



**EVALUATING AND RANKING FACTORS AFFECTING OPERATIONS OF DRY
PORT THROUGH DECISION MAKING MODEL: A CASE OF MODJO DRY PORT**

MSc THESIS

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HAWASSA UNIVERSITY, HAWASSA, ETHIOPIA

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**A THESIS SUBMITTED TO
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Approved by Board of Examiners

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I, hereby declare that this master of science thesis is my original work and all sources of materials used for the thesis have been duly acknowledged. I further confirm that the thesis has not been submitted and presented to any other higher learning institution for a similar or any other degree award.

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List of Acronyms

AHP	Analytical Hierarchical Process
CFS	Container Freight Station
CTT	Container Tracking and Tracing
ESCAP	Economic and Social Commission for Asia and the Pacific
ESLSE	Ethiopian Shipping and Logistics Service Enterprise
FCL	Full Container Load
ICD	Inland Container Depot
ICT	Information Communication Technology
IT	Information Technology
JICA	Japan International Cooperation Agency
LCL	Less Container Load
MCDM	Multicriteria Decision Making
MDP	Modjo Dry Port
PCS	Port Community Systems
PPP	Private and Public Partnership
RFID	Radio Frequency Identification
RMGs	Rail mounted Gantry cranes
RTGs	Rubber Tyre Gantry cranes
UNDP/Ethiopia	United Nation Developmental Program for Ethiopia
UNCTAD	United Nations Conference on Trade And Development
UNECA	United Nation Economic Commission for Africa
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
WB	World Bank

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Abstract

Currently, there are a number of factors that affect dry port operations and these factors need to be identified systematically in order to evaluate significant factors that are highly constrained to their operations. In this regard, this study is aimed to identify the factors that affect the operations of MDP and ranking according to the level of significant impact from top to bottom by developing Analytical Hierarchical Process (AHP) model. A qualitative and quantitative method of research approach was employed and both primary and secondary data were collected. For primary data collection, the researcher used both probability and non-probability sampling techniques in which the samples were selected by stratified and purposive sampling respectively from the target population of MDP. Meanwhile, secondary data was collected from published documents or databases such as books, journals, reports, official websites, etc. This work also examines the critical factors contributing to the success of MDP operations. Finding suggests that five main factors and nineteen sub-factors that affect the operations of MDP were identified. From the main factors, information systems are the dominant factor affecting MDP operations followed by service features, dry port capacity, government policy, and hinterland conditions, which took the last place. Furthermore, from the overall factors investigated in this study, lack of coordination between stakeholders and inadequate customs clearance process are the influential factors ranked as the 1st and 2nd level affecting the operations of MDP respectively. The implications of this finding suggested that managers should pay more attention to top-ranked factors and the significance of the research is expected to be of managerial value to dry port operators when eliminating high operational constraint factors to improve the efficiency of MDP operations.

Keywords: Analytical Hierarchy Process (AHP), Critical success factors, Dry port, Operational factors.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

The increased vessel size scale and maritime transport massification put high pressure on seaports and transport networks of hinterlands. To reduce this pressure inland nodes or dry ports play an important role in improving seaport and hinterland transport connectivity (Nguyen & Notteboom, 2019). Dry ports are playing an important role for seaports, to face the instability of global trade and to fulfill the need for regional transport economic scale. The dynamic change of maritime business, from various components like shipping activities, seaport operations, and inland networks has brought significant influence on container seaport competitions. Hence, dry ports have become the main component for seaports to sustain a competitive market (J Jeevan *et al.*, 2017).

The term dry port is used interchangeably with the terminologies such as inland container depot, inland port, freight village, inland terminals, and others. Within these terminologies, the dry port concept rotates around three major areas; first offer service similar to seaports, second high-capacity transport link such as rail, road, and the inland waterway to its seaport, and thirdly intermodal terminal facility where modal shifts take place. This dry port concept has been applied both in developing and developed countries by different names, but with similar purposes like reducing the congestion around seaports, promoting modal shift, and improving transport accessibility between hinterland trade zones and seaports (Nguyen & Notteboom, 2019).

Countries that are less connected with the rest of the world, face challenges of access to maritime transport where the shippers travel long distances to reach seaports in neighboring countries. These long distances to the seaport result in high transport costs driven by complex logistics. However, dry ports located in landlocked countries, connected to the seaports with efficient transport mode represent an economic tool for minimizing maritime transport access challenges and promoting economic growth and competitiveness of landlocked countries (Charuka, 2014). With the growing demand for integrated logistics services and intensifying port competition, the role of the dry port has evolved from the traditional functions of cargo handling and temporary storage to becoming an integral part of the global supply chain. In this

global supply chain, a dry port should collaborate and cooperate with its supply chain partners for providing value-added services to port users (Han, 2018).

However, dry ports face challenges in operations such as difficulty in meeting different stakeholder's objectives, having port capacity constraints, limited availability of transportation modes, and being located at less strategic zones which have a significant impact on its operations (Obed, 2013; UNCTAD, 2019). The report of ESCAP (2019) shows many of the existing dry ports have struggled to meet the challenge of current growth of container transport, operationally inefficient, lack specialist terminal operators and modern technology, display limited functional integration, and suffer restrictions on maritime and landside access.

By examining theoretical and empirical literature on factors that influence dry port operations, as well as conducting empirical study on Modjo Dry Port in Ethiopia, this study evaluates and ranks factors that affect the operations of dry ports. Ethiopia, one of the landlocked and developing countries in East Africa is enjoying a period of rapid growth in the past decade and within this period Ethiopia's international trade has grown rapidly. Currently, the country is served by the Ethiopia-Djibouti corridor linking Ethiopia to the port of Djibouti. The country has no access to seaports and is far from neighboring ports faced with the challenges to global integration and rapid economic growth (Debela, 2013).

