weight bridge, customs control and clearance, banking and insurance, container depot service and engage in other related activities conducive to the achievement of its purposes. And this move has helped the country to save foreign currency and increased its efficiency in import and export operations (Alebachew, 2020).

A dry port's container terminal is a zone of the port where containers are loaded, unloaded and stored in a buffer area called a yard. Inbound containers are unloaded from container careers train and/or truck by cranes or reach stacker and then transported by internal trucks to the storage yard where they are stacked by yard cranes to their allocated positions waiting for the consignees to pick them up (Tigabu, 2020).

According to Tigabu (2020), The terminal operation of a port has significant influences on the competitiveness of the port in global logistic service and the performance of the container terminal at the dry port can be reflected in the longer cargo dwelling time and its manifestation of higher port handling service cost to pay by customer reduce the attractiveness for them to be a hub for the supply chain at a port.

In supply chain and logistics activities, inefficiency is one of the activities which can be exhibited in terms of higher cost, delay and unpredictability in delivering the product and service to the customer, in turn, impacts the economic growth of a country (Miraj et al., 2021).

In terms of efficiency, several key issues need to be addressed for both imports and exports that relate to the movement of containers through the port, and inefficiencies in the management of trucks loading and unloading, processing of custom duties, man power productivity, port machinery productivity and storage dwelling time, etc.

Therefore, it is necessary to analyze the performance of the port particularly transport logistics performance which had an impact on the competition with international trade to improve the efficiency and effective of MDP.

In essence, performance analysis is an analysis of both efficiency and effectiveness in accomplishing a given task. All evaluations is concerning "how well the goal is met"(Hamilton, 2015).

1.2.Statement of the problem

Landlocked developing countries (LLDC) continue to face significant constraints and challenges in terms of trade, transit, and overall socio-economic development. Among them, with no direct access to the sea and port charges at the monopolistic Djibouti port, landlocked Ethiopia appears to be serious due to competitiveness and efficiency of transportation of goods (Debela, 2013). Even though the port of Djibouti currently handles about 95 percent of Ethiopian imports and exports (Georgise et al., 2020), the port of Berbera and the port of Sudan handle 3 percent and 2 percent respectively (World Bank, 2020). However, still Ethiopia, as a landlocked developing country, faces several challenges like; high transit transportation costs, limitation of technical and technological capacity, delays, customer dissatisfaction, high-value cost, etc. (Musemma, 2016).

According to Waktole (2017), the major problems of shipments at the port were time wasted in queues to get service at the check points, traffic congestion, and low integrated cooperation of the departments. According to Alebachew, (2020), the major problems observed in MDP were cargo delays and waiting times at dry ports and terminals. This indicates that the logistics service in the country is still now at the early stage of development against the global best practices. the problems of the port were the arrangement of facilities and equipment, poor operational procedures and control, and lack of yard management systems are responsible for the excess time for truck turnarounds and for 35%-40% of the container dwell time (Tigabu, 2020).

The customers and users frequently complained about the slow pace of goods and services delivered by the port which leads to a serious congestion problem in the dry ports which has, in turn, resulted in substantial operating costs for the port and the customers. Even though MDP is the key logistics channel of the country, it hosts an overall poor logistics performance (Musemma, 2016).

During preliminary observation, the researcher has also found that the port faces an impact utilization of resources, absence of control, procedures while delivering services, and poor ICT infrastructure and communication system.

1.3. The Objective of the Study

1.3.1. General Objective

The general objective of this study was to model and analyze the dry port transport logistics performance in the case of Modjo dry port.

1.3.2. Specific Objectives

The specific objectives of the study are as follows;

- To examine the transport logistics performance of the Modjo dry port related to its appearance.
- To assess transport logistics processes and performance attributes of Modjo dry port
- To model the transport logistics operations of the Modjo dry port

1.4. Research Questions

The research answers the following perspective questions. These questions are;

- What is the status quo of the transport logistics performance related to its appearance in Modjo Dry Port?
- How the transport logistics Process and its performance attribute is performed at the Modjo dry Port?
- Does the transport logistics operations of the Modjo dry port are working efficiently?

1.5. Significance of the Research

The role of modeling and analysis the dry port transport logistics performance is to assist the planners and managers in an organization in choosing the system which will provide the best cost/service combination from among the alternative configurations which are possible. The models should inform them how efficient and effective results may occur easily with optimum cost. It also identifies whether there is traffic congestion, handling service strikes and whether pure information is delivered. Regarding this, the model should also emphasize and address relevant transportation and communication issues. The next researcher should also use this research as a reference for further study.

1.6. Scope and Limitation of the Research

The study concerned with some transport logistics activities and assessing their performance at the dry port. Currently, there are eight operational dry ports in Ethiopia; those are Modjo, Samara, Kombolcha, Mekelle, Dire Dawa, Kality, Galan and Woreta. Each dry port is characterized by different sizes of dry port and terminal areas, in TEUs handling capacity, infrastructure, or in the range of services offered and the like.

Therefore, this research focused on modeling and analysis of the Modjo dry port transport logistics performance. Some of the basic areas of operations research involved in solving logistical issues are distribution models, inventory management, optimization, etc. However, this research is limited to the model and analysis of some parts of transport logistics activities related to optimization; particularly transportation logistics at the port and terminal and custom control at gates with their other relatives that take place at Modjo dry port to reap beneficiary performance.

In another hand, the limitation of the study was finance and time to cover other parts of the area since the logistics performance is satisfied by analyzing all logistics activities.

Additionally, some respondents were unwilling and unhappy to fill out the questionnaires distributed to them. Among 146 distributed questioners, 117 fulfilled according to requested while the lefts 29 respondents were uninterested. This was not to say the replayed responses were not sufficient to analysis the results.

1.7. Organization of the study

The research paper is organized into five chapters to determine and clarify the objective of the research. Chapter One deliberates on the introduction of the study which contains the background of the study, statement of the problem, the objective of the study, research questions, significance of the research, scope and limitation of the research and organization of the study. Chapter two contains the literature review; which highly focuses on the transport logistics performance of the dry port, which deals with the subject matter of the issue and related concepts valuable to the study. Chapter three focuses on the methodology and materials of the research, which tell us the mechanism of data collected, analyzed and sources of data as well as data type with reliability and validity test.

Chapter four focuses on the result and discussion of the research which is the main part of the study to answer the research questions and fit the objective of the study while the fifth chapter contains the conclusion, recommendation suggested for solving the problems stated in the introduction part and finding a summary of the research to tell the key findings.

CHAPTER TWO

LITERATURE REVIEW

The chapter contains, the scholar's idea, investigation and literature related to the research topic were discussed to aid this thesis as a secondary source. Therefore, the general idea of dry port, transport logistics and its performances, and additional different related topics were discussed in detail as a theoretical concept, whereas an empirical part contained a summary of similar or related research findings obtained from another earlier research.

2.1. Theoretical Review

The dry port was first introduced by Munford in 1980, in which it was considered as the case study of Argentina and the term "dry port" was used specifically (Varese et al., 2020)

Several definitions can be found in the literature that describes the dry port concept as "an inland intermodal terminal" that is directly connected via rail and/or truck to one or more water ports, and which can substitute certain port services in certain areas.

According to Rodrigue et al., (2013), The term port comes from the Latin Portus, which means gate or gateway. Important to note that, the definitions emanate from the perspective of the physical facility, function and purpose. The definitions were also born of the fact that the periodical steep rise in container flows resulted in crowded terminals, congestion and prolonged dwell time for containers. This definition takes into account the fact that a dry port does not only do the traditional role of transshipment as inland terminals but in addition to this role, it provides other services like; consolidation, storage (both cargo and empty containers), maintenance and repair of containers, and customs clearance (Bekele, 2019).

Dry Port is an intermodal terminal situated in the hinter-land servicing a region connected with one or several seaports by rail and/or road transport and offering specialized services between the dry port and the overseas destinations. Normally, the dry port is container-oriented and also supplies all logistics facilities, which are needed for shipping and forwarding agents in a port (Cezar-Gabriel, 2006)

A dry port since an element of hinterland transport, i.e., it is a part of many supply chains and therefore, affects the supply chain performance. Dry ports can also play a significant role in inducing a modal shift, as they are designed to allow the diversion of cargo movement from inefficient to efficient combinations of transport, mainly from all road to rail plus road, but also from all road to inland water transport, where applicable, plus road.

2.1.1. The Dry port function and classification

A dry port is also defined as an inland setting with cargo-handling facilities allowing several functions to be carried out (UNCTAD, 1991; Georgise et al., 2020); Container handling and storage, breakbulk cargo handling and storage, container stripping and stuffing, customs and other border controls inspection and clearance, container light repairs, freight forwarding and cargo consolidation services, banking/insurance and/or financial services, transport booking and value-added services (e.g., labeling, packaging, long term warehousing).

According to UNCTAD (1991), the facilities of dry ports designed to handle those break-bulk loads in small consignments, Less-than container loads (LCLs) and full-container loads (FCLs) selected for customs inspection.

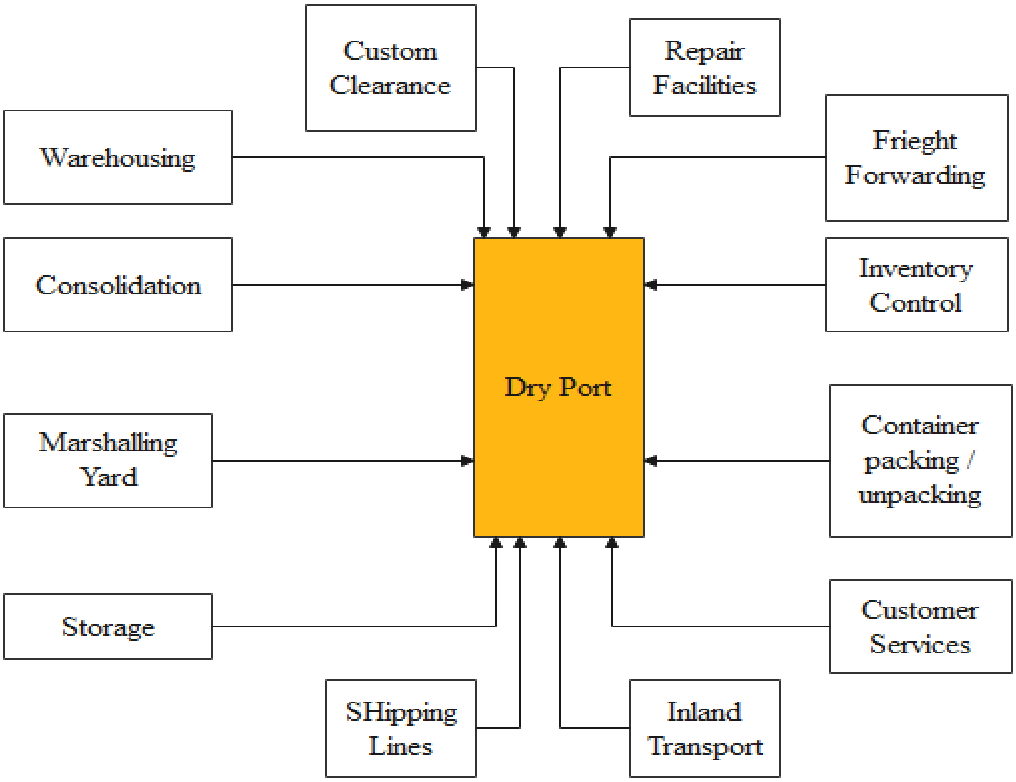

Figure 2-1. Major functions of the dry port.

Source: - (UNCTAD, 1991)

Dry Ports are located based on their assessment criteria, need and the center of gravity favorable to the shippers. Nevertheless, dry port development should be evaluated with its cost functions and also value-added services that can be provided to every stakeholder in the logistics network. According to Roso et al., (2009), as shown in Figure 2.2-2.4 and this classification has been used by many scholars in their works. Generally, the dry port plays a role of operations by rail or road to and from serving ports customs clearance, warehousing with temporary storage of cargo and containers and computerized processing of documents. Dry ports can also be sited in a different location based on their distance to the seaport and the three types of the geographical location of the dry port also plays a different role.

The major role of close dry ports (around 50km and less distant from a sea port) is to relieve the seaports from the burden of space shortage, congestion and environmental issues. With abundant land available, all high space-consuming activities, such as warehousing or sorting, are shifted from seaports to dry ports. The customs clearance procedures could be carried out in these close dry ports.

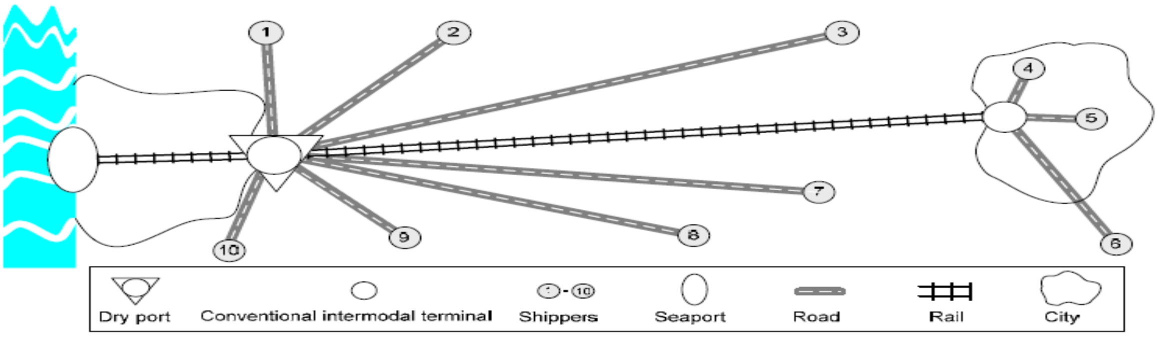

Figure 2-2. A seaport with a close dry port

Source: (Roso et al., 2009 p-343)

Mid-range dry port (distance from around 70km to 500km) functions as a consolidation center for diverse rail services, denoting technical and administrative equipment define for sea transport. It works as an inter-modal center to consolidate or de-consolidate cargo from shippers. It can also function as a trans-modal/trans-loading terminal before cargoes are transported to their designated markets. These types of dry ports are more beneficial to the seaports because it increases the hinterland access in getting close to customers. Pollution and congestion are also tackled by the implementation of a modal shift from trucks to barges/trains.

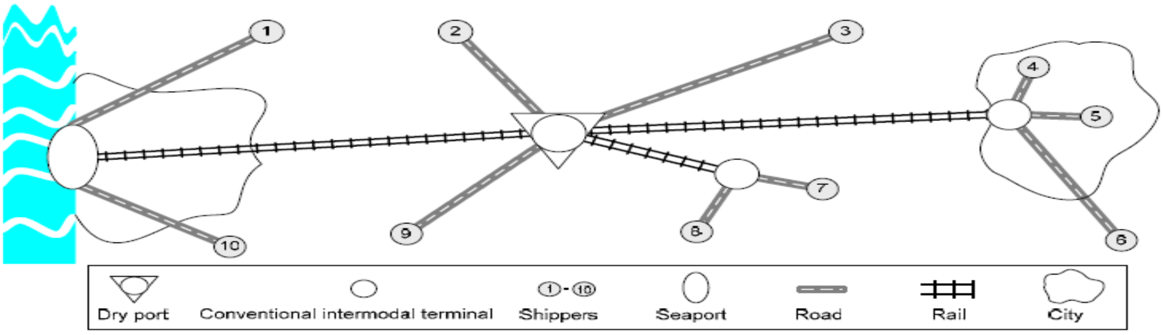

Figure 2-3. A seaport with a midrange dry port

Source: (Roso et al., 2009 p-342)

The distant dry port (over 500km) is situated near the market, which might be the consuming area in import-based supply chains or a core production location in export-based supply chains. This type of dry port plays an imperative role in the logistics system of landlocked countries to connect to international markets. In this case, the seaport will benefit from the connection to this type of dry port by gaining access to the inland market.

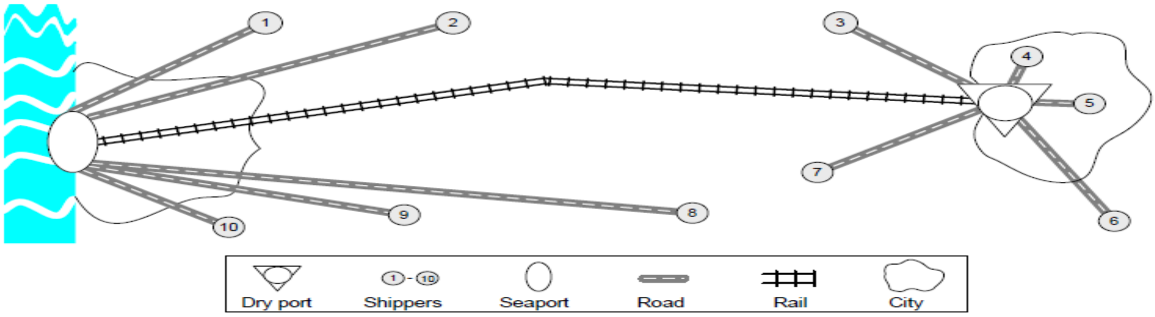

Figure 2-4. A seaport with a distant dry port

Source: (Roso et al., 2009 p-341)

2.1.2. Logistics Activities

Logistics is defined as a business planning framework for the management of entities; material, service, information and capital flows. It includes the increasingly complex information, communication and control systems required in today's business environment (Ganesh et al., 2011).

The Council of Logistics Management (Gözaçan and LAFC, 2020) describes Logistics as "…is 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 to meet customers' requirements". In this definition, companies have recognized that logistics management plays a vital role in industries. Another important value we point out regarding the concepts of logistics performance state is the transportation of the products to the receiver on time with the quality of the logistics services and competence of it.

