Addis Ababa University
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Improving Operation Performance of Warehouse System in Ethiopian Shipping and Logistics Service Enterprise

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I hereby declare that the work which is being presented in this thesis entitle “Improving operation performance of warehouse system in Ethiopian Shipping and Logistics Service Enterprise" is original work of my own, has not been presented for a degree of any other university and all the resources of materials used for the thesis have been properly acknowledged.

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This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

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ABSTRACT

Terminal operations consist of the motion of full and empty containers between gateways of the terminals. In this study the problem focus on loading/unloading operations, driver's waits due to customs clearance and other related processes, lack of technical and technological capacity as a result loading/unloading operation becomes tardy and causes labor productivity issues, operators' schedule reliability, and various types of equipment utilization decreases the service quality and customer satisfaction.

The objective of this paper is to identify the current practices and challenges in the warehouse and to set strategies that optimize and improve warehouse operation performance using ARENA simulation. The scope of study is focusing on Kality dry port and terminal at Addis Ababa.

The procedures include data gathering, model building, simulation, verification, and validation and performance analysis. Then the model is simulated using the actual container and warehouse operation through collecting data which include the daily empty and full in/out containers, service requirement, parameters, operation schedule and port machine breakdown. The output of the simulation is generated in a form of report. The results show that the percentage error of ARENA model is less than 5% as targeted.

This research propose three major decision options(scenarios) to improve the system. The first scenario is changing level of resource at port operation with higher number of waiting. The second one is avoiding unnecessary duplication resource from processes with low capacity utilization to increase the operation output and capacity utilization. Lastly, third scenario focused on merge similar operations through reduced resource to 12 from existing 25 and percentage of productivity per operator for full-in: full-out operation and empty-in: empty- out operation is improved to 84.72% and 63.19% from existing 48.36% and 41.11% respectively.

Finally, the research has recommended the enterprise use from creating different opportunities and overcome the challenges as well as the optimization of the dry port warehouse operation system.

***Keywords*: -** Arena, Containers, Dry port, Loading, Operation, Performance, Simulation, Unloading

Table of Contents

LIST OF FIGURES

•

LIST OF TABLES

LIST OF ACRONYMS

CFS	Container Freight Station
EMMA	Ethiopian Maritime Affairs Authority
ERCA	Ethiopian Revenue and Customs Authority
ESLSE	Ethiopian Shipping and Logistics Service Enterprise
KPI	Key Performance Indicator
KS	Kolmogorov–Smirnov graph
MTSO	Multimodal Transport System Operator
OECD/ITF	Organization for Economic Co-operation and Development/ International Transport Forum
OM	Operation Management
SCOR	Supply Chain Operations Reference
TEU	Twenty-Foot Equivalent Unit
UNDP	United Nations Development Program
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
WIP	Work- In Process
WMS	Warehouse Management System

CHAPTER ONE

1. Introduction

Operation management is the management processes or systems that create goods and/or provides services. The operation function is the core of most business organizations; it provides inputs, transformation processes and outputs. The transformation process adds value for operational functions. (R. Dan Reid &Nada R. Sanders, 2011).

The need for critical management and control in terminal operation play a role in improving the transportation vehicles and terminal system. Transporting containers in the logistics system is not limited for loading and unloading operation rather it encompasses other value adding operations like storage, packaging and internal transport modes are important.(Derse & Göçmen, 2018).

Dry ports constitute one of several important instruments employed by the government for the purpose of consolidation and distribution of goods. Their functions are analogous to those of a seaport, thus also including customs procedures and other steps necessary to relieve congestion and delays at state border crossings and ports, reducing in this way supply chain costs for exporters and importers. (Haralambides & Gujar, 2011).

According to Teshome, 2017, Multimodal transportation would also contribute to the Ethiopia development strategy by saving time of transportation and wait time at terminals and reduces cost related with cargo at port and terminals. Warehouse is an important distribution center. It is an integral part of every logistics system that receiving and delivering are the interface of a warehouse for incoming and outgoing material flow. In a warehouse, all the processes in the loading and unloading systems are run simultaneously. Due to the voluminous transportation of freight in warehouses of different industries, long waiting time of truck is predictable. (Abedinzadeh, Erfanian, & Mostofi, 2018).

Performance measurement of warehouse is a method of evaluating the activities performed in a warehouse. This measurement quantifies both the efficiency and effectiveness of jobs done at the warehouse. (Kusrini, Novendri, & Helia, 2018). Different researchers explore the measurement of warehouse performance in different ways. Some of them focus on one specific area while others encompass all activities done in the warehouse. (Staudt, Alpan, Di Mascolo, & Rodriguez, 2015).

A container terminal is a facility where cargo containers are moved between different transport vehicles, for the allowing the exchange of every kind of goods. The inland container terminal tends to locate in or near major cities with rail connection to maritime container terminal. Mostly loaded container is stored for short periods, while waiting for moving on in transportation; unloaded containers may be stored for longer periods awaiting their next use. (Pietrobon, 2014).

In today's world, company competition requires to improve their logistics performance focusing on warehouse performance to improve quality level, delivery time, and customer satisfaction, reduce cost in relation with logistics system. As a result of the enhancement of logistics network, the warehouse performance analysis has become an important issue. Many activities are performed in a warehouse consisting of receiving, put way, storage, picking and shipping. (Kusrini et al., 2018).

1.1. Background of the Study

A warehouse management system (WMS) is an information system that supports stock management and administration in the warehouse. It is used to increase the performance of the warehouse by supporting the management processes systematically. Because of the higher degree of automation in the warehouse, manual administrative tasks are reduced, resulting in less chance of human errors and accurate inventory levels. (Wienk, 2019).

Dry port operations play a differentiating role in the development of world trade and their competitiveness. The logistics process also depends on the port operation efficiency, by improving the efficiency of dry port operations. Assuming vitality in the creation of new markets and distribution of goods across the geographical borders such are the gains or losses that the logistics operations can induce in the system. Thus as inland logistics centers, dry ports are playing an increasingly pivotal role in the multimodal transport network that sustains economic activity by delivering key inputs to local enterprises and facilitating their exports of raw materials, semi-manufactured products, and finished goods (Haralambides & Gujar, 2011).

Liviu & Crisan, (2017), define Performance as to the way in which work is done. It can be a good performance or a poor one. Performance measurement process of quantifying the efficiency and effectiveness of an action or activity. The purpose of performance measurement is to find out whether things are going the right way and, if not, to find what the causes that generated a poor performance were.

There are several reasons for measuring performance: for improving performance, for avoiding inconveniences before it's too late, for monitoring customer relations, for process and cost control and for maintaining quality. The main instruments for assessing performance are performance indicators, also named key performance indicators. They are specific characteristics of the process which are measured in order to describe if the process is realized according to pre-established standards. The best way to use indicators is to compare process values with normal, standard values. If there are poor results, poor performance, in reality, improvements for the process have to be made. Indicators are used basically for comparison with expected values. They are the control system of the studied process. (Liviu & Crisan, 2017).

1.2. Problem statement

According to World Bank 2007, Ports are well known as playing an important role in multimodal transport systems and international supply chains, apart from their traditional role as clusters of economic activities.

Ports engage in various activities:

- loading/discharging cargo onto/from vessels;
- providing value- added services such as labeling, packaging, cross-docking, and others;
- Acting as warehouse and distribution centers and also in 2013 the bank report, Ethiopia's relative ranking in the World Bank Logistics Performance Index dropped from 123 in 2010 to 141 in 2012 (out of 155 countries surveyed).

The recent introduction of the multimodal system, in particular, has stimulated substantial public debate. The sole MTSO (Multimodal Transport System Operator), ESLSE, is currently overwhelmed with the task at hand. There is a serious congestion problem in the dry ports which has, in turn, resulted in substantial operating costs for ESLSE.

According to (United Nations Development Programme (UNDP), 2017), containers with the imported cargo to Addis Ababa are inspected by customs and other agencies at Modjo Dry port if traveling under the multimodal system (72% of total multimodal imports) and at Kality Dry port if traveling under the unimodal system (70% of total unimodal imports). The report also introduces long delays, significant uncertainties and unnecessary costs due to poor operational procedures and control, insufficient yard management systems, cumbersome customs procedures and failure to relocate abandoned and long term boxes.

ESLSE has already tackled some of this issues but it remains to be seen if those activities produce the desired results. The average dwell time of 44 days masks the fact that some are cleared in 3 to 5 days, while others are held for over 140 days (and perhaps should be considered abandoned at that time). These long held containers take up space at the container yard, increase the number of containers per stack, and increase the number of moves to get to a container. (UNDP, 2017).

As observed from 2016 to 2018 annual report of the Kality dry port and terminal the operation performance of closed warehouse decreases 95%, 74% and 54% respectively.

From the above constraints the study intends to assess the existing practices of warehouse management and which will identify the nonperforming area and limitation. Through preliminary interview made with kality container terminal follow up and control team coordinator and panning department division head , the existing problems currently witnessed in the warehouse operation services are far from each other and from office area this may causes delay and communication gaps between and among the operators and staffs, during loading/unloading operations drivers waits for more than six hours for unloading full containers and above two hours for empty containers due to customs clearance and other related processes, interruption of electric power and network connection problems make delay and produce long queue for customer service time, machine breakdown and frequent failures becoming the operation tardy and carrying of different products from containers to warehouses takes extended period of time.

As a conclusion, Ethiopian Shipping and Logistics Service Enterprise (ESLSE), is very essential to observe the above challenges and practices in the warehouse performance in the enterprise, in relation with labor productivity issues, operators' schedule reliability, and shortages of various types of equipment decreases the service quality and customer satisfaction. Hence, this paper aimed to contribute in dry port and terminal operation especially on warehouse improvement.

1.3. Research questions

Based on the above problem statement, this study searches to answer the following questions:

1. What are the current warehouse practices and its major shortcoming during loading and unloading activity?
2. How to enhance the operational performance of warehouse of the case company?

1.4. Objectives

1.4.1. General objectives

The main objectives of this study are to identify the existing operations in the warehouse and to set optimization strategies that improve warehouse operation performance.

1.4.2. Specific objective

1. To determine the limiting factors in warehouse operation performance of Kality dry port.
2. To identify the major activities during loading and unloading that enhances performance.
3. To evaluate factors of dry port performance in its container handling and customs clearance operations.

1.5. Significance of the study

The study would enable to assess the current status of warehouse operation system and its role to the enterprise dry port and terminal performance. The findings of the research besides their academic significance were expect to give some lesson to the concerned government authorities and other stakeholders on how to improve the dry port and terminal operation especially in warehouse economic benefits in Ethiopia and scale up its role in the nation’s economic development.

1.6. Scope of the Study

This study were conducted to identify the current level of warehouse operation practices and to improve performance. Despite the time and availability of warehouses and its operation, the researcher could not address all the dry ports found in ESLSE. The study has been delimited only cover dry port and terminal only at Addis Ababa Kality dry port and terminal, according to Gudisa, (2016), identified that this branch has a lower level of perceived quality of service, goods stay for long period of time in the port and also a problem in loading and unloading process as a limitation to reduce operation level and customer satisfactions. In addition to these, Kality dry port is the only port found in the capital city and the warehouse contribute in the market economy of the country.

CHAPTER TWO

2. Literatures Review

In this section, the literature relevant to this research is reviewed. There are a lot of literature associated with warehousing, its operational techniques and overall performance measurement criteria in exclusive manufacturing and service industries. Thus, it is suitable to focus on operation management, concept on dry port and it also helps to understand the warehouse performance metrics and its implication on warehouse performance in service giving industries.

2.1. Basic Concepts in Operation Management

According to Nedyalkov, 2010; Samson & Singh, 2008, define operations management (OM) as a business function that plans, organizes, coordinates, and controls the resources needed to produce a company's goods and services. Operations management is a management function. It involves managing people, equipment, technology, information, and many other resources. It is the central core function of every company and its role is to transform a company's inputs into the finished goods or services. Inputs include human resources (such as workers and managers), facilities and processes (such as buildings and equipment), as well as materials, technology, and information. The transformation process is the physical change of raw materials into products or services and its outputs are the goods and services a company produces. More precisely, this undertaking deals with transformation (conversion) of resources.

In that system, primarily based on rational division of labor and stable combination of production factors in time and space, is realized the operations (production) function, i.e. set of actions for processing (conversion) the sources obtained from the external surroundings and transmit the consequences of the identical exterior environment to fulfill customer's needs. Therefore, the management of operations device and its characteristic can be defined as operations systems and subsystems including basic operation, support operation and management operation.(Nedyalkov, 2010)

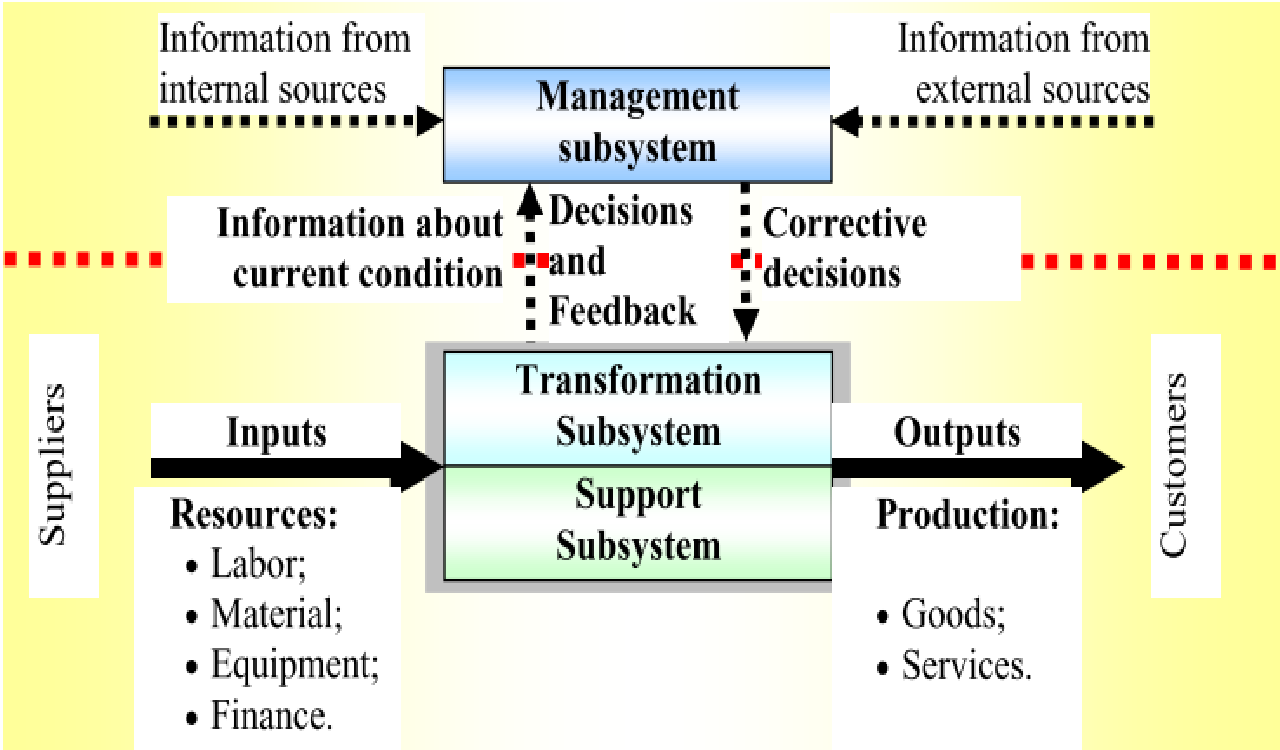


Figure 2. 1. The components of operations system(Adopted from (Nedyalkov, 2010))

In the above figure, the operation system encompasses input resources (like labor, materials, equipment, finance and others), transformation process that gives the final outputs delivered to the customers.

2.1.1. Function, Objectives and Purpose of Operation Management in Service Industry

Operations management involves the planning, scheduling, and control of activities that transform inputs into finished goods and services. For organizations providing transportation services, the success of the management of the operations impacts directly on the ability of that organization to deliver services of a certain quality standard in the amount and appropriateness that meets the needs of the consumers of the services.

'Service Operations Management: The implementation of the organizations strategy through the operational control of the organization by focusing on not only product or service development, but also the delivery of products and services to the end customer in a way that drives co-creation of value between customer and business'.(McLaughlin, 2010)

According to Nedyalkov (2010),Operations management is one of the main fields of management well-informed of strategic management, financial management, marketing, organizational behavior and information systems management and is closely related with them. It uses as essential results of scientists from different areas, beginning from Adam Smith's up to the use modern Information and Communication Technologies.

All organizations perform the following three functions to create goods and services

- Marketing: generates demand, takes the order for a product or service;
- Production/Operations: creates the product or service; and
- Finance/Accounting: cash control, funds management, etc. (Martin & Lembke, 2015)

2.1.2. Operation Management in Logistics Service Industry

Logistics offers with the storage of items and the procedure of planning, implementing and controlling the flow of resources. In this fast developing industrial and global opposition logistics performs a fundamental role, which agencies need to diagram and agenda for environment friendly manufacturing to make sure the customer's satisfaction. In general, a logistic system consists of the most important and secondary process that of the first group includes transport operations, warehouse operations, transshipment, materials management and in the other aspects of the support method are packaging, labeling, tagging, making ready orders and shipping documentation and others.(Solomon, 2013)

The vital aim of logistics is to coordinate all efforts of the company to keep a cost effective flow of goods. In terms of logistics system design and administration, each company need to concurrently gain one of kind operational targets which are the fundamental determinants of logistical performance, consist of fast response, minimum variance, minimal inventory, movement consolidation, quality, and life-cycle support.(*International Practices In Logistics Management*, n.d.)

Logistic offerings best play an integral position in helping the transportation of worldwide change in goods; inefficient logistic offerings restrict alternate thru imposing an extra price in phrases of time as properly as money. Most developed nations shift from usual manufacturing and agricultural practices are increasingly more involved in international vertical specialization, the want for efficient logistics services will become greater important. High quality logistics offerings improve the competitiveness of a country's export thru decreasing the value worried in transporting items particularly for international locations that are disadvantaged by means of being far from foremost markets. (Fekadu D., 2013)

The effectively and effectiveness of the logistics operation has an incredible have an influence on no longer only on the enterprise organization performance of producers but additionally on the customer's understanding of the excellence of the produce and choices furnished by using means of the plant. Effective logistics administration can furnish fundamental supply of competitive benefit to a company thru ensuring that it is in a position to constantly respond quicker, greater correctly than commercial enterprise rivals to its customers' requirement on world groundwork. (Adebambo, Omolola, & Victor, 2016). Therefore, companies implement different operational strategies to improve their logistics performance as result of nations of the globe becomes more and more integrated through trade and fight for the success of their developmental goals, calls for the need for efficient logistic system, development of a plan, implementing, controlling the efficient and cost effective flow and storage of raw materials as well as related information from point of origin to point of destination for the purpose of meeting customers' requirements.

2.2. Definition, Role and Purpose of Dry Port

Growth and enhancement of transportation enterprise is key indications of nations' economic development. Nowadays, the impact of transportation enterprise on non-stop enhancement is a clear issue. This zone includes activities which are considerably involved with production, distribution and consumption of items as properly as services. Such things to do possess a unusual function among one-of-a-kind financial activities.(Jafari, 2013).

UNESCAP,(2015) , describe the dry port thought as follow:

> *Dry port refers to an inland location as a logistics center connected to one or more modes of transport for the handling, storage and regulatory inspection of goods moving in international trade and the execution of applicable customs control and formalities.*

Dry Ports can be constructed and established from an inland terminal including other supplementary services that are characterized for dry ports. Therefore, the terminal should have a direct linkage to a seaport either by rail or by road, it should have a high capacity traffic mode (i.e. rail) and it also offer similar kinds of facilities as can be found in a seaport.