To tackle this problem the country develops several operational dry ports. The main one of these is Modjo Dry Port, which was established a decade ago along the Ethio-Djibouti corridor which is the largest corridor account 95% of country import-export and the dry port has been identified by Ethiopia government as the key logistics node for the emerging country intermodal trade (WB, 2017). The recent growth in cargo traffic along this corridor motivated the use of Modjo Dry Port as a transshipment node of import/export of containers. According to World Bank report, the dry port is playing an important role to facilitate the quick clearing of import traffic from Djibouti seaport, be a hub for the consolidation of export goods, deconsolidation point for imports goods and provide a range of modern logistics services to support the country's emerging manufacturing industries. In additions, the dry port offer service such as loading and unloading, temporary storage, weighbridge service, container maintenance and wash service, inland custom clearance process, insurance and banking service (Georgise *et al.*,

2020) and quality and standard control, warehousing, stuffing and unstuffing and different transport service (Alo *et al.*, 2020).

Nevertheless, most research conducted in the area investigated that the dry port has not been able to serve the purpose for what is established and not operated at its intended capacities. To improve operational efficiency and capacity utilization of Modjo Dry Port, it is important to identify the influential factors that affect their operations and rank factors accordingly from most significant impact to least. This objective is met in this study by conducting an empirical study on Modjo dry port staff, to evaluate the influential factors of Modjo Dry Port operations, based on which improvement strategies are proposed.

1.2 Statement of problem

The introduction of dry port is emerging in the countries, to tackle the operational constraints related to seaports and for cost-effective use of the transport infrastructure. According to ESLSE report shows there are eight operational dry ports in Ethiopia such as Modjo, Kality, Mekele, Semera, Kombolcha, Gelan, Dire Dawa and the recent one Woreta. Of these Modjo Dry Port is the largest port that covers about 78% of freight shipment under the Ethiopian shipping line service enterprise (WB, 2017).

In Modjo Dry Port, to provide modern logistics services and increase the holding capacity of the dry port, massive expansion work was done from time to time. But still, there are significant operational constraints and cannot provide necessary services to handle the continued growth of trade traffic flow through Modjo Dry Port that leads to congestion, long delivery time, high material operational cost, and increased total logistics cost (WB, 2017). There is underinvestment in infrastructural facilities, insufficient information systems, poor service quality, increased congestion around the facility and lengthy of custom clearing procedures which causes long delays, unnecessary costs to the port and significant uncertainties in MDP (Alo *et al.*, 2020). Modjo dry port face continued pressure to handle higher throughput, improve productivity, and adopt new technology and ICT systems that can meet the increasingly demanding service standards expected by importers, exporters, logistics companies, freight forwarders and shipping operators (Alebachew, 2020). Generally, most research conducted in the area investigated that the dry port has not been able to serve the purpose for what is

established and not operated at its intended capacities. This can be due to the lack of systematic procedures to identify the factors that largely affect their operations and the influence of each factor on dry port operations to take managerial actions.

So, it is important to evaluate factors that influence dry port operations and identifying these factors systematically according to their significant impact, help in taking managerial decisions, improve operational efficiency and capacity utilization. Based on this implication, by examining related reviews of the worldwide operations of dry ports and conducting an empirical study on the Modjo Dry Port in Ethiopia, this work identifies and ranks factors that affect dry port operations according to their significant impact using Analytical Hierarchical Process (AHP). Therefore, the study aimed to evaluate and rank factors affecting the operations of Modjo Dry Port operations through a decision-making model.

1.3 Research questions

In connection with the aim and objectives of this study, the following research questions are set to guide the study.

1. What are the factors that affect the operations of Modjo Dry Port and which factors have a significant impact?
2. How do these factors influence Modjo Dry Port operations?
3. How do top ranked critical success factors perform in Modjo Dry Port operations?

1.4 Objective of the study

1.4.1 General objective

The general object of the study is to evaluate and rank factors affecting the operations of Modjo Dry Port through decision making model.

1.4.2 Specific objectives

- To identify factors, affect the operations of Modjo Dry Port.
- To rank and weight the factors according to their significant impact on Modjo Dry Port operations.
- To assess the influence of identified factors on Modjo Dry Port operations.

- To examine the level of Modjo Dry Port considering critical factors that contribute to its success.

1.5 Significance of the study

The dry port concept is a recent phenomenon in Ethiopia compared to other economically emerged countries. As a result, it might be difficult to identify problems that can affect the effectiveness and efficiency of dry ports in the country. Identifying the relative influence of such factors would help governments and other concerned bodies who can implement corrective actions to these factors affect dry port operations. In addition to these further researches would be undertaken considering this study as the initial effort of literature.

1.6 Scope of the study

This study was conducted to evaluate and rank factors that affect operations of Modjo Dry Port in Ethiopia and critical factors contributing to the success of its operations. Currently in Ethiopia, among the planned dry ports, Modjo, Kality, Mekele, Semera, Kombolcha, Gelan, Dire Dawa and Woreta Dry Ports have become operational. Of these, Modjo Dry Port is the largest port that covers about 78% of freight shipment under the Ethiopian shipping line service enterprise (WB, 2017). Due to time and budget constraints, the study was not permitted to cover all dry ports in Ethiopia and only concentrate on Modjo Dry Port. Furthermore, the study did not include all variables that have factors on operations of the dry port but the major factors were assessed.

1.7 Limitation of the study

The study is limited to only one dry port which is Modjo Dry Port and the conclusion drawn from the study did not generalize the existence of factors identified for other dry ports. Because operation in some dry ports may be different due to different criteria and condones. Another limitation of this study is related to the sampling technique used. The researcher used both probability and non-probability sampling and in non-probability sampling, there might be the risk of the sample being unrepresentative of the targeted population but care has been taken in selecting experts of individuals who can provide accurate and reliable information. Furthermore, the current COVID-19 situation has also restricted the researcher to conduct the focus group discussion. However, the researcher developed the research questions they are most

suitable for answering as well as specific ethical issues that were required to protect COVID-19 was considered.