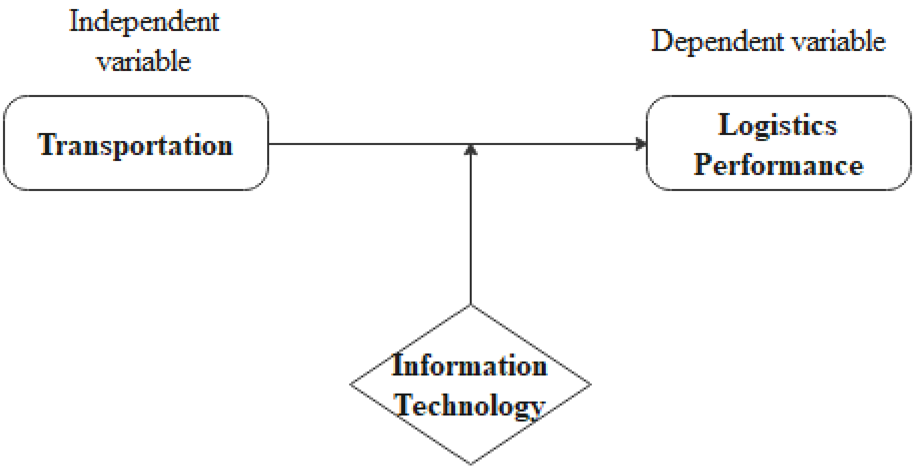

Figure 2-5. Conceptual model of transportation logistics

Source: Nurul at el., (2016)

Generally, the typical logistics functions or elements include procurement, transport, warehousing, inventory management, information systems, materials handling, order management, customer service, packaging, and reverse logistics (Villiers, 2015).

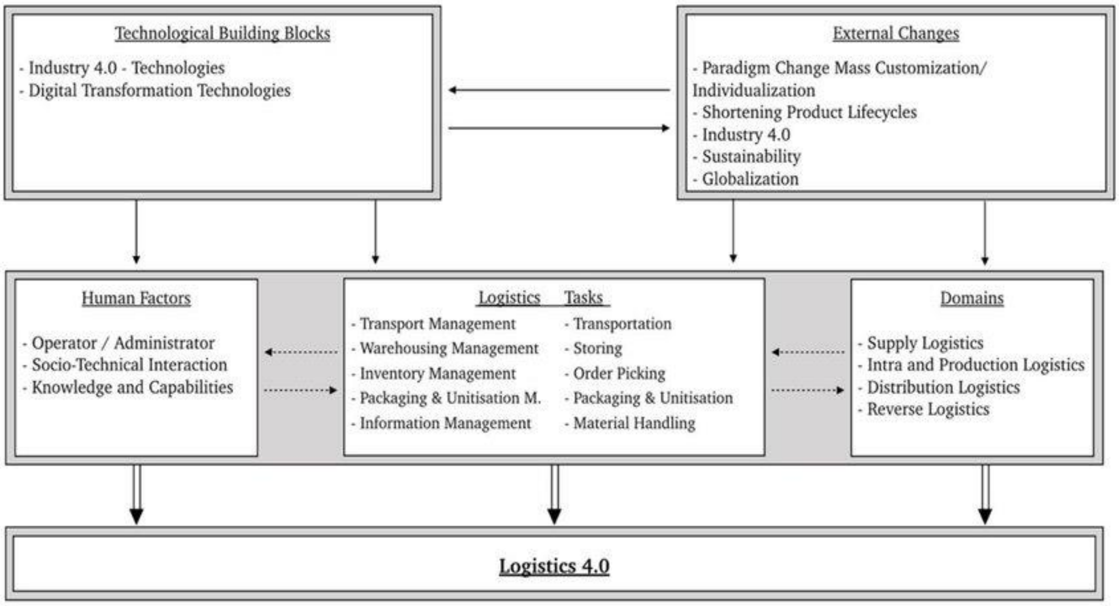

Figure 2-6. Logistics and its elements

Source: (Waters, 2003)

A. Transportation

Transportation is a backbone for the export, and import of basic infrastructure for a country. The transport system is a crucial element in the logistics chain, it joins the separated activities. Transport is part of integrated logistics management which presents approximately one-third to two-thirds (40%) of the expenses of enterprises' logistics costs spent on the transport of all logistics costs. Transportation is not only limited to the flow of goods across space and is not only a connective function in the fields of delivery of raw materials for manufacturing needs and for distributing final products, but also transport itself is regarded as one of the major components of distribution and logistics.

Now, transportation by different modes is offered in a consolidated mode in the name of "Multimodal transportation". Multimodal transportation in some places is also named "Combined Transport". Inter-modal/Multimodal transportation may be viewed as an alternative to Uni-modal transportation in the case of long travel distances and high volumes (Wisetruangrot, 2020).

The major transport system those inheritances enjoyed by today's generation, which are road, rail, water, air and pipeline. They are competitive among themselves not only for freight share but also in the application of technology and efficient resource utilization (Waters, 2003). Among these transport systems, Modjo dry port utilizes rail and road to deliver the cargo from/to the seaport. Here, the port terminal uses both transport methods through different in-get and different material handling equipment. However, both are delivering the container to warehouses, container freight stations and container yards. In this case, there are a lot of problems; delays long distances, over-movement, etc. Therefore, this study was conducted against these problems by using a mathematical model. The logistics of transportation can include network design, and optimization, shipment management, fleet and container management, and carrier and freight management. In this case, the objective of transportation is to form a linkage between all pick-up and deliver-to points within the time to response requirements of the customer service policy and the limitations of the transportation infrastructure at the lowest possible cost.

Transport and logistics; understood as connectivity with air and maritime and logistics performance is wide and varied which includes the whole range of transportation infrastructure (high-speed roads, cool storage warehouses, terminal facilities, and runaway length) and the corridors within (roads, railways, sea-lanes) and the interconnectedness with different modes of transport. Transport is the single most expensive component of trade logistics and adequate infrastructure is required to facilitate transportation (Gani, 2017).

Logistics and transport have been increasingly playing a great role in international trade relations (OECD, 2002).

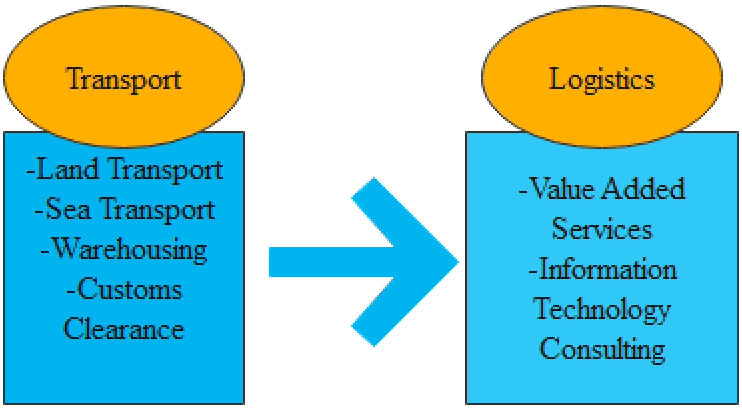

Figure 2-7.Concept of Transport logistics

If an organization should use third-party transport, the price by which the unit material moves between different locations is the rate or/ tariff. This rate is set by the cost of the service provided, the distance moved, value to the customer, weight, size, value of goods, the complexity of the journey, and the like. This rate is an important considered entity for logistics and can affect the whole pattern of movement (Waters, 2003).

B. Customer Response

In modern business conditions, managers must pay great attention to logistics activities that are best manifested through adequate customer service, which attracts new customers and retains old ones. Therefore, it directly affects the competitive advantage of the company in the market. The main task of logistics management is to fulfill the function of adequate customer service, primarily by defining goals and policies for customer service and the implementation of the selected strategy (Konečnik Ruzzier et al., 2014).

C. Information and Communication

The growth of modern logistics facilities is recognized for the application of update information and communication technologies (ICT), digital solutions, and innovative business models; as is aimed at increasing the attractiveness of intermodal and multimodal transport operations, as well as developing region-wide strategic vision of digital transport corridors.

Providing and delivering reliable service to the interacting concerns of the transportation chain is a major objective of any container terminal. Within a port community, the effective and efficient flow of information is considered to be an important variable (Kia et al., 2000).

The lack of updates, flexibility and clearness of the operations is a strike for the logistics processes integration (ESCAP, 2018).

The advancement of information technology provides a wide range of options for the container terminal operator to automate its information system. Electronic devices employed in container terminals and the port reduced the manual effort and paper flow, facilitated timely information flow and enhanced control and quality of service and decisions made (Kia et al., 2000).

The application of ICT to transportation should have also led to the emergence of Intelligent Transport Systems (ITS) where ITS links individual transportation elements, and combines them into a single system through the use of advanced information technologies. ITS integrates different many technologies and institutional functions to realize efficient, safe and environmentally friendly transport systems. It offers the potential to improve the efficiency of the use of transportation systems by generating additional capacity from existing physical infrastructure(OECD, 2002).

According to OECD (2002), with the traditional design approach of transport infrastructure, it is inherently difficult to take into account dynamic changes associated with logistics. To overcome this gap, dynamic control of logistics operations is necessary. Strategic applications of innovative information such as Global Positioning System (GPS), Electronic Data Interchange (EDI), ITS, and Electronic Commerce (EC) integrated through the internet will then become inevitable.

Generally, Port terminals use different many types of information systems. As Herv et al., (2019), they are divided into different types: national single window, vessel traffic services, TOSs, port community systems, gate appointment systems, automated gate systems, automated yard systems, port road and traffic control information systems, intelligent transportation systems, and port hinterland intermodal.

2.1.3. Logistics performance

In the beginning, evaluation and assessment of logistics performance were limited to financial measurements, but nowadays, different scholars count a lot of metrics to evaluate the logistics performance and grouped them into three major categories: measurements of costs, measurements of services, and measurements of the output (Charkaoui & Bouayad, 2012).

Particularly, as Waters (2003) the performance in practice is much better to use direct measures of logistics, such as the distance traveled, the number of tons delivered, and/or stock turnover.

Capacity, productivity and utilization give general measures of logistics performance, but we can use many more specific ones. For example, some common measures of transport performance include Reliability of delivery, total travel time and distance, delivery cost, customer satisfaction, frequency of service, loss and damage, availability of special equipment, helpfulness of drivers, time to load and unload, total weight moved, number of errors in deliveries, errors in processing and administration, size and capacity of vehicles, skills of drivers and utilizations of vehicles (Waters, 2003).

For an individual country, logistics performance is key to economic growth and competitiveness. Inefficient logistics, but raises the cost of doing business and reduces the potential for both domestic and international integration. The toll can be also particularly heavy for developing countries when they trying to compete in the global marketplace (Arvis et al., 2018).

Noted that the importance, and complexity of logistics performance measurement have led to the development of numerous performance measurement frameworks and models by different scholars which quantify the effectiveness and efficiency of actions through a specialized set of indicators. Among them, Hamilton (2015), argues the interdependence of logistics efficiency, effectiveness, and differentiation between logistics performance and overall organizational performance.

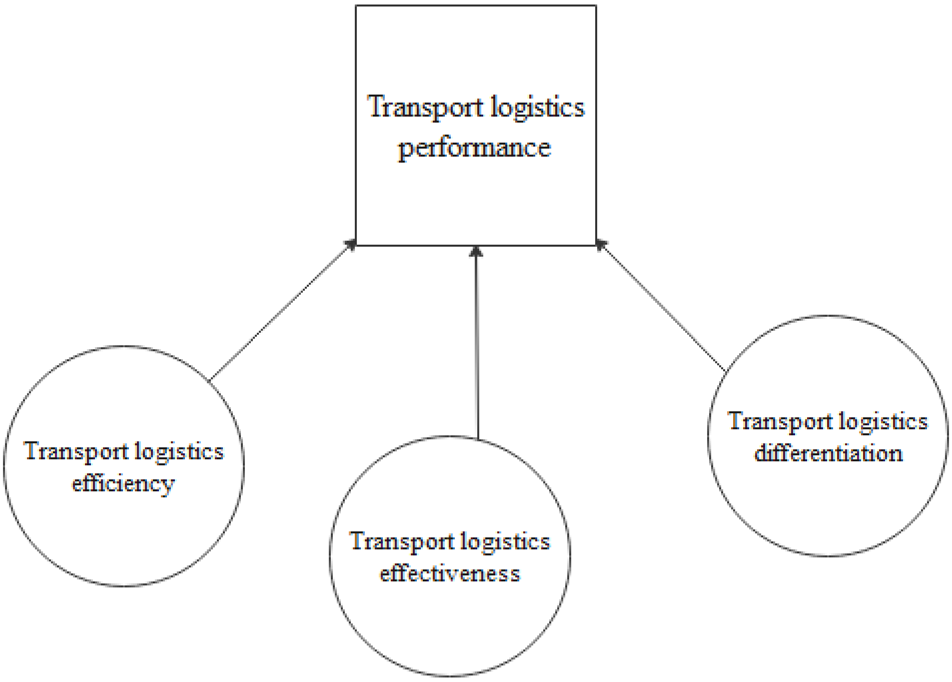

Figure 2-8. A model for Transport logistics performance

Source: (Hamilton, 2015)

The above model and view of logistics performance are supported by many other scholars who agreed that logistics performance is a multidimensional function of efficiency, effectiveness, and differentiation.

Conceptually, logistics performance may be considered a subset of the larger notion of organizational performance. Here, according to Demse (2018), transportation today is may all about logistics in international trade. The primary and mainly task of logistics is transportation which deals with moving products/goods from one place to another.

2.1.4. Key Performance Indicators (KPI) and Logistics Performance Index (LPI)

The common purposes of performance management are to minimize costs and to improve efficiency and effectiveness. As Gözaçan & LAFCI, (2020) argue as KPIs are excellent indicators to monitor performance. The identification and measurement of KPIs are very important for a good assessment of port terminals and TOS performance. For different scholars, Terminal operating systems (TOS) are information and communication systems (ICT) used to control and monitor the movement of containers at a container terminal. Additionally, the aim of developing performance indicators for the logistics system is to monitor the achievement of logistics policies, evaluate the efficiency and sustainability of logistics systems, and explore possible improvements (OECD, 2002).

About, according to Tigabu (2020), the study of the World Bank indicates “Logistics Performance Index” is broader than the study of ports and terminals alone and measures logistics instead. Yet, the study is interesting as it includes different port users’ evaluations of specific factors which deal with logistics performance, as well as a framework on how to measure them. The Logistics Performance Index measures on-the-ground trade logistics performance based on six dimensions: timeliness, international shipments, tracking and tracing, customs, infrastructures and services quality(Beysenbaev & Dus, 2020).

To permit comparison across around 160 countries, Ojala & Çelebi (2015) argue the LPI is used by organizations to identify the challenges and/or opportunities related to different entities; like the receiving country’s logistics competence, transport infrastructure and availability of efficient supply chains.

According to the World Bank, the Overall Logistics Performance Index is measured on a scale of 1 to 5 (low to high). The World Bank’s Logistics Performance Index (LPI), 2018 ranks countries on six sub-dimensions of logistics performance of trade: - Customs: efficiency of customs and border management clearance, Infrastructure: quality of trade and transport infrastructure, Ease of arranging shipments: ease of arranging competitively priced shipments, Quality of logistics services: competence and quality of logistics services- trucking, forwarding, and customs brokerage, Tracking and tracing: the ability to track and trace consignments and Timeliness: the frequency with which shipments reach consignees within scheduled or expected delivery times

In this concept, the LPI is a useful indicator of the host country’s trade logistics performance and also a benchmark when choosing locations for various types of operations. This is one of the main reasons why countries tend to focus on their ranking rather than on improvements in actual indicator values of the LPI. According to Ojala & Çelebi (2015), Several countries have announced specific targets for LPI score or LPI rank in their strategic development plans.

According to the index, Germany, Luxembourg and Sweden are the most efficient and highest-ranked LPI countries at positions 1, 2, and 3 in the 2016 LPI respectively and whereas, in Africa, South Africa, Kenya and Egypt are the most consistent and highly ranked in logistics performance at 20, 42 and 49 positions respectively whereas Ethiopia ranked 126th out of 160 countries (Arvis et al., 2018). Furthermore, based on the sixth key dimension of the logistics performance measure Ethiopia gets lowering performance compared to the neighboring country, such as Kenya ranks 42, Sudan at 103, Tanzania at 61, and even the landlocked county of Uganda, Rwanda, and Zambia ranked 58, 62, and 114 out of 160 countries respectively (World Bank, 2016).

The World Bank (2018) showed us the study of the logistics sector (LPI), for the period of 2012-2018, which place Ethiopia 131st out of 167 participating countries. It was indicating the poorest performance on overall logistics performance.

2.1.5. Benchmarking

Babović et al., (2012), argue that the term "competitive benchmarking" was initially launched in 1982 in "Xserox" company during employees' training in New York. Then Benchmarking was characterized as "a possibility and the need for comparison not only to direct competitors but also to any company.

According to Tuominen (1996), Benchmarking is the continuous process applied for measuring the products, services and practices and marking a reference point (Babović et al., 2012) against our toughest competitors or those companies renowned as the leaders. From this definition, we point out Benchmarking is the standard measure of value that utilizes the continuous process of measuring the current business operations and comparing them to best-in-class operations.

2.2. Empirical Review

Many types of research about dry ports have been done by some academicians; by different people at different times even if they have their limitations evaluated empirically. Accordingly, the researcher has evaluated the following research titles which were directly related to the study under investigated.

2.2.1. Custom Clearance at dry port and terminal

The introduction of the Automated System for Customs Data (ASYCUDA) is improving the customs clearance system (Demse, 2018), but procedures should be simplified to facilitate the quicker clearance of consignments. They expect the operation of custom control and clearance procedures at ports and in transportation to be well established and one of the first definitions of dry ports, is the Inland Clearance Depot (Tigabu, 2020), specifically respective to the provision of customs clearance services. These facilities are defined as inland intermodal terminals dedicated to the handling and storage of goods under customs transit.

2.2.2. Gate Operation System of dry port

As the container arrives at the container terminals during both receiving and delivery operations, different operations take place container inspecting, checking documents, custom processing and checking bill of lading. In addition, at the gate, information on import containers was located and export containers to be stored is provided.

During this checking process, the waiting time and queue time in the port gate area occurs which is one of the biggest challenges faced by the port manager (Binti Mohamad et al., 2018). The Security measures and customs delays cause longer waiting times that affect the port terminal efficiency, this result will create lower operating service quality as well as reduce operation performance.