The main transport network actors who are benefited from the dry ports as a result of shorter waiting time in ports are the freight forwarders, shippers and port authorities as well as the road operators. However, the society was beneficiary when the road congestion and environmental pollution highly reduced and job creation was increased to support the communities as a whole. (Tadesse, 2016).

So, the role of a dry port is becoming particularly important. Because of the coordination of materials and information flows; minimization of costs; as well as reliable cargo handling which is becoming critical as a practical part of the global logistics and supply chain management.

According to (UNESCAP, 2015), dry ports have a lot of advantages in the national as well as international trade economy and classified as follow:

Economic benefits

- Reduced transport price of shifting freight inland by means of rail as an alternative than road
- Reduced transport expenses reflected in smaller expenses for traded goods
- Lower costs for traded goods presenting motivation for exchange and GDP growth
- Investment in services is possibly to generate different financial activities to do in the area

Business benefits

For industry

- Better incorporation of transport into the supply chain
- Enhanced access to seaports
- Inexpensive logistics
- well-organized access to services such as Customs activity
- Access to extra logistics services like packaging, labeling, warehousing

For port authorities

- A well-organized operation with less congested dock
- Larger growth chances

For road operators

- minimum period in jammed roads and terminals as a result greater asset utilization
- cost of road maintenance becomes small by fewer vehicles

Social and environmental benefits

For people in neighborhood regions

- Improved workers opportunities

For port cities

- road overcrowding become decreased
- Improved land use

For society

- Decrease traffic accidents through less trucks on main road
- Minimize road network overcrowding

2.2.1. Common Activities in a Dry Port

In landlocked countries, dry port is often developed as a logistic center for smooth trade and custom clearance activities. Dry ports have been a higher contribution in the marketing system of financial reforms; alternate improvement and the growth of land infrastructure have eliminated confined surroundings, therefore by considering different dry ports to compete for customers requirements. More desire in routing consignment and similar progresses in logistics network has improved the nature of competition.

Therefore, in a dry port operation some activities are common such as in-transit storage, custom clearance, assistance in inventory practices, freight accumulation and combination, concerning of bill of loading, and other related activities including temporary storage.

2.2.2. Factors of Dry Port Performance

Container terminals furnish the interface between rail roads, ocean-going ships, and vans and accordingly characterize the integral hyperlink in the intermodal transportation chain. Containers arrive at the terminal through train, ship or truck and are stored in the terminal yard. Then they leave the terminal by the equal capability to reach their closing destinations. Containerized cargo movements have no longer only changed in which transportation modes operate; it has also modified the manner in which transportation modes have interaction with every other. The new demand with containerization is how to develop more environment friendly concepts for the interplay of transportation modes, i.e. combine ship, rail, and avenue haulage to forward freight shapes the starting place to the ultimate vacation spot of a transportation order. This need for mixed freight transportation structures has added about revolutionary transportation facilities, equipment, and administration practices committed to intermodal freight movement.(Kulak, Polat, & Guenther, 2008).

Container terminals switch containers between sea vessels and inland transport modes (trucks, trains and barges). Three sorts of container flows are distinguished: import containers that arrive on vessels and go away on inland transport modes, export containers that arrive on inland transport modes and depart on vessels and transshipment containers that arrive and leave on vessels. It also manages unique container types like hazardous, reefer and empty containers. Different material handling equipment is used to (un)load landside transport modes. Trucks may be (un)loaded immediately in the yard with the aid of the yard crane or at unique change vicinity by way of straddle carriers; trains by means of devoted cranes, fork lifts or reach stackers; and barges via devoted cranes or by means of the equal cranes than vessels. Empty containers are normally handled with the aid of reach stackers. Reefer and hazardous containers are handled with the equal equipment as other containers, but would possibly be assigned to specific areas within the yard. (Zehendner & Zehendner, 2014).

According to Aravindan & Thiruvenkatasamy (2016), container terminal is the area of the port the place vessels dock on a berth and containers are loaded, unloaded and saved in a buffer region called yard. In import-export terminals the glide of containers continues inland and containers are picked-up and delivered by vehicles and trains in a region referred to as gate, whereas in transshipment terminals, containers are exchanged between ships generally referred to as mother vessels and feeders, in accordance to a hub-and-spoke system.

In relation with dry port activities warehouses play a crucial role in the success, or failure, of businesses today and they are a key characteristic of modern supply chains. Moreover, in business organization especially in transport service giving industry the incoming as well as the outgoing commodities waits in the warehouse until the customers finished the compulsory requirements in the company.

Therefore, warehousing is an integral part of every logistics system that Stores products raw materials, parts, goods in process, finished goods at and between point of origin and point of consumption.(Kiisler,2014). A warehouse is a facility in the supply chain to consolidate products to decrease transportation cost, gain economies of scale in manufacturing or in buying or grant value- brought processes and shorten response time. Warehousing has also been recognized as one of the primary operations the place groups can provide tailored offerings for their customers and attain aggressive advantage.(Ramaa, Subramanya, & Rangaswamy,2012).

In this study, depending on the observed literatures we identify six major factors in dry port operation performance. These factors include dry port infrastructure, material handling equipment, customs operation, and service quality, port staff and reliability of port operations.

2.3. Warehouse Performance Measurement

The performance analysis has the objective of helping managers to evaluate the performance of the enterprise and to make decisions in significance. As for any manager, the warehouse supervisor also uses performance analysis tools and techniques to assess the performance of the warehouse.

Through the literature, scholars continuously insist that no uniform or unchanging definition of performance exists, and they argue on how it is a multidimensional concept. Krause (2005) define Performance as the degree of the achievement of objectives or the potentially possible accomplishment regarding the important characteristics of an organization for the relevant stakeholders. Performance is therefore principally specified through a multidimensional set of criteria. Grüning (2002) understood the word Performance as the ability of a company to achieve goals, i.e. meet expectations, and is therefore influenced by results in a wider sense, but also by the corresponding goal setting. (Okar, 2016)

Manikandan & Chidambaranathan, (2018) in their review and classification of Port Performance Improvement Studies tried to identify the port competitiveness was evaluated and ranked according to the total weights obtained based on the different criteria used to help and monitor the performance of operations and terminals in a port through providing a port with indicators that will assist in assessing port productivity in a complicated operations.

According to Ramaa et al., (2012) Measuring warehouse metrics is essential for imparting managers with a clear imaginative and prescient of reasonable problems and opportunities for improvements. Metrics are tied at once to the business method and operation's success drives the monetary outcomes of the organization. If warehouses are going to make contributions to be a source for adding fee to the provide chain, then they want to measure their overall performance with ideal metrics. Therefore, Performance measurement refers to the way in which work is done; also it can be defined as a standard used to enumerate the efficiency and/or effectiveness of an accomplishment.

Furthermore, Performance dimension is one of important keys to smoothly manage supply chain as a whole. In a variety of products and services, overall performance is often examined in each step from supplier's points of views down to distributor's points of views in order to fulfill purchaser necessities as identical as take responsibility to society as well. Currently, warehouse management is the implementation of advanced techniques and applied sciences technologies to optimize all functions at some stage in the warehouse. There are very large quantity and sorts of products with problematic tasks in the course of warehouse operations. However, gaining manage of the warehouse can decrease costs, improve investor carrier and flip the warehouse into a profit center as an alternative of an ongoing problem. Typically, a company has one or greater than warehouse and each single warehouse is distinctive in term of operational efficiency (Hirunwat, Khemavuk, & Rungreunganun, 2017).

Warehouse performance measurement was synthesizing the indicators utilized in warehouse performance analysis, providing clear definitions and delimitations of them on the periodic performance evaluation of warehouse operations and proposing an activity-based framework to help clarifying the boundaries of the direct and indirect warehouse operation performance indicators and also develop a framework to classify indicators not only according to quality, cost, time and productivity dimensions, but also in terms of warehouse activities such as receiving, storage, picking, shipping and delivery. (Staudt et al., 2015).

Axelsson & Frankel,(2014) in their study of Performance measurement system for warehouse activities was conducted to make sure enough knowledge was gained about warehouse management, performance measurements and empirical data was gathered in a combinatory approach between a qualitative pre-study and a quantitative and qualitative web-based survey to develop the SCOR model. Additionally, the model provide a set of metrics suited for each supply chain, though the company must select performance attributes themselves to align the set of metrics towards their strategy and propose a process model to show the operation done in each steps.

Laosirihongthong,et al., (2018) examined in the Prioritizing Warehouse Performance Measures in the overall performance associated with warehouse operations in manufacturing, third-party logistics (3PL) service provider, and retail industry supply chains by using an integrated approach to prioritize individual performance measures within each category and integer linear programming model was used to validate prioritized categories, using the judgment of multiple decision makers across three industries and the result of the study shows that the financial category is a dominating and most important performance category in managing warehouse operations. Even though, the result shows that the financial category is a dominating performance category in managing warehouse operations across all three industries selected. Within the financial category, cost of insurance accounted for quarter of total weight of the category, and is considered to be a powerful measure.

In every business, warehouse performance measurement can be used to deliver valuable information on the performance and possible impact of infrastructure design, operational policy and improvement methods. Therefore, by measuring warehousing service, it is expected to increase the performance of the company and provide superior service to its competitors as well as to minimize cost and to enhance efficiency and effectiveness of the company.

2.3.1. Common Warehouse Activities

Warehousing refers to the activities involving storage of goods on a large-scale in a systematic and orderly manner and making them available conveniently when needed. There are many steps in warehouses from receiving goods until their delivery to customers.

Each warehouse has its own operations or different steps depending on their industry and product requirements. But there are some basic steps that can be found on the warehousing literature. Therefore, the following activities are common in any warehouse:

Receiving: It is the collection of activities involved in the orderly receipt of all materials coming into the warehouse, in providing the assurance that the quantity and quality of such materials are unloaded from shipment vehicles and deliver as ordered.

Inspection: After receiving, goods should be verified by inspection. Checking of an order is a process that checks if the order is complete and accurate.

Put away: Put away can require a fair quantity of labor because product may additionally need to be moved tremendous distance to its storage location, to know all the time what storage locations are available, what is the location of a specific type of goods and where each particular pallet is stored due to these and other reasons put-away usually debts for about 15% of warehouse working expenses.

Storage: - is the physical comprising of merchandise while it is awaiting a demand. The structure of storage depends on the size and quantity of the items in inventory and the manipulation characteristics of the product.

Order picking: It is the process of removing components from storage to support a specific demand. Order-picking is the most important process in most warehouses because it needs the maximum labor and it determines the level of service.

Transportation of goods to the shipping area: Ready-to-ship orders are made available for shipment to customers. Shipping generally handles larger units that picking, because packing has consolidated the items into fewer containers (cases, pallets). So, there is still less labor here. There may be some walking if product is staged before being loaded into freight carriers (Erdil, 2017; John J BARTHOLDI, 2011; Karasek, 2013).

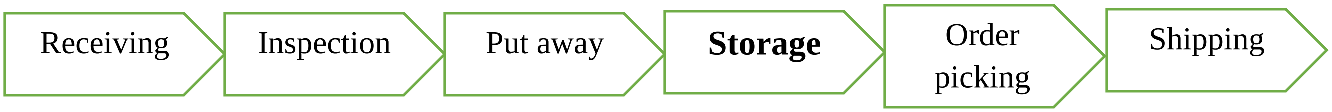


Figure 2.2 **Basic warehouse operations**

The fundamental information necessary in creating receiving and delivery operation decisions usually include information about the incoming shipments of arrival time and contents of transporters, demands in orders and their expected shipping time and information about warehouse in a dry port layout and material handling equipment used. Using this information, one would like to determine the assignment of inbound and outbound carriers to ports, the scheduling of the service of carriers at each port and the allocation and dispatching of material handling equipment and labors.(Evans, 2010).

2.3.2. Requirements for a Warehouses Operation

A major success in the development of the warehousing requirements in the success of different operations are Professionalism that will be seen as a critical logistics step and a competitive impact, Customer awareness also have a high respect for the customer, will know the customer's requirements, and steadily met these requirements, establishing warehouse standards and performance will be measured against these standards and timely actions taken to overcome any deviations in relation with operations planning and logistics network allows the warehouse manager to pro-actively design the operations as opposed to reactively respond to external circumstances and warehouses will not be viewed as independent operations, but as elements of the overall, well-planned logistics system. Similarly, due to the growth in warehouse stage and variety, all warehouse systems, equipment and people will be more flexible to reduce vagueness through the incorporation of warehouse activities. Therefore, some of these requirements of success may then be used as a basis to assess the status of one's warehouse operations.(*Warehousing and Supply Chain Management*, 2013)

The main characteristic of the warehousing systems is to receive merchandise (from inbound or manufacturing lines), to shop substances until they are requested, and then, to extract merchandise from inventory and ship them in response to the customers' orders. Warehousing is a procedure which corporations all activities that allow: designing of a warehouse, definition of critical sources for it operation, definition of the more than a few operations within it and its management.(Mohamed, Radi, & Okar, 2016). Furthermore, warehouse management center is the focus of enterprise warehouse management system. In addition, it has the basic storage and delivery functions of warehousing in the logistics functions, and it also has management functions such as auxiliary examination and coordination of internal logistics.(Han & Zhu, 2017)

2.3.3. Warehousing Key Performance Indicators

In order to understand the determinants of warehouse performance, we should first identify the indicators of performances measures. Since the environment in which warehouses in a dry ports operate has changed dramatically and affected by various new forces driving global competition.

Today, numerous factors such as the impact of increasing globalization, evolution of world economies and growing of communities drive to increase demand for transport, movement and logistics handling of goods and materials, as well as complicating and expanding the existing logistics and supply chain systems.

Derick, (2018) tries to assess a set of warehouse performance indicators in order to efficiently measure warehouse overall performance in the Warehousing Industry in Cameroon through indicators such as time, quality, cost and productivity and the research findings discovered that however there was an increase in the quantity of goods received and issued out of warehouse within the time period , there was a drop in the quality of warehouse services, an increase in the time taken to perform warehouse transactions and an increase in warehouse cost. It is therefore inadequate to consider quantities as the only performance indicator for assessing warehouse performance.

Performance indicators are important analytical equipment that can facilitate an appreciation of the nature and scale of issues going through the delivery industry and ports, and assist check the viable influence of choice policy options. Indicators are also critical for self-evaluation and benchmarking, two elements that are vital to policymaking, as they help examine development closer to set dreams and targets. Bearing in thinking the strategic and practical usefulness of performance indicators, indications with multidimensional metrics spanning a vary of factors, such as efficiency, cost-effectiveness, productivity, profitability, connectivity, access, social inclusiveness and environmental sustainability, are increasingly viewed quintessential for maritime business and its users, as properly as for Governments and policymakers. Data at the united states stage are becoming ever greater vital to help set up the nature and scale of maritime transport undertaking and underlying trends, as well as to interpret the results and implications for policymakers, in particular in developing countries.(Maritime, 2019)

According to Frost, 2018, Operational management through key performance indicators and in recognizing the most intensive processes within the warehouse operations, design adequate KPIs that can be used to control the warehouse operations from and Create a template that will be used in the development process of KPIs by using a mixed research method has been applied. Observations and several unstructured and semi structured interviews have been performed to establish and understand the present state, since the interviews have been open in character it leads to a qualitative research method and in the result it can concluded that the most important KPIs for their case studies are the productivity and cost efficiency KPIs. These two KPIs will be the basis for action decision regarding companies' productivity and cost efficiency in their warehouse operations.

The performance indicator or key performance indicator (KPI) is a measure of performance of the business in order to standard against the competition and explore the possibility to improve in order to gain competitive advantage. Warehousing function is a very critical within any supply chain. If the products do not move seamlessly within supply chain business would face serious service related challenges. Hence, it is necessary to drive the performance of the warehouse through key performance indicators. People, Cost, Space and Systems drive the performance inside the warehouse. Hence, generally warehouse KPIs are based on the above stated drivers and focused on activity in order control the performance.(*Warehousing and Supply Chain Management*, 2013)

According to (OECD/ITF, 2019), Performance indicators are important analytical tools that can facilitate an understanding of the nature and scale of issues facing the shipping industry and ports, and help assess the potential impact of alternative policy options. Indicators are also necessary for self-evaluation and benchmarking, two factors that are integral to policymaking, as they help assess progress towards set goals and targets.

Obviously in different literature, there is no common understanding on how to define indicators and how to measure them. Many studies are established using indicators that are categorized and measured differently depending on the nature and way of doing their jobs in every business both for production and service industries. Therefore, a performance indicator is a description for a definite kind of performance measurement and also used by many businesses or enterprises to measure their internal operation performance or the performance of a specific task in which they are involved. Similarly, key performance indicators are used for improving processes and/or operation performances of the company.

Table 2.1: Relevant KPI’s in warehouse activities (adopted from (Frost, 2018; Kusrini et al., 2018; Liviu & Crisan, 2017; Warehousing and Supply Chain Management, 2013))

KPI's	**Activities**				
	Receiving	**Put-away**	**Storage**	**Order picking**	**Shipping**
Cost	Cost of Receiving per receiving line	Cost per put-away line	Storage cost per item	Cost of picking per order line	Cost of delivery per order
Productivity	Volume received per man-hour	Put-away per man-hour	Inventory per sq. meter	Order lines picked per hour	Order process for delivery per man hour
Utilization	Receiving Port utilization %	Utilization % of labor and equipment	% Location and space occupied	Picking labor and equipment utilization %	Utilization of delivery ports in %
Quality	Accurate receipts %	Perfect put-away %	% Location without inventory inconsistencies	Perfect picking lines %	Perfect delivery %
Cycle time	Time taken to process a receipt	Time taken for each put-away	Inventory days on hand	Order Pick cycle time per order	Transport time per order

2.3.4. Factors on Warehouse Performance

In broad terms, there are two related and in the sometime distinct approaches to establish performance measurement system: economic (i.e., revenue related to cost) and technical (i.e., outputs related to inputs). Economic performance measures are somewhat difficult because warehouses typically do not generate revenues; rather, their function is to support the supply chain. Whereas, Technical performance measurement in the warehouse industry traditionally employs a set of single factor productivity measures that compare one output to one input. (Johnson & McGinnis, 2011)

Ghaouta, Bouchti, & Okar, (2018), try to identify the major causes in warehouse operation depending on main processes as receiving, storage and picking. In receiving process poor organization of the receiving process, lack of planning or rather a planning tool and also insufficient resources (materials and labor), during storage processes the structure of the warehouse is not well organized and accessibility to the storage area is defeated and finally during picking process absence of an allocation strategy and the gap between the physical stock and the system.

The potential of dry ports to equip with the advantage of economic system of scale would now not be accomplished without ample capacity such as equipment, vast roads or highways as nicely as house availability for container storage. By proudly owning such capacity, dry ports may fulfill the demand from home and global clients. (Cahoon,2016). So, improving and advancement on the current operation capacity in dry ports should be encompassed as one the key schedules to create a competitive organization in order to develop national productivity.

In this specific study we adopted four of the most commonly used factors in the literature, namely quality, response time, total warehouse cost, and productivity therefore to operationalize warehouse performance metrics.

2.4. Simulation Approach to Performance Analysis

Because of the significance of container transport, a growing wide variety of research dealing with the warehouse and dry port operation performance measures through simulation models associated to container terminal in particular port related operations.