1.8 Organization of the thesis

The research report consists of 5 chapters, which is organized as follows: Chapter One is an introductory part in which the background of the study, statement of the research problem, research questions, objectives of the study, significance of the study, scope and limitation of the study was presented. Chapter two of this study, reviews the literature on concepts of dry ports, factors affecting dry port operations, dry ports in east Africa, dry ports in Ethiopia, applications of AHP in ports and dry ports, research gap and conceptual framework were discussed. The third chapter presents a methodology, which includes description of the study area, research approach, source of data, sample size and sampling techniques, tools and methods of data collection, methods of data analysis and interpretation. In chapter four, results and analysis on the findings of this study are incorporated and finally, in chapter five conclusion, recommendations and future work are presented.

CHAPTER TWO: LITERATURE REVIEW

2.1 Concepts of dry port

Logistics services which include activities required for the transportation, storage and handling of production inputs and finished products from producers to consumers play a critical role in international trade (Caldeirinha et al., 2015). Thus, the ability of countries to deliver and/or receive goods and services on time at the lowest possible cost in international trade is a key determinant of integration into the world economy (Debela, 2013). Compared to landlocked countries, countries with seaport access are more integrated into the world economy. Because seaports are important nodes in intermodal transport and their earlier narrow focus on cargo handling has been replaced with a wide range of logistic activities giving the seaports a more active role in the transport chain (Roso & Lumsden, 2009).

Market demand factors such as door-to-door distribution and just-in-time delivery have contributed to the strong growth in both road and rail transport sectors. This heavy reliance on ground transport has resulted in increased traffic congestion, worsened bottlenecks throughout the network, road deterioration, air pollution, highway accidents, and fuel consumption (Chakwizira *et al.*, 2014). In addition to this in recent years, because of the growth of the volume of trade containers and congestion of seaports due to insufficient and incompatible infrastructures, dry ports have proven to be important nodes in the transportation chain. Due to this, global maritime logistics often consider the presence of dry port/inland freight terminals as a place where consolidation of goods, custom services, information processing activities, short-term storage and value-added services for the containerized goods take place before shipment toward the next destinations (Crainic *et al.*, 2015).

Similarly, the dry port concept has gained significant attention among researchers all around the world, due to its potential to improve hinterland intermodal transportation, generate economic benefits, and reduce environmental impacts (Khaslavskaya & Roso, 2020). By being a one-stop center, close to a high capacity transport network, and offering customs clearance services, a dry port reduces cargo flow time, increases speed and reduces operational costs (Gerald & Jin, 2016). Since a dry port should act as the seaport's inland interface, shifting port

services to an inland region, provides development and generates new employment (A. Ng & Tongzon, 2010).

The motivation of dry port development in some instances highlights gaps in conventional inland freight distribution that require different mitigation measures. First, the intensified activities at the main seaport facility with limited land availability for expansion prompt search for lower-valued land locations to support less demanding freight activities. Secondly, the increasing goods flow has resulted in growing road traffic and intensified maritime traffic congestion at the seaport. This seaport capacity inadequacy and lack of efficiency is another major reason for the development of dry ports. The third reason is that dry ports have been found to offer relatively higher levels of accessibility resulting from lower costs of distribution with improved capacities via the long-distance transport corridors. The fourth major factor that motivates the development of the dry port concept is to do with environmental challenges associated with cargo haulage activities. Because inadequate transport networks and traffic congestion have significantly undesirable impacts on the natural environment through local and global environmental pollution (Abdoulkarim *et al.*, 2019).

From these points of view, a dry port defined as cargo-handling facilities allows several functions to be carried out such as consolidation and distribution, temporary storage, customs clearance and connection between different transport modes. This is further discussed by M.Hemalatha & G.B.Karthikeyan (2017), as a dry port is an intermodal terminal situated in the hinterland servicing a region connected with one or several ports by rail and/or road transport and is offering specialized services between the dry port and the overseas destinations.

According to Roso *et al.* (2009), a dry port was defined as an inland intermodal terminal directly connected to seaports with high capacity transports meant, where customers can leave and pick up their standardized units as if dealing directly with a seaport. It's a logistics node that improves cost-efficiency, environmental performance, and the quality of hinterland network connections (Woxenius & Bergqvist, 2009). In line with this, dry ports could make goods handling more efficient, and shifting freight volumes from road to rail (between the port and dry port) could result in a lower environmental impact (Oláh *et al.*, 2018).

Dry ports can be developed in the hinterland based on different approaches, involving different criteria, need and the center of gravity favorable to the shipper's logistical models. Nevertheless, dry port development should be evaluated with its cost functions and also value-added services that can be provided to every stakeholder in the logistics network. From a functionality and location perspective, dry ports are categorized as close, mid-range, and distant dry ports by the distance to seaports (Roso & Lumsden, 2009).

Close dry ports are located close to the seaport with a strong link between on-dock and off-dock terminals. They act as extensions of seaports to deal with problems at seaport terminals, such as land shortage, congestion, and local environmental impacts. These all high space-consuming activities, such as warehousing or sorting and customs clearance procedures are shifted from seaports to close dry ports (Degbe & Song, 2019). The close dry port consolidates road transport to and from shippers outside the city area. Compared with the two dry ports, a close dry port offers larger possibilities for buffering containers and even loading them on the rail shuttle in sequence to synchronize with the loading of a ship in the port that results in reliable rail service in reducing dwell times of container vessels. Also, close dry ports help in reducing seaport gate congestion from shippers at long or midrange distances (Roso & Lumsden, 2009).