2.2.3. Terminal operations system of dry port

An inland intermodal terminal concept has been developed to integrate various individual components in adding logistics value at a facility that acts as an intermediary in the supply chain. Furthermore, it can be understood as an inland facility which directly connected with the seaport terminal by a different mode of transport; rail, inland waterway, and road transport, to offer services that are similar to seaports (e.g., maintenance services and customs clearance), and it is a place where customers may leave and/or pick up their standardized units in the same way as in a seaport (Herv et al., 2019). Ethiopian dry ports and terminals range from small loading/unloading platforms to large freight-delivering centers offering a wide range of trade and transport and also other related services (Alebachew, 2020). According to Rodrigue et al., (2013) terminal was explained as any facility where passengers and freight are assembled and/or dispersed. Here, the term can be identified and clear is the terminal is both origin and destination of freight in the case of a dry port. Due to this reason, insufficient capacity in the infrastructure automatically leads to congestion. Congestion means that transport vehicles are not utilized well, as they spend much time queuing and burning fuel in traffic jams or waiting for a port terminal or a landing slot to become available. According to Herv et al., (2019), the key term affecting inland port performance is the road connection to the inland terminal and it also has to be considered to improve its performance in case of transshipment volume and growth. Land vehicles caught up in congestion do not operate at optimal speed, meaning their engines are burning more fuel than necessary (B Grant et al., 2015).

Generally, de Villiers (2015), stated the terminal in itself is usually not an encouraged profitable business as the operation and equipment are very capital and volume sensitive. But the peripheral services linked to the terminal and its inherent efficiencies are those that can create a significant return on investment. Peripheral services at an inland intermodal terminal can include: In-bond warehousing; Cartage, delivery and pickup; Container repair and refurbishment; Container cleaning and maintenance; Empty container storage; Specialised warehousing (e.g., refrigerated, high security, liquid/bulk handling and storage); General warehousing for less-than-container loads (LCLs); Groupage (consolidation of loads); Shipping line container parks; and Specialised services such as export packing (ibid.)

From different points of view, an element of the terminal like information and communication technology (ICT) systems, container handling equipment, infrastructure and terminal operators' performance, etc. affects the terminal performance, hence, it is better to deal with the brain of terminal known as the Terminal Operating System (TOS) which is covering all within the terminal processes (Herv et al., 2019).

Benefits of the terminal operation should have occurred because the terminal serves as the central point or hub around which all container movements and operations gravitate within the area. The flow of containers to/ from the target area becomes more cost-effective and thus benefits the importer or exporter, making them more competitive in the global markets.

The terminal makes it easier for the transport service providers, both on rail and road, to achieve economies of scale by operating from one central hub. This reduces unnecessary shunting with significantly improved turnaround times for rolling stock as well as road equipment, as the central hub allows for efficient loading or off-loading of the container.

In another hand, optimization, mathematical, and modeling methods have been used to analyze the effect of inland terminals and this study also aided some of these techniques.

2.2.4. Characteristics of Material Handling Equipment at dry port and terminal

Most of the time, container terminals are specifically viewed concerning their equipment and stacking facilities. However, from a logistic point of view, terminals consist of two components: stocks and transport vehicles. Relatively similar to seaports, container handling equipment used in dry ports include; rubber-tired gantry cranes, mobile cranes, side handlers, top handlers, reach stackers, forklifts and the like. Usually, container handling equipment is observed as the main machines for both dry ports as well as seaports and they can greatly affect both the container handling capacities and in turn, the performance of the dry port (Tigabu, 2020).

In this study, only a great variety of handling equipment was involved in container yard operation such as company vehicles (yard trucks), reach stackers, and forklifts were considered to improve the handling system performance.

Hervás-Peralta et al., (2019) define productivity as the average number of gross moves per hour for each cargo handling equipment. A move is considered to be a lift of a container either for loading, discharging, or repositioning. The gross moves are explained as the sum of these three types of moves per hour. Gross Moves Per Hour, GMPH, are the gross moves handled divided by the hours for cargo operation as presented below.

This indicator does not deal with the factor several stackers can be used and therefore alter the result which can double if using three stackers instead of one.

A. Inter-terminal Vehicles

Inter- terminal vehicles; Yard trucks, reach stackers, and forklifts move containers between the temporary storage and container yard (CFS, Storage or stack, empty container storage, maintenance area) as well as warehouses. Here, the long movement is a relay to yard truck whereas loading and unloading by reach stacker and empty container movement by fork lift in Modjo dry port terminal. These movement and processing times at the container terminal cause delay and also cause other factors that affect the attractiveness of terminal ports (Binti Mohamad et al., 2018).

To overcome these problems, different methods are used by many academician authors. Those are;

2. Mathematical model

Among the mathematical model transshipment model is a special case of the minimum cost capacitated flow model in which there are no capacities or minimums on the arc flows.

The General transshipment Model

The general linear programming model for a transshipment problem is

$$Min \sum_{all\ arcs} C_{ij} X_{ij} \quad (2.1)$$

Subject to:

$$\sum_{arcout} X_{ij} - \sum_{arcin} X_{ij} = s_i \text{ Original nodes i} \quad (2.2)$$

$$\sum_{arcout} X_{ij} - \sum_{arcin} X_{ij} = 0 \text{ Transshipment nodes i} \quad (2.3)$$

$$\sum_{arcout} X_{ij} - \sum_{arcin} X_{ij} = d_j \text{ Destination nodes j} \quad (2.4)$$

Where:

X_{ij} = number of units shipped from node i to node j

C_{ij}= Cost per-unit of shipping from node i to node j

s_i= Supply at origin node i

d_j= Demand at sink node j

From the above model, we understand that the supply point is the point that can only send goods to another point but cannot receive goods. While the demand point is also a point that can only receive goods from other points but cannot send any. Then the transshipment point(s) is that point(s) that can receive goods from other points and also send goods to another point (s). In this model, all goods within the network must be transported or shipped without any reservations until all constraints are fully satisfied(Taylor, 2013).

3. Simulation model

A simulation is an analytical tool that has proven to be a cost-saving tool for companies. It also could assist a user to make a quick and reliable decision. Experimenting with the real system can be very costly if using simulation that operation can apply like in a real system. Unlike mathematical models, a simulation model is utilized to mimic the port operations and allows to incorporation of several variables, that affect the system's behavior before applying it at the real port operation. This model contributed some equations through means, and time-dependent behavior that has been determined (Binti Mohamad et al., 2018).

The important and challenging phenomena for the proposed queueing models are expressed in the mathematical formulation. The following notation is used for representing queues: A/B/c/N/K where A denotes the distribution of the inter-arrival time, B that of the service time, c denotes the number of servers, N represents the system capacity and K denotes the size of calling populations. If N and K are omitted, we assume that both N and K are infinite (N, K= ∞).

Additional notation (primary performance measures) used for parallel server systems:

P_n: the steady-state probability of having n customers in the system,

λ: arrival rate,

μ: service rate of the server,

ρ: server utilization,

L_s: long-run time-average number of customers in the system,

L_q : long-run time-average number of customers in the queue,

W_s: long-run average time spent in the system per customer,

W_q: long-run average time spent in queue per customer.

Application Areas of Simulation

The simulation is used in manufacturing, computer systems, telecommunications, finance, transportation, military and E-business/workflow systems to increase the productivity of the area (Ganesh et al., 2011).

2.3.Research Gap

Cargo handling equipment, customs operations, port infrastructure, size of dry port, port staff, reliability of port operations and quality of logistics service are found to be important factors in determining the performance of Modjo dry port (Mussema, 2016). Even though, he determined the determinants of the port performance, the mechanism, procedure and method they determined the performance were proverb. Therefore, this study bridge such and related gap.

Most of the studies of dry ports and seaport focus on the location of dry ports, but there is little research on the performance evaluation of the global system. In this study, the research bridges this gap; the researcher presents a global approach to evaluate the transport logistics performance of the dry port and model it.

Alebachew (2020), proposed that the MDP performance indicators of port infrastructure and timeless affected the port logistics performance. He argues also some problems such as low technological and ICT tools availability, high dwelling time, and trucks' stay time in dry ports indicate the port logistics performance is highly affected. In addition, Demse (2018), argues the long turn-round time for a substantial number of containers is attributed to the inefficient transport system and inadequate Container Freight Station (CFS) facilities at inland destinations, and then ultimately goes to the low level of customer services. To overcome these problems, this study fills the gap.

Generally, the different researchers who conducted their study on Modjo dry ports argued for assessment of the dry port performance (Mussema, 2016), evaluation of dry port logistics performance (Alebachew, 2020), assessing freight transport (Waktole, 2017) and other researchers also conducted with the related study. However, no one were model the transport logistics performance on the Modjo dry port and there are few researchers conducted on modeling the transport logistics performance of the dry ports. To overcome these gaps, this study focused on approving and modeling the area raised concretely in the above study.

2.4. Conceptual Frame Work

Improving the country's transport logistics performance is at the core of the economic growth and competitiveness strategy (Arvis et al., 2018). Policymakers globally recognize the logistics sector as one of their key pillars for development. Hence, identifying those factors which influence the performance of ports is crucial. The previous sections demonstrated that, the importance of transportation based on the views of economics, logistics activities and business competitiveness. Without well-organized transportation systems, logistics could not bring its performance into full applied. On the contrary, good transport activities in the logistics system could provide improved logistics effectiveness, reduce operation costs, and promote service quality.

From this point of view, common benefits of transport are timely delivery of commodities, safety movement of commodities, secure movement of commodities, improve service quality (by mobility & accessibility, economic and financial viability) and assessing technology. These benefits lead to Modjo dry port improving logistical effectiveness, efficiency and generally its performance which leads to ensuring end users' satisfaction. From this statement, we conclude that, if there is good transportation practice in the MDP, there will be better logistics performance.

Therefore, the researcher will be guided by the conceptual framework that is indicated below the diagram.

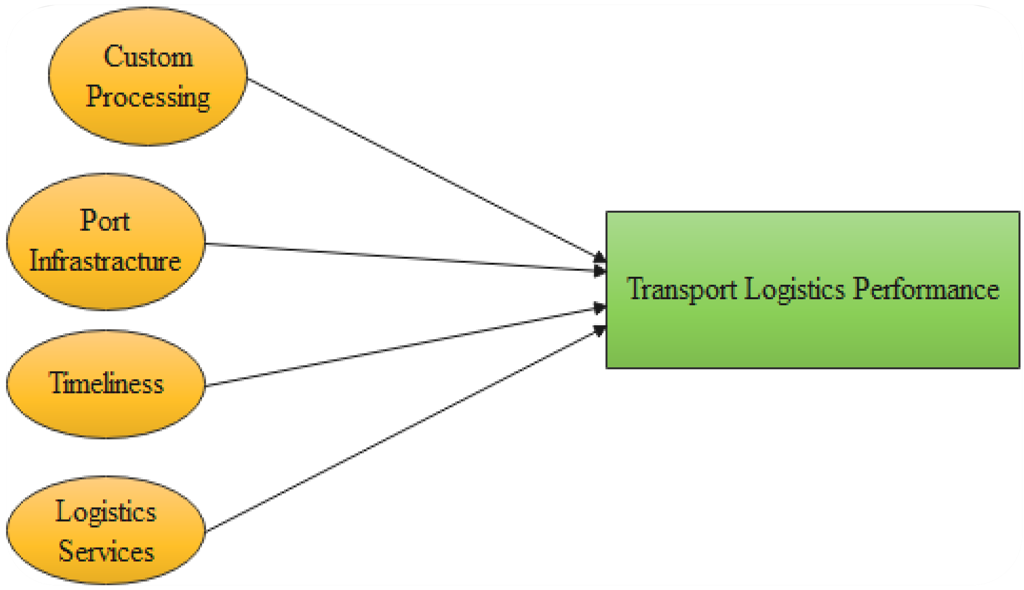

Figure 2-9. Conceptual frame work of the study

Source: Developed by author

2.5. Literature Summary

Dry Port is an intermodal terminal and an element of hinterland transport situated in the hinter-land servicing a region connected with one or several seaports by rail and/or road transport and offering specialized services between the dry port and the overseas destinations. Logistics is defined as a business planning framework for the management of entities; material, service, information and capital flows.

The common purposes of performance management are to minimize waiting time, and cost and to improve efficiency and effectiveness. The study of the World Bank indicates "Logistics Performance Index" is broader than a study of ports alone and measures logistics instead.

Therefore, the study concentrated on transport logistics performance which circulated pass through the port and terminal from in/out the gate to dispatch based on key performance indicators (Custom process, Port infrastructure, timeliness and logistics services) of the logistics as the World Bank put them together.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

In this chapter, the materials and methods; the research approach, methods and design being used by the study were presented. The materials and methods section describes in detail all the materials that have been used to conduct the study as well as the procedures that were undertaken. It mainly deals with the whole issues of the research framework; including research strategy and design, the sample size of the respondents, research methods, how was data collected and analysis techniques.

3.2. Description of the study area

The study was conducted on transport logistics performance at Modjo Dry Port (Figure 3.1). The dry port is located approximately 75 km from the capital city Addis Ababa and about 850 km from Djibouti (the main gateway to the seaport for Ethiopia). It is one of the dry ports stationed in the central part of Ethiopia that regularly operates. This dry port helps many importers and exporter customers more than the other operational dry ports. As the largest dry port in the country, Modjo Dry Port can hold 600,000 containers annually and it handles more than 78 percent of the nation's imports/exports. According to an unpublished report of ESLSE, the dry port covers about 180 hectares of land, from which 31.7hectare land area have been devoted to container terminal services. In addition to the road transport system, the dry port is connected to a new railway system with a capacity to move 3,500tn of cargo on a single trip and the train can make two trips in a day to Djibouti, while truck transport takes more than four days for a two-way trip. MDP works with two systems known as unimodal transport and multimodal transport. The study would engage in modeling and analysis of the transport logistics performance of this dry port as it is the subsystem of the whole performance of the port.

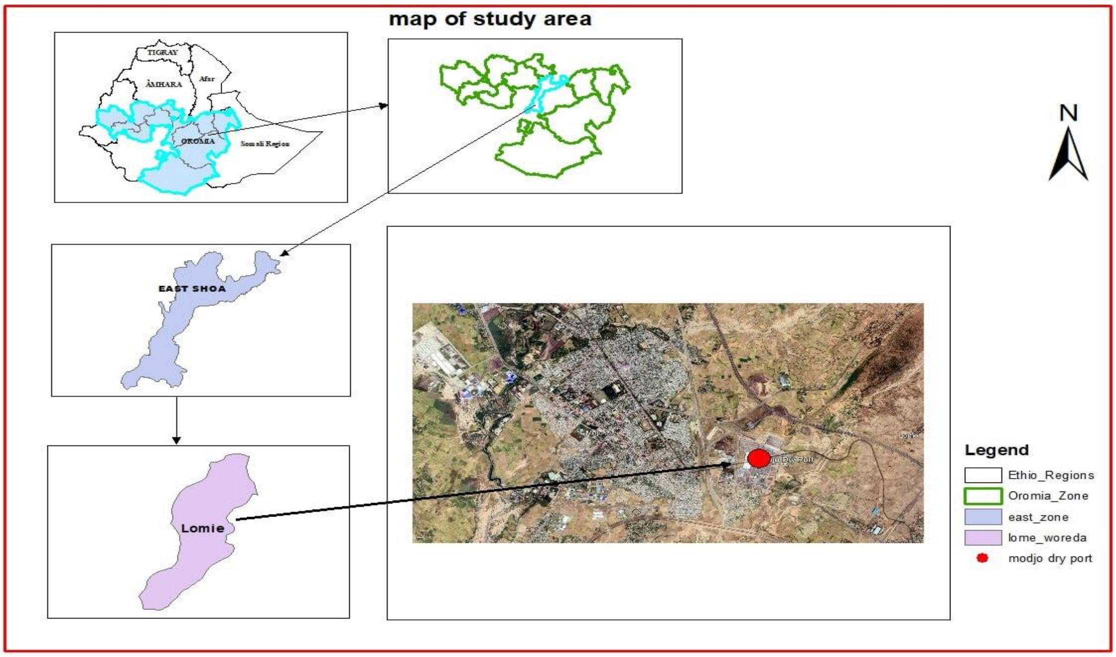

Figure 3-1: Map of Modjo dry port

Source: GIS images,2022

3.3. Research approach

The research used the mixed research approach which involved both qualitative and quantitative approaches. A mixed method study involves the collection or analysis of both quantitative and qualitative data in a single study in which the data are collected concurrently or sequentially, are given priority, and involve the integration of the data at one or more stages in the research process. In this case, the quantitative research approach emphasizes numerical value to describe, record, analyze and interpret the existing conditions. It is based upon the measurement of amount or quantity and applies to the process that can be expressed in terms of quantity. It is important to generate extensive information that is summarized and presented in tabular and figure form. Generally, it helps to transform reality into numeric value rather than meaning (Neal, 2011). Whereas, the qualitative research approach is concerned with the subjective assessment of attitudes, opinions and behavior whereas investigative methods include questionnaires, interviews, observation by participation, and interpretation of written material. Such a research approach generates results in a non-quantitative form in describing the existing conditions. It is concerned with qualitative phenomena that are related to or evolving quality or kind (ibid).

Quantitative: The researcher recorded the number of trucks that arrived at different checkpoint channels of the port and the number of arrived at temporary storage to overcome the problem regarding waiting time around in gates, loading and/or unloading area and the movement networks of the truck in the terminal. The transshipment cost of the container at different nodes and the number of containers moved through transshipment nodes were also recorded.

Qualitative: More information on transport logistics performance, logistics activities and the respondent's background were gathered theoretically. To analyze the gathered data, the researcher used a five-point Likert scale to know the transport logistics performance stage which was converted into a number and used a categorical survey due to performance attributes.

3.4. Source of data and its tools

The sources of data used in this research are both primary and secondary data. The primary data source is the primary information that was collected directly from Modjo dry port workers and recorded data was taken at the port and terminal.

3.4.1. Primary Data

In this data collection, information obtained was primarily through structured questionnaires, field observation and structured interviews with participants.

The **questionnaire** has three sections. The first section is containing general information about the participants of the company. In the second section, participants were asked to evaluate the transport logistics performance of Modjo dry port based on the point of view satisfaction they got from the service of Modjo dry port and terminal. In the final section, respondents were requested to indicate the significance level of some transport logistics performance characteristics which has an impact on the transport performance of Modjo Dry Port.