Altarazi & Ammouri, (2010) in their study of warehouse resource selection we examine supervisors of manual storing and picking warehouses have to determine how many workers resources to use and how a whole lot area to have. The study is essential because of the fact that warehouse performance affected in terms of throughput and operational costs. The researcher's runs discrete event simulation model using Arena of the interior tasks for selecting significant warehouse resources thoughtful about each shared and depending on the characteristics. Simulating eighteen working month experiments consists of ten replicates to test various random number generating groups are designed in order to simultaneously thinking about multi arrive effects. However, this case ignores in developing an optimal procedure for warehouse assets selection and assisting it with simulation results.

Aliyu, Gambo, Alhassan, & Yusuf, (2015) in their study to find a strategy that will minimize the time of any van or truck within the warehouse and found out those customer truck drivers waited for a long period of time due to slow and congested service process. The average service times of the processes are high so that for the simulation period, the service periods are insufficient to serve all the trucks and also average waiting time of customer's truck, the order picking, sealing and loading were high and an additional worker is required in the activity to minimize the long waiting times and employment of the workers. In the processes involved in the unloading system, the average waiting and service times are zero. However, their study examined only on loading and unloading operation, they ignored other activities in operation activity of warehouse.

Evans, (2010), in their studying performance of the largest warehouse of the Defense Logistics Agency (DLA) located in New Cumberland, PA and propose a near optimum design for the receiving area of the warehouse to improve its performance. As a result of this dynamic model, we obtain average cycle time for Materials in the improvement from the initial condition.

Pawlewski, (2015), focused on building a simulation model for analyzing distribution center to prepare the optimization tool built into FlexSim and we proposed methodology with designed tools make it possible to find in short time a better product assignment than the currently applied one. The proposed solution needs validation and it shows shorter travel distance from the previous picking time and its performance of the Distribution Center in a controlled environment so the validation and verification is more valuable.

Kotachi, Rabadi, & Obeid, (2013) discussed on the complex operations involved as well as the utilization of resources and to reflect the overall interactions in the real system in a simulated environment, and to develop a tool that would be able to give numeric outcomes of the current system highlighting areas and opportunities of improvement through using a discrete event simulation model was developed using Arena 14.0 to model generic port operations as well as the movement of incoming and outgoing ships, trucks, trains and containers and the researchers may not consider pick time during loading/ unloading operation in the port, this may affect the result of the study.

Axelsson & Frankel, (2014), in reviewing on the development of a performance measurement system for warehouse activities through the Supply Chain Operations Reference (SCOR) model and find out that SCOR to provide a set of metrics suited for each supply chain, however the company must select performance attributes themselves to align the set of metrics towards their strategy and propose a process model to show the operation done in each steps.

Derse & Göçmen (2018), applied and develop a simulation model for a container terminal system considering loading and unloading processes through ARENA simulation software and find that Waiting times as hours at queues of the processes are shown as more than two hours. It also shows the hardest workers in the system and Sensitivity analysis is applied to see the effects of the inputs to the output with changes the coefficients or weights. For the results of sensitivity analysis by adding more personal to the system provides to decrease of the workloads; adding more berth crane to the system also decrease the usage of the crane. In other side of the study by adding more transport trucks to the system decrease the usage of the truck.

Similarly, Abedinzadeh & Reza Erfanian, (2018) , in the discussion of improving the performance of warehouse loading and unloading system by reducing waiting times and to propose strategies to lower the average waiting time of the personnel using Arena simulation software after implementation of model in ARENA software, the model was run for 6 days and these initial results attained Employing personnel in pick hours in a way that loading and unloading are always performed, is regarded as an improving strategy through the two parallel stations in reception department decreases the waiting time of personnel and facilitates service level. However, Colombaroni, Fusco, Isaenko, & Quadrifoglio, (2017) studied using a stochastic discrete event simulation model and used a powerful simulation software, FlexSim CT, that allowed to model and compared different scenarios to understand cost effective operation. It also reduces waiting times in the queue of trucks, thus improving the offered service. The only downside that can be found in this scenario is the initial investment, which is greater compared to the other solution studied. At this cost, any civil expenses should be added, such as the reinforcement of the floor for the crane.

Gnanavelbabu, et al., (2017) analyze to implement the concepts of lean production in terms of waste elimination, in the matter of identification of time waste, factors leading to it and eventually reduce or eliminate the similarity to provide guidance to the industry evaluation results after putting the optimized loading and unloading time will increase the range of elements per shift. The consequences indicate that there has an impact on of lean structures for the productiveness enhancement in truck industries. But the researcher's only use single tools to analyses waiting time in machinists loading and unloading operation.

Manikandan & Chidambaranathan(2018), applied the Analytic Hierarchy Process (AHP) port competitiveness was evaluated and ports ranked according to the total weights obtained based on the different criteria used and performance measurement system helps to monitor the performance of operations and terminals in a port through providing a port with indicators that will assist in assessing port productivity a complicated operations.

As a conclusion, simulation has been used as a technique in evaluating dry port performance and numerous simulation models of port activities, particularly container port operations, have been developed and also used for different purposes like the planning of future dock requirements, proposing a method that uses buffer space to decrease container loading times and improve equipment utilization, dealing on the impact of employee schedules on container port throughput and as a cooperative instrument for evaluating and increasing port activities.

Table 2.2: Simulation approaches to performance analysis

No.	Authors	Publication year	Applied model	Focus area
1	Altarazi & Ammouri	2010	discrete event simulation model using Arena	warehouse performance affected in terms of throughput and operational costs
2	Evans	2010	use of ARENA 13.9 and Opt Quest software	optimum design for the receiving area of the warehouse to improve its performance
3	Kotachi, Rabadi, & Obeid	2013	A discrete event simulation model was developed using Arena 14.0	Focus study the complex processes involved as well as the utilization of resources. Likewise, the result of the port movement is evaluated and different situations are simulated.
4	Jafari, Hassan	2013	Use of PROMETHEE method to detect and prioritize the causes of delay in dry bulk cargo Loading and Unloading operation together with AHP method.	Focus on ranking the causes and to reduce halt and lags in Loading and Unloading and set a policy suggestion.
5	Axelsson & Frankel	2014	through the Supply Chain Operations Reference (SCOR) model	Focus on the operational tasks within warehousing design.
6	Aliyu, Gambo, Alhassan, & Yusuf	2015	ARENA simulation software	Evaluating the substitute strategies in order to decrease the waiting times, dwelling times of any truck or van in the warehouse and operational cost

7	Pawlewski	2015	FlexSim GP v7.5.2 software with a built-in optimizer Opt Quest	Focus on order picking problem in commercially available warehouse
8	Gnanavelbabu, et al.,	2017	Lean concept on optimizing loading and unloading time	Reduction in time waste in loading and unloading activities will increase each production line and in an enhancement in the number of components produced per shift
9	Colombaroni, Fusco, Isaenko, & Quadrifoglio	2017	using a stochastic discrete event simulation model and used a powerful simulation software, FlexSim CT,	To discover the intense variety of trucks that may want to be controlled with the diagnosed solutions, examining the effect on waiting times as demand improved.
10	Manikandan & Chidambaranathan	2018	Applied Analytic Hierarchy Process (AHP)	Reveal the overall performance of operations and terminals in a port through proposing a port with metrics that will assist in evaluating port productivity of complex operations
11	Abedinzadeh & Reza Erfanian	2018	using Arena simulation software	Focus on improving the performance of warehouse loading and unloading operation by minimizing waiting times and to propose strategies to lower the average waiting time of the workers.

12	Laosirihongthong, Tritos A. Dotun et al.,	2018	Use a Fuzzy analytical hierarchy process (FAHP) was then used to prioritize individual performance measures within each category and integer liner programming model	Focus on financial category is a dominating performance in managing warehouse operations and is considered to be a powerful measure for decision makers as the most important performance category.
13	Derse, Onur Göçmen, Elifcan	2018	A simulation model is developed for a container terminal considering loading and unloading processes by ARENA simulation software	Focus on deciding the well-organized planning of the terminals considering the cost and time reduction.
14	Abedinzadeh, Setareh Reza Erfanian, Hamid	2018	Using ARENA simulation software.	Focus on strategies to reduce personnel waiting time affecting in loading and unloading operation in a dry port
15	Manikandan, M and Chidambaranathan, S	2018	Using the Analytic Hierarchy Process(AHP) based on the different criteria used	Focus on port performance improvement and the advanced approaches that deal with problems also review and classify the existing approaches based on the analysis criteria in port performance improvement

2.5. Literature Review Summary

For warehouse operation performance measurement, the literature presented that performance measurement system is a set of metrics used to evaluate the efficiency and effectiveness of activities done in the working area.

Different scholars and researchers define operations management in various ways that includes common understanding in their definition. So that, operation management as a business activity that strategy categorizes, organizes, and manage the resources desired to produce a company's goods and give services through operational activities until the finished product and shipping of this product to the end users.

United Nations Conference on Trade and Development, define a dry port as "a common user facility with public authority status, equipped with fixed installations and offering services for handling and temporary storage of any kind of commodities passed through customs transit by any relevant way of transport ,put under customs control and with customs and other actors competent to clear commodities for home use, warehousing, temporary admissions, re-export, temporary storage for ahead of shipment and complete transfer" .

Performance indicators are also critical for self-evaluation and benchmarking, two elements that are vital to policymaking, as they help examine development closer to set dreams and targets and also similarly necessary for self-evaluation and benchmarking, two factors that are integral to policymaking, as they help assess progress towards set goals and targets. Furthermore, different researchers categorize key performance indicators depending on the above listed major activities that will be done in warehousing operation.

Warehousing activities consists of major operation which includes receiving, put away, storage, order picking and transport activities. Measuring warehouse is indispensable for imparting managers with a clear ingenious and prescient of life like troubles and opportunities for improvements. Thus, measuring performance refers to the way in which work is done it also can be defined as a trendy used to enumerate the efficiency and/or effectiveness of an accomplishment.

Finally, the listed literatures in this chapter are only some of the several works on dry ports and warehouse improvement. Though, some areas of research for instance containers loading and/or unloading activities related with advanced material handling equipment need extra attention from researchers. In this regard, innovative investigation can support in constructing approaches to confirm smooth running of the whole dry port organization.

CHAPTER THREE

3. Research Design and Methodology

In previous chapter a related literature review on operation management, dry port concepts, warehouse operation, performance measurement, key indicators and simulation approach to performance analysis has been discussed. The research design, study area, sample size, the participants of the study, the type of data source, and the research instrument used to collect the data, the methods of data gathering and analysis were presented.

The business environments of the transport companies were interrelated to the performance of the warehouse measurement is commonly demanded for service industry. Thus, we were discussed and highlight the overall methodology used in the collection and analysis of data to give solution for the research questions in considerations with the study. Therefore, we would use both qualitative and numerical research methods in carrying out this research.

3.1. Research design

Research design is necessary due to it facilitates the smooth sailing of the various research operations, thereby making research as efficient as possible yielding maximal information with minimal expenditure of effort, time and money. First, we were select the research topic and analyzing the existing problems and challenges in the warehouse operation was a major area for doing these specific paper, after that we generate research questions with the related topics and by reviewing different literatures through integrating with the operation science in the selected case.

According to Kothari (2004), an experiment refers to an investigation in which a factor or variable under test is isolated and its effect(s) measured. In an experiment the investigator measures the effects of an experiment which conducted intentionally. It would conduct to check the validity of the model and includes creating the choice model, executing the simulation runs, and statistically evaluating the alternatives overall performance with that of the real system.
Simulation has the ability to experiment with the real system without experiencing any direct capital investment, allowing alternative strategies to be verified, future dry port expansion to be

formed, and the real time of the dry port operations to be compressed and also used as a decision making techniques for dry port performance evaluation studies.

In particular, it has been found out that the most critical keys to success include: quality of services, efficiency and productivity, ability to accommodate larger amount of containers, advanced information technology.

In general, simulation models incorporate fundamental dry port processes through simplifying complex activities, and these processes are defined depending on cargo handling nature. In this study, various objects were observed in the real dry ports as a group of cargoes, loading/unloading equipment's and transportation vehicles, as well warehouses activities.

The overall research design includes related literature review, data collection, analysis, result presentation and interpretation, validation, conclusion and recommendation and the future research direction. The research design flow was developed as shown in figure below.

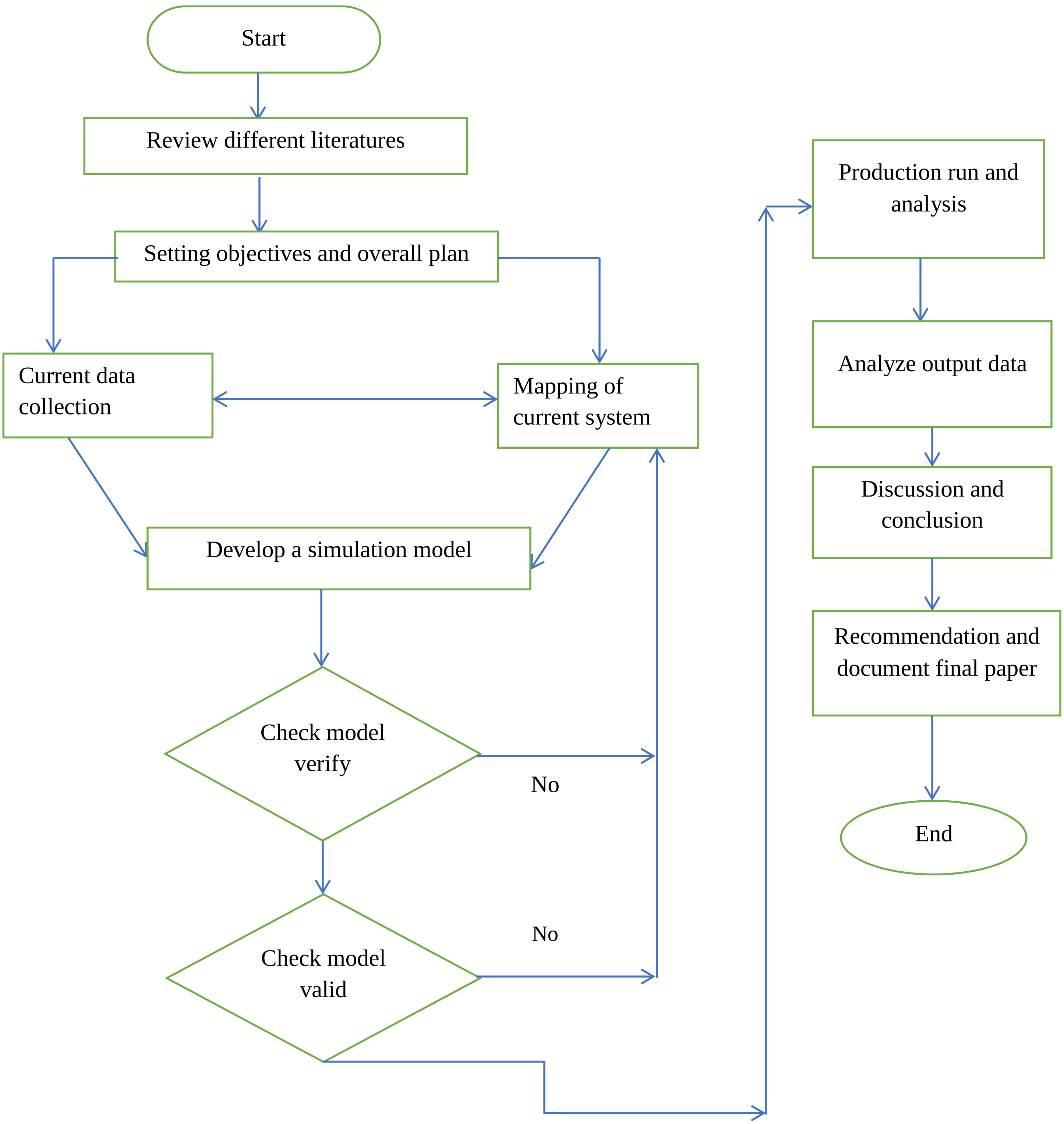


Figure 3.1. Research Design and Flow Diagram [Adopted from (Alithawi, Ali, & Hussain, 2016; Liong, Hamid, & Ibrahim, 2016)]

3.2. Study Area

ESLSE administers nine ports and terminals including the Modjo, Kality, Mekelle, Kombolcha, Semera, Diredawa, Gelan, Hawassa and Woreta Port and Terminal.

Table 3.1 illustrates the number of containers and vehicles that were received by the dry ports for the year 2018/2019 using intermodal transportation. It is clear that in cumulative Mojo and Kality dry port handles more than 89% of the containers. Furthermore, out of the total containers, 12.54% were delivered to the Kality dry ports. It also engaged through identifying dry port and warehouse operation factors which influence the performance of the dry port and to identify those factors data were collected and also give a higher contribution for the country economy.

Table 3.1. Received number of containers and Vehicles terminal services (Ro/Ro) at the dry port 2018/2019, (Adapted & revised from ESLSE annual report 2018/2019).

Dry Ports	Distance from the Capital City(in Km)	Container Terminal Area(Hectare)	Annual Containers Handling Capacity(TEU)	Share in %
Modjo	73	31.7	483,623	76.75
Kality	14	3	79,046	12.54
Mekelle	783	3	30,301	4.81
Kombolcha	380	4	4,891	0.78
Dire Dawa	550	0.78	13,174	2.09
Semera	592	2.5	18,444	2.93
Woreta	620	3	659	0.10
Hawassa	300		1,252	0.20
Gelan	25	4.5	Vehicles terminal services(Ro/Ro)	-
Total		**52.48**	**630,138**	

In addition to annual containers handling capacities of the dry port, table 3.2 shows the number and types of machinery used in dry port for loading and/or unloading activities. Furthermore, Modjo and Kality dry port handles in cumulative more than 77% of port machinery, out of the total machineries, 15.57% were carried to the Kality dry ports.

Table 3.2. Number and types of machinery at the dry port 2018/2019, (Adapted & revised from ESLSE annual report 2018/2019).

Port	Port machinery types in Numbers				**Total**	**%age**
	Terminal tractors	Reach stacker	Forklift	Empty container handler		
Modjo	11	17	44	3	75	**61.48**
Kality	1	4	14	0	19	**15.57**
Mekelle	0	2	7	0	9	**7.38**
Semera	0	1	3	0	4	**3.28**
D/Dawa	0	2	3	0	5	**4.10**
Kombolcha	0	2	4	0	6	**4.92**
Hawassa	0	0	3	0	3	**2.46**
Gelan	0	0	1	0	1	**0.82**
Sum	12	28	79	3	122	
% age	**9.84**	**22.95**	**64.75**	**2.46**		

The proposed research was done using simulation approach to evaluate the current activities and enhance the performance of the dry port and warehouse operation in ESLSE. Kality dry port and terminal was selected to make the research as it is the higher contributor next to Modjo not only in relation with annual containers handling capacity but also numbers and types of dry port material handling equipment including port machineries.

Being the only container terminals fund in capital city, this dry port and terminal has been chosen as a reference scenario to carry out the proposed simulation study due to several economic and technical reasons.

Therefore, the researcher was focused on Kality dry port and terminals not only to achieve research questions and objectives but also to contribute on the performance improvement of the operation.

3.3. Types of Data and Tools/Instruments of Data Collection

The data collection methods to achieve the objectives of this research, the researcher were collecting not only primary but also secondary data. The research were collects both qualitative and quantitative data using interviews, on-site observations, and time measures.

3.3.1. Primary data

For collecting primary data, the researcher were collected both quantitative as well as qualitative data and identifies the major operations performed in the warehouse such as receiving, unloading, putting a way, storing, order preparation and picking, loading and finally shipping. To execute the model, we collect raw data related with the loading/ unloading of the warehouse performance in the dry port and record using excel sheet.