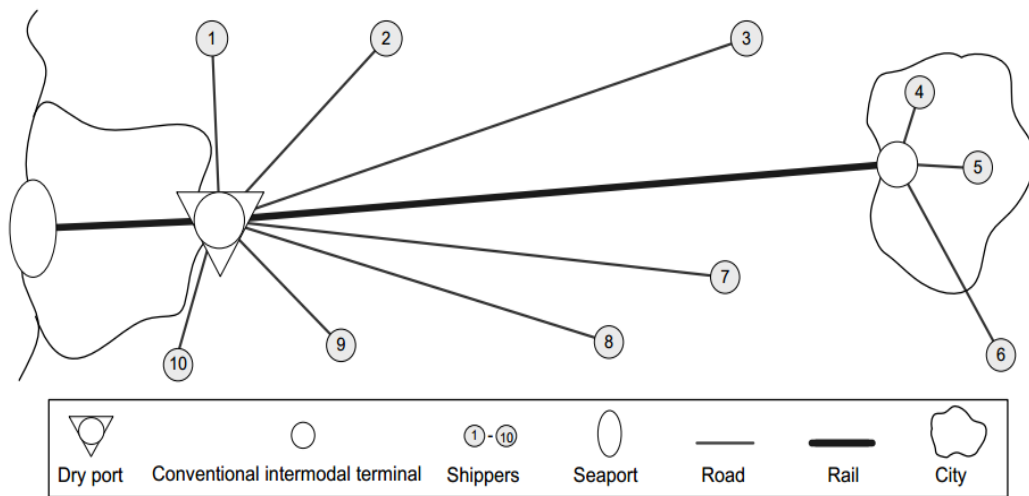


Figure 2.1: A seaport with a close dry port (Roso & Lumsden, 2009)

A mid-range dry port is set around the middle point between a seaport and its end market and works as a consolidation and deconsolidation point for different rail services. These dry ports are more beneficial to the seaports because it increases the hinterland access in getting close to

customers. Environmental pollution and traffic congestion are also tackled by the implementing modal shift from trucks to trains (Degbe & Song, 2019).

A midrange dry port is located within a distance from the port generally covered by road transport. But price and service quality are competing for traffic modes, the competitiveness of intermodal road-rail transport depends on geographical and demographical conditions. In addition to achieving high frequency by consolidating flows together for different rail services, midrange dry port implying administration and technical equipment specific for sea transport (Roso & Lumsden, 2009).

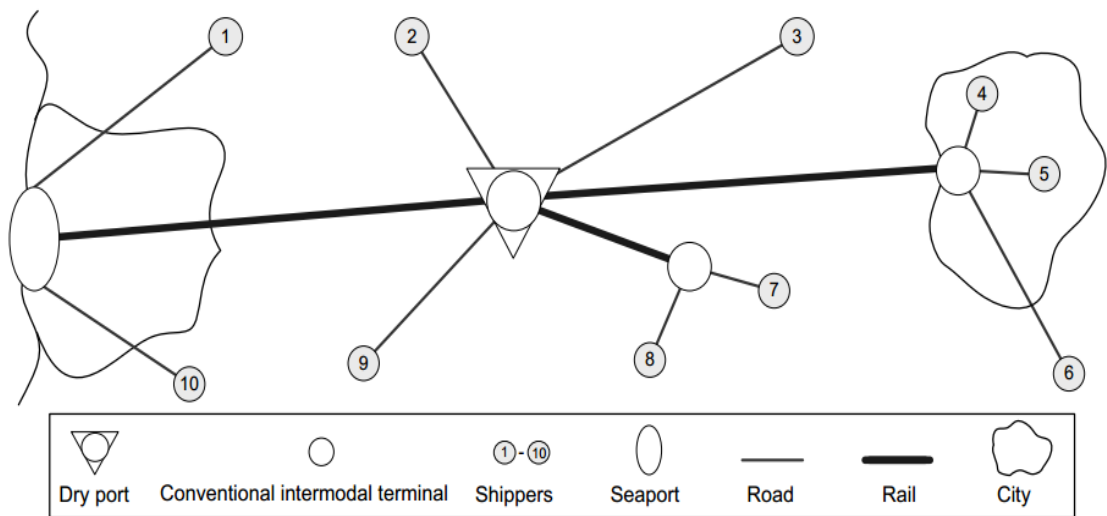


Figure 2.2: A seaport with a mid-range dry port (Roso & Lumsden, 2009)

Distant dry ports are located in the proximity of the end markets, which might be the consuming area in import-based supply chains or a core production location in export-based supply chains. This type of dry port plays an important role in the logistics system of landlocked countries to connect to international markets. In this case, the seaport will benefit from the connection to this type of dry port by gaining access to the inland market (Degbe & Song, 2019).

A distant dry port is the most conventional of the three and has the longest history because the distance and the size of the flow make rail viable, which promotes economies of scale on high capacities and long-distance links. The other benefits of distant dry ports are related to the modal shift from road to rail that results in reduced congestion at the seaport gates and cost of delivery. For example, one train can substitute about 35 lorries in Europe and more than 100 in

the US. A well-implemented distant dry port offers a greater range of logistics services for wider hinterland shippers at low cost and high-quality services (Roso & Lumsden, 2009).

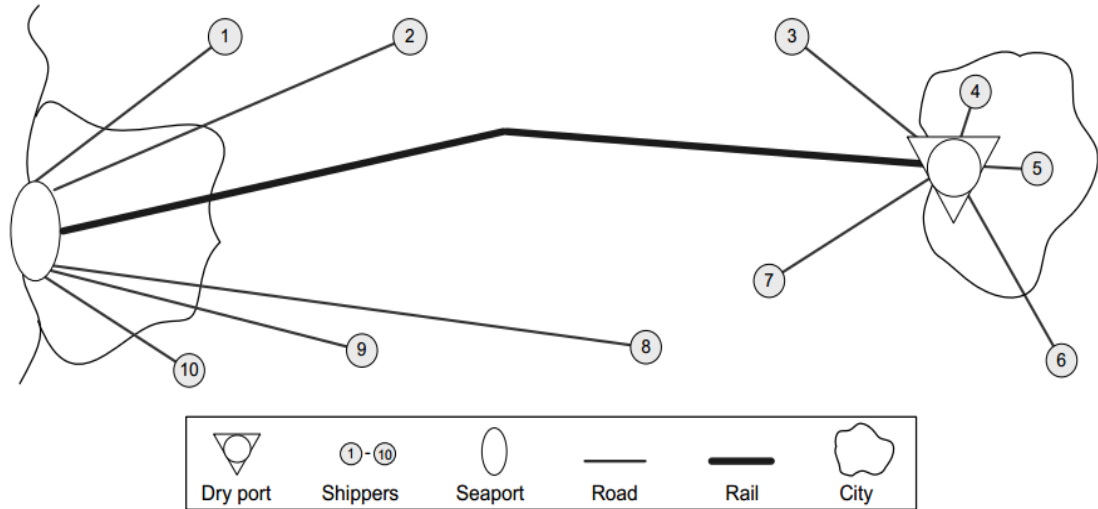


Figure 2.3: A seaport with a distant dry port (Roso & Lumsden, 2009)