During field **observation**, the researcher recorded the number of trucks that arrived per hour at checking points for getting all necessary services. At the same time, the number of containers arrived at temporary storage for loading/unloading or delivering to necessary places of terminals. Here, for the sake of multi-nodes being needed for recording data, the researcher gave training to four people who helped him during the data collection. At this time, the mechanism used was a stopwatch, hours of observations and paper notes for recording arrived and took service trucks at the nodes. During observation, the researcher also identified that where the traffic congestion occurred, insufficient port infrastructure was faced (out of 11 reach stackers only five were functional, out of 16 forklifts only four were working and out of 10 tractors only four were on work), lack of ICT tools were bolded issue and the others. Additionally, the number of containers moved by the yard's tractors to different nodes was recorded to identify the problems with turnaround and cost. During the **interview**, the dialogue is conducted until the information has reached saturation and no additional information could be generated from the interview (Appendix I).

3.4.2. Secondary data source

It is the information that was extracted from the published and unpublished documents such as from the company's documents, books, journals, reports, official websites, and theses that related to the research topic. In this case, it had been collected before the primary data collection took place to familiarize with the case company and also after the primary data collected to double-check some of the insights obtained and this data was also used for validation and analysis of the data collected from these sources.

3.5. Population and Sampling

To answer the research questions, the researcher used primary and secondary data sources. In the case of a primary source of data collection, sampled the Modjo dry port workers based on their department; strata sample. The entire set of cases from which the researcher's sample is drawn is called the population (Taherdoost, 2020). The study was conducted at MDP and the data were collected from the company workers. Since the researcher neither had the time nor the resources constraints to analyze the entire population, he applied a sampling technique to reduce the number of respondents. A low variance shows that there is high precision and high certainty of the sample and sampling procedure.

3.5.1. Sample Design and Technique

To achieve the objectives of the study, both primary and secondary data were collected. Primary data was collected from the respondents using a sampling frame based on Stratified sampling where the population is divided into strata (or subgroups) according to their departments (Custom control and clearance, Dry port terminal operators, ICT and Shippers; importer/exporter) and a random sample is taken from each subgroup. There are mainly two types of sampling techniques such as non-probability sampling and probability sampling. In non-probability sampling, randomization is not necessary to select a sample from the case or population of interest whereas, in probability sample selection, each sample has an equal chance of being chosen or the population has a non-zero chance of being selected using a random selection procedure. Here, the researcher used probability sampling to get the greatest freedom and free from bias. Stratified sampling is the category of probability sampling that is often used where there is a great deal of variation within a population. Its purpose is to ensure that every stratum is adequately represented (Taherdoost, 2020).

The targeted total population in the study were Modjo dry port workers grouped as; Custom clearance office (26), Terminal operators (169), ICT office (23) and shipper company (12) based on the research objective. The total lists of targeted respondents and their respective percentages are shown in Table 3.1. below.

Table 3.1. Summary of the target population for primary data sources

Total Stratum	Targeted Total Population	Percentage (%)
Customs Clearing Office	26	11.30
Modjo Dry Port terminal operations	169	73.48
ICT office	23	10
Shipper company (import/export)	12	5.22
Total	230	100

According to Table 3.1., Before sampling the target population, the respondents were 230 in total from different four groups of the stratum.

3.5.2. Sampling Size

The term “sample” refers to the portion of the population that enables us to draw inferences about the population and so the sample size must be adequate so that meaningful inferences can be made. How we select a sample of individuals to be research participants is critical. How we select participants (random sampling) will determine the population to which we may generalize our research findings (Taherdoost, 2020).

In the case of probability or random sampling, the purposive sample size will be used through which the following formula is applied from the targeted population as Adam (2020), provides a simplified formula to calculate sample sizes.

$$n = \frac{N}{1 + Ne^2}$$

Where N = is the population size, n = is the sample size, and e = is the level of precision which is 95% according to the researcher. Therefore, the sampling size became;

$$n = \frac{230}{1 + 230\ (0.05)^2} = 146$$

Therefore, for this study, the sample size is 146. Based on this sample size, the researcher assigned a proportion (146/230 = 0.634) to each stratum. Then, each stratum targeted population had a multiple of 0.634 with its population size as summarized in Table 3.2. below.

Table 3.2. Summarized sample size

Total Stratum	Targeted Total Population size	proportion	Sample Size
Customs Clearing Office	26	0.634	16
Modjo Dry Port terminal operations	169	0.634	107
ICT office	23	0.634	15
Shipper company (import/export)	12	0.634	8
Total	230	146/230	146

From Table 3.2 above, the numbers of the respondents after sampling were 16 from the custom clearing office, 107 from port terminal operations, 15 from the ICT office and 8 from the shipper company.

Generally, from all 230 workers, the research questionnaire was distributed to 146 respondents.

3.6. Data Management and Analysis

Proper data handling and management are very important to the success and reproducibility of statistical analysis. Selection of the appropriate tools and efficient use of these tools can save the researcher numerous hours, and allow other researchers to leverage the products of their work. To analyze the data this study used descriptive statistics. According to Ali &

Bhaskar, (2016), descriptive statistical procedures allow researchers to describe groups of individuals and events, examine the relationships between different variables, measure differences between groups and conditions, and examine and generalize results obtained from a sample of the population from which the sample should be drawn.

Furthermore, descriptive statistics of frequency tables are used to describe the data collected in research studies and to accurately characterize the variables under observation within a specific sample. In this study, the analysis was done with the help of Statistical Package for Social Sciences (SPSS, version 20), Microsoft Excel and QM for Windows. The responses in the questionnaire were coded into common themes to facilitate analysis. Data were presented in descriptive form supported by tables, frequency distributions, and percentages.

In addition to these descriptive, other methods of solving the analyzed data were used to fit the research objective. These methods are a mathematical model for modeling transportation at the dry port terminal and a graphical model was used to show the transport logistics performance and its attributes. In addition, simulation modeling at the area of in-gate and loading and unloading at temporary storage was utilized to show the transport logistics performances and to show better performance, the scenario analysis was applied.

Simulation is the process of mathematically modeling an existing or future system and observing the behavior of the system over time to identify and understand the factors that control the system and predict future behavior. The value of simulation-based tools is that they give the user the ability to examine alternative designs, decisions, and plans, and allow for testing the effect of those alternatives without experimenting in a real environment, which is often cost prohibitive or altogether infeasible.

3.7. Research reliability and validity

Reliability and validity are more important factors when performing research. Reliability refers to the consistency of a measure. Psychologists consider three types of consistency; over time (test-retest reliability), across items (internal consistency), and different researchers (inter-rater reliability). In this study, internal consistency was considered. The recorded data were correctly recorded and the same value was obtained by manual and computer software of operators at the port.

Validity is defined as the extent to which a concept is accurately measured in a quantitative study (Heale & Twycross, 2015).

Therefore, the data collected from participants were evaluated and assessed by changing to quantitative value where the recorded data for simulation were directly recorded and accessed by inserting to the mathematical formula that no varies with the evaluation, then it indicates that the data was valid.

In addition, by using a histogram the arrival of the truck at the port was Poisson distribution and exponential at the server's point which is shown in detail in Figure 3.2 below.

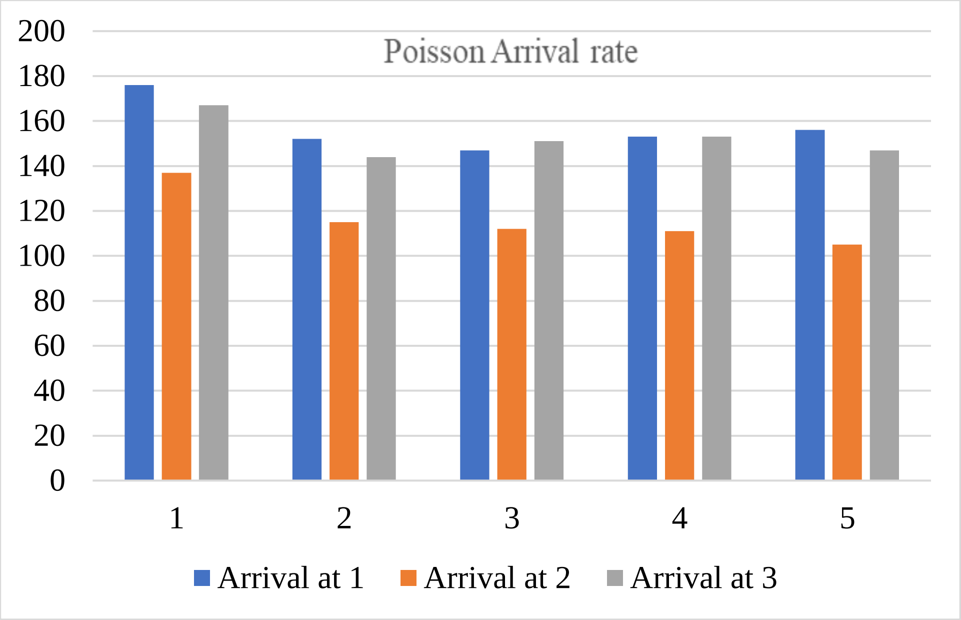

Figure 3-2: Poisson arrival rate of a truck at in-gates

After the data were collected, the collected data's validity was checked by using the Kolmogrove-Smirnov test as shown in Table 3.4 below.

Before analyzing the data observed and empirical, the mean and standard deviation must be known as shown in Table 3.3 below.

Table 3.3: Mean and Standard deviation of descriptive statics

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
arrival1	5	156.80	11.212	147	176
arrival2	5	116.00	12.288	105	137
arrival3	5	152.40	8.877	144	167

Table 3.4: Kolmogorov-Smirnov test

One-Sample Kolmogorov-Smirnov Test				
		arrival1	arrival2	arrival3
N		5	5	5
Poisson Parameter[a,b]	Mean	156.80	116.00	152.40
Most Extreme Differences	Absolute	.304	.312	.259
	Positive	.304	.312	.259
	Negative	-.207	-.169	-.237
Kolmogorov-Smirnov Z		.680	.698	.580
Asymp. Sig. (2-tailed)		.744	.714	.890

a. Test distribution is Poisson.

b. Calculated from data.

From Table 3.4 above, we observed the value of Kolmogorov-Smirnov was small and it indicates the data was accepted.

In addition, p-value that exceeds the level of risk associated with the null hypothesis indicates that the observed sample approximates the empirical sample.

State the Null and Research Hypotheses

The null hypothesis states that the observed sample has an approximately Poisson distribution. The research hypothesis states that the observed sample does not approximately resemble a Poisson distribution.

The null hypothesis is:

H_0: There is no difference between the observed distribution of survey scores and a Poisson-distributed empirical sample.

The research hypothesis is:

H_A: There is a difference between the observed distribution of survey scores and a Poisson-distributed empirical sample.

The critical value for rejecting the null hypothesis is $\delta = 0.05$ and the obtained value of P is 0.563 as SPSS. Therefore, we did not reject the null hypothesis.

CHAPTER FOUR

RESULT ANALYSIS AND DISCUSSION

4.1. Introduction

This chapter deals with a presentation and discussion of the empirical findings and results of the research. The data presented include response rate, background information of the respondents and the presentation of research findings against each specific objective. In this case, descriptive statistics were employed in analyzing the findings. Descriptive statistics are utilized to describe the relationship between variables in a sample or population and it provides a summary of data in the form of mean, median and mode (Ali & Bhaskar, 2016).

Other contents of the chapter were a graphical model and analysis of transport logistics performance, queuing model at nodes and a transshipment model of transport logistics operations were discussed. The results contained questionnaire results, observation results, interview results and different modeling from these results.

4.2. Response Rate and Demography of the Respondents

Response Rate

From the data collected, out of 146 questionnaires administered, 117 were filled and returned which represents an 80.14% response rate. Such a response is adequate according to different authors. Therefore, the result obtained from the response rate implies the rate is the best representative of the sample size, and analyzed using statistical software SPSS (Version 20) and Excel.

Demography of the Respondents

The study analyzed the background information of the respondents by using the following parameters: gender, age, educational background, position in the organization, and work experience held by the respondents. The demographic data of respondents were presented and analyzed as shown in the following Table 4.1.

According to the following Table 4.1., out of the total 117 respondents 80 (68.4%) of them were males while the rest 37 (31.6%) of them were females.

Table 4.1: Gender of the respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	80	68.4	68.4	68.4
	Female	37	31.6	31.6	100.0
	Total	117	100.0	100.0	

Age of the respondents

The respondents' age was a concern as the descriptive of frequency and percentage showed, 33 (28.2%) of respondents were found between the age groups of 20-29 years, and about 64 (54.7%) of them were found between the age groups of 30-39 years, about 17 (14.5%) of them were found between the age groups of 40-49 years, and about 3 (2.6%) of them were found above 50 years. According to the age distribution of the respondents, the majority of them were belonging to the young and youth age group.

Table 4.2: Age of the respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-29	33	28.2	28.2	28.2
	30-39	64	54.7	54.7	82.9
	40-49	17	14.5	14.5	97.4
	>_50	3	2.6	2.6	100.0
	Total	117	100.0	100.0	

Educational background

As Figure 4.1. indicates, the educational level of the respondents was; 3(2.6%) certificates holders,4(3.4%) diploma holders, 90(76.9%) first-degree holders and the lefts 20(17.1%) the respondents found education-level of second-degree and above holders. According to the data collected was showing, the level of education of the respondents in Modjo Dry port dominated by first-degree holders, followed by second-degree and above, diploma holder and certificates respectively.

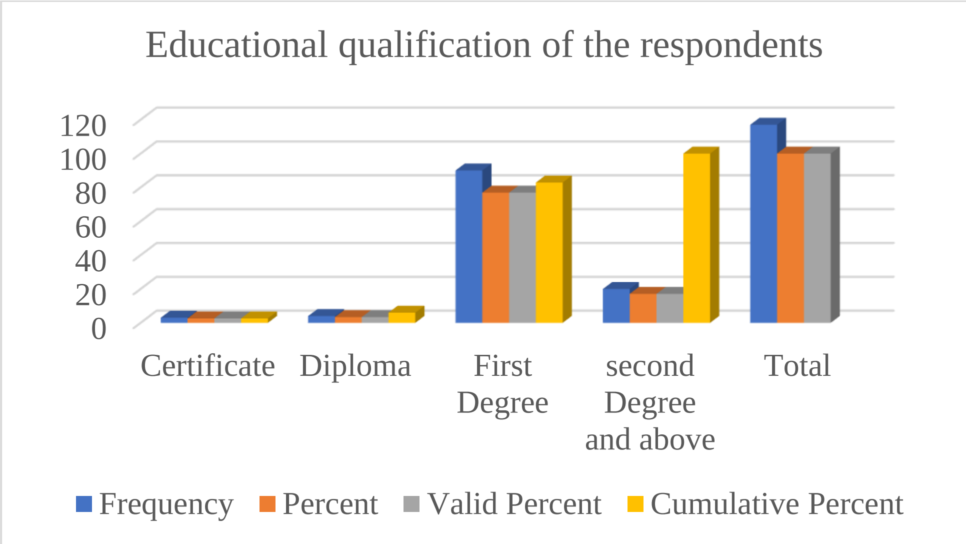

Figure 4-1:Educational qualification of the respondents

Job title of the respondents

In the area of research, different experts have required the questions organized as questionaries and then distributed to them. Many of them were from different job titles 46 (39.3%), the next respondent's job title was an officer 34 (29.1%), middle managers were 28 (23.9%) while senior managers were 8 (6.8%) and 1 (0.9%) was CEO of the company. More details were discussed in Table 4.3 below.

Table 4.3: Job title of the respondents

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CEO/President	1	.9	.9	.9
	Senior Manager	8	6.8	6.8	7.7
	Middle Manager	28	23.9	23.9	31.6
	Officer	34	29.1	29.1	60.7
	Others	46	39.3	39.3	100.0
	Total	117	100.0	100.0	

Years stayed in an organization

The questionary paper distributed to the respondents contains the year that they stayed in an organization and were categorized into different levels. Among these, 4 (3.4%) of the respondents stayed for below 2 years, 43 (36.8%) stayed between 2 to 5 years, 51 (43.6%) for between 6 to 10 years and 19 (16.2%) of the respondents stayed above 10 years. The frequency of the respondents and the year they stayed at the organization were shown in Figure 4.2 below.

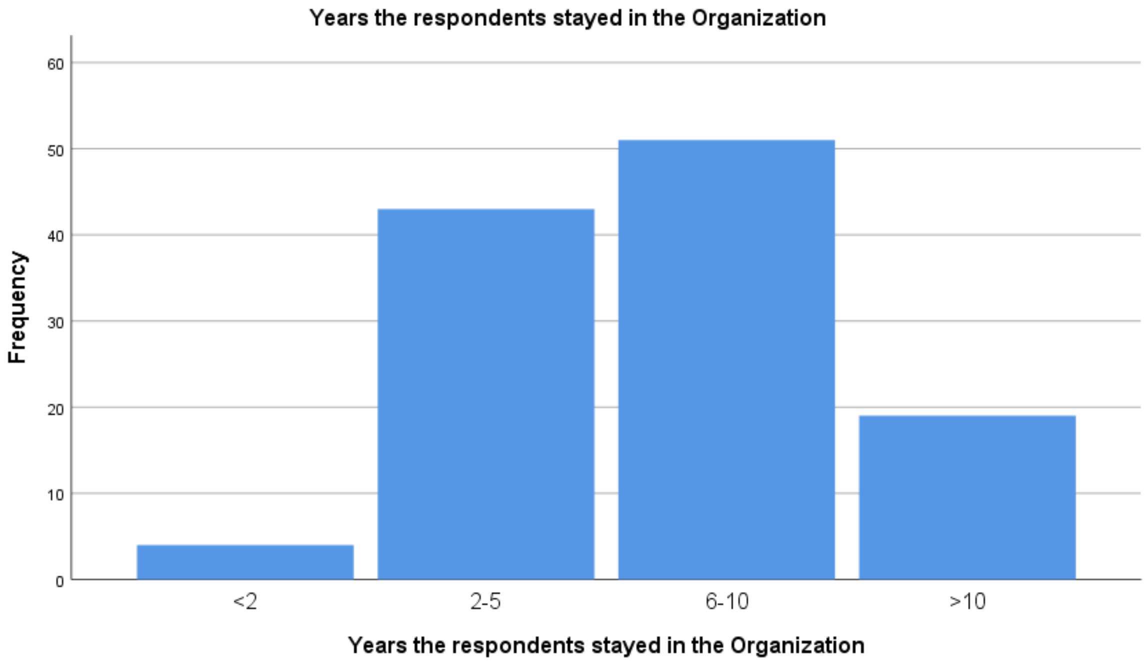

Figure 4-2:Years the respondents stayed in an organization

Department of the respondents

The departments of the respondents in an organization were; operation 82 (74.4%), customs clearance 12 (10.3%), ICT 11 (9.4%) and shipping 7 (6.0%) of the respondents participated in the questions required. Figure 4.3 below indicates the details.