In addition to collecting raw data through the above methods the researcher would also use a workflow analysis as a methodology to understand and mapping of the current system in relation with the time spent in the loading/unloading as well as containers waiting time in the port and also to propose alternative solutions for the identified problems

The cargo-handling process starts with arranging the truck arrival for unloading, and then reach stackers and forklifts are assigned for unloading activity. The cargo can then be directed into inland storage system. The unloaded cargoes are moved to the warehouses by trucks, forklifts, terminal trailers and so on. Then, equipment and machineries are assigned for unloading, and cargo is stuffed in an open or closed place depending on the types of goods.

For inland transportation, cargo is loaded from the warehouse or directly from the trucks after equipment and machineries have been assigned and are transported to customer endpoints. If the freight is loaded by the truck (exported cargo), it follows the reverse process.

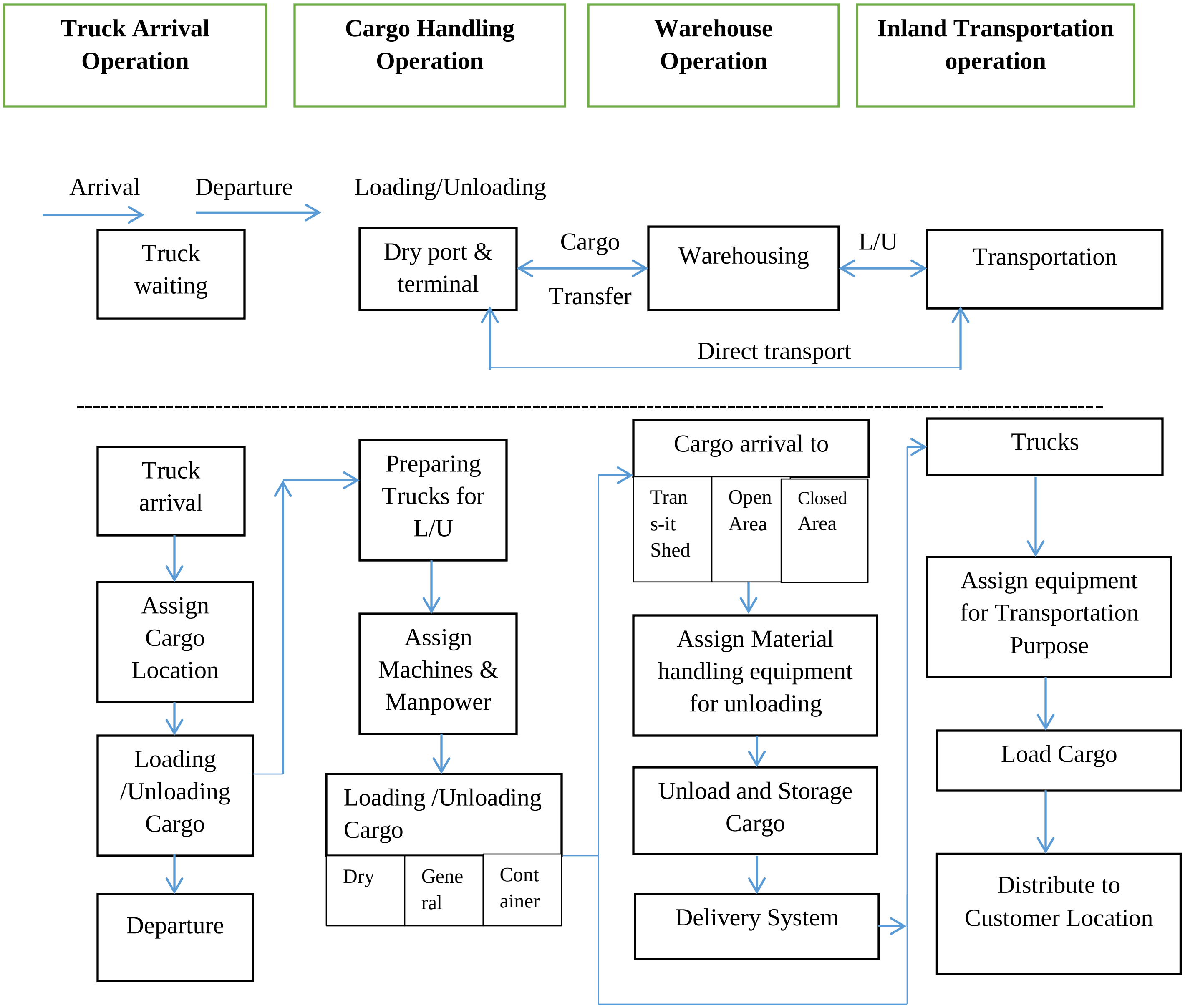


Figure 3.2 **Current dry port operation and Sequence (Adapted & revised from Demirci, 2016)**.

The data related to the dry port operation, which include prepared forms and dry port activity records, were investigated. These forms and records provide details of ship and cargo movement information, such as truck arrival and departure dates, tonnages and lengths, cargo types, destinations, and other. Later, the dry port coordinator and professional on port operations were interviewed. Interviews were conducted with containers department employee and coordinators of ESLSE. Data gathered during these interviews were used for the mapping of existing work processes at the port.

Moreover, to produce statistics and check the detailed data, we made field observations. On-site observations were performed to analyze the current operation activity of the dry port and to understand the work processes. All work processes were analyzed in detail in order to develop a simulation model.

Information about employees, handling equipment, warehouses, and distances were obtained from the plans of the working area. Time measures were conducted to collect service times of receiving empty and/or full containers, arrival rates and workers distribution in the system.

Furthermore, real quantitative data were collected at the entrance gate of dry ports on the arrival of heavy trucks from Djibouti in order to measure the line and determine the performance of the provided service. Heavy truck arrivals meet physical and document check at the entrance gates of the destination dry ports which results in waiting of the trucks. The arrivals of the trucks will random and the queue system follows single queue single server in a discipline of First Come First Served (FCFS) manner for the dry port. Data would be gathered at peak hours during the operational day for successive days in addition to off- peak hours' data for a single day to analyze the steady movement of the trucks and the utilization factor. The entrance gate at Kality dry port and terminal delivers service from 12:00 morning up to 1:00 evening at local time. The peak hour was after 5:00 o'clock due to the dry port permits an empty container waiting time only for 24 hours.

To determine the number of observations required for data collection, five preliminary samples were measured for loading and unloading activities in the dry port.

Table 3.3: - preliminary sample for loading and unloading activities

Observation	**Stopwatch Time in Minutes**
1	21
2	17
3	23
4	25
5	19
Sum	**105**
Mean	**21**
Standard Deviation	**3.35**

Standard deviation and number of observations were calculated by ***Equation 3.1 and 3.2*** respectively.

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$ ---------------------------------- ***Equation 3.1***

$$N = \left(\frac{zs}{h\bar{x}}\right)^2$$ ---------------------------------- ***Equation 3.2***

Where,

- **N** = the number of observation required,
- **n** = preliminary sample,
- $\mathbf{x_i}$ = recorded stopwatch times,
- **x-bar** = mean of initial preliminary sample,
- **s** = standard deviation
- **h** = half the precision interval in percent,
- **z** = number of normal standard deviations needed for desired confidence level.

The value of normal standard deviations (z) and half the precision interval (h) were fixed for the reason that most of industries including service providers use the confidence level of for 95.5% and correspondence values for z and h are 2 and 0.1 respectively.

According to (Kothari, 2004), finding the appropriate sample size usually matters in determining the right proportion and statistically significance sample size. Often, an optimum size of sample is far better that minimum or average size when it comes to representation. In other words, sample size neither needs to be unreasonably large nor too small. Having this, the number of observations during loading and unloading activities in the dry port was determined as 40 observations. Thus, Data were collected for 10 working days to determine the service rate.

In addition, to have the arrival rate and service rate time intervals for determining the performance parameters, data were collected for a day excluding the peak hours. Therefore, the researcher focuses on required probability distribution for simulation in gathering information.

3.3.2. Secondary data

Secondary data, the integral documents were gathered from various related sectors including Ethiopian Shipping and Logistics Service Enterprise (ESLSE), Ethiopian Revenue and customs Authority (ERCA), Ethiopian Maritime Affairs Authority (EMAA), Kality port and terminal. Furthermore, company annual reports, relevant international journals, reports and thesis works have been gathered to support the study.

3.4. Methods of Data Analysis

As described below, the collected raw data were arranged and recorded using excel sheet and put the data as an input for model development in arena simulation model analysis. The operation in the warehouse clearly identified and data probability distributions of the waiting and service times for the process of loading and unloading were obtained through work flow analysis. After analysis we were identify the main concerning study area and it major causes and finally to propose alternative solutions for enhancing the performance of warehouse by reducing the waiting time, service time and total time of the customers stay in the system.

3.4.1. Arena Simulation Model Analysis

Dry port systems are complex because of the involvement of different related sectors, various truck arrivals, different dimensional cargoes, different loading/unloading handling machines, and so on. Therefore, to handle this complexity, simulation is used for these systems.

According to Yang, Low, & Cayirli (2014) Simulation is the process of designing and creating a computerized model for a real or proposed system for the purpose of conducting numerical experiments to give us a better understanding of the behavior of that system for given set of conditions.

Simulation is an imitation of performance of the real process or system over the time. As a system will be developed over the time, its behavior is studied by creating the simulation model. This model is usually in the form of a set of assumptions related to the system's performance and expressed in the framework of mathematical, logical and symbolic relations among the institutions or intended purposes of the system. (Saidabad & Taghizadeh, 2015).

The model was design and simulates using the Arena simulation software. The probability distributions of the waiting and service times for the processes of loading and unloading was obtain from the arena input analyzer

The input analyzer is a standard tool that accompanies arena and is designed specifically to fit distributions to observed data, provide estimates of their parameters, and measure how well they fit the data. Input Analyzer requires text files containing basic data to fit probability distributions to data. These input distributions will use as an input variables in the model and inter-arrival time distribution is a basic input parameter that has to be assumed or inferred from observed data of loading and unloading trucks in the port.

The collected data from dry port warehouse including the waiting time, service time and total time of all the entities in the system. The number of trucks that enter and leave the dry port warehouse was also collected.

3.4.1.1. Simulation Model Verification and Validation

The researcher would propose a simulation methodology through introducing the existing problem, and define objectives, limitations and scheduling, visualization and run times. The required data were collected and a model is defined and programmed. The model would also be verify and validate.

Verification is the determining processes if the operational logic is correct and is interested if we build the model in the correct way. Model validation is the task that ensures the model works in the same way as the real system. As results it produces are within a tolerable level of accuracy. In contrast, validity is the process of determining if the model correctly denotes the system.

The model should be validated before productive simulation runs are started. To do this, the input data for the model like truck arrivals, service times, etc. produced through probability distributions were validated with real data. In general, model validation is made by comparing the simulation model outputs with the real data of the dry port.

Therefore, to achieve the objective of this study the researcher would expect to explore in depth, operation, event, activity, process and collect detailed information through different procedures over sustained period of time and limited activity. So, this specific study aims to use company cases as a research design to study how to improve operation performance of a warehouse system.

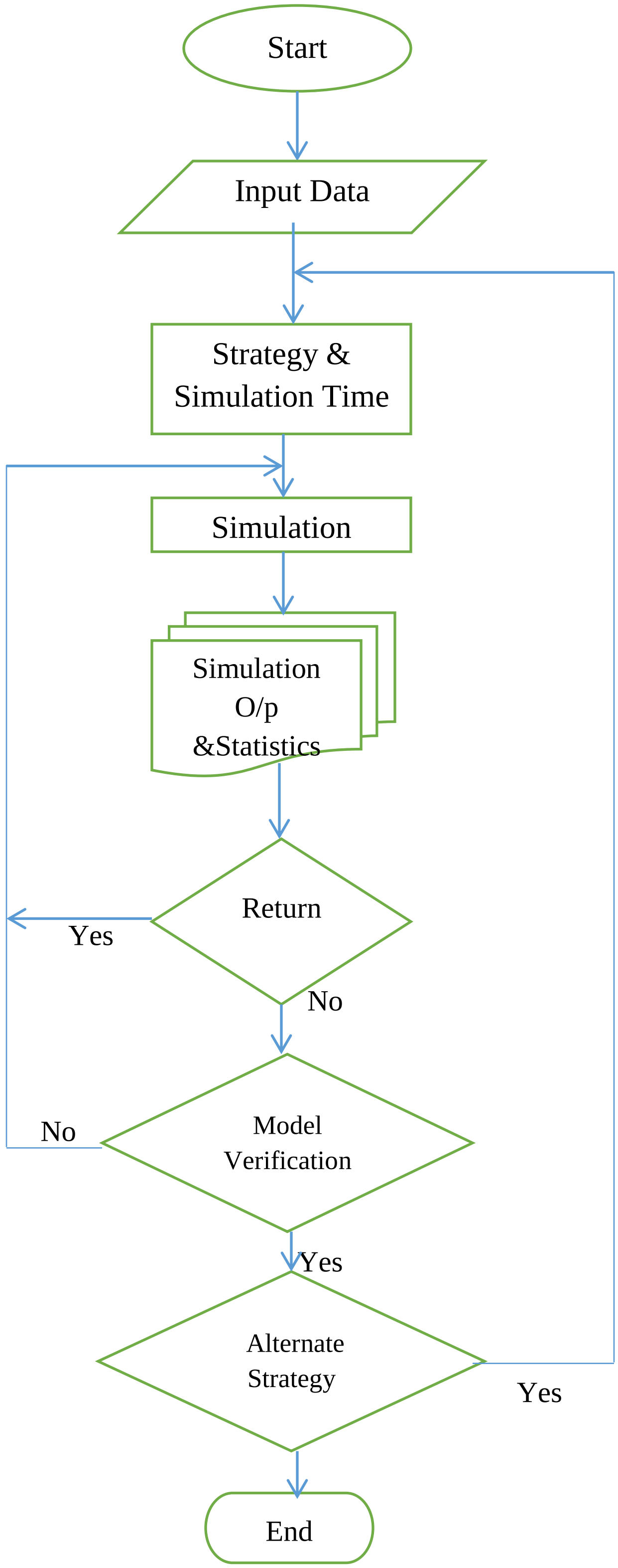


Figure 3.3 Operational sequence of simulation runs (Adapted & revised from Demirci, 2016)

The researcher was made contributions for container terminal problems exist in current operation related with loading/unloading activities and also storage operation. Although, a lot of literature concerning container terminal problems, most studies have focused on broad terminals; only a few studies concentrate on divided decision problems.

The development of arena simulation model contributes to the area of container terminal modeling. The model can be modified, depending on the level of details needed; and can be applied to most port terminals. After modeling and production run of the activities, we were analyze by putting scenarios to compare the real system (As-Is process) and simulation run results in improving operation performance of port activities through identifying the bottleneck on main activities or processes. Furthermore, the result of the dry port process on each activity was studied and different scenarios are simulated.

Therefore, the methodologies used through the development of arena simulation were providing not only to answer the research questions and to meet research objectives but also contribute for future researchers on related area.

CHAPTER FOUR

4. Data Collection and Analysis

4.1. Over view of Case Company

The Ethiopian Shipping and Logistics Service Enterprise is a merger of four enterprises which have been working independently in the sea transport sector. These have been Ethiopian Shipping Lines Share Company, Ethiopian Maritime and Transit Service Enterprise, Dry Port Enterprise; and the former Comet Transport Share Company which was consolidated in to the new company, August, 2016. The Dry Port Enterprise set up in 1999 has carried out incredible tasks in reducing the cost, time and property losses at Djibouti port with the aid of put into effect dry port initiative and enlargement projects. Though it’s a current development, it has exhibited a incredible port and ports associated overall performance excellence. Comet Transport Services Joined ESLSE, to furnish inland transport service for import and export authorities as nicely as personal zone cargoes with sound institutional capacity.

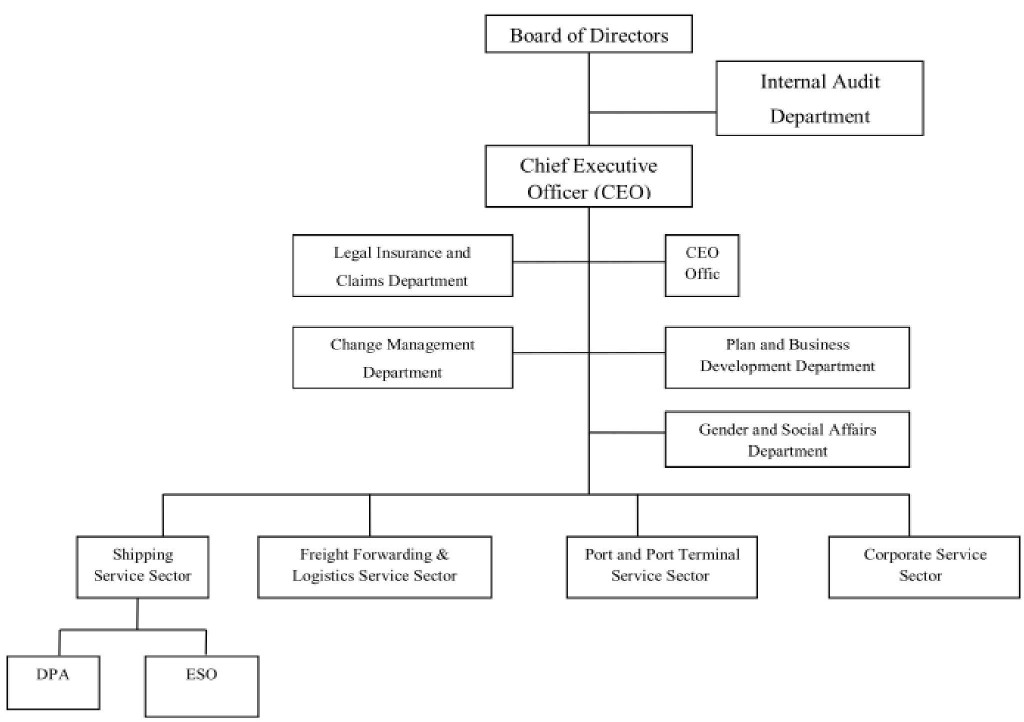


Figure 4.1: Organization Structure of ESLSE (source: *Enterprise profile, 2017*)

4.2. Port and Terminal Service

Including inland Port Operation Coordinator and Port Facility Development sections within itself, this sector contains the Modjo, Gelan, Mekelle, Kombolcha, Semera, Diredawa, Hawassa, Kality and Woreta Port and Terminal. This sector administers nine ports and terminals, leads and monitors project activities and the development of other dry ports.

Services Port and Terminal Sector renders; Providing port and terminal services for import and export cargoes consisting of Ro-Ro, cars receiving and managing over of cargoes to customers, Receiving and delivering cargos, Loading and unloading of cargos; Placing items out and region goods into container, Provision of empty containers, Stuffing and sending export cargos; warehouse offerings for incoming cargos and other cargos of a variety of function and also Providing port clearance services.

4.3. Existing Process Flow of Dry Port Operation

During field observation for data collection and current operation activities were done in the dry port includes work flow for incoming cargo, outgoing cargo and full-in containers handling operation.