2.2 Overview of factors that affect the operations of dry ports

With significant investment undertaken or planned in the key links along the corridor or supply chain, attention is now focusing on inefficiencies at the key logistics nodes and in the regulatory and policy framework (Degbe & Song, 2019). As their statements, dry ports exist in very different forms and arrangements under different terms around the world and they differ in location, functionality, maturity level, ownership, and initiation processes which means no two dry ports are the same. Usually, the logistics industry develops through hubs, which are clusters of logistics activities accordingly. This efficient hub is characterized by high service levels and low overall costs. Such hubs are crucial for consolidating/de-consolidating small flows to achieve the critical masses to gain the benefits of economies of scale that are crucial for international competitiveness (UNDP/Ethiopia, 2017). But some factors influence each of these main nodes which leads to delays, uncertainties, and increased logistics costs to all logistics supply chain partners (Black *et al.*, 2013). J. Jeevan *et al.*, (2018) conduct a study on Malaysian dry ports and identify primary factors that influence dry port operation, such as information sharing, hinterland condition, dry port capacity, government policy, and service features. Not only this, dry ports face challenges related to existing political, social, environmental, financial,

technical and technological development such as land and infrastructure use, location and optimization issues, competitive business environment and stakeholder interests in their implementation and development phases (Khaslavskaya & Roso, 2020). Similarly, Kebede (2019) identified six significant challenging factors affecting Modjo Dry Port operation such as government policy, socio-cultural influence, hinterland conditions, technological advancement, information accuracy and capacity. From this the following influential factors that affect dry ports operations are discussed.

2.2.1 Influence of hinterland conditions on dry port operations

A dry port in the hinterland is a logistics node that improves cost-efficiency, quality of hinterland network connections and environmental performance (Cullinane *et al.*, 2012; Woxenius & Bergqvist, 2009) Efficient handling and distribution of cargo from and to the hinterland are important for the overall performance of seaports and the whole supply chain (Cullinane *et al.*, 2012). According to J. Jeevan *et al.*, (2018), factors affecting dry ports associated with hinterland conditions are; location, transport connectivity, freight market and seaport-dry port relationship.

Authors identified that strategic positioning of the dry port is one of the key prerequisites for their subsequent successful operations and its key factor in optimizing freight transport networks and lowering overall logistics costs. Because, concerning the origin and destination of the cargoes handled and to the seaports and/or dry ports they are connected to, dry ports location plays a key role in their long-term viability (ESCAP, 2019). These dry port location decisions are affected by different factors due to the influence of informal relationships between stakeholders, production facilities and policy restrictions (Khaslavskaya & Roso, 2020). The location of dry ports to seaports and industrial zones affects how they can support the capacity of seaports to accommodate container traffic and help shippers reduce their transportation costs (Bergqvist *et al.*, 2010). Dry ports extend the reach of seaports to the hinterlands by increasing their catchment area of existing ports, but this catchment area may overlap with other dry ports which increases competition (ESCAP, 2018). There are various purposes of developing dry ports, which can be understood by their types in terms of distance such as close, mid-range and distance dry ports (Roso *et al.*, 2009) and location including seaport-based, city-based and border-based dry ports (Beresford *et al.*, 2012). Each type of dry port plays various roles in the

freight transport system, such as a freight distribution center, an extended gateway for seaports, and a hub of intermodal transport (ESCAP, 2018).

The other factor associated with hinterland conditions, affecting the operations of dry ports is transport infrastructure connectivity. Because, transport connectivity of dry ports with seaport and other destinations should possess high transport frequency as well as sufficient transport infrastructure for effective container distribution to and from seaports (Roso *et al.*, 2009). The dry port can only operate at its intended capacities if transport infrastructures such as rail, road and waterway are well connected with its seaports (ESCAP, 2018). Compared to rail transport links the availability of road connections in every dry port becomes an advantage for freight distribution due to its less investment cost and high frequency of services over a short distance. However, dependency on a single mode of transport in the freight system delayed the transfer time and increased cost. Instead, it needs to be equally balanced among the components in multi-modal transportation to ensure effective connectivity between the hinterland and its foreland (Jagan Jeevan *et al.*, 2018). A good connection to multiple transport links such as connections between road and rail infrastructure is required to gain benefits from dry ports (Gerald & Jin, 2016).

The delivery of the freight from the industrial zone to seaports through dry ports importantly supports dry port operations (J Jeevan *et al.*, 2017). Dry ports offer hinterland massification opportunities that are associated with reduced transport costs. But for small businesses or freight markets that are unable to achieve economies of scale affects operations of dry ports (Fatouma *et al.*, 2019).

Not only transport connectivity and freight market but also lack of smooth coordination between a seaport and its dry ports directly impacts the throughput of the effective operation of the logistics supply chain. If there is a good relationship between seaports and dry ports the two nodes need to work efficiently in a freight system (Wang *et al.*, 2018). Although, as Mirzabeiki *et al.* (2016) study shows, the coordination between dry ports and seaports can positively affect the speed of operations, resource utilization, reliability, safety, and data quality.

2.2.2 Influence of service features on dry port operations

Dry ports act as an enterprise, which is required to provide quality services to its customers to survive economically. It offers different services similar to seaports like customs clearance/inspections, value-added services, container transfer, container maintenance, container storage, and so on.