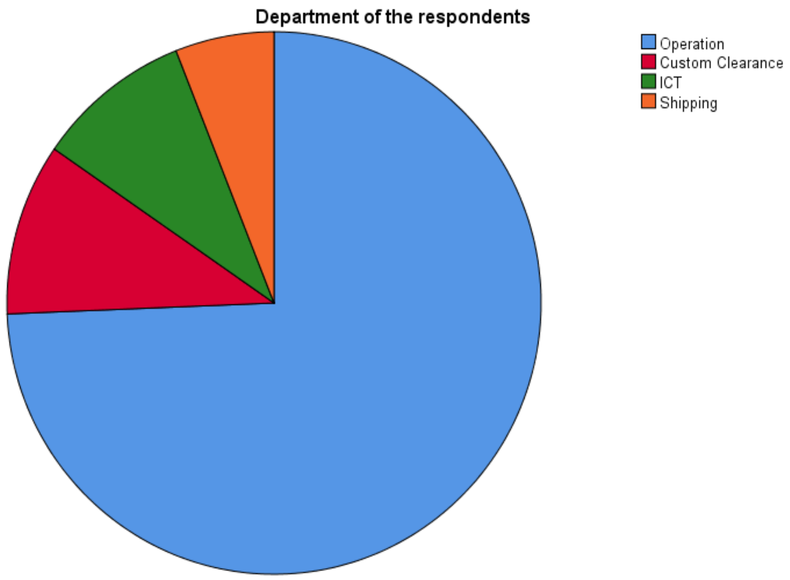

Figure 4-3: Department of the respondents

Source: own completion, 2021

4.3.Descriptive analyses of the Transport logistics activities at MDP

4.3.1. Assessment of Transport Management

The transport management of MDP was evaluated in terms of fast delivery service, assurance of performance, efficiency, profitability and storage utilization of the port. Accordingly, the respondents replied to all questions asked by the researcher during data collection. The questions were; transport management has a role in achieving faster delivery service with a mean score (of 3.64), Transport management ensures the port logistics performance (3.45), Transport management has a role in achieving efficiency in port operation (3.46), Transport has a position in maximizing a profit of the port (3.44) and Transportation management sometimes used as storage to utilizing warehouse cost (3.50).

In general, the result shows transport management delivering faster service in moderate value and others also, like, it ensures port logistics performance, achieving port efficiency, maximizing the port's profit and utilizing as a warehouse failed under less understanding of the workers. Therefore, it needs to clearly understand and thought the role of transport management in dry ports.

The result is presented in the following Table 4.4.

Table 4.4: Assessment of transport management

	N	Mean	Std. Deviation
Transport management has a role in achieving faster delivery service	117	3.64	.737
Transport management ensures the port logistics performance	117	3.45	.713
Transport management has a role in achieving efficiency in port operation	117	3.46	.714
Transport has a position in maximizing the profit of the port	117	3.44	.712
Transportation management is sometimes used as storage to utilize warehouse cost	117	3.50	.638
Valid N (listwise)	117		

4.3.2. Assessment of Information and communication

Transport and warehousing management are refined by the optimal use of different transport modes and by the increasing use of Information and Communication Technology (ICT). Efficient information technology has reduced processing time and cost and created seamless links, thereby facilitating intermodal transport.

Furthermore, besides transportation services, information communications technology (ICT) has chief importance in the contemporary business world, since it is seriously assisting transportation operations and the whole supply chain process at large.

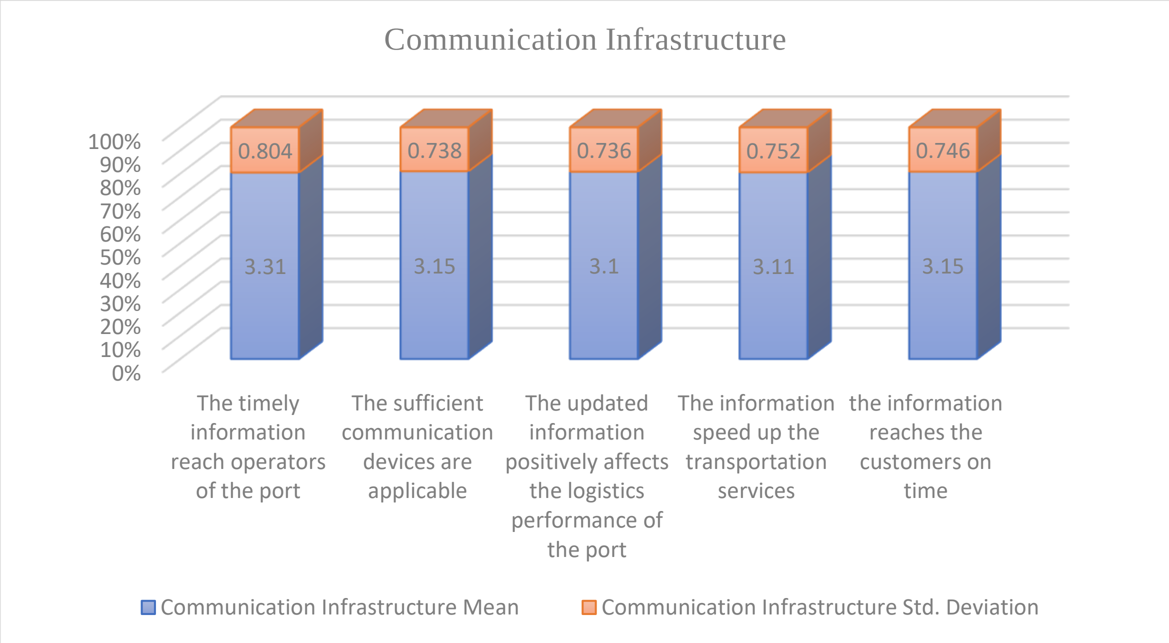

Figure 4-4: Assessment of information and communication technology

4.3.3. Assessment of Customer Response

The analysis of the study on customer response to Modjo dry port was shown in the following table 4.5. According to the respondents, among five questions they were requested somehow MDP tried to respond quickly to the customers' needs (3.59) and others were below this one. This indicates that MDP has to improve the situation to answer customer responses.

Table 4.5: Assessment of customer response

		Responding quickly to the customers' needs	Fulfilling customers' orders on the promised date	Sharing information with customers when required	Measuring and evaluating customer satisfaction level	Accepting the customer comments
N	Valid	117	117	117	117	117
	Missing	0	0	0	0	0
Mean		3.59	3.46	3.48	3.39	3.50
Std. Deviation		.697	.737	.726	.694	.652

4.4.Assessment of Transport Logistics Performance of MDP

4.4.1. Assessment of Custom Clearance

The customs clearance component of the LPI measures the efficiency and effectiveness of customs dispatch; procedures in terms of speed, simplicity and predictability. Improvements in customs clearance performance are tied to the overall trade policy environment (Alebachew, 2020).

The questions regarding customs clearance produced for respondents were speed and procedure (3.34), simplicity and predictability (3.14), efficiency (3.16), and physical inspection and without physical inspection at in-gate were 2.85 and 4.09 respectively. From the responses, we concluded that the customs clearance at MDP should be at risk. Among all questions unless inspection without physical at gates, all other needs improvements and make clear and understand for the workers.

Table 4.6: Assessment of custom clearance

	N	Mean	Std. Deviation
The speed of customs clearance & procedure	117	3.34	0.939
The customs operation's simplicity and predictability	117	3.14	0.798
The efficiency of custom service	117	3.16	0.84
The time to obtain gate authorization with a physical inspection	117	2.85	0.912
The time to obtain gate authorization without a physical inspection	117	4.09	4.73
Valid N (listwise)	117		

4.4.2. Assessment of Port Infrastructure

Facilities at nodes have to be standardized to provide efficient services, accessibility to these nodes has to be developed or improved and transportation systems have to be integrated to attain intermodally. The links which connect the nodal points to form the logistics network are most effective when they appear to be seamless, i.e., facilitating transport with minimum interruption, inconvenience and wasted time.

Table 4.7: Assessment of port infrastructure

	N	Mean	Std. Deviation
The logistics area where cargo logistics operation done	117	3.18	0.867
The connectivity to road networks at the port and terminal	117	3.2	0.801
The number of cargo handling equipment at terminal	117	3.18	0.795
The technological and ICT tools available	117	2.85	0.857
port infrastructure quality	117	3.32	0.762
Valid N (listwise)	117		

4.4.3. Assessment of Logistics Services

It is very vital to note here that, service quality is not only assessed as the results but also on how it is delivered during the service process and its ultimate effect on consumer's perceptions (Alebachew, 2020). The logistics service quality analysis of MDP was shown in the following table 4.8 below.

According to the respondents' responses, the logistics service quality of the port scored a mean value of 3.35, freight delivering service in the port 3.26, transporters availability and their efficiency 3.11 and delivering services of logistics at the terminal scored a mean of 3.18. the results indicate that the logistics service given at the port had affected the transport logistics performances. Therefore, the company must be improving these problems to increase its productivity and compete with other companies.

Table 4.8: Assessment of logistics services

	N	Mean	Std. Deviation
The logistics service quality of port	117	3.35	0.813
The freight delivering service in dry port	117	3.26	0.709

The transporter's availability and efficiency	117	3.11	0.74
Delivering services of logistics at the terminal	117	3.18	0.816
Valid N (listwise)	117		

4.4.4. Assessment of Timeliness

The time to complete trade transactions is a useful outcome measure of logistics performance.

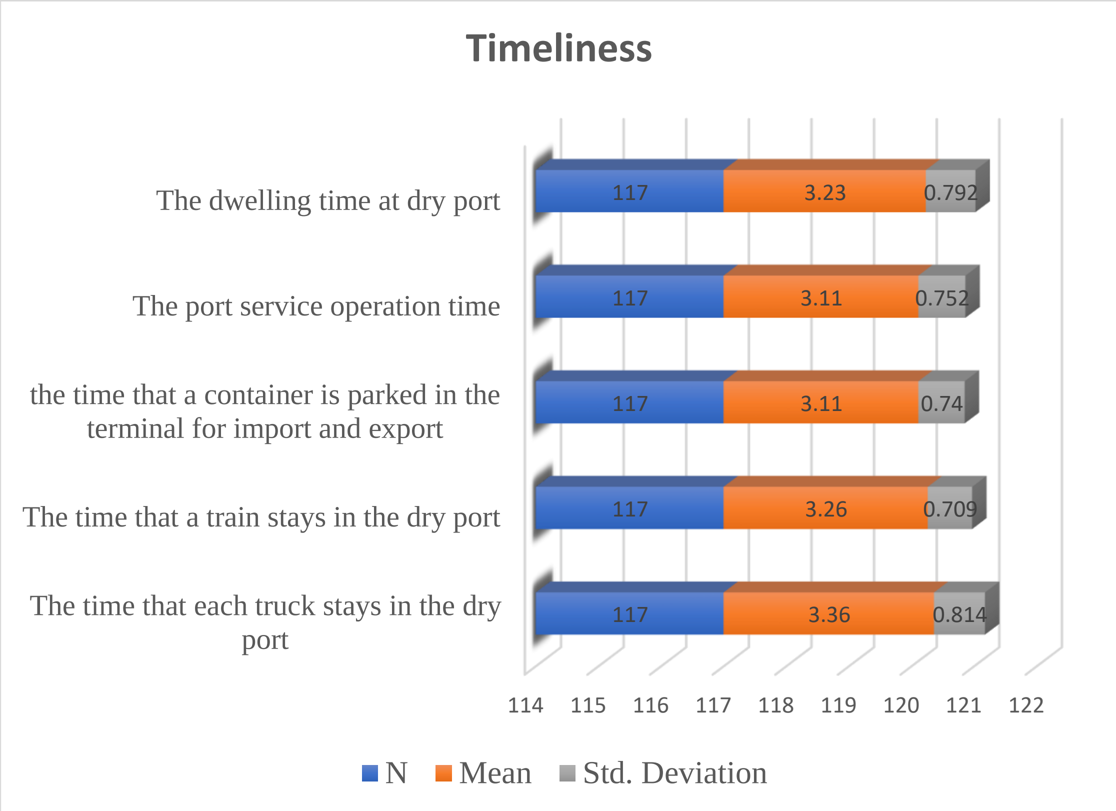

Figure 4-5: Assessment of timeliness

From Figure 4.5 above, the results of the respondents indicate that the dwelling time at dry port scored a mean value of timeliness 3.23 whereas the port service operation time, duration of containers in the port either for import or export, the time a train in the dry port and the truck stay in the port was 3.11, 3.11, 3.26 and 3.36 respectively. Based on these results port service operation time and dwelling time at the dry port had a high impact on Modjo dry port and its indicator of the need for improved dwelling time and others.

4.5. Modeling the Transport Logistics Performance at MDP

The transport logistics in Modjo dry port and terminal are considered from in/out the gate to exit the train/road through the terminal. This process takes a lot of entities (time, cost, etc.) which affects the transport logistics performance of the port and overpasses the country's logistics performance. The flow process is shown in Figure 4.6 below.

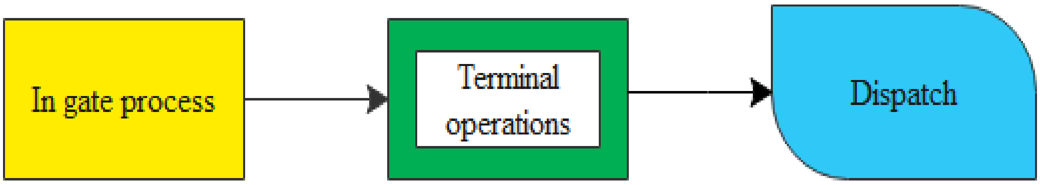

Figure 4-6: The MDP transport logistics flow path

To reduce the inter-terminal transport service time and cost, different port and terminal systems have been studied. Some of these systems are delivering custom control and clearance, information flow and communication, port infrastructure (availability of terminal equipment, information technology, ...) and attractive logistics services. This is because the terminal transport logistic system involves the coordination of many sectors and integration between the different operations of the terminal to overcome the required performance.

The major nodes that affect the MDP performances are shown in Figure 4.7 below to assess every activity avail between the connections. In these relations, the backbone of the system to facilitate every activity is an information flow between all of them.

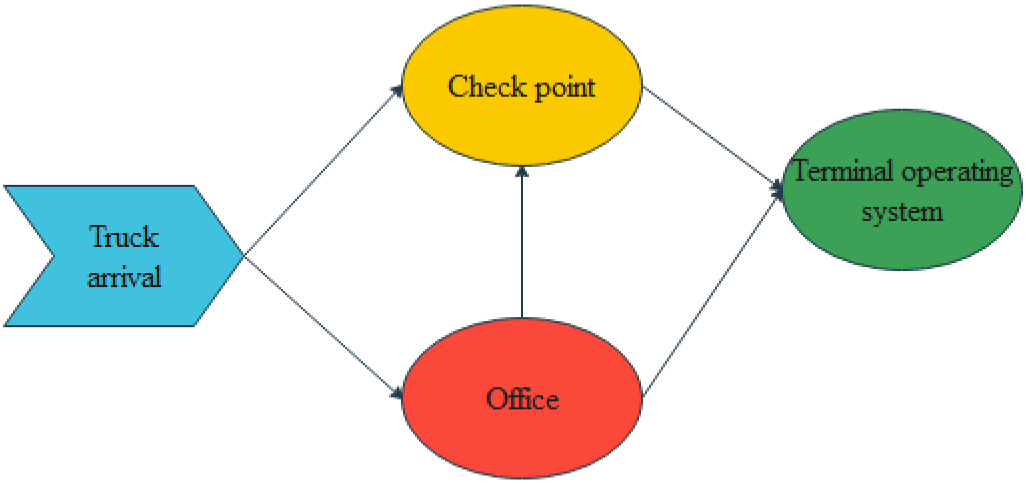

Figure 4-7: The integration of different nodes of MDP

From the point of view of integrated systems of the port sectors and operations, the performance of the transport logistics of MDP becomes valuable when all considered parts are working together. Because the transport logistics includes many activities and operations. It is defined as "the relationship between transport and integrated approaches to logistics and supply chain management" (Topolšek et al., 2018). In other words, the main target is on the movement of goods in a supply chain, which is more than mere transport of goods, since it covers full business and operational frames within which the movement or movement of the cargo is planned, managed and ultimately carried out, therefore, transport logistics could be considered as a broader term than transport alone, but a sub-activity of logistics and supply chain management(Topolšek et al., 2018).

From the point of different scholar's aspects, transport logistics encompasses all sectors in the processes to facilitate the transformation and delivery of cargo in the port. To ensure this concept, (Topolšek et al., 2018) argued that "Transport logistics encompass all steps in the transfer of freight between the various institutions intervening in international freight transport, the operators transporting it, and the transport intermediaries providing brokerage services between freight transfers. Consequently, the customs administration, insurance companies, banks, transport operators, terminal operators, Shippers' Councils, private carriers, and intermediaries are considered as intervening in transport logistics".

Therefore, the departments, sectors and operators in MDP must collaborate and integrate to overcome the situation and problems (delay, cost, traffic congestion, assigning…) as well as to maintain the performance of transport logistics. The following transport logistics performance model was constructed to help the manager and planner to enable efficient and effective transport logistics with clearly identified performance attributes.