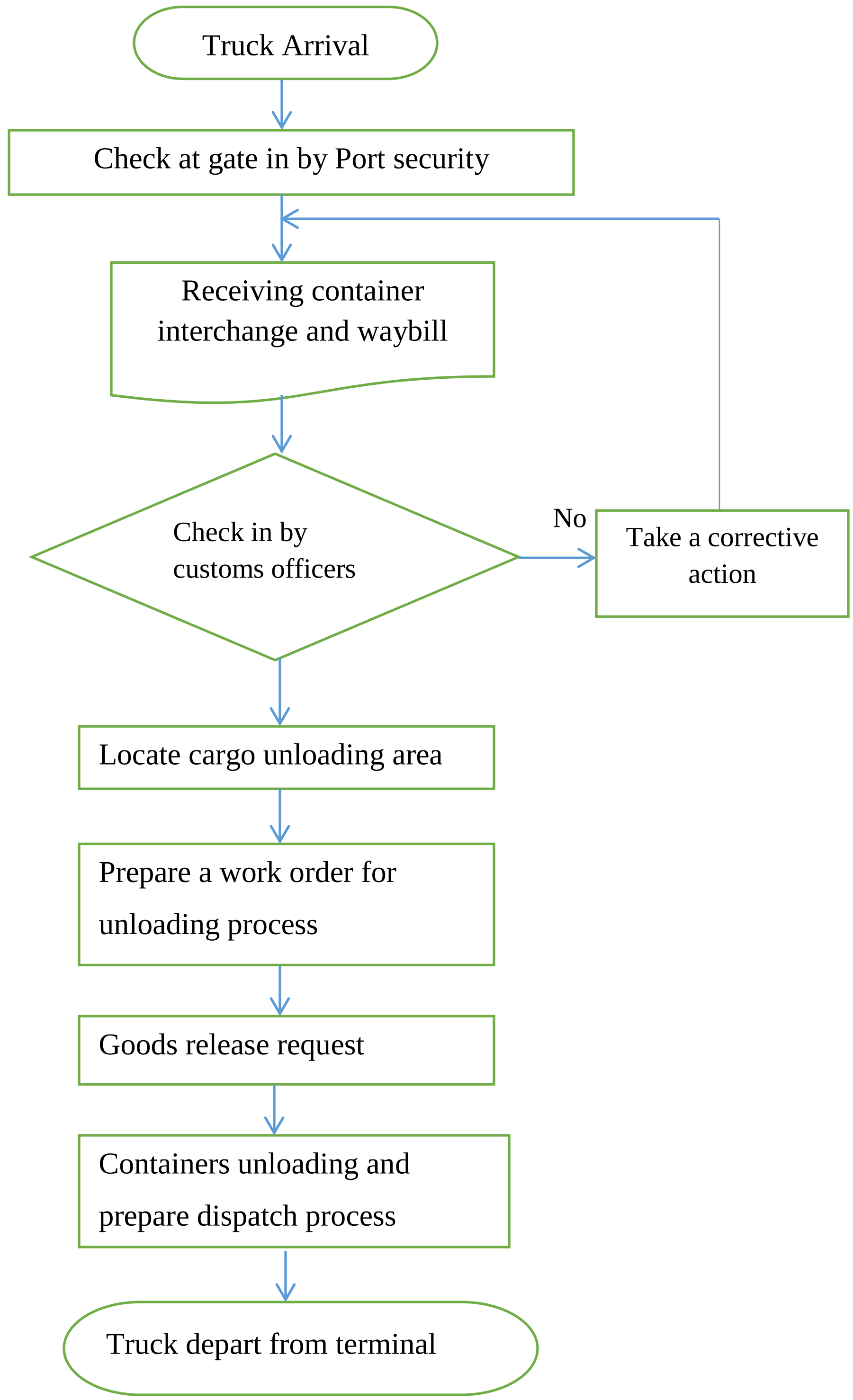


Figure 4.2. Incoming Cargo Work flow

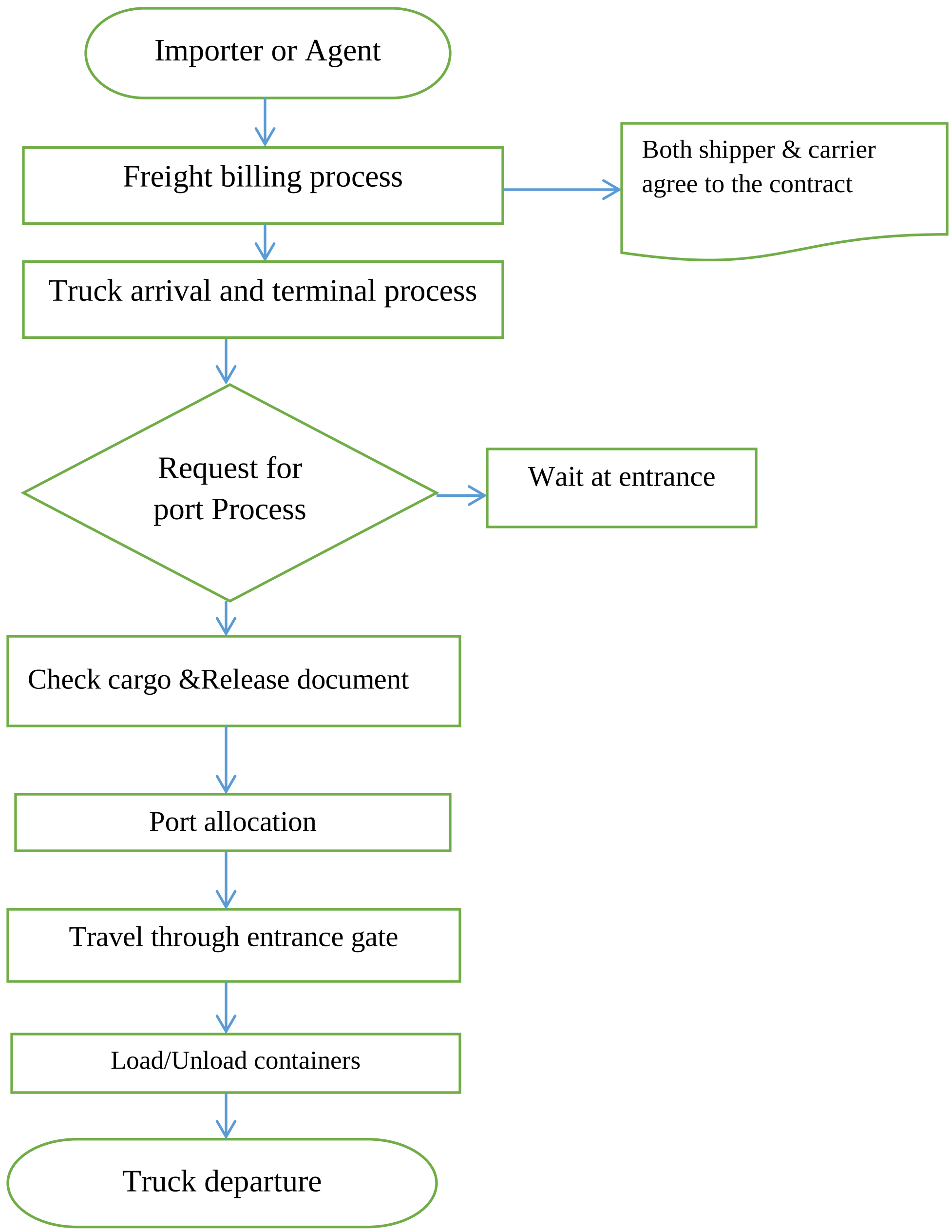


Figure 4.3. Outgoing Cargo Work flow

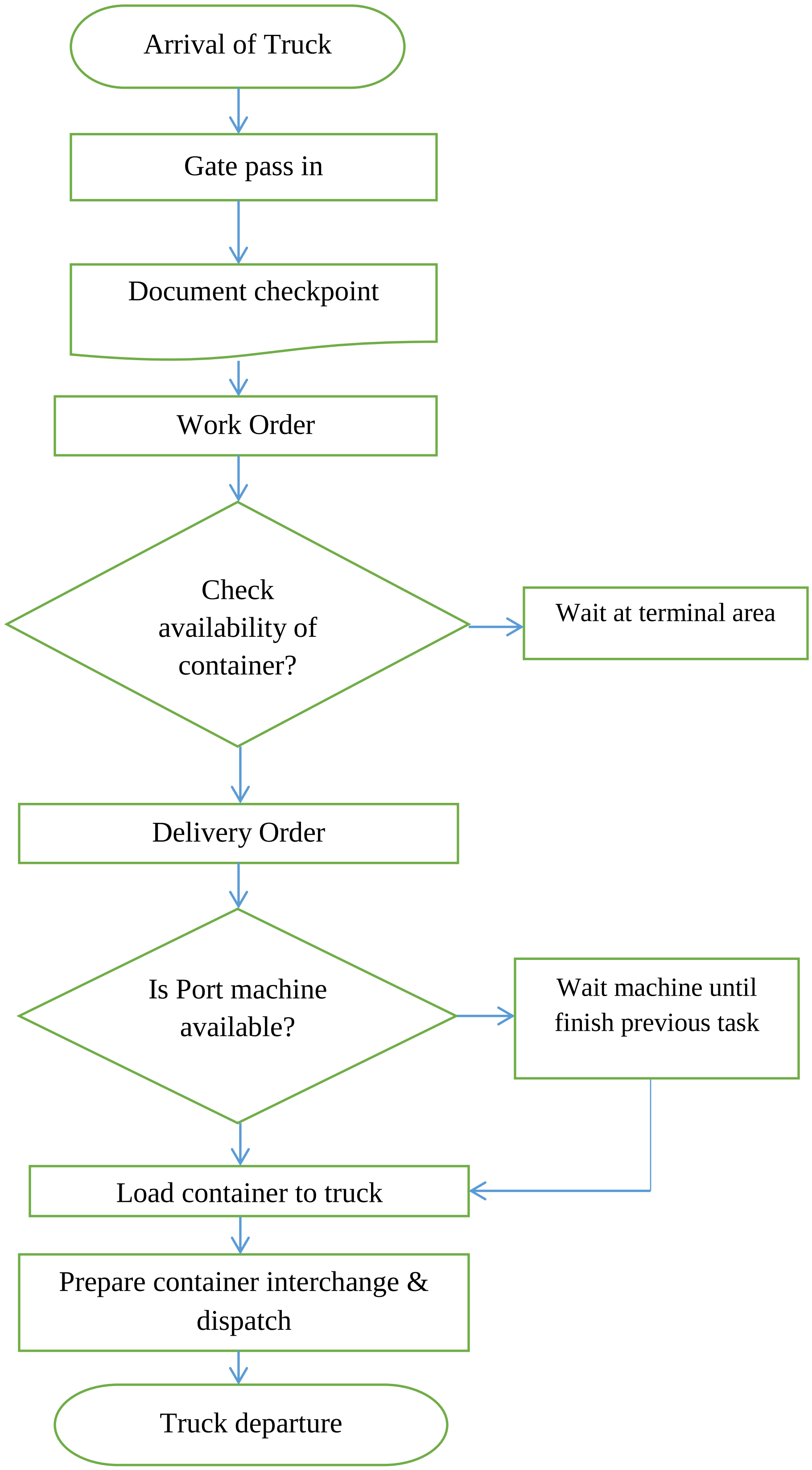


Figure 4.4. Loading Process Work flow

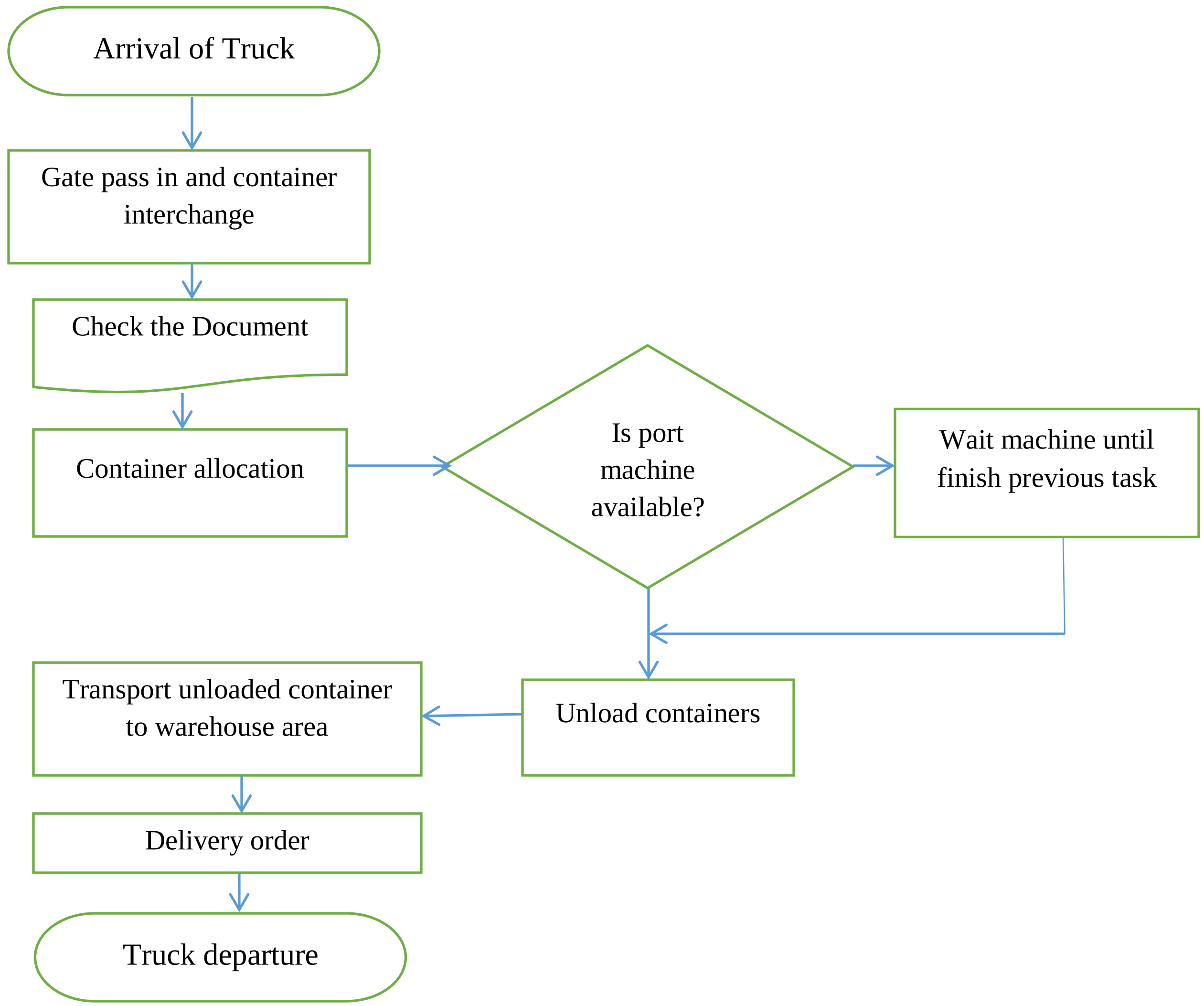


Figure 4.5. Work flow in a dry port for Full in Container

4.4. Data Collection Process

Data collection and examination for developing simulation model is significant as all output depends on the accuracy of the data in order to enhance loading and unloading operation in the dry port. Primarily, data collection begins from identifying and observing the different operations done on arrivals, checking, loading and unloading service. After observing all operations or tasks which are done on the port; then defining individual work elements to each activities follows. Individual work element is a minimum rational work element having a specific limited objective. Based on this, the number of tasks on each activities are determined and the service time for each operation was measured in minutes recorded using stopwatch. In addition to make more accurate/validate the collected data, daily service reports and operation breakdowns and service plans considered.

For this research standard times were not taken into consideration, but the distributions of the collected time for each task considered. Because the service time of operations is variable and therefore a distribution is the better way to represent real system; depending on the predetermined standard times would decrease the model's validity for accurate representation.

Generally, the data were collected includes:

- Empty containers arrivals
- Full containers arrivals
- Loading/Unloading activity
- Total number of containers(TEU)
- Service time for each activity
- Working hours

All service times were found to be probabilistic rather than deterministic. The variation in service times and the random arrivals of cargo from day to day operations according to customer demand caused randomness in the observations.

Occasionally machineries are going to break or not functional due to maintenance and also crowdedness in the port to handle or maneuver the loading/unloading activities. This makes challenging and difficult to gather the data and emphasis on data collection to follow the activity rather than the machines. The second approach was to get the data over numerous single day activities that had prejudiced the quality of the data due to the variation in the incoming and outgoing cargoes in the terminal and also the change of the work force size.

Table 4.1: - Collected operating time for each activities for Full-In operation

Full Container -IN Operation																						
No.	**Activities or Operation Name**	**Observed data (minutes)**																				**Average Time**
1	Inter-Arrival time of Truck	9.5	9	15	12	13	15	10	12	13	20	13	11	18	10	8	12	14	9	8.5	16	12
		9	13	13	11	8.5	12	22	18	16	17	12	14	14	12	15	15	13	21	12	16	
2	Gate Pass In	6	7	6	8	7	7	5	6	8	5	4	5	3	8	5	4	5	3	4	4	6
		2	3	6	6	5	4	4	5	3	2	4	4	5	3	4	5	6	4	3	3	
3	Check Container Status	3	2.5	2	3	3	4	2	3	3	3	2	3	4	4	3	2.5	3.5	3	5	4	3
		3	4	2	3	4	3	2	3.5	3	5	4	3	2	3.5	2.5	2	3	2	4	2	
4	Order Delivery	8	7	8	7	6	6	5	4	5	6	4	4.5	4	5	3	3	5	4	2.5	3	5
		4	3.5	5	6	5.5	4.5	7.5	4	6	6	3.5	4	3.5	3	4	4.5	4	3	3	5	
5	Job Order	6	11	10	8	9	11	9	10	9	7	5	4	6	8	7	7	11	6	6	8	8
		4	5	5	3	3	4	7	11	10	9	5	10	9	7	6	5	5	8	6	7	
6	Unloading Process	11	12	10	9	12	11	10	14	12	14	10	12	16	14	14	16	14	16	18	15	13
		10	12	13	15	17	11	10	14	18	12	12	15	16	15	13	12	15	13	14	16	
7	Full -In Interchange	6	5	5	4	6	5	6	4	5	6	4	5	5	4	6	6	4	5	3	5	4
		6	4	4	6	5	5	4	3	3	3	5	4	4	3	6	5	4	5	4	6	

Table 4.2: - Collected operating time for each activities for Full-Out operation

Full Container -OUT Operation																						
No.	**Activities or Operation Name**	**Observed data (minutes)**																				**Average Time**
1	Inter-Arrival time of Truck	12	14	15	13	15	13	18	14	16	20	17	14	12	13	13	18	16	15	16	18	15.1
		21	19	14	14	11	17	18	21	12	17	16	17	18	13	17	16	19	19	20	21	
2	Goods Receiving Order(GRO)	2	3	5	4	3	3	5	4	4	3	2	5	6	3	4	2	5	3.5	4	5	3.78
		4	4.5	4	4	3	5	4.5	6	5	4	5	3.5	5	4	4	3	3.5	5	5	3	
3	Container Release Document	3	2.5	2	3	3	4	2	3	2	3	2	2	1.5	4	3	5	4	6	2	3	3.00
		3	5	4	3	5	3	4	4	3	5	4	5	5	3	2	3	4	2	4	4	
4	Bill of Loading	2	2	2	3	2.5	3	2	3	5	4	3	3	2	1	1	3	4	3	3	2.5	2.70
		2.5	3.5	2	3	4	4	3.5	4	5	3	3	3	1.5	1	2	3	5	2.5	2	3	
5	Customs Release Document	5	7	5	4	5	5	8	6	5	5	3	2	2	4	4	3	3	4	3	4	4.35
		3	3	5	4.5	3.5	4	5	3	5	4	4	4	3	2	4	5	3	3.5	4	4	
6	Loading Full Container	12	11	13	12	11	12	10	13	14	12	12	15	10	14	11	12	12	15	14	16	12.55
		15	13	11	12	10	10	12	11	11	13	12	13	12	11	12	15	12	14	11	13	
7	Full -Out Interchange	6	5	5	4	6	5	6	4	5	6	4	4	6	5	5	4	3	5	3	5	3.8
		4	4	3	4	5	3	2.5	3	3.5	2.5	4	3	3.5	4	5	4	3	5	6	4	