The availability of customs clearance service in dry ports reduces transportation costs as well as providing time advantages to customers (Jagan Jeevan *et al.*, 2018). This concept is extended as dry ports providing customs clearance can increase seaport throughput as well as amplify hinterland activities by reducing congestion arising from customs clearance at seaports (Wan *et al.*, 2013).

Providing value-added services to the clients, dry ports may attract more clients to utilize their services and gain various advantages from it. A range of value-added services in dry ports, such as sorting, barcoding, packing and labeling is an advantage to attracting customers and helping to compete with seaports or other types of intermodal terminals (Galvão *et al.*, 2013). Value-added services offered at dry ports can make a region more attractive to the actors in the immediate vicinity, as well as attract potential new users from more remote locations.

Customer services such as container storage, warehousing, container maintenance service, providing a depot for empty containers and containers transfer facilities between modes (rail to road and vice versa) are a prerequisite for dry port operations (A. K. Y. Ng & Cetin, 2012; Roso & Lumsden, 2010). As J. Jeevan *et al.*, (2017) also revealed that providing extensive services such as stuffing/unstuffing, consolidation/ deconsolidation, less container load (LCL) and full container load (FCL) as well as repair of containers, more clients may be attracted to use the dry port and its capacity could be further utilized.

2.2.3 Influence of dry port capacity on its operations

Sufficient availability of facility and equipment, space, workforce, and safe/secure accessibility in dry ports ensure dry port operations (Jagan Jeevan *et al.*, 2018). Adequate facilities and infrastructure are necessary to provide efficient and effective activities in dry ports. Customers are willing if good transport infrastructure and high standard and sophisticated equipment can be sufficiently provided by dry ports to handle their valuable containers safely (Jaržemskis &

Vasiliauskas, 2007). Facilities and infrastructures should be developed with adequate space and equipment to allow efficient, reliable, and economical movement of containers in dry ports. According to Stoilova & Martinov (2019), the reach stacker system is the suitable handling equipment for small and rail-road terminals, whereas the Rail Mounted Gantry cranes (RMGs) is the best one for the large rail-road and medium terminals. Similarly, insufficient or restrictions of space in dry would affect dry port operations. So, the availability of space for current and future operations is the main issue to be considered in dry port operations (Jagan Jeevan *et al.*, 2018).

Safe and secure availability to and from a dry port is important in enhancing smooth operations in dry ports to gain the confidence of the customers in its operations. This safety and security aspect of dry ports increases punctuality, reliability and frequency of container throughput (Jaržemskis & Vasiliauskas, 2007). The efficiency measurements of dry ports are not only concentrated on quantity or annual container throughput but also capability to reduce cargo security risk (Abdoulkarim *et al.*, 2019).

Organizations or industries seek to employ low-status operational logistics workers to pay low salaries for them. But a skilled workforce both at the operational and managerial level is important to improve logistics performance (ESCAP, 2018). A reliable labor force and a highly trained professional workforce are essential in improving port operational efficiency (Jagan Jeevan *et al.*, 2018).

2.2.4 Influence of government policy on dry port operations

Dry ports cannot be isolated from government support, regulation and policy, especially if the dry port belongs to state-owned corporations (Jagan Jeevan *et al.*, 2018). The government's role is very important in helping the development of the dry port, including all support resources (financial or budget, human resources) and also to support investment, tax regulations, inland customs clearance procedures, concession contracts, operational authorizing, land arrangements, and other regulation and policies either by local or central government (Beresford *et al.*, 2012).

The investment policy which allows a mass between private and public partnership (PPP) in dry port operations is widely adopted, involving the private sector in financing dry ports

development while the public sector provides lands for development and plays a regulatory role in operations (Jagan Jeevan *et al.*, 2018). PPP is a viable model for the provision of necessary funds to develop and operate by encouraging both public and private partnerships (Panova & Hilmola, 2015). Therefore, PPP is the combination of both sectors that increases efficiency by providing logistics experts and financial competence between parties to manage and operate dry ports (Rodrigue *et al.*, 2010).

In a multi-modal transport system, using more than one mode of transport is adapted to optimize transport cost, time of transfer and economic scale. A multi-modal transport policy encourages modal shifts in a freight transport system, which affects the time and costs of freight movements (van der Horst & van der Lugt, 2011). The function of dry ports as intermodal or a transport interface terminal contributes to cooperative freight distribution networks and has a significant effect on reducing congestion as well as improving competitiveness in the supply chain (Wisetjindawat *et al.*, 2007). In addition, to sustain the development of landside modes of transport expected from the government, interventions of government policy are necessary to optimize transport costs through least modal choice (UNESCAP, 2019).

Seaport policies intended at utilizing dry port operations by improving landside transportation and establishing inland networks. This policy has been developed parallel to the seaport industry especially in terminal specialization and the demand for effective inland transportation systems (Wisetjindawat *et al.*, 2007). Moreover, coastal shipping or short shipping seaport policy enhances dry port operations (Jagan Jeevan *et al.*, 2018).

The investment in infrastructure to increase collaboration between seaports, dry ports and other stakeholders becomes a crucial factor for logistics infrastructure development and economic benefits (A. K. Y. Ng & Cetin, 2012). However, transport infrastructure development and operations without government transport policy cannot be effective for what purpose it desired. According to (UNESCAP, 2019), the government infrastructure policy to avoid frequent damage of infrastructures is necessary by restricting the gross vehicle weight allowed for road transport. Therefore, government support regulation and policy became one of the important factors that should be considered in the successful operations of a dry port.

2.2.5 Influence of information systems on dry port operations

Sufficient and standardized information sharing between multiple dry port actors is a prerequisite for efficient and effective dry port operations (Heilig & Voß, 2016). This sufficient and standardized information in daily operations of the dry port is an important factor that enables coordination between stakeholders, accurate forecasting, risk sharing, providing facility utilization, and making decisions (Jagan Jeevan *et al.*, 2018).