Before the container is assigned to the place to be stored or taken by the customer, as the truck/train arrived at the port the message arrives at the office, checkpoint and terminal operators. In this process, there were a lot of activities in those departments; documenting invoices, bill of lading, checking containers at checkpoints; custom clearance, assigning orders by an office, and assigning the containers to appropriate bays by terminal operators. Due to a lack of an information delivering system, there was waiting for an office at both checkpoints and the terminal operating system. The message was delivered to the terminal operator by a man after it took some minutes to arrive. The customs clearance process, port infrastructure, logistics services and timeliness were the factors consequences in the delay, cost, and congestion, and in general, those were serious issues for transport logistics performance.

After all sides and corners of the performance factors are dealt with, an efficient, effective and differentiated transport logistics performance is fulfilled and settles the manager's goals.

Model of Transport logistics performance

Figure 4-8: Model of Transport logistics performance(author,2022)

After data was surveyed from MDP workers and observed by the researcher, four performance indicators of transport logistics were assessed concerning their attributes. Then after, the model of transport logistics performance was developed.

From the model we analyze that; during custom clearance at the port, factors influenced its performance attribute (speed and procedure, simplicity and predictability and custom services), port infrastructure to deliver the cargo easily; sufficient road network at the port, number of handling equipment (reach stacker, forklift, terminal truck) and ICT tools, Logistics service; service quality, freight delivering and transporters availability, Timeliness; delay of the truck at the port, during container parked and operation time were figure outed. Where these performance indicators and their attributes function appropriately, an efficient and effective even if the differentiation of transport logistics performance take a place and also increases the port's logistics performance which influences the country's logistics performances as a whole.

4.6.Modeling the Transport Logistics Operations at MDP

In the case of transport logistics operation in this study, the process of the event from the arrival of the train/truck to its departure was formulated and modeled with different mathematical equations: queue model at checking points, loading and unloading queue model at temporary storage, network flow of the vehicles between terminal nodes, etc. in the container terminal.

4.6.1. In-Gate (Checkpoint) to Temporary Storage Model

The port terminal process flow of queuing time started from road/rail truck arrival at the port until they leave the port terminal. In these processes, several activities need to be followed after the truck/train arrival. This indicates the efficiency of transport logistics determined by quick service of gate process, loading and unloading, etc.

To understand the basic queuing model, know its components and its following structure where the procedure of a simple queueing system is shown in Figure 4-9. follows.

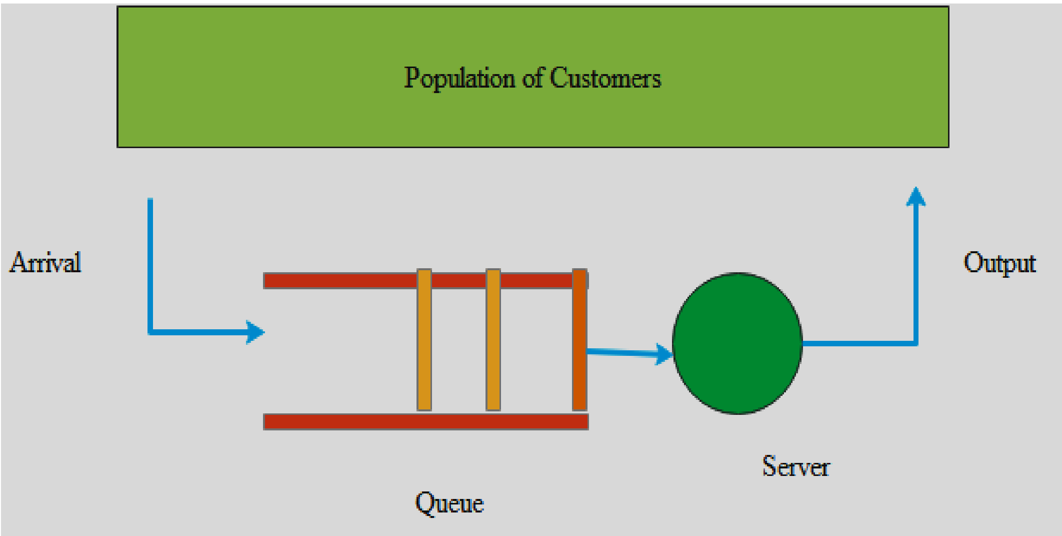

Figure 4-9: General queueing system

In the Modjo dry port and terminal, there were a delay, traffic congestion, other problems due to delays, and lack of information transmission on time, etc. To overcome these problems, it is possible to minimize queue time by using a mathematical model.

In this study, a different scenario was used to analyze “what if” after the waiting time for five hours per day successively in one month (November,20/2021 to December 20/2021) for five working days per week was recorded at Modjo dry port checkpoint to a terminal process flow. The queueing parameter's properties and their characteristics were discussed in detail. Here, the truck road arrives at port and then follows the queue discipline of FIFO and joined to the shortest queue line. As we saw in Figure 4.8 above, after the arrival of the truck road, they joined the queue (triple queue) and then take a service at checkpoints. Then after, again joined the single queue which formed the network queue and here there was traffic congestion due to narrow roads, and more but it occurred due to less service time at loading/unloading at temporary storage. The single and multiple queue parameters were discussed as follows.

A. M/M/1 Queue

The queuing system M/M/1 is the simplest non-trivial queue where the customers arrive according to a Poisson process with rate λ that is, the inter-arrival times are independent, exponentially distributed random variables with parameter λ. The service times are assumed to be independent and exponentially distributed with parameter μ.

Therefore, the results have concluded as follows:

i. The probability of having zero customers in the system

$$P_o = 1 - \rho \qquad (4.1)$$

ii. The probability of having N customers in the system

$$P_N = \rho^N P_o \qquad (4.2)$$

iii. Average number of customers in the system

$$L_s = \frac{\rho}{(1-\rho)} \qquad (4.3)$$

iv. Average number of customers in the queue

$$L_q = \frac{\rho^2}{(1-\rho)} \qquad (4.4)$$

v. Average waiting time in the system

$$W_s = \frac{1}{\mu(1-\rho)} \qquad (4.5)$$

vi. Average waiting time in the queue

$$W_q = \frac{\rho}{\mu(1-\rho)} \qquad (4.6)$$

Where;

ρ= server utilization

P_o=probability of an empty system

L_s=long-run time-average number of customers in the system

L_q=long-run time-average number of customers in queue

W_s=long-run average time spent in the system per customer

W_q=long-run average time spent in queue per customer

B. M/M/c Queue

The queuing system M/M/c is the queueing discipline where c service channels are ready for the arriving customers following the Poisson process. λ and μ have the usual meanings with all the random variables independent as described in the subsection single server. The followings are some of the formulae for the performance measures of this model.

i. The probability of having zero customers in the system

$$P_o = \left[\sum_{N=0}^{c-1} \frac{(c\rho)^N}{N!} + \frac{(c\rho)^c}{c!(1-\rho)}\right]^{-1} \qquad (4.7)$$

ii. Probability of having N customers in the system

$$P_N = P_o \frac{\rho^N}{N!}, \text{ for } N < c \qquad (4.8a)$$

$$P_N = P_o \frac{\rho^N}{c^{N-c}\, c!}, \text{ for } N > c \qquad (4.8b)$$

iii. The average number of customers in the queue

$$L_q = P_o \frac{(c\rho)^{c+1}}{c\, c!} \frac{1}{(1-\rho)^2} \qquad (4.9)$$

iv. The average number of customers in the system

$$L_s = L_q + c\rho \quad (4.10)$$

v. The average waiting time in the system

$$W_s = \frac{L_s}{\lambda} \quad (4.11)$$

vi. The average waiting time in the queue

$$W_q = \frac{L_q}{\lambda} \quad (4.12)$$

$$\rho = \frac{\lambda}{c\mu} \quad (4.13)$$

As the road arrived at the port, the arrival time is recorded then through different queues goes to the respective checkpoint until the road truck is unloaded and the container loaded to the terminal truck is moved to the wanted places.

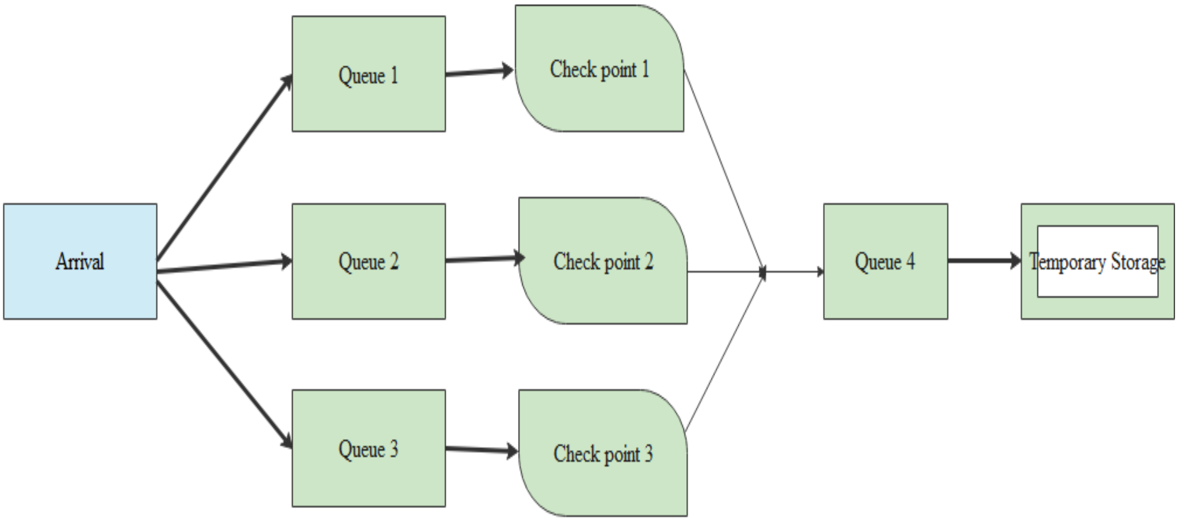

Figure 4-10: Network flow model of transport logistics at MDP container terminals (author,2022)

Queuing time was the most time-consuming phase based on the real situation. “What if” analysis is used to improve the performance based on a few scenarios.

The convenience of loading and unloading at temporary storage is very crucial for an effective multimodal transport service. the congestion, theft, security risk, reach stacker allocation, the capacity of terminal truck and regulations at the port of loading can be affecting the loading/unloading operations. These and other factors affect the performance of transport logistics of the port.

According to Waktole (2017), the major reason for the delay of shipments was due to the time wasted in queues and the researcher realizes these problems while the road gets service at the checkpoints, especially 8 minutes to 2 hours as recorded for consecutive five days for one month by a researcher at Modjo dry port terminal gates as shown as figure 4-11 below.

Figure 4-11: Queue at terminal gate control

Source: photo captured by the researcher,2021

The road truck arrived per month per week per day per hour and the service given for arrived trucks recorded by the researcher were displayed in Table 4.9 and 4.10 respectively while its details are in (Appendix II).

Table 4.9: Daily arrival rate of queuing system analysis for servers

	W_1			W_2			W_3			W_4		
	λ_1	λ_2	λ_3	λ_1	λ_2	λ_3	λ_1	λ_2	λ_3	λ_1	λ_2	λ_3
D1	41	34	37	46	36	46	52	41	48	37	26	36
D2	32	27	31	41	31	38	40	29	38	39	28	37
D3	34	28	31	36	29	41	37	26	39	40	29	40
D4	38	25	32	40	30	41	38	29	41	37	27	39

D5	38	29	33	41	25	37	40	25	40	37	26	37
Tot.	**183**	**143**	**164**	**204**	**151**	**203**	**207**	**150**	**206**	**190**	**136**	**189**

The table shows that the number of road trucks that arrived at port checkpoints on five consecutive days per week was recorded for four weeks. At this time, the arrival for took service at each checkpoint was added as bolded in the last row of the table. As an example, the number of trucks that arrived at the first, second and third checkpoint in the first week were 183, 143 and 164 respectively and the lefts were also the same procedure.

Among arrived trucks, more trucks were taking checking services and the details are as follows.

Table 4.10:Daily service rate of queuing system analysis for servers

	W_1			W_2			W_3			W_4		
	μ_1	μ_2	μ_3	μ_1	μ_2	μ_3	μ_1	μ_2	μ_3	μ_1	μ_2	μ_3
D1	28	26	30	30	24	29	30	26	30	29	23	29
D2	26	22	26	29	25	29	29	24	29	31	23	29
D3	27	23	27	25	23	29	28	21	29	29	24	31
D4	28	22	25	29	24	29	28	24	30	28	24	30
D5	29	24	26	29	21	30	28	21	29	28	21	28
Tot.	**138**	**117**	**134**	**142**	**117**	**146**	**143**	**116**	**147**	**145**	**115**	**147**

From Table 4.10 above we concluded that servers may work faster than usual when the waiting line is long, thus effectively reducing the service times. Particularly, on the first working day almost fast service is given to the customers (truck checking at gets) when compared with other days. This was due to the truck accumulated Saturday and Sunday since no offering on other days according to observation during data gathering at MDP.

Generally, the server’s utilization per month per week is shown in Table 4.11. below.

Table 4.11: Weekly queuing system analysis of the servers

		Server 1		Server 2		Serve 3	
		Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
Week1	Total	183	138	143	117	164	134
	Average	36.6	27.6	28.6	23.4	32.8	26.8
Week2	Total	204	142	151	117	203	146
	Average	40.8	28.4	30.2	23.4	40.6	29.2
Week3	Total	207	143	150	116	206	147
	Average	41.4	28.6	30	23.2	41.2	29.4
Week4	Total	190	145	136	115	189	147
	Average	38	29	27.2	23	37.8	29.4
Total for month		784	568	580	465	762	574
	Average system of utilization	1.38		1.25		1.33	

From Table 4.11 above we observed that there was a delay that affects the port's transport logistics performance. That means where the system utilization may be above 1, it needs more improvement to deliver immediate services for the road truck during checking at terminal gates control.

The precise result of the system per week were put in the following table 4.12 below.

Table 4.12: Weekly System Utilization for each Server

weekly record	server 1	server 2	server 3
Week 1	1.33	1.22	1.22

Week 2	1.44	1.29	1.39
Week 3	1.42	1.29	1.40
Week 4	1.31	1.18	1.28

From Table 4.11 above we have the average arrival and service rate to analyze the customer arrival and service rate for each server per month.

Analysis of the customer arrival rate for each server;

Customer arrival rate for server 1 (λ_1) =$\frac{\lambda_{w1}+\lambda_{w2}+\lambda_{w3}+\lambda_{w4}}{4\times 5\times 5}$ =8 customers/hr.

Customer arrival rate for server 2 (λ_2) =$\frac{\lambda_{w1}+\lambda_{w2}+\lambda_{w3}+\lambda_{w4}}{4\times 5\times 5}$ =6 customers/hr.

Customer arrival rate for server 3 (λ_3) =$\frac{\lambda_{w1}+\lambda_{w2}+\lambda_{w3}+\lambda_{w4}}{4\times 5\times 5}$ =8 customers/hr.

Average customer arrival rate for the servers (λ) = $\frac{\lambda_1+\lambda_2+\lambda_3}{3}$ =7.33 customers/hr.

Analysis of the service rate for each server as follows;

Service rate for server 1(μ_1) $= \frac{\mu_{w1}+\mu_{w2}+\mu_{w3}+\mu_{w4}}{4\times 5\times 5} = 6\frac{customers}{hr}$.

Service rate for server 2 (μ_2) = $\frac{\mu_{w1}+\mu_{w2}+\mu_{w3}+\mu_{w4}}{4\times 5\times 5} = 5\frac{customers}{hr}$.

Service rate for server 3 (μ_3) = $\frac{\mu_{w1}+\mu_{w2}+\mu_{w3}+\mu_{w4}}{4\times 5\times 5} = 6\frac{customers}{hr}$.

Average customer service rate for the servers (μ) = $\frac{\mu_1+\mu_2+\mu_3}{3} = 5.67\frac{customers}{hr}$.

System utilization per month for each Channel from equation (13);

$\rho_1 = \frac{\lambda_1}{c_1\,\mu_1} = \frac{8}{1\times 6}$ = 1.33, where system utilization of the second and third channels are 1.25 and 1.33 respectively.

The server's utilization of the gate which serves the port for checking gate is 1.30 which is greater than one. If $\rho > 1$, then the system is overloaded since the requests arrive faster than they are served. It shows that more servers are needed and it needs improvement to be the queue will be stable (Ghimire et al., 2017).

In all performance measurement parameters, the values of terms were analyzed as follows based on the equation above 4.1-4.13.

The probability of the customers zero in the system (P_o) and customers in the queue (L_q) from equations 4.7 and 4.9 were;

Table 4.13: Scenario analysis of checking point servers

C	L_q	P_o
1	0	-0.323
2	0.52	0.204
3	0.14	0.257
4	**0.03**	**0.345**
5	0.004	0.266
6	0.0007	0.266

From Table 4.13 above, we observed the servers' idle time when no customer (truck) for service (for checking) and the number of customers (trucks) in the queue waiting for the service at the checkpoint of the dry port. Here, as a result, the necessary servers (checkpoint in gates) were four: c=4 and at the same time the average customers waiting for the service $(L_q) = 0.03$, $P_o = 0.345$ as shown in Table 4.13 above.

Other parameters: like average waiting time for an arrival not immediately served $(W_a) = \frac{1}{c\mu-\lambda} = \frac{1}{4\times6-7} = 0.058hrs = 3.53minutes$, The average time customers wait in line $(W_q)= \frac{L_q}{\lambda} = \frac{0.03}{7} =$ 0.0043hrs = 0.30minutes.

The probability that may an arrival will have to wait for service (Pw)

$$(P_w)= \frac{W_q}{W_a} = \frac{0.0043}{0.058} = 0.074$$

The average number of customers waiting for service and waiting time in the system from equation (4.10) and or (4.11) respectively;

$$(L_s) = L_q + \frac{c\lambda}{\mu} = 0.03 + 4.8 = 4.83$$

$$(W_s) = \frac{L_s}{\lambda} = \frac{4.83}{7} = 0.69$$

Now, the system utilization $(\rho) = \frac{\lambda}{c\mu} = \frac{7}{4\times6}$=0.29; i.e., the system capacity = $c\mu = 24.$

The road truck after being served at all checkpoints was inter to the single line to unload the carried container to be delivered at temporary storage. At this stage also there was another queuing line nominated as queue 4; it should analyze the performance of single server parameters.