Table 4.3: - Collected operating time for each activities for Empty -In operation

Empty Container -IN Operation																						
No.	**Activities or Operation Name**	**Observed data (minutes)**																				**Average Time**
1	Inter-Arriva time of Truck	15	13	20	18	15	14	14	22	25	18	18	16	17	12	14	14	13	15	15	13	16
		21	16	13	15	18	17	15	12	12	11	16	18	19	17	16	15	15	22	23	14	
2	Check in Process	5	8	7	4	5	6	6	5	4	8	3	5	4	3	2..5	3.5	6	5	4	4	5
		4	3	5	5	4	6	6	5	2	3.5	4	3.5	3	5	6	4	5	6	5	4	
3	Inspection Incoming Empty Container	6	4	8	5	3	4	5	5	4	6	3	3	2.5	4	3	4	3	3	4	4	4
		5	2	3	3	5	4	4	3	3	3	4	4	5	3	5	4	3	3	5	4	
4	Transport Inspected Containers to WH	12	14	12	15	14	13	14	12	13	14	16	13	14	15	16	15	13	14	13	13	14
		12	14	16	17	15	14	13	12	11	14	12	12	11	16	14	15	16	15	15	15	
5	Unload Empty Container from Truck	15	18	10	16	12	14	12	15	12	15	11	15	12	13	14	13	15	16	15	15	14
		16	14	12	12	15	14	15	15	13	13	15	14	12	13	16	15	14	13	15	13	
6	Empty In Interchange	6	5	5	4	4	5	3	4	5	3	5	5	6	4	6	5	4	4	4	5	4
		3	6	5	5	4	5	4	6	5	5	3	3	5	4	5	4	4	3	3	5	

Table 4.4: - Collected operating time for each activities for Empty -Out operation

Empty Container -OUT Operation																					
No.	**Activities or Operation Name**	**Observed data (minutes)**																			**Average Time**
1	Truck Arrival time	15	14	20	18	15	25	20	22	23	26	20	18	15	14	14	22	23	18	15	15	19
		17	18	17	19	21	21	22	23	24	24	19	18	13	15	15	16	14	18	16	14	
2	Empty Container Request	4	6	5	5	4	4	2	3	3	4	3	2	2	3	5	4	4	2	2	3	4
		3	4	2	3	4	3	2	2	3	3	1.5	2	3	4	3	3	4	5	3	3	
3	Document Check in Process	5	8	7	4	5	6	6	5	4	8	4	3	3	4	5	3	2	4	3	3	5
		4	3	5	4	4	3	2	3	3	4	4	3	4	5	3	2	3	2	3	4	
4	Freight Order	2	3	4	4	3	2	3	3	4	3	2	2	4	2	4	3	2	5	4	3	3
		3	4	3	4	2	3	2	2	4	4	3	1.5	2	2	3	3	4	5	4	5	
5	Order Receiving	5	6	7	8	5	6	6	4	5	3	3	4	2	2	3	3	2	4	3	5	4
		4	5	3	4	5	3	6	5	6	5	4	5	3	5	3	5	3	4	5	4	
6	Load Empty Container	15	18	14	16	12	14	12	15	13	15	12	10	10	13	11	15	14	16	17	22	14
		24	18	12	13	15	14	17	18	18	15	16	12	13	14	14	11	12	14	15	14	
7	Empty Out Interchange	4	5	3	4	4	5	3	4	3	3	5	4	3	5	3	5	4	4	3	6	4
		5	4	5	4	5	5	3	4	3	3	4	4	3	5	3	2	3	6	4	3	

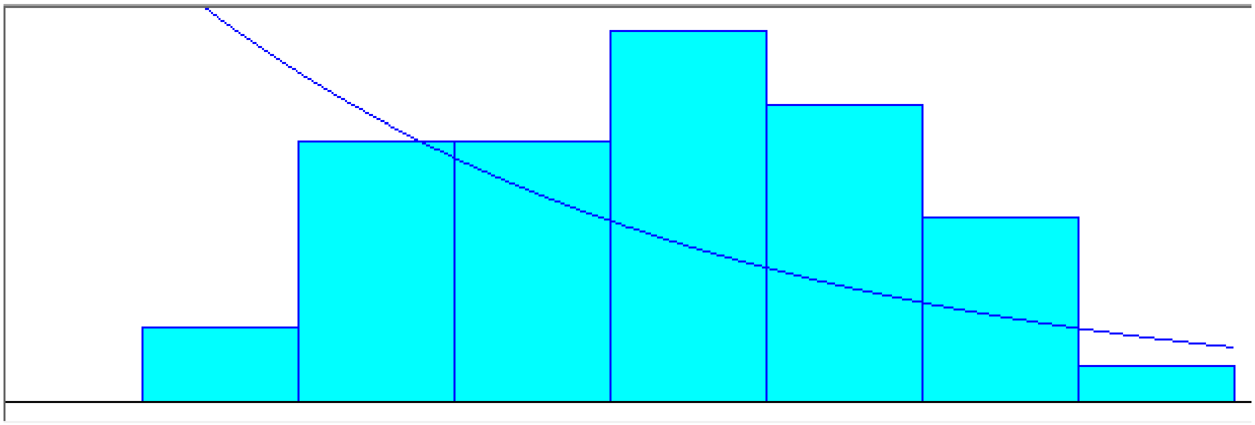
4.5. Data Distribution Determination

Data collection was the first step for developing a model. The input data in the model involves specifying the theoretical distributions in the simulation platform program through collecting raw data for each activity in relation with dry port activities from the existing system and putting in a notepad to prepare a data set. The fitting process within the input analyzer is extremely dependent upon the intervals that are chosen for the histogram of the data. The input analyzer tools built in arena was used to change the collected raw data which was obtained from container terminal have been used for the purpose of entering service times at loading, and unloading processes to the simulation program as probability distributions.

It was an important stage to determine the best distribution because it affects the performance of the port operation. In deciding which distribution to present, it tried to choose those that are not only simple to understand, smallest squared error but also practically well-organized.

Thus, the collected data were processed in the Input Analyzer tool built in Arena, and the results are used to set the type of probability distribution function and its value to be used in simulation model. It was an important stage to determine the best distribution because it alters the performance of the dry port. The distribution types of variables used to imitate the simulation model are according to arrival of trucks in the terminal.

Sample Input analyzer data distribution function for transport inspected containers was shown in ***figure 4.6*** below.



```
Distribution:   Exponential
Expression:     10.5 + EXPO(3.35)
Square Error:   0.085211

Chi Square Test
  Number of intervals   = 4
  Degrees of freedom    = 2
  Test Statistic        = 36.5
  Corresponding p-value < 0.005

        Data Summary

Number of Data Points   = 40
Min Data Value          = 11
Max Data Value          = 17
Sample Mean             = 13.9
Sample Std Dev          = 1.51
```

Figure 4.6. Input analyzer distribution function for transport inspected containers

Data distribution function for Full-In, Full –Out, Empty-In and Empty-Out operations summarized as below on table 4.5 respectively.

Table 4.5: - Input analyzer data distribution function of each Dry port operations

Full Container -IN Operation				
No.	**Activities or Operation Name**	**Distribution**	**Expression**	**Square Error:**
1	Inter-Arrival time of Truck	Weibull	8 + WEIB(5.58, 1.32)	0.007951
2	Gate Pass In	Weibull	1.5 + WEIB(3.7, 2.2)	0.001808
3	Check Container Status	Normal	NORM(3.08, 0.81)	0.08252
4	Order Delivery	Triangular	TRIA(2, 3.5, 8)	0.010549
5	Job Order	Beta	2.5 + 9 * BETA(1.41, 1.31)	0.004333
6	Unloading Process	Beta	8.5 + 10 * BETA(1.85, 1.98)	0.016523
7	Full -In Interchange	Beta	2.5 + 4 * BETA(1.9, 1.57)	0.000857

Full Container -OUT Operation				
No.	**Activities or Operation Name**	**Distribution**	**Expression**	**Square Error:**
1	Inter-Arrival time of Truck	Beta	10.5 + 11 * BETA(1.48, 1.45)	0.005851
2	Goods Receiving Order(GRO)	Triangular	TRIA(2, 3.67, 6)	0.054963
3	Container Release Document	Triangular	TRIA(1.05, 3.11, 6)	0.003475
4	Bill of Loading	Triangular	TRIA(0.999, 2.59, 5)	0.055392
5	Customs Release Document	Normal	NORM(4.08, 1.23)	0.01772
6	Loading Full Container	Weibull	9.5 + WEIB(3.21, 1.94)	0.010475
7	Full -Out Interchange	Erlang	2.15 + ERLA(0.717, 3)	0.07653

Empty Container -IN Operation				
No.	**Activities or Operation Name**	**Distribution**	**Expression**	**Square Error:**
1	Inter-Arriva time of Truck	Weibull	11 + WEIB(5.56, 1.43)	0.017898
2	Check in Process	Erlang	ERLA(0.652, 7)	0.019636
3	Inspection Incoming Empty Container	Normal	NORM(3.96, 1.14)	0.025787
4	Transport Inspected Containers	Exponential	10.5 + EXPO(3.35)	0.085211
5	Unload Empty Container from Truck	Beta	9.5 + 9 * BETA(3.21, 3.32)	0.030622
6	Empty In Interchange	Beta	2.5 + 4 * BETA(2.02, 2.12)	0.00722

Empty Container -OUT Operation				
No.	**Activities or Operation Name**	**Distribution**	**Expression**	**Square Error:**
1	Truck Arrival time	Erlang	1.5 + ERLA(0.408, 6)	0.007719
2	Empty Container Request	Normal	NORM(3.26, 1.04)	0.008146
3	Document Check in Process	Erlang	1.5 + ERLA(0.833, 3)	0.00411
4	Freight Order	Lognormal	1.14 + LOGN(2.04, 1.26)	0.074224
5	Order Receiving	Beta	1.5 + 7 * BETA(2.08, 3.07)	0.013091
6	Load Empty Container	Weibull	9.5 + WEIB(5.71, 1.83)	0.01757
7	Empty Out Interchange	Erlang	1.5 + ERLA(0.408, 6)	0.00772

4.6. Simulation Model Formulation

The model was built using Rockwell Arena® version 14.0 simulation software. The construction period of the model is based on the current containers loading and/or unloading as well truck arrivals in process flow diagram which highlighted during field observation. Port machines are organized and arranged according to the operation process flow, but the number of machines and workers which are used for each operation are determined by the terminal containers handling capacity.

The aim of model development or formulation was to determine which part of the system should be included in the model and how the model should flow to imitate the actual system. The model development was started with the declaration of the entity, the location of the workstations, resources, random inter-arrival time, declaration of the arrival and service time as well resource allocation in service software design.

Logic flow describes the way by which the entity acts during its journey in the simulation model. It was easy to observe the route the entity follows during the model building stage. The simulation run part of the Arena was very useful in ensuring that each activities works as desired.

Some assumptions were made in order to formulate a model and analyze a container terminal system. These assumptions were determined based on field observation, data collection and reviewing related literatures:

- The Model was flexible and new elements can be easily add or remove
- The arrivals of the trucks were random distributions in simulation program
- The loading process begins after the unloading of cargos from the truck.
- Processes of unloading/loading have been done successively.
- No operator works interruption; their performance stays constant throughout the entire service time.
- The handling activities inside of terminal, except loading/unloading process, are not taken into consideration
- 480-minute working time does not include lunch breaks.

4.6.1. Container Loading and Unloading Simulation Model

Loading and unloading system of dry port in transportation is a typical discrete event simulation system, in which the truck arrived time as well the loading and unloading amount of incoming and outgoing cargo. All the events are focus on certain distribution of discrete events. In this paper, using discrete event simulation optimization model for loading and unloading cargo in logistics system. This study represents discrete-event simulation modeling and the dry port works for 480 minutes (8 hours) in a day. It's important to make the loading and unloading system process was shown in the above figures before the simulation.

4.6.1.1. Dry Port Operation

The operation in dry port is done depending on the inspection and document checkpoint starting from Djibouti port till final destination this makes the workflow smooth through minimizing back and forth movement of documents.

This loading/unloading operation starts with different activities in the dry port. As a result of this, the model logic for full-in, full – Out, Empty-In and Empty-out operation is developed for current system using Arena simulation software and shown below from Figure 4.7 up to Figure 4.10.

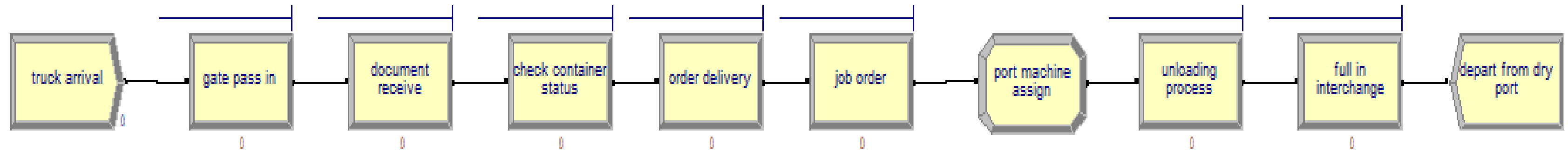


Figure 4.7. Full-In operation

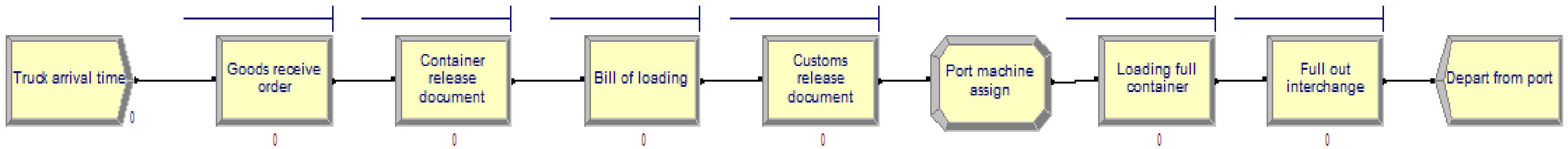


Figure 4.8. Full-Out operation

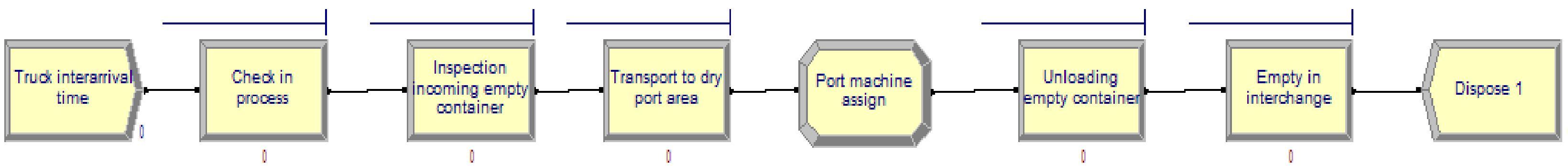


Figure 4.9. Empty-In operation

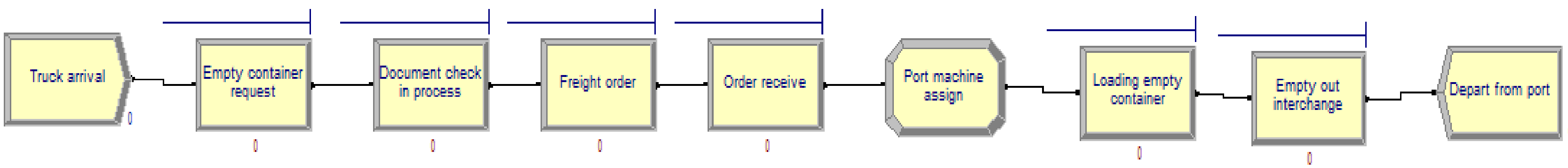


Figure 4.10. Empty-Out operation

4.7. Model Verification and Validation

A model is an intellectual and basic representation of an actual system which includes the most important system components and the behavior or interaction between these components. However, a model cannot represent the real system exactly rather it can approximate the system how it behave and interact. This is mainly due to the assumptions made while developing the model. Therefore; there is some variation between the constructed model and the real system and also influence the performance measures of the system. If the formulated model does not show the real system, outputs of the model has a bad effect on the reliability and quality of the decision that will be made. Thus, in order for this model to correctly reflect the service line behavior, it is verified and validated.

4.7.1. Model Verification

Verification is the determining processes if the operational logic is correct and is interested if we build the model in the correct way. It also assesses the correctness of the formal representation of the intended model. A model which includes all of the components specified under the system definition phase and capable of running without any errors or warnings is considered to be verified successfully. The model logic was checked whether it manifest the characteristics of the flow process of the real model. In other words, the arrival times, service time take and stations where queues are developed are examined and compared with the existing system.

During test run model working easily without any interruptions or errors under different settings of the inputs by varying the arrival times. It also performing simulation check runs and inspecting sequence pattern to confirm that the underlying program reasoning is correct which includes consistency checks. In addition simulation modeling for each dry port operation of model run with specific set of inputs and the received outputs had been compared through the use of throughputs with real outputs. The animation of each activity observed; the path was correct. Thus, this model verified and represents the actual system.

4.7.2. Model Validation

The validation process helps the researchers in knowing whether it is appropriate to proceed with the simulation study. Model verification techniques are general while the approach taken to model validation is likely to be much more specific to the model, and system, in question.

Model validation for this study is made using validity by comparing the output of the current system and the simulation model output of the existing system. If there is no significant difference between the data sets, then the model is considered valid. Conversely, if there is a difference, then the model is not valid and needs additional work before further analysis may be conducted.

To validate the model reliability by comparing the result of the real system and the model output of the existing system, a test run with 10 replications was done and the output value checked.

The model test run with 10 replications showed the output value of full in: full out and empty in: empty out containers model in the real operation system at an average per eight hours; ranges from 26 to 45 and 18 to 24 containers with an average output of 33 and 20 containers respectively. The output level the simulation model accessible per eight hour shift is 39 containers and 28 containers at an average for successive operation. Even output of the existing system highly varied, the simulation model approaches the average output of the existing system. Therefore the model can represent the actual system, and is said to be valid.

In addition to this; service line with relatively high work in progress and low work in progress in real system are also observed in the simulation model. For instance, in empty out operation observed with relatively high WIP that of 12.20 in real system but in case of empty in operation smaller WIP 2.90 in the running the simulation model for this line, this station is registered with higher and smaller level of WIP similarly other stations also observed the same phenomena. Therefore, this can also strongly validate the developed model to represent the real system.

4.8. Calculation of Replication Number

The input distributions of simulation models are usually probabilistic in nature. This input variability naturally results in some variation in the output measures of performance. Because the output measures have some variation, it is inappropriate for the simulation practitioner to recommend any given course of action based on the results from a single simulation run or replication. To reduce the chance of making a wrong recommendation, it is necessary to run a number of simulation replications and then make the recommendations based on all of the available data. The question is: If not one replication, then how many? This is the purpose of replication analysis. Number of replication is number of simulation runs that should be executed to analyze statistically the differences between the simulation model and the real system thereby we can estimate the error we introduce in modeling the real system. Chung,(2012).

In order to perform the replication calculations, we must first calculate the mean and standard deviation for the first ten replication means. The following table 4.5 shows the average output and standard deviation for ten replications of case study for the four operations.

These summary statistical values are then used to calculate what is known as the standard error of the data using the following formula. Chung,(2012) :

Standard Error = $t_{1-\alpha/2,\, n-1} * s/\sqrt{n}$ **----------------------------** *Equation 4.1*

Where,

t= t distribution for $1 - \alpha/2$

n − 1 = degrees of freedom

s= standard deviation of the replication means

n= number of observations in the sample

The standard error is essentially the amount of dispersion around the mean value that data may exhibit. The first term t comes from the t probability distribution table; the t value depends on two parameters, α level and the number of degrees of freedom.