Currently, technologies provide a range of advanced information systems that enable the integration/coordination of different stakeholders around dry ports. Information systems such as port community systems (PCS) have been used for coordination and information sharing between port actors, which provides an exchange of electronic information among users and it is recognized as the most advanced technology for the exchange of information between partners (UNESCAP, 2019).

Apart from the coordination of different stakeholders, the availability of information systems for accurate throughput forecasting in dry ports helps to provide asset utilization (Jagan Jeevan *et al.*, 2018). The use of accurate information in dry port operations can bring advantages in terms of avoidance of congestion and on-time demand arrival (UNESCAP, 2019). According to Heilig & Voß (2016), real-time data about the status and positioning of objects is highly important to efficiently plan and organize activities including multiple stakeholders in port operations. They investigate Global Position Systems (GPS) that enables exact position detection, locate and tracking of movable objects such as vehicles, containers and equipment which is essential for forecasting containers arrival times and route prediction. Likewise, the implementation of REID-based collaborative tracking and tracing for real-time wagon information is adapted as a tool to improve the speed of operations, utilize available resources, timeless operations and safety (Mirzabeiki *et al.*, 2016).

2.3 Critical factors contributing to the success of dry port operations

Investigating and implementing critical factors contributing to the success of dry port operations will gain advantages of improved efficiency, increase the capacity of freight distribution, increase the availability of space and improve the speed of delivery (Zainuddin *et al.*, 2018). From their investigation, they identified critical success factors to dry ports or inland ports

operations such as cost, infrastructure development, institutional framework, geographical locations and hinterland, demand management, and technological advancement and innovations. Furthermore, quality services provided by the dry ports, strategic location in relation to industrial zones or trade generating zones and transport linking or connectivity are the key principle factors that would lead to the successful operations of dry ports (ESCAP, 2019).

The successful operations of dry ports are importantly associated with transport connecting with seaport and other industrial/trade generating zones. Dry ports connected by trimodal transport mode are larger in size and serve high traffic flow than bimodal means intermodality is important to inland networks (Nguyen & Notteboom, 2019). Seaports and dry ports can only serve the purpose for which they were established and operate at intended capacities, if the existing or connecting rail, road and waterway infrastructure can handle efficiently the cargo volumes that are processed through these facilities. Unless otherwise, transport infrastructure bottlenecks can result in high logistics costs and inefficiencies of facilities (ESCAP, 2019). Thus, dry ports need high-quality road linkages to seaports, cargo sources and to other dry ports to reduce transit time and road congestions, which is a critical success factor.

As a result of technological progress, day to day dependency of dry port operations on information systems is unquestionable. Technological advancement and innovations refer to information systems that play a vital role between dry port stakeholders (Zainuddin *et al.*, 2018). Without information systems, successful operations of dry ports are impractical.

Apart from technological advancement and innovations, availability of a range of services such as speed of delivery (timeless), flexibility to alternative solutions when things go wrong and reliability is the main service quality required for successful operations of ports (PwC & Panteia, 2013).

Not only this dry port is a logistics system with huge investment. It cannot be viable without government support in activities such as planning, regulations, infrastructure investment, least cost modal choice and other support. According to the report of (ESCAP, 2019), longline haul by rail transport and short local delivery by road transport is recommended in terms of economic advantages. The other critical factor contributing to the successful operations of the dry port is

associated with technical infrastructures. According to Nyema (2014) to foster trade development, to avoid congestion and efficient cargo handling operations, the adequate technical infrastructure is the necessary condition in the terminal.

2.4 Applications of AHP to ports and dry ports

To reduce the total logistics cost and enhance efficient operations of seaports and dry ports, Analytical Hierarchical Process (AHP) models are widely used in literature reviews. This method is used when there is a need to choose between different alternatives and different principles or considerations have to be taken into account (pay more attention) in optimizing the alternatives. In addition to this, the method used to prioritize or rank elements to suggest the importance/impact of elements being investigated.

According to the author, AHP and FTOPSIS (fuzzy technique for order preference by similarity to an ideal solution) model is used in combination for the prioritization of port performance improvement strategies. The model used to evaluate different strategies such as crane productivity, the accuracy of information and documentation, port information and technology systems, value-added service for customers, training and education, yard utilization, commitment and loyalty, leadership, culture, the incidence of a service delay, and sea-side connectivity were evaluated. The obtained results according to this hybrid method (AHP-FTOPSIS) indicated that incidence of service delay and crane productivity were the important indicators of port performance (Ha *et al.*, 2017).

Recent research conducted by Abdul Rahman *et al.* (2019) used the AHP method in identifying the delay factor that affects the dry bulk cargo operation in one of the Malaysian ports. In their investigation, they identified the main factors and sub-factors that influence the operations of dry bulk cargo and ranked them according to their relative significant impact on dry bulk cargo operations by using the analytical hierarchy process (AHP) method.

AHP method is also widely used as a systematic procedure for the selection of the most appropriate location of dry port on strategic places based on alternative criteria. For example, Roso *et al.* (2015) used this method for “inland intermodal terminals location criteria evaluation in case of Croatia”. Their result shows that goods flows have the most significant impact on the selection of the terminal location, followed by the spatial criterion out of location criterion such

as legislative, environmental, goods flows, spatial, technical-technological, and organizational. Similarly, Dyck & Ismael (2015) used AHP to evaluate and rank ports competitive in West Africa according to the total weights obtained based on the different criteria investigated. Hence, the result of their investigation shows that Port of Abidjan is the most competitive port followed by Ports of Lomé, Port of Tema, Port of Dakar Lagos, Port Complex and Port of Cotonou in Benin respectively.

The research conducted by Georgise *et al.* (2020), also used the AHP method to select modified alternatives layouts from existing warehouses to improve Modjo Dry Port warehouse performance that reduces container congestion both at warehouse and terminals.

Compared to different MCDM methods, the AHP method has been analyzed in its advantages and disadvantages and identified the types of studies for which they are more suitable. Based on this, the main demerit of the AHP method is the fact that dependencies between variables can lead to inconsistencies in the ranking of the criteria and this produces rank reversal. However, AHP results are more consistent and accurate than other decision-making methods as the size of the matrix is not greater than ten criteria. Hence, the AHP is a suitable method, if the researchers want to rate the criteria against other criteria at the same hierarchical tree level (Velasquez & Hester, 2013).