After the checkpoint of the in-gate, another line has formed for delivering the container at temporary storage. Here, there was traffic congestion which needs improvement. However, the formed queue made a rough cut to observe the performances of loading and unloading at the buffer area was analyzed as follows. In this flow, other containers arrived from the train to this buffer, and the overall arrival rate into queue 4, λ_4, is the sum of the arrival rate from all sources.

According to (Banks et al., 2010), if customers arrive from outside of the network at a rate a_j, then

$$\lambda_j = a_j + \sum_{all\ i} \lambda_i p_{ij} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (4.14)$$

Where: the overall arrival rate into queue j, λ_j is the sum of the arrival rate from all sources.

From the perspective view of this formula, the recorded data during site observation were showed in the table below.

Table 4.14: Arrival of both trucks/trains at temporary storage

	Arrival from the road at the network line in a month				Arrival from the train at the network line in a month			
Days		Weeks				Weeks		
	W1	W2	W3	W4	W1	W2	W3	W4
D1	84	83	86	81	31	28	24	27

D2	74	83	82	83	24	29	21	29
D3	77	77	78	84	26	26	23	35
D4	75	82	82	82	27	29	29	22
D5	79	80	78	77	29	35	32	29
Total	389	405	406	407	137	147	129	142

The network was an open loop and then the container come from the wagon joined to road transport at the storage area. In this area also there was another queue waiting to unload/loading of reach stacker from road transport and onto the terminal truck respectively. During unloading/loading operation due to insufficient MHE in the area, the queue form traffic congestion too.

Table 4.15: Arrivals and services at temporary storage

Arrival and service rate at loading and unloading of temporary storage								
Days	W1		W2		W3		W4	
	$\lambda 1$	$\mu 1$	$\lambda 2$	$\mu 2$	$\lambda 3$	$\mu 3$	$\lambda 4$	$\mu 4$
D1	115	90	111	88	110	99	108	79
D2	98	83	112	91	103	91	112	86
D3	103	87	103	89	101	85	119	97
D4	102	94	111	93	111	87	104	90
D5	108	97	115	98	110	100	106	83
	526	451	552	459	535	462	549	435

From the above table, the performance analysis for different parameters of the fourth line and node were;

Average customer's arrival for temporary storage queue:

$\lambda_4 = 2162$ customers per week per day per time=$\frac{2162}{4\times5\times5} = 21.62 \sim 22 customers/hr$

Average service rate for server for temporary storage (loading and unloading):

$$\mu_4 = \frac{1807}{100} = 18.07 \sim 18 customers/hr$$

The server utilization (the capacity of reach stacker loading and unloading concerning the terminal truck) is;

$$\rho = \frac{\lambda_4}{\mu_4} = \frac{22}{18} = 1.22$$

Now, the result obtained indicates as the utilization of the loading and unloading machine at temporary storage had to be improved. For finding an improvement, the scenario analysis was told as the result in Table 4.16.

Table 4.16: Scenario analysis of reach stacker at temporary storage

Server (c)	Utilization (ρ)	(L_q)	(L_s)	(W_q)	(W_s)
1	1.22				
2	0.61	0.73	1.95	0.03	0.09
3	**0.41**	**0.1**	**1.32**	**0**	**0.06**
4	0.31	0.02	1.24	0	0.06
5	0.24	0.01	1.23	0	0.06

Therefore, by making the reach stacker three or the server three the utility of the area became stable.

i.e., $\rho = \frac{\lambda_4}{c\mu_4} = \frac{22}{3\times18} = 0.41$

The probability of having zero customers in the system $(p_0) = 0.28$

The average customers in the system (L_s) = $1.32 customers/hr$

The average customers in the queue (L_q)= $0.1 customer/hr$

The average waiting customer in a system (W_s)=$0.06hr$

The average waiting customer in the queue (W_q)= $0hr$

From the above results obtained by QM for Windows, we conclude that the servers (reach stackers) should be three for fitting queuing performances. In this result, no waiting time to deliver the container at temporary storage then the idle of the servers is 28%.

Table 4.16 Shows us the preferred solution after the scenario, and the necessary reach stackers for loading/unloading at temporary storage should be three for performing the transportation performance at the terminal.

4.6.2. Inter-terminal transport model

A vehicle as transport equipment is a component that can transport containers from the unloading point to their destination. Every vehicle possesses data relating to its speed and states such as the loaded state and the empty state, its pickup and delivery points of origin and destination, and its load. The objective of the model is to determine the unknowns X_{ij} (container) that will minimize the total transportation cost while satisfying all the supply and demand restrictions.

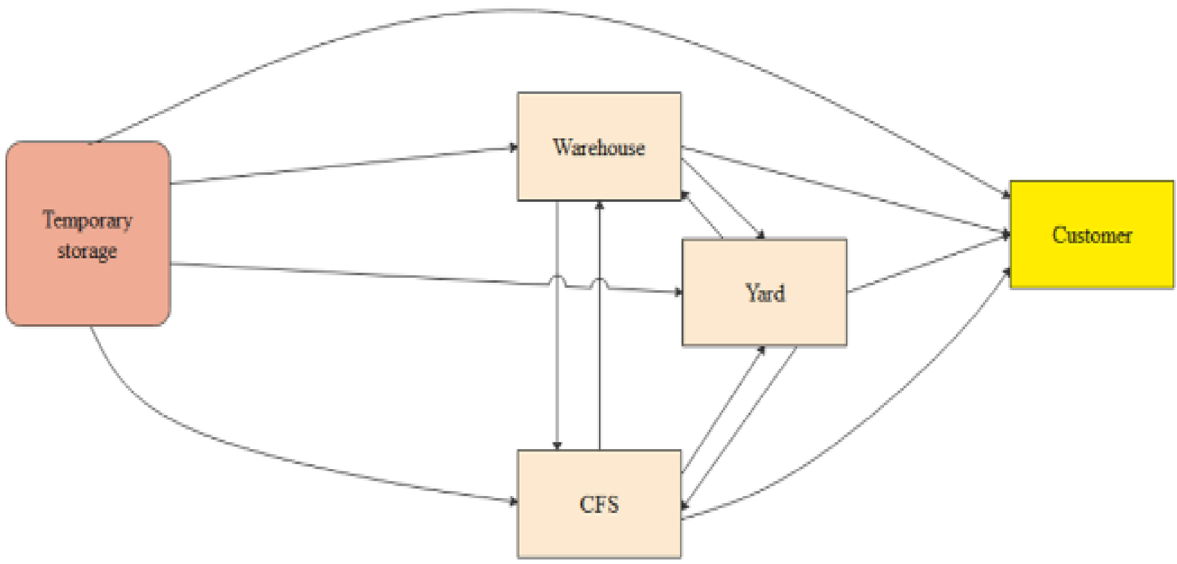

Figure 4-12: Terminal transport logistics model at MDP

Source: own completion,2022

In this model, the transshipment nodes between temporary storage were received and delivered while temporary storage only supplied the containers to transshipment nodes and customers who demand the cargo could be only received from different transshipment nodes.

In this case, we define a supply node as a point that can send an item to other nodes but cannot receive an item from any other point reversely. Similarly, a demand node is a point that can receive goods from another node but cannot send goods to any other point while the transshipment node is a node that can both receive goods from other nodes and send goods to other points.

Here, the transshipment model was constructed due to minimize transportation costs and also traffic congestion at the same time. The shipping costs (in birr) between the nodes were put in the following table.

Assume;

- 1 (source 1) represents Temporary storage or supply point
- 2 (source 2) represents Warehouses
- 3 (source 3) represents the Storage yard
- 4 (source 4) represents CFS
- 5 represents the customer or demand point in this transshipment model.

Table 4.17: Shipping costs for transshipments

From	To (Birr)			
	2	3	4	5
1	120	180	160	210
2	0	140	90	120
3	140	0	60	110
4	90	60	0	50

Table 4.17 above shows us the transshipment costs per container (TEU) by which containers moved from one node to others by terminal truck where arrived containers at temporary storage per a day were 90 TEU containers shipping to customer passthrough the transshipment nodes (Warehouse, storage yard and container freight station).

The temporary storage was supplying point, with supplies of 90TEU containers per day. in this case warehouse, storage yard and container freight station are transshipment points. The customer is a demand point with a demand of 38TEU containers per-day. A graphical representation of possible shipments was given in Figure 4.12.

Here now, we have;

- Total supply (from temporary storage) = 90 containers/day
- Total demand (of customer) = 38 containers/day

Therefore, it was necessary to add a dummy demand point (with a supply of 0 and a demand equal to the problem's excess supply; 52 containers) to balance the flow containers. Shipments to the dummy and from a point to itself will, of course, have a zero-shipping cost. Then, construct a transportation tableau as a row containing the original supply point and transshipments while the column contains transshipment points and demand points with the dummy.

Table 4.18: Total supplied and demanded of containers/day

Transshipment model					
	2	3	4	5	SUPPLY
Source 1	120	180	160	210	90
Source 2	0	140	90	120	90
Source 3	140	0	60	110	90
Source 4	90	60	0	50	90
DEMAND	90	90	90	38	

From Table 4.18 above we concluded that the cost of transporting the containers between different nodes and the container supplied and demanded at the supply point and demand point respectively.

From this observation, an object of the model was to minimize the transportation cost of the container occurring between the points. By using equations (1-4) in chapter two, we get;

$$Min\ C = 120X_{12} + 180X_{13} + 160X_{14} + 210X_{15}$$

$$+0X_{22} + 140X_{23} + 90X_{24} + 120X_{25} +$$

$$140X_{32} + 0X_{33} + 60X_{34} + 110X_{35} +$$

$$90X_{42} + 60X_{43} + 0X_{44} + 50X_{45}$$

Subject to;

$$X_{12} + X_{13} + X_{14} + X_{15} \leq 90 \quad \{Supply\ constraints\}$$

$$X_{12} + X_{32} + X_{42} - X_{23} - X_{24} - X_{25} = 0$$

$$X_{13} + X_{23} + X_{43} - X_{32} - X_{34} - X_{35} = 0$$

$$X_{14} + X_{24} + X_{34} - X_{42} - X_{43} - X_{45} = 0\{Transshipment\ constraints\}$$

$$X_{15} + X_{25} + X_{35} + X_{45} \geq 38 \ \{Demand\ constraints\}$$

$$X_{ij} \geq 0$$

Where; i=supply and transshipment point as a supply and

j = transshipments as a demand point and demand point

X_{ij}= the number of containers produced at i points and sent to j points.

From the above transshipment model, by using the QM for Windows software, we gained an optimum solution.

The solution indicated that the containers at temporary storage should be moved to CFS and then to the customer.

Table 4.19: Optimum path of containers

Transportation Results

Transshipment model solution solution

solution value = $7980	2	3	4	5	Dummy
Source 1	0	0	38		52
Source 2	90				
Source 3		90			
Source 4			52	38	

The optimum solution became as minimized costs is 7980 birrs (Table 4.19) to deliver 38containers to the customer after analyzed by those three methods that can be used to find a basic feasible solution for balanced transportation problems and optimization transport cost methods; northwest corner, minimum-cost, and Vogel's methods. As a result, the transportation cost of a container should be profitable if the container is transported to CFS and then to the customer. CFS is an area where value-added tasks took a place like; stuffing/unstuffing, packaging, and checking, …

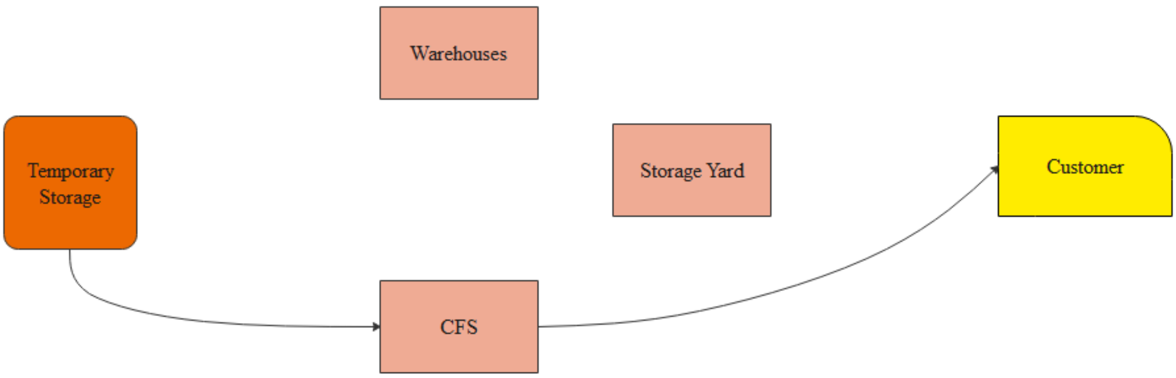

Figure 4-13: Optimum terminal transport logistics model at MDP

The model indicated that the optimum transportation cost was obtained when the containers moved from temporary storage to the customer through the containers freight station (CFS). In this result, as the line of movement become decrease, the traffic congestion also decreases and transportation logistics performed as they wanted. An improvement of TOS with better functionalities, and their optimization, would increase the efficiency of the terminal (Hervás-Peralta et al., 2019).

A well-developed and organized transport system ensures better efficiency, minimization of operating costs, and the best service quality of logistics systems(Topolšek et al., 2018).

4.7. Discussion of the results

The transport logistics performance at the port has become clear and easy to understand after the model identifies performance indicators and their attributes the factors that affect the logistics performance. The efficiency and effectiveness of transport logistics of the case company were factored by all performance indicators and their attributes. Therefore, the model made it easier to identify all factors and the manager/planner must consider them. After identifying and understanding the model, the differentiation of transport logistics performance should be applicable. At the same time the key performance indicators; custom clearance, port infrastructure, logistics service and timeliness were discussed. Here, the operations and department nodes were connected due to information exchanges and cooperation. The performance attributes are also clearly discussed in the model to make the hint to stakeholders. After the combined and teamwork of the concerned body in the model, the performance measure entities; efficiency, effectiveness and differentiation of transport performance of the port have to occur.

The delay at the checking point and temporary storage was solved by using a simulation /network model. As a result, one additional in-gate and two additional reach stackers at temporary storage will be necessary to facilitate the operations.

The road/rail transport arriving at the port to delivering the container to the customer were solved by different methods/mechanisms, among them, the transshipment model was performed to solve transportation cost between terminal nodes. an efficient inter-terminal transport (ITT) system is minimizing the delay of containers moving between different areas of terminals, even reducing and eliminating the delayed departure of containers and minimizing the transportation cost to 7980 birrs.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

In this research, the transport logistics performance at MDP was analyzed through different models. Several scenarios to improve the efficiency and effectiveness of transportation logistics were executed for modifying the structure and parameters of the model. In the graphical model; transport logistics performance indicators, performance attributes and different components of the transport logistics performance were modeled and analyzed. In these results, an attribute affecting the transport performance was identified to get focus on improvement. In addition, queuing network model and transshipment model at inter-terminal transportation were also discussed. After the discussion, one in-gate point and two additional reach stackers for unloading/loading operations at temporary storage are necessary. Here, the server(s) utilization was improved after calculating the recorded data at each in-gate and at temporary storage. The transport path between nodes was reduced to one linkage through CFS to the customer from temporary storage. This result decreases the traffic congestion and demurrage cost at the time.

5.2. Recommendation

Containers are transported with less time in MMT from\to Ethio-Djibouti corridor. That increases the round trips of trucks from the port of discharging up to the destination (dry ports), even though the cargo cannot distribute at the right time, quality & quantity as per the shipping interview responses. There are various reasons can be seen in these challenges: there is not enough and well-equipped machinery at the dry ports in the loading and unloading operation, the truck capacity did not use efficiently to transport containers, shortage of transport trucks and lack of coordination, loss of items from cargo parts (spare parts) especially vehicle shipments, the truck drivers take two days from discharging port to dry ports and sub-contract is engaged with individual trucking companies to fill the gap.

- The grounded and chassis storage system of the containers caused delays in unloading and loading at temporary storage. It needs consideration for improvement.
- The capacity of the terminal truck to carry the container was 65 tons. This capacity was considered with 40 FEUs, but at the most, the truck transferred 20 TEU. This

delivery is very costly and reduces customer satisfaction. So, it has to be considered to solve the problem.

5.3. Future work

Different stacking configurations at the bay or storage area can strongly influence times and costs related to loading and moving operations. This problem didn’t solve in this research. So, it is recommended that future researchers overcome the problem. Among all transport logistics performance indicators, this research was conducted with only four and among logistics activities only three were targeted. Therefore, the lefts may be analyzed in future work. The material handling equipment at the terminal needs scheduling, particularly at temporary storage. Here, the terminal truck had a delay due to turnaround through the bays which needs improvements since the reach stacker waiting for the terminal truck.

Lastly, the model used for loading and unloading at rail/wagon, and transport processes with export is also recommended for future research.

References

Adam, A. M. (2020). *Sample Size Determination in Survey Research Sample Size Determination in Survey Research*. *June*. https://doi.org/10.9734/JSRR/2020/v26i530263

Alebachew, S. (2020). *DRY PORT LOGISTICS PERFORMANCE OF MODJO BY : SILESHI ALEBACHEW ADVISOR : TARIKU JEBENA (PhD) Thesis for the Partial Fulfilment of the Requirements of Master of Arts Degree in Logistics and Supply Chain Management*.

Ali, Z., & Bhaskar, S. B. (2016). Basic statistical tools in research and data analysis. *Indian Journal of Anaesthesia*, *54*, 662–669. https://doi.org/10.4103/0019-5049.190623

Arvis, J.-F., Ojala, L., Wiederer, C., Shepherd, B., Raj, A., Dairabayeva, K., & Kiiski, T. (2018). Connecting to Compete 2018. *Connecting to Compete 2018*. https://doi.org/10.1596/29971

Bank, T. W. (2020). *Project Information Document (PID)*. 1–16.