The α level has to do with the level of confidence, for 95% confidence level the α level is 1 minus the confidence level, or 0.05. The mathematical formula for the *sample standard deviation* of the replication averages is:

$$s = \sqrt{\frac{\sum_{1}^{n} \left| \overline{x_i} - \overline{\overline{x}} \right.}{n-1}}$$ ---------------------------------- *Equation 4.2*

Where,

- **s** = standard deviation of sample
- **x_i - bar** = the replication average
- **x -bar** = average of the replication averages
- **n** = number of replications

Considering the first 10 replications, the standard deviation and half width value shown below on ***table 4.6.***

Table 4.6: - Mean standard deviation and half width for initial 10 replication

Number of Replication	FULL-IN	FULL-OUT	EMPTY-IN	EMPTY-OUT
1	4.0	6.0	4.0	4.0
2	4.50	6.00	3.50	4.00
3	4.0	6.33	3.67	4.0
4	3.5	3.25	3.75	3.75
5	3.6	6.2	3.8	3.8
6	3.5	6.12	3.83	3.67
7	3.71	6.14	3.71	3.57
8	3.63	6.13	3.75	3.5
9	3.56	6.11	3.78	3.56
10	3.7	6.1	3.8	3.6
Mean	**3.77**	**5.84**	**3.76**	**3.74**
Standard Deviation	**0.30**	**0.87**	**0.12**	**0.19**
Half width	**0.21**	**0.62**	**0.08**	**0.14**

Standard deviation measures the amount of variability or dispersion of the replication results from the mean. The half width statistic is used to help in determining the reliability of the results from the replication. In other word half width is a sampling error introduced in taking sample. Therefore, the value of half width can be simply determined by using the standard error. Considering a 95% confidence level the value of t can be read from t probability distribution table.

Hence: t (at 95%, 9) = 2.262

Half width for Full-In operation: -

$= t_{1-\alpha/2, n-1} * s/\sqrt{n}$

$= (2.262*0.30)/\sqrt{10}$

= **0.21**

Half width for Full-Out operation:-

$= t_{1-\alpha/2, n-1} * s/\sqrt{n}$

$= (2.262*0.87)/\sqrt{10}$

= **0.62**

Half width for Empty-In operation: -

$= t_{1-\alpha/2, n-1} * s/\sqrt{n}$

$= (2.262*0.12)/\sqrt{10}$

= **0.08**

Half width for Empty-Out operation:-

$= t_{1-\alpha/2, n-1} * s/\sqrt{n}$

$= (2.262*0.19)/\sqrt{10}$

= **0.14**

To achieve specific half width h, probably smaller than the one we got in the initial set of 10 replications, we set h equal to the half-width formula above and solved for n.

$$n = t^2_{1-\alpha/2, n-1} * s^2/h^2$$ ------------------------------------- *Equation 4.3*

The difficulty is that it may not solve for n since the right-hand side still depends on n. However, to get at least a rough approximation to the sample size required, the t probability distribution value replaced in the formula above with the standard normal probability distribution value. This led to the following as an approximate required sample size to achieve a confidence interval with a half width equal to a pre-specified desired value h:

$$n \cong z^2_{1-\alpha/2} \frac{s^2}{h^2}$$ --Equation 4.4

Where s is sample standard deviation from initial set of n replications. The above equation can further be approximated as:

$$n \cong n_0 \frac{h_0^{\ 2}}{h^2}.$$ ---Equation 4.5

Where,

- n_o is the number of initial replications we had and h_o is the half width. If error level from the initial sample of 10 replications is not quite satisfying, the initial half width can be reduced thus greater precision level can be achieved

Assume we wanted half width for full-in: full-out operation to be 1.25 and for empty-in: empty-out to be 1.5, and taking the value of Z at 95% confidence level to be 1.96 form z table then the number of replication for each line became:

n= $(1.96)^2 * (3.41)^2 / (1.25)^2 = 28.59 \approx 29$ replication (full-in: full –out operation) and
n= $(1.96)^2 * (4.59)^2 / (1.5)^2 = 35.97 \approx 36$ replication (empty-in: empty-out operation).

Therefore 36 replications are taken for both operations which would give low acceptable error level.

CHAPTER FIVE

5. Experimental Analysis and Results

5.1. Simulation Model Results and Analysis

Simulation result study is the examination of data generated by a model and its purpose is to forecast the performance of a system or to compare the performance of two or more substitute system designs. It also predicts the initial model performance and look after the drawbacks.

The objective of this study is to improve the performance of warehouse operation in dry port and terminal through the simulation model results for the existing activities and propose different scenarios for performance improvement.

Therefore, based on the output from simulation model the performance measures were analyzed for the existing service system and for various proposed scenarios to balance service lines, increase capacity utilization, increase output, minimize service time, minimize work in process, improve service productivity, and reduce the waiting time in providing service.

Table 5.1: - Existing Dry port operation system simulation model results

Port operation	**Average input**	**Average output**	**WIP**	**Total time (min)**	**Total Number of Resource**	**Productivity /Resource (%)**
Full in container	7.72	3.25	3.220	51.2316	9	40.62
Full out container	13.50	5.61	5.260	49.8380	11	56.10
Empty in container	6.81	2.31	2.90	56.7729	9	38.50
Empty out container	25.86	3.06	12.20	63.491	8	43.71

Output: The output value seemed similar for full in, empty in and empty out operation, but the full out operation higher than the other operation. Comparing the output values of each operation it was observed that the full out container operation might be limited due to 2.3 less service in full-out operation. From the above table the average output is multiplied by eight working hour to get containers output per day.

As a result of this WIP of the activities moved to the subsequent service day which may affect the overall service plan of the incoming days, in other word, the output of the full out operation not balanced.

Average makespan: for full-in container operation 51.23 minute, for full-out container operation 49.83 minute, for empty-in container operation 56.77 minute and for empty-out container operation 63.49 minute. The total average makes span is 221.32 minute (3.688hour).

Productivity per operator: Another scenario to show that the productivity port operation is low and is not balanced. In the above table 5.1 it's shown that productivity per operator for full-in , full-out, empty-in and empty-out operation 40.62%, 56.10%, 38.50% and 43.71% which is lower compared to planned productivity per resource 85% for all operations.

5.2. Performance measures by running the model for existing system:

5.2.1. Full In Operation System

Table 5.2: - Capacity utilization of existing full in operation

Full-In operation						
Instantaneous Utilization	**Average**	**Half Width**	**Minimum Average**	**Maximum Average**	**Minimum Value**	**Maximum Value**
Customs Officer	0.1877	0.03	0.0497	0.3359	0.00	1.0000
Forklift Operator	0.5280	0.05	0.2464	0.8175	0.00	1.0000
Port Officer 1	0.5032	0.05	0.1711	0.8402	0.00	1.0000
Port Officer 2	0.5961	0.07	0.1499	0.9466	0.00	1.0000
Port Officer 3	0.3449	0.05	0.0885	0.7139	0.00	1.0000
Port Officer 4	0.3443	0.05	0.0626	0.6477	0.00	1.0000

From the above table it can be seen that port officer 2 has the highest capacity utilization equal to 59.61% whereas customs officer has the lowest capacity utilization equal to 18.77%. Therefore, port officer 2 is the bottle neck for full –in operation.

5.2.2. Full Out Operation System

Table 5.3: - Capacity utilization of existing full out operation

Full-Out operation						
Capacity Utilization	**Average**	**Half Width**	**Minimum Average**	**Maximum Average**	**Minimum Value**	**Maximum Value**
Customs Officer	0.4097	0.01	0.3335	0.5136	0.00	1.0000
Forklift Operator	0.7982	0.01	0.7365	0.8445	0.00	1.0000
Port Officer 1	0.4901	0.01	0.4406	0.5814	0.00	1.0000
Port Officer 2	0.8984	0.02	0.7742	1.000	0.00	1.0000
Port Officer 3	0.7298	0.02	0.6469	0.8335	0.00	1.0000
Port Officer 4	0.5713	0.02	0.5031	0.6669	0.00	1.0000

From the above table it can be seen that port officer 2 has the highest capacity utilization equal to 89.84% whereas port officer 1 has the lowest capacity utilization equal to 40.97%.

5.2.3. Empty In Operation System

Table 5.4: - Capacity utilization of existing empty in operation

Empty-In operation						
Capacity Utilization	**Average**	**Half Width**	**Minimum Average**	**Maximum Average**	**Minimum Value**	**Maximum Value**
Customs Officer	0.4734	0.02	0.2868	0.6401	0.00	1.0000
Forklift Operator	0.4784	0.02	0.3750	0.5793	0.00	1.0000
Port Officer 1	0.8586	0.01	0.7548	0.9182	0.00	1.0000
Port Officer 2	0.8142	0.02	0.6395	0.9426	0.00	1.0000
Port Officer 3	0.6156	0.02	0.4743	0.7215	0.00	1.0000
Port Officer 4	0.5788	0.02	0.4386	0.7398	0.00	1.0000

From the above table it can be seen that customs office and port officer 1 has the highest capacity utilization equal to 85.86 % whereas customs officer has the lowest capacity utilization equal to 47.34%.

5.2.4. Empty Out Operation System

Table 5.5: - Capacity utilization of existing empty out operation

Empty- Out operation						
Capacity Utilization	**Average**	**Half Width**	**Minimum Average**	**Maximum Average**	**Minimum Value**	**Maximum Value**
Customs Officer	0.7157	0.03	0.5029	0.8486	0.00	1.0000
Forklift Operator	0.5972	0.05	0.1423	0.7729	0.00	1.0000
Port Officer 1	0.8715	0.03	0.6653	0.9802	0.00	1.0000
Port Officer 2	0.8551	0.02	0.7621	0.9737	0.00	1.0000
Port Officer 3	0.4106	0.03	0.1942	0.5671	0.00	1.0000
Port Officer 4	0.8417	0.02	0.6874	0.9477	0.00	1.0000

From the above table we can see clearly how the capacity utilization of different resources of operation is varied. It can be seen that port officer 1, 2 and 4 has the highest capacity utilization whereas port officer 3 has the lowest capacity utilization equal to 41.06%. This shows that the work content is not distributed uniformly among activities. In other word the activities are not balanced. Therefore, from the above dry port operation resource capacity utilization varies differently in the existing system.

5.2.5. Number of waiting time

In the existing port operation system some activities were show higher number of waiting time in comparison with other activities as shown in **table 5.6.**

Table 5.6: - Number of waiting time for existing port operation system

Port operation	Activity queue	Waiting time (min.)	Number waiting
Full-In container	Document check. Queue	2.9869	0.2858
	Order delivery. Queue	3.0279	0.2339
	Unloading process. Queue	3.6646	0.2643
Full-Out container	Container release document. Queue	3.9443	0.4927
	Loading full container. Queue	10.8206	1.127
Empty-In container	Empty in interchange. Queue	10.5695	0.3265
	Check in process. Queue	5.7311	0.4132
	Unloading empty container. Queue	4.1819	0.1729
	Order receives. Queue	17.8206	1.8467
Empty-Out container	Empty container request. Queue	12.6641	3.8069
	Freight order. Queue	11.1828	2.1335

5.2.6. Alternative Scenarios Development

This section is concerned on the development of different alternative models in which all problems that have been identified in the simulation model analysis will be seen and solved for better performance of dry port operation. To build the proposed model different analysis and decision-making are used on the existing operation. In order to improve the service line for each operation below three alternative models were proposed.

1. Changing level of resource at port operation with higher number of waiting
2. Avoiding unnecessary duplication of resources from processes with low capacity utilization
3. Merging similar operations with low resources utilization together and assign to one worker

Scenario 1. Changing level of resource at port operation with higher number of waiting

In port operation some activities with small waiting number and the number of resource capacity allocated for each activity in the existing system, due to these there is no any significant input to add resources from this operation.

Table 5.7: - Comparison on existing port operation output with simulation results

Port operation	Existing					Scenario 1				
	Average input	Average output	Total time (min)	Total Number of Resource	Productivity/Resource (%)	Average input	Average output	Total time (min)	Total Number of Resource	Productivity/Resource (%)
Full in container	7.72	3.25	51.23	9	40.62	18.5	3.78	64.64	7	53.97
Full out container	13.5	5.61	49.83	11	56.1	14.44	6.08	47.65	9	67.56
Empty in container	6.81	2.31	56.77	9	38.5	6.19	3.67	43.12	7	52.39
Empty out container	25.86	3.06	63.49	8	43.71	5.6	3.52	38.4	7	50.29

Output: The output value for full out and empty out operation, increased to 2.56 in comparison with full in and empty in operation.

Average makespan: for full-in and empty-out container operation 64.64 minute and 38.40 minute which is a bit higher from the existing 63 minute and 38.40 minute respectively, in contrast for full-out and empty-in container operation 47.65 minute and 43.13 minute decreased from the existing system.

Work in process: WIP for full-in container operation is 8.4135 which are higher from 7.6595 of the existing system and for other port operation is almost similar to existing system.

Productivity per operator: for full-in and full-out container operation improved to 53.97% and 67.56% from 46.25% and 61.0% of the existing system. In other word, the distribution of work content among operations is improved.

Table 5.8: - Scenario 1 proposed dry port operation simulation model number waiting

Port operation	Activity queue	Existing Model		Scenario 1	
		Waiting time	Number waiting	Waiting time	Number waiting
Full-In container	Document check. Queue	3.7155	0.4879	2.4675	0.3193
	Full in interchange. Queue	5.2449	0.2567	7.0691	0.3759
	Gates pass in. Queue	11.9441	2.5752	12.2558	2.7121
	Unloading process. Queue	3.5233	0.2398	4.4459	0.3342
Full-Out container	Goods receiving order. Queue	1.8675	0.2752	1.7721	0.2568
	Loading full container. Queue	15.43	1.9963	15.7422	1.9963
Empty-In container	Unloading empty container. Queue	0.6556	0.0317	0.4135	0.02
Empty-Out container	Empty out interchange. Queue	1.3157	0.0505	1.136	0.0474
	Loading empty container. Queue	0.3367	0.0162	0.4516	0.022

Scenario 2. Avoiding unnecessary duplication of resources from processes with low capacity utilization

Some port operation have multiple resources but their capacity utilization is below 50%. In this activity unnecessary duplication of resources exists. Therefore, these unnecessary duplication resources should be deducted from the operation. From the capacity utilization tables presented above these activities and their corresponding capacity utilization and average number of busy resources are presented in the following table.

Table 5.9: - Scenario 2 proposed dry port operation simulation model capacity utilization

Port operation	Capacity Utilization	Existing Model		Scenario 2		
		Average	**Scheduled Capacity**	**Average**	**Number of deducted capacity**	**Resource Utilization**
Full-In container	Customs officer	0.2719	3	0.7759	1	2
Full-Out container	Port officer 2	0.3818	2	0.8449	1	1
	Port officer 3	0.4025	2	0.8510	1	1
	Port officer 4	0.3136	2	0.6195	1	1
Empty-In container	Port officer 1	0.3649	2	0.6231	-	2
	Port officer 2	0.2878	2	0.8827	1	1
	Port officer 3	0.1829	2	0.7535	1	1
Empty-Out container	Customs officer	0.1388	3	0.4271	1	2
	Port officer 1	0.2313	2	0.4958	-	2
	Port officer 2	0.2960	2	0.5493	1	1
	Port officer 3	0.1529	2	0.3708	1	1
	Port officer 4	0.3994	1	0.3721	1	0
Total			**25**		**10**	**15**

From the above comparison tables of each operation, we can observe that how the different resource improved for the proposed scenarios 2 with respect to the existing port operation system. The second scenario show an increment in capacity utilization almost all port activities through minimization of duplicated resources with low utilization this gives the best performance improvement results.

Scenario 3. Merging similar operations with low resources utilization together and assign to one worker

By combining both alternative scenarios (1&2) based on the data analysis simulation model for similar activities to improve further the results. Through categorizing similar operation for full-in: full-out and empty-in : empty-out operation by resource level merged and varied by trial and error to see whether the utilization improved or not. For some few specific operations to handle two or more operations by optimal machine operator training needs to be consider to improve the productivity of the operator. Assuming that training is given and machine operator capable to work in two or more operations. For both operation with the same type of resource (machines) and human power merge made and listed in Table 5.10.

Table 5.10: - Scenario 3 proposed dry port operation simulation model capacity utilization

Port operation	Activity	Average input	Average output	WIP	Total time (min)	Total Number of Resource	Productivity/ Resource (%)
Full-In : Full-Out	Full-In Containers	17.2222	1.6389	8.5121	52.1744	4	84.72
	Full-Out Containers	28.888	1.7500	15.078	70.6469		
Empty-In: Empty-Out	Empty-In Containers	12.5556	1.4722	6.887	50.3185	4	63.195
	Empty-Out Containers	11.0556	1.0556	6.1619	41.9201		
Total						**8**	

Productivity per operator: through merging similar operation in the dry port, the productivity per operator for full-in: full-out operation improved to 84.72% from 48.36% of the existing system and for empty-in: empty-out operation the productivity improved from 41.11% to 63.20% of the existing operation. Even if the WIP increased for both operation of productivity is improved.

Table 5.11: - Capacity utilization for proposed dry port operation simulation model

Capacity Utilization	Full-In: Full-Out operation		Empty-In: Empty-Out operation	
	Existing Average	Scenario 3 Average	Existing Average	Scenario 3 Average
Customs Officer	0.4734	0.7259	0.41325	0.9322
Forklift Operator	0.7034	0.8033	0.62485	0.7576
Port Officer 1	0.6623	1.00	0.2981	1.000
Port Officer 2	0.4733	0.8831	0.2919	0.9081
Port Officer 3	0.4804	0.6976	0.1679	0.9064

From the above comparison tables of each operation, we can observe that how the different resource improved for the proposed scenarios with respect to the existing port operation system. The last scenario three gives the best performance improvement results. Therefore; it is recommended that the enterprise to take into consideration this developed scenario.

Furthermore, if the company may not select scenario three as best performance improvement it is better to choose the second scenario as alternatives through avoiding unnecessary duplication of resources from service with low capacity utilization to improve the operation.