Banks, J., Carson II, J. S., Nelson, B. L., & Nicol, D. M. (2010). *Discrete Event System Simulation (Fifth Edition) .pdf*.

Bekele, R. (2019). Determinants of Throughput Performance of Modjo Dry Port, Ethiopia. *Journal of Business and Administrative Studies*, *11*(2), 1.

Beysenbaev, R., & Dus, Y. (2020). Proposals for improving the Logistics Performance Index. *Asian Journal of Shipping and Logistics*, *36*(1), 34–42. https://doi.org/10.1016/j.ajsl.2019.10.001

Binti Mohamad, F., Shahadah Binti Osman Mydin, N., & A.N.Aizat, A. (2018). Reducing Ship Queuing Time in Port Operation: A Modelling and Simulation Approach. *International Journal of Engineering & Technology*, *7*(3.20), 114. https://doi.org/10.14419/ijet.v7i3.20.18992

Cezar-Gabriel, C. (2006). *PERFORMANCE ASSESSMENT IN OPERATING DRY PORTS Ciortescu Cezar-Gabriel "Alexandru Ioan Cuza" University of Ia ú i Faculty of Economics and Business Administration*. 934–938.

Charkaoui, A., & Bouayad, B. (2012). Modeling the Logistics Performance in Developing Countries: An exploratory study of Moroccan context. *International Journal of*

Academic Research, *4*(2), 129–135.

de Villiers, G. (2015). *Inland Intermodal Terminals and Freight Logistics Hubs*. *September*, 123–151. https://doi.org/10.2495/978-1-78466-077-2/006

Debela, F. M. (2013). *Logistics Practices in Ethiopia*.

Demse, H. (2018). *Master ' s Thesis Challenges of Multimodal Transport Services : May*.

ESCAP. (2018). *Digital Solutions for Dry Ports Operations*. 1–15.

Ganesh, K., Koh, S. L., Saxena, A., & Rajesh, R. (2011). Logistics Design and Modelling–A Simulation Perspective. *Logistics Is the Future*, 1–28. http://www.shef.ac.uk/polopoly_fs/1.142317!/file/Logistics-Design-and-Modelling-Collaborative-White-Paper.pdf

Gani, A. (2017). The Asian Journal of Shipping and Logistics. *The Asian Journal of Shipping and Logistics*, *33*(4), 279–288. https://doi.org/10.1016/j.ajsl.2017.12.012

Georgise, F., Assefa, B., & Bekele, H. (2020). *Advances In Industrial Engineering And Management DESIGN OF ALTERNATIVE WAREHOUSE LAYOUT FOR EFFICIENT SPACE UTILIZATION : A CASE OF MODJO DRY PORT*. *9*(1), 6–13.

Ghimire, S., Thapa, G. B., Ghimire, R. P., & Silvestrov, S. (2017). *A Survey on Queueing Systems with Mathematical Models and Applications*. *November*. https://doi.org/10.5923/j.ajor.20170701.01

GÖZAÇAN, N., & LAFCI2, Ç. (2020). *Evaluation of Key Performance Indicators of Logistics Firms*. *11*(1), 24–32. https://doi.org/10.2478/jlst-2020-0002

Hamilton, T. (2015). , "The State of Logistics Performance Measurement: A Comparison of Literature and Practice". *Honors Program Theses. 129. Http:Digitalcommons.Georgiasouthern.Edu/Honors-Theses/129*, 1–33.

Heale, R., & Twycross, A. (2015). *Validity and reliability in quantitative studies*. *18*(3), 66–67.

Herv, M., Poveda-reyes, S., Molero, G. D., & Santarremigia, F. E. (2019). *Improving the Performance of Dry and Maritime Ports by Increasing Knowledge about the Most Relevant Functionalities of the Terminal Operating System (TOS)*. https://doi.org/10.3390/su11061648

Hervás-peralta, M., Rožić, T., & Poveda-reyes, S. (2019). *Modelling the performance of port terminals using microsimulation*. *September*.

Kia, M., Shayan, E., & Ghotb, F. (2000). The importance of information technology in port terminal operations. *International Journal of Physical Distribution and Logistics Management, 30*(3), 331–344. https://doi.org/10.1108/09600030010326118

Konečnik Ruzzier, M., Ruzzier, M., & Hisrich, R. (2014). Value, satisfaction and customer loyalty. *Marketing for Entrepreneurs and SMEs*, *November*, 21–36. https://doi.org/10.4337/9781781955970.00008

Miraj, P., Berawi, M. A., Zagloel, T. Y., Sari, M., & Saroji, G. (2021). Research trend of dry port studies: a two-decade systematic review. *Maritime Policy and Management, 48*(4), 563–582. https://doi.org/10.1080/03088839.2020.1798031

Musemma, A. (2016). *AN ASSESSEMENT ON DETERMINANTS OF DRY PORT PERFORMANCE: THE CASE OF MODJO DRY PORT*. Addis Ababa.

Neal, J. M. (2011). Research Methodology. In *Regional Anesthesia and Pain Medicine* (Vol. 36, Issue 4). https://doi.org/10.1097/aap.0b013e3182208cea

OECD. (2002). *Transport Logistics: Shared Solutions to Common Challenges*. 52. http://books.google.com/books?id=VSncNCIEMJsC&pgis=1

OJALA, L., & Çelebi, D. (2015). *The World Bank ' s Logistics Performance Index (LPI) and drivers of logistics performance*. *March*.

Roso, V., Woxenius, J., & Lumsden, K. (2009). The dry port concept : connecting container seaports with the hinterland. *Journal of Transport Geography, 17*(5), 338–345. https://doi.org/10.1016/j.jtrangeo.2008.10.008

Taherdoost, H. (2020). *Sampling Methods in Research Methodology ; How to Choose a Sampling Technique for Research Hamed Taherdoost To cite this version : HAL Id : hal-02546796 Sampling Methods in Research Methodology ; How to Choose a Sampling Technique for*.

Taylor, B. W. (n.d.). *Management Science*.

Tigabu, A. (2020). *AND ITS AFECTING FACTORES ; By : Amare Tigabu Advisor : BushaTemesgen (PhD) Thesis Paper Submitted to the Department of Logistics and Supply award of Master ' s Degree in Logistics and Supply Chain Management*

School of commerce Addis Ababa , June 2020. *June*.

TOPOLŠEK, D., ČIŽIŪNIENĖ, K., & CVAHTE OJSTERŠEK, T. (2018). *Defining transport logistics : A literature review and practitioner opinion based approach DEFINING TRANSPORT LOGISTICS : A LITERATURE REVIEW*. *December*. https://doi.org/10.3846/transport.2018.6965

UNCTAD. (1991). Handbook on the management and operation of dry ports. In *Unctad* (p. 93).

Varese, E., Marigo, D., & Lombardi, M. (2020). Dry Port: A Review on Concept, Classification, Functionalities and Technological Processes. *Logistics*, *4*(4), 29. https://doi.org/10.3390/logistics4040029

Waktole, K. (2017). *ADDIS ABABA INSTITUTE OF TECHNOLOGY SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING Assessing Freight Transport Performances in Relation to Delays in Ethiopia : the case of Addis Ababa-Djibouti Corridor A Thesis Submitted to Road & Transport Engineering Str*.

Waters, D. (n.d.). *Logistics: An Introduction to Supply Chain Management*. PALGRAVE MACMILLAN.

Wisetruangrot, S. (2020). Multimodal Transportation Concept and Framework Definition and Concept of Modes of Transportation. *Multimodal Transportation Concept and Framework Definition and Concept of Modes of Transportation*, 1–158.

APPENDIX I

QUESTIONARY

Hawassa University

Institute of Technology

Faculty of Manufacturing

Department of Industrial Engineering

QUESTIONNAIRE

Dear respondents, the purpose of this questionnaire is to gather data on the Modeling and analysis the Dry Port Transport Logistics Performance a case of Modjo Dry Port in order to fulfill the University's (Hawassa University) requirement set for awarding of a Master Degree in Industrial Engineering and Logistics Management. The study is purely for academic purpose and thus not affects you in any case. So, your genuine, frank and timely response is vital for successfulness of the study. Therefore, I kindly request you to respond to each item of the question very carefully.

Sincerely Yours,

Hunduma Bersisa

General Instructions

- ✓ There is no need of writing your name
- ✓ Where answer options are available, please tick (√) in the appropriate box for part I and part II.

Contact Address

If you have any query, please do not hesitate to contact me and I am available as per your convenience at (Mobile: 09-21-05-24-20/09-39-19-01-88 or e-mail: hundumaab@gmail.com or hundaafuub@gmail.com)

Thank you for sacrifice your precious time in advance!

PART I: Demographic Information

1. Gender: ☐ Male ☐ Female
2. Age: ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ ≥ 50
3. Educational Qualification:

☐ Certificate ☐ Diploma

☐ First Degree ☐ Second Degree and above

4. Job title

☐ CEO/President /Vice President ☐ Director ☐ Manager

Other (Specify)________________

5. Years stayed at the organization:

☐ Under 2 years ☐ 2–5 years ☐ 6–10 years ☐ over 10 years

6. Your department/work unit ____________________________

Part II: Modjo Dry Port Logistics Performance

This section of the questionnaire deals with indicators of the transport logistics performance of Modjo dry port. You are therefore expected to undertake your personal evaluation of the performance extent of the Modjo Dry port based on your experiences with the benchmark of the dry port as a stakeholder.

Please put a tick mark (√) in the table against each rating scale of choice. The rating represents your level of agreement as follows:

1=Very Low, 2= Low, 3= Average, 4=High, 5=Very High

1. Customs Clearance (CC)		Rating				
		1	2	3	4	5
1	The speed of customs clearance & procedure					
2	The customs operation simplicity and predictability					
3	Efficiency of customs service					
4	The time to obtain a gate in authorization with physical inspection					
5	The time to obtain a gate in authorization without physical inspection					
2. Port Infrastructure (PI)		1	2	3	4	5
1	The logistics area where cargo logistics operations done.					
2	The Connectivity to road networks at port and terminals					
3	The number of cargos' handling terminal equipment					
4	The technological and ICT tools available					
5	Port infrastructure quality					
3. Logistics Service Quality (LQ)		1	2	3	4	5
1	The logistics service quality of port					
2	The freight delivering service in dry port					
3	The transporters availability and efficiency					
4	Delivering services of logistics at the terminal					
4. Timeliness (TL)						
1	The time that each truck stays in the dry port					
2	The time that a train stays in the dry port					
3	The time that a container is parked in the terminal for import and for export					

4	The port service operation time					
5	The Dwelling time at dry port					

This section of the questionnaire addresses the logistics activities of Modjo dry port those related to transport. Please read each statement applied to the MDP and indicate the extent of your agreement towards the statements by putting a tick mark (√) in the table representing your judgment. Please use the rating scale representing your level of agreement as follow:

1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

Part III. Modjo Dry Port Logistics Activities

	1. Customer Response (CR)	CODE	1	2	3	4	5
1	Responding quickly to the customers' needs	2CR1					
2	Fulfilling customers' orders in the promised date	2CR2					
3	Sharing information with customers when required	2CR3					
4	Measuring and evaluating customer satisfaction level	2CR4					
5	Accepting the customer comments	2CR5					
	2. communication infrastructure	CODE	1	2	3	4	5
1	The timely information reach operators of the port	3CI1					
2	The sufficient communication devices are applicable	3CI2					
3	The updated information positively affects the logistics performance of the port	3CI3					

4	The information speeds up the Transportation services	3CI4					
5	The information reaches the customers on time	3CI5					
	3. Transportation Management (TM)	CODE	1	2	3	4	5
1	Transport management has a role in achieving faster delivery service	1TM1					
2	Transport management ensure the port logistics performance	1TM2					
3	Transport management has a role in achieving efficiency in port operation	1TM3					
4	Transport has a position in maximizing a profit of MDP	1TM4					
5	Transportation management sometimes used as storage to utilizing warehouse cost	1TM5					

Interview Questions

1. Introduce Yourself and define your current job position.
2. How the ‘Transport Logistics Performance of MDP’ goal have been set? Is it the port and terminal transport logistics fits the performance’s benchmark of the MDP?
3. While the custom process, what mechanism/methods you use for inspection? What kind of items may with physical and without physical inspection?
4. What the information integration looks like between port gates, terminal operation and custom operation processes, even with customers?
5. What are the bottlenecks for port and terminal transport logistics which more affects its performance?
6. What are the characteristics of terminal machinery (crying capacity, cost for deliver, maintenance time…)?

APPENDIX II

Daily recorded arrived and serviced containers by truck at check points

Week 1

			Monday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	11	7	10	6	11	7
3:00-4:00	12	6	9	5	8	6
4:00-5:00	8	6	8	5	10	6
5:00-6:00	6	5	4	6	4	6
6:00-7:00	4	4	3	4	4	5
	41	28	34	26	37	30

			Tuesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	10	5	8	5	7	6
3:00-4:00	6	5	4	4	8	4
4:00-5:00	5	4	6	4	5	5
5:00-6:00	5	6	4	4	6	5
6:00-7:00	6	6	5	5	5	6
	32	26	27	22	31	26

			Wednesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	9	5	7	5	7	5
3:00-4:00	6	5	6	4	8	5
4:00-5:00	6	6	7	5	6	6
5:00-6:00	7	6	4	4	5	5
6:00-7:00	6	5	4	5	5	6
	34	27	28	23	31	27

			Thursday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	10	6	8	4	9	4
3:00-4:00	8	6	5	4	6	5
4:00-5:00	7	5	4	4	5	5
5:00-6:00	7	5	4	5	5	6
6:00-7:00	6	6	4	5	7	5
	38	28	25	22	32	25

			Friday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	10	7	7	6	11	6
3:00-4:00	8	6	7	5	4	6
4:00-5:00	7	6	6	4	8	5
5:00-6:00	6	5	5	5	4	5
6:00-7:00	7	5	4	4	6	4
	38	29	29	24	33	26

Week 2

			Monday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	14	7	11	6	10	7
3:00-4:00	9	7	7	5	10	6
4:00-5:00	8	6	7	5	9	6
5:00-6:00	8	5	6	4	9	5
6:00-7:00	7	5	5	4	8	5
	46	30	36	24	46	29

			Tuesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	10	6	8	6	12	7
3:00-4:00	10	6	7	5	7	6
4:00-5:00	6	6	5	5	8	6
5:00-6:00	7	6	7	5	6	5
6:00-7:00	8	5	4	4	5	5
	41	29	31	25	38	29

			Wednesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	7	6	8	6	11	7
3:00-4:00	8	6	6	5	8	6
4:00-5:00	9	5	6	4	7	6
5:00-6:00	6	4	4	4	8	5
6:00-7:00	6	4	5	4	7	5
	36	25	29	23	41	29

			Thursday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	9	7	8	6	11	7
3:00-4:00	8	6	6	4	8	6
4:00-5:00	9	6	6	5	8	6
5:00-6:00	7	5	4	4	9	5
6:00-7:00	8	5	6	5	5	5
	41	29	30	24	41	29

			Friday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	12	7	9	4	10	7
3:00-4:00	8	7	6	5	8	7
4:00-5:00	6	6	3	4	9	6
5:00-6:00	6	5	4	4	6	5
6:00-7:00	8	4	3	4	4	5
	40	29	25	21	37	30

Week 3

			Monday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	14	7	13	6	14	8
3:00-4:00	12	7	10	6	11	7
4:00-5:00	9	6	4	5	7	6
5:00-6:00	8	5	8	5	6	5
6:00-7:00	5	5	6	4	10	4
	48	30	41	26	48	30

			Tuesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	11	7	8	6	9	7
3:00-4:00	7	6	7	5	10	6
4:00-5:00	7	6	6	5	8	6
5:00-6:00	7	5	4	4	5	5
6:00-7:00	8	5	4	4	6	5
	40	29	29	24	38	29

			Wednesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	8	6	5	4	9	7
3:00-4:00	8	6	6	5	6	6
4:00-5:00	6	5	5	4	9	6
5:00-6:00	7	5	5	4	8	5
6:00-7:00	8	6	5	4	7	5
	37	28	26	21	39	29

			Thursday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	7	6	6	6	9	7
3:00-4:00	8	6	7	5	8	6
4:00-5:00	9	5	5	4	7	5
5:00-6:00	7	5	5	4	8	6
6:00-7:00	7	6	6	5	9	6
	38	28	29	24	41	30

			Friday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	8	6	5	4	9	6
3:00-4:00	9	5	4	3	7	6
4:00-5:00	7	6	5	4	9	6
5:00-6:00	10	6	6	5	7	5
6:00-7:00	6	5	5	5	8	6
	40	28	25	21	40	29

Week 4

			Monday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	7	6	6	5	9	7
3:00-4:00	8	6	5	5	7	6
4:00-5:00	8	6	5	4	8	5
5:00-6:00	8	5	4	5	5	6
6:00-7:00	6	6	6	4	7	5
	37	29	26	23	36	29

			Tuesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	7	7	6	5	9	7
3:00-4:00	10	6	7	5	8	6
4:00-5:00	6	7	5	5	6	6
5:00-6:00	7	6	4	4	8	5
6:00-7:00	9	5	6	4	6	5
	39	31	28	23	37	29

			Wednesday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	14	7	9	6	9	7
3:00-4:00	5	6	5	5	9	6
4:00-5:00	7	5	4	4	6	6
5:00-6:00	7	6	6	5	8	6
6:00-7:00	7	5	5	4	8	6
	40	29	29	24	40	31

			Thursday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	7	6	6	5	10	7
3:00-4:00	8	5	6	5	5	6
4:00-5:00	6	5	6	5	9	6
5:00-6:00	7	6	4	4	8	5
6:00-7:00	9	6	5	5	7	6
	37	28	27	24	39	30

			Friday			
	Server 1		Server 2		Server 3	
Time	Arrival rate	Service rate	Arrival rate	Service rate	Arrival rate	Service rate
2:00-3:00	8	7	6	6	5	5
3:00-4:00	11	6	4	4	9	6
4:00-5:00	6	5	7	3	3	5
5:00-6:00	6	5	5	4	11	6
6:00-7:00	6	5	4	4	9	6
	37	28	26	21	37	28