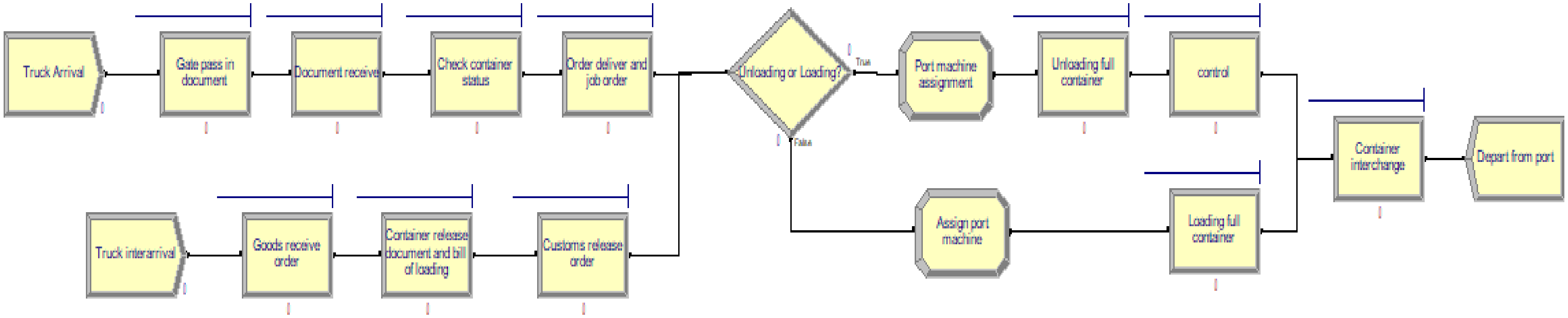


Figure 5.7. Proposed Full-In: Full-out operation simulation model

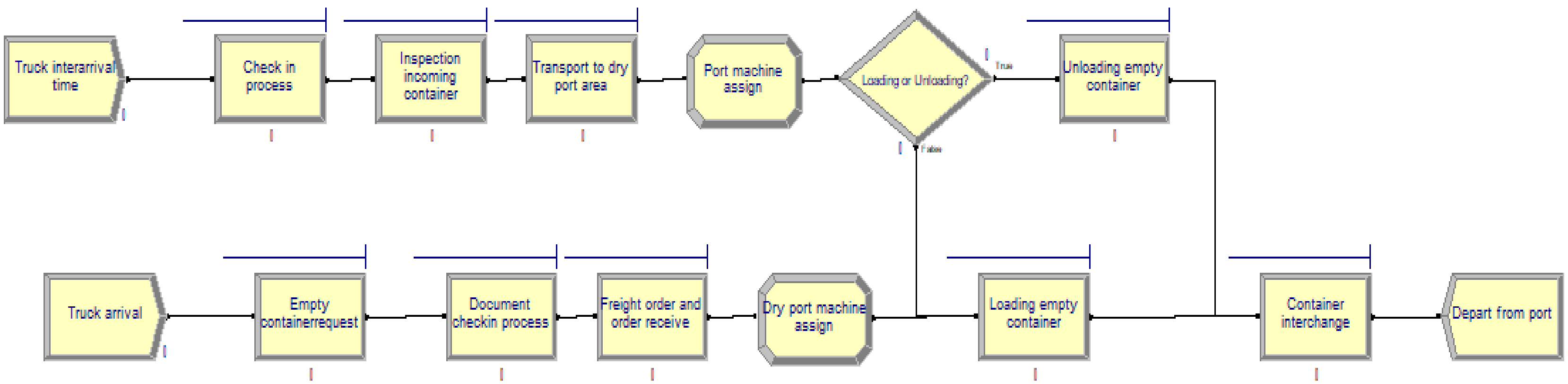


Figure 5.8. Proposed Empty-In: Empty-out operation simulation model

5.3. Improvement Results and Discussion

From the above simulation model output measures of concern between the existing system and the improved system, it is clearly assumed that the improved system with the model developed has shown significant improvements in different aspects.

Based on the generated report problem areas of the current system identified and analyzed in terms of output, work in process, capacity utilization, productivity per operator, Number of operator/resources and waiting time in queue. The results forecast there is a gap in resource utilization and consecutively low output on the operation. Output differences shown with in each operation, as a result of this relatively higher WIP observed in the operations. We also observe Low capacity utilization and duplicated outcomes seen with some waiting time and also productivity per operator is low.

In order to improve identified gaps, there are different possibilities to manipulate the existing model. This research addressed three major decision options(scenarios) to propose improved model. The first scenario is changing level of resource at port operation with higher number of waiting. The second one is avoiding unnecessary duplication resource from processes with low capacity utilization to increase the operation output and capacity utilization. Lastly, by observing the result of the first and the second scenario third scenario focused on merge similar operations with low resource utilization together by enhancing the operator skill and assign to one worker the service time operation developed.

Average makespan for full-in container operation 51.23 minute, full-out container operation 49.83 minute, empty-in container operation 56.77 minute and empty-out container operation 63.49 minute. The total average makes span is 221.32 minute (3.68hour).

The proposed model showed the makespan of the simulation for full-in: full-out operation becomes 61.41 minute which was initially 50.54 minute whereas for empty-in: empty-out operation becomes 46.11 minute which was initially 60.13 minute. In addition, the number of resources reduced to 12 from existing 25 and capacity utilization of each operation improved. Percentage of productivity per operator for full-in: full-out operation and empty-in: empty- out operation improved to 84.72% from existing 48.36% and 63.19% from existing 41.11% respectively, still for empty operation lower as the productivity per operator.

Table 5.12: - Comparison of dry port operation simulation model scenarios

Port Operation	Scenarios	Input	Output	Makespan	Total Number of Resource	Productivity/Resource (%)
Full in: Full Out	Existing System	10.61	4.43	50.535	10	48.36
	Scenario 1	16.47	4.93	56.14	8	60.76
	Scenario 3	23.05	1.694	61.41	4	84.72
Empty in: Empty Out	Existing System	16.34	2.685	60.132	9	41.11
	Scenario 1	5.89	3.59	40.76	7	51.34
	Scenario 3	11.81	1.264	46.112	8	63.195

Among the three developed scenarios, the third scenario, 'Merge similar operations with low resource utilization together by enhancing the operator skill and assign to one worker' gives better performance of dry port and warehouse activities for the identified operation.

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

In this study performance improvement is an important concern in dry port and warehouse operation industry in order to satisfy customer requirements. The enterprise profit earning of terminal and warehouse activities largely depends on throughput improvement. It has been done in actual dry port and warehouse operation using simulation model. Dry port operation analysis has been started with activity of collecting the appropriate data, representing these data in understandable manner, identify the relevant performance indicators and interpreting these figures, to understand or clarify service losses and transform the activity into information on port operation effectiveness.

Through understanding the existing problems and used as performance indicator to measures, analysis and identifies warehouse process that indicate area of improvement, priorities improvement efforts and provides recommended strategy to be implemented to improve operation and service requirements for better customer satisfaction. Simulation models were built for warehouse and terminal service to provide a deep understanding of the process, to understand real back ground of the performance reduction, to find as well as to test appropriate improvements before implementing on the actual system for enhancing performance and the improvement of the operation system.

This research concerned with the performance improvement of warehouse operation in the case study taken for Ethiopian shipping and logistics service enterprise. In order to achieve customers demand orders on time it is essential to recognize the existing situation of a system. By using Arena simulation software to imitate the real operation system to describe a behavior of the activities and to generate alternative operations for performance improvement.

The research focused on dry port incoming and outgoing cargoes which consist of four activities that of full in, full out, empty in and empty out operations. All the necessary data collected for each operations and analyzed with the help of arena input analyzer to develop simulation model for the existing operation. After verifying and validating, system runs with 36 replications to generate the simulation results report. The following conclusions are drawn based on the results of the study:

- Simulation model for the existing operation system has been developed using ARENA software under varying set of conditions, background of challenges, options of failure reduction, and service performance measures in the improvement area has been studied in detail, as a result, high waiting time, frequent failure and duplicated resource utilization has been identified as reasons for lower performance. Thus, identifying the problems from the current operation to start improvements.
- The proposed model showed the makespan of the simulation for full-in: full-out operation becomes 61.41 minute which was initially 50.54 minute whereas for empty-in: empty-out operation becomes 46.11 minute which was initially 60.13 minute.
- The number of resources reduced to 12 from existing 25 and capacity utilization of each operation improved. Percentage of productivity per operator for full-in: full-out operation and empty-in: empty- out operation improved to 84.72% from existing 48.36% and 63.19% from existing 41.11% respectively, still for empty operation lower as the productivity per operator.
- Strategies in the forms of action plan to be implemented by the company and the major challenging areas and related problems are documented for further improvements. Proper implementation has been expected to enhance performance through setting of changes and modifications to system model have been suggested and an improved model was developed.

Thus, company can meet the requirement demand; reduce service waiting time, enhance service capacity to increase its competitiveness and improve its operational as well as performance in the logistics sectors. Therefore, it can be concluded that the service productivity analysis and proposed model is beneficial to the company. Still there is a possibility for further performance improvement which is not addressed due to time constraint for this research work.

6.2. Recommendation

Based on the result of this study, the researcher recommends the following specific points.

- The enterprise loses opportunities in capacity and resource utilizations, improving the resource allocation to have sufficient number of fork lifts and other related machine to improve loading and unloading and also help to minimize waiting time in relation with ensuring quick delivery and customer satisfaction of services for better supply chain operations.
- As mentioned above, simulation modeling plays a great role in designing a model of a real system and conducting experiments. I strongly recommend not only for service providing company in Ethiopian but also for manufacturing industry to use and adapt the commercial simulation software like Arena in order to solve all the above stated performance related problems; the enterprise should revise the proposed scenarios and apply it for better performance of the dry port and warehouse operation for their business come to success.
- The enterprise may arrange a scheduled training program on performance improvement will help the enterprise to improve the productivity of machinery and workers.
- This research study invites other interested researchers and stakeholders in order to make similar or alternative research analysis on other dry ports that the customers can use.

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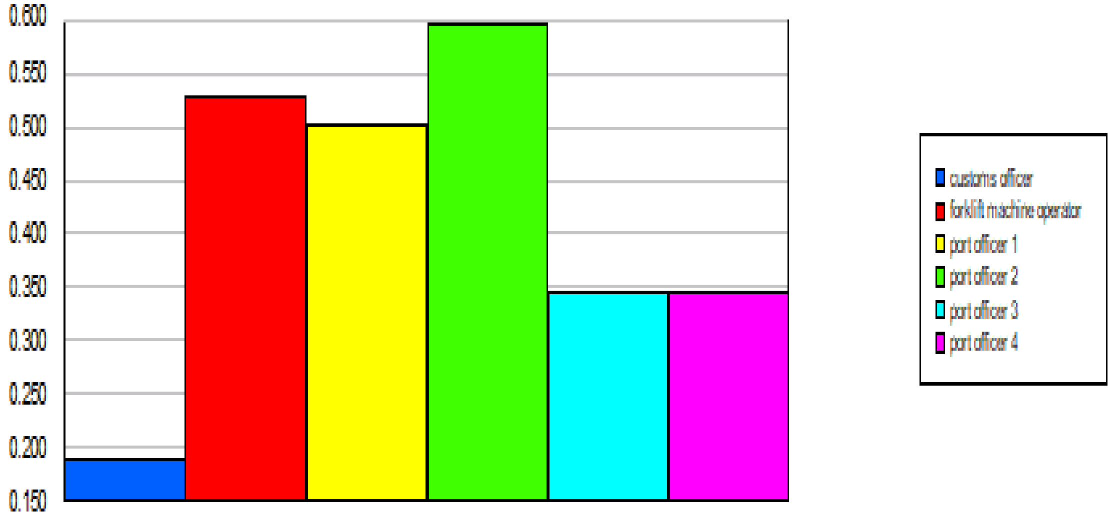
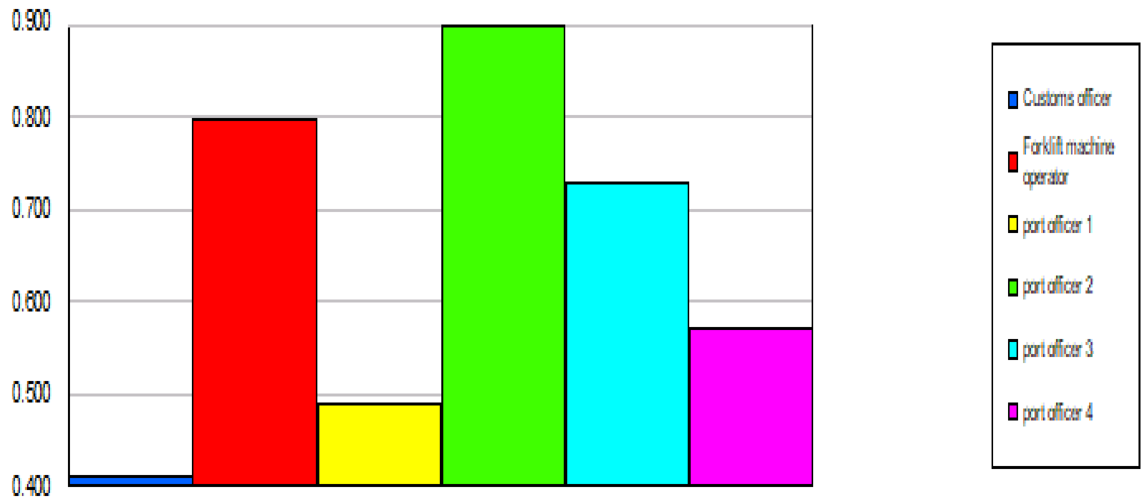
Annexes

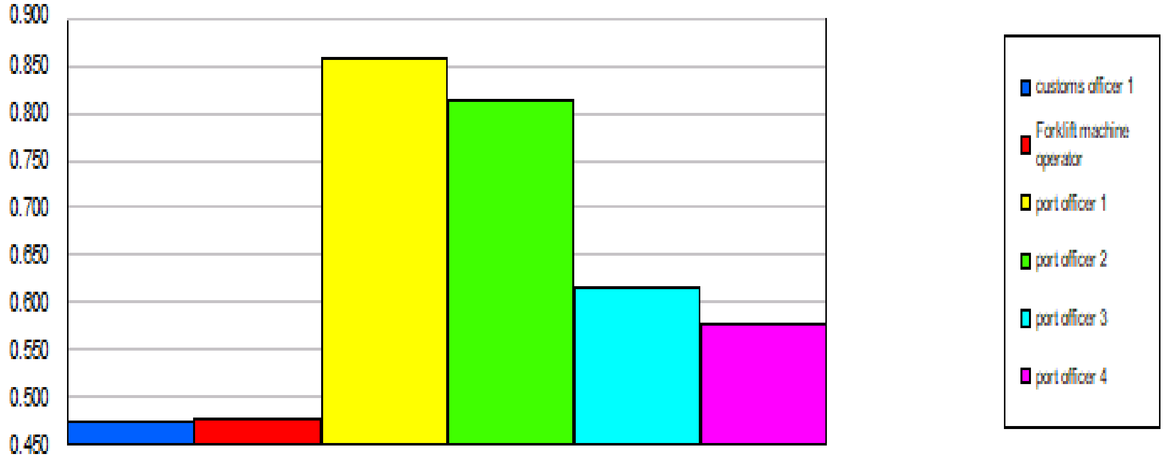
Annex A: **- Instantaneous capacity utilization**



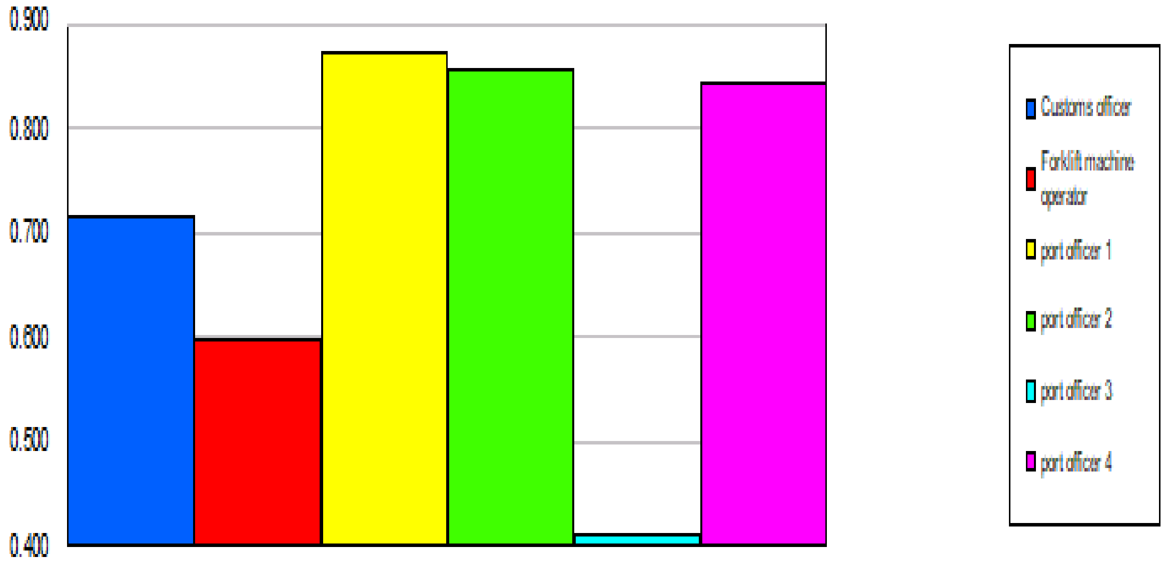
(a) full-in operation



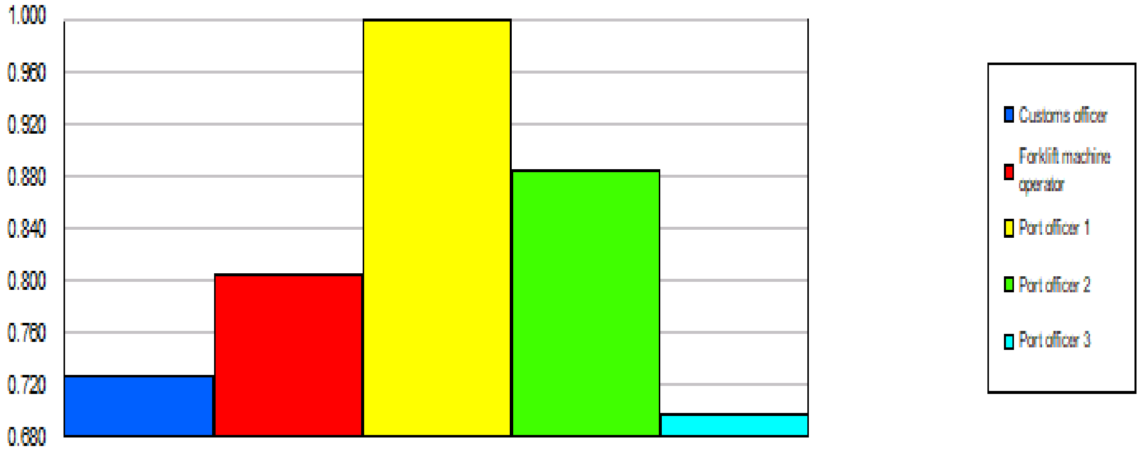
(b) full-out operation



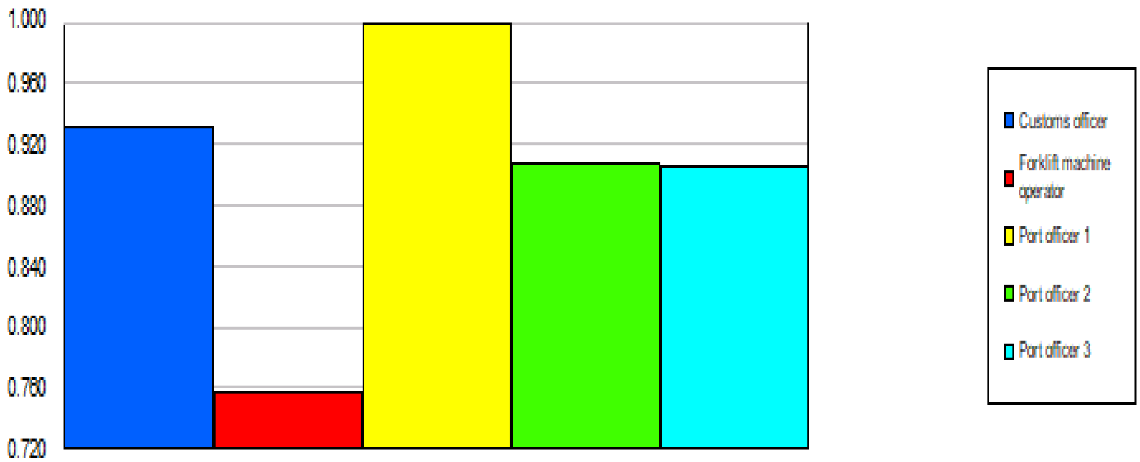
(c) empty-in operation



(d) empty-out operation



(e)Full-In: Full-out operation



(f) Empty-In: Empty-out operation