AHP is a tool to evaluate objective and subjective functions to help users, for achieving the best and optimal judgment for the problems. It quantifies the weight of the evaluated criterion in the form of a numeric basis. This weight criterion determines the relative impact/importance of one factor with the other factors. Thus, it assists the decision-maker to identify and rank significant factors according to their level of impact (Waris *et al.*, 2019).

After analyzing the application area of AHP in port and dry port, due to AHP method requires comparison of all pairs of factors (main factors and sub-factors) at the same hierarchical levels, allows hierarchizing both qualitative and quantitative data easily and also able to assist dry port managers in obtaining a detailed understanding of the factors that largely impact on the operational efficiency of the dry port to give a strategic decision, AHP in the classical form selected for this study.

2.5 Dry ports in East Africa

Dry port development is motivated to access hinterland resources and growth of hinterland areas. This issue was revealed by Zeng *et al.* (2016) in China's peculiar case where cities and regional governments prioritize investment in dry ports to spur regional growth. Since the construction of terminals is accompanied by investment in high capacity transport links and connection nodes, dry port development can ably serve this purpose not only in developed countries like China but can be rivaled by other natural resource-rich areas like East Africa (Gerald & Jin, 2016).

Not all but from East African country which composed of Uganda, Kenya, Tanzania, Rwanda, Burundi, Somalia, Ethiopia, Eritrea and Djibouti as well as Sudan, South Sudan, and the Democratic Republic of Congo, apart from Somalia, Kenya and Tanzania which is linked to the international maritime transport network by the Indian Ocean and Djibouti and Eritrea which enjoy the red sea, the rest are landlocked and it currently relies on Mombasa Seaport (Kenya) and Dares salaam Seaport (Tanzania) are needed for shipping (Gerald & Jin, 2016). Djibouti is also one of the East Africa countries which is the key gateway for landlocked country Ethiopia through Djibouti port (Rahmanto, 2016).

Mombasa and Isaka dry ports are the main operational dry ports located eastern part of Africa to serve other landlocked countries in the region. Isaka is located 982 km from Dares Salaam and 485 km from Kigali along the Dar-Mwanza railway line. This dry port in Tanzania provides custom clearance services and temporarily holds for different types of cargo transfer from and to Dares Salaam seaport to serve shippers from Rwanda, Uganda, Burundi, DRC and Western parts of Tanzania. Similarly, Mombasa dry port in Kenya, located at the coastal city of Mombasa approximately 4 Km from the seaport of Mombasa is connected by rail and road. This corridor is serving the northern landlocked country of eastern Africa from Mombasa port in Kenya through the cities of Nairobi, Eldoret, Kampala in Uganda, to DRC and Southern Sudan (Gerald & Jin, 2016).

Ethiopia one of the landlocked countries in East Africa is served by Djibouti port after Somalia Ports of Mogadishu and Kismaayo were unviable due to political instability and terrorism. Not only the port of Somalia before the 1998 dispute between Ethiopia and Eritrea, but port Asseb

also used to handle about 85% of the Ethiopian maritime traffic through the red sea while Djibouti covered only 15% during the period. But at present, the port of Djibouti which is located at the southern entrance to the Red Sea and handles most of Ethiopia's maritime traffic, between Addis Ababa and port Djibouti (WB, 2017).

Currently, port Berbera in neighboring Somalia and Sudan port in neighboring Sudan are also used as getaways to Ethiopia but to a lesser degree. Ethiopia signed an agreement with the Ports Authority of Somaliland in March 2018, which may result in a gateway to Ethiopia via Berbera. In July 2018, Ethiopia signed another agreement with Eritrea to restore diplomatic relations and trade, which also signals the potential for Ethiopian bound shipping to transit via ports at Assab and Massawa in Eritrea.

Recent investments in road and rail along the Ethio-Djibouti corridor have the potential to significantly reduce transport costs and time (WB, 2017). At the end of 2017, a new 756 km electrified railway became operational, linking Djibouti port to Addis Ababa. The Ethiopia-Djibouti corridor is the key channel for Ethiopian trade. As the report of the World Bank shows, the Ethiopia-Djibouti Corridor linking Ethiopia to the Port of Djibouti is now the dominant gateway for the country with over 95% of Ethiopia imports and exports using this route.

2.6 Dry ports in Ethiopia

In the logistics systems that Ethiopia is developing the dry ports are the key nodes for logistics services activities. As a landlocked country, the other key nodes for Ethiopia are at the border and the Port of Djibouti. The United Nations Convention on the Law of the Sea (UNCLOS) defined a landlocked country as a “state or country without any access to the sea” and the permission by a coastal country for hinterland nations to transit through its seaport(s) is a permissible right. Ethiopia established several dry ports to take the advantage of landlocked logistics services (Modjo, Kality, Mekele, Semera, Kombolcha, Gelan, Dire Dawa and Woreta). Such ports handle the customs inspections, documentation of cargo, temporary storage, container maintenance, and packaging for import and export. The detailed description of these dry ports is summarized in Table 2.1.

These ports are to create logistic chains to ports in Somaliland, Djibouti, Kenya, Sudan and South Sudan. This strategic drive also aims to take advantage of the growing international and

regional trade including the country’s burgeoning economic relationship with its trading partners in the region. So, this can be held if influential factors affecting dry ports are identified and remedy actions take place by dry port actors.

Table 2.1: Dry ports in Ethiopia (<https://eslse.et/dryport.html>)

Year of started	Name port	Place/Regional	Current area occupies	Current total capacity (TEU)
2009	Modjo	– Oromia National Regional State, Lome woreda at Modjo town which is 73 Km from the capital and it is connected to the new Ethio – Djibouti Railway line.	– 150 hectares while 31.7-hectare land area is used for container terminal services.	– 17,539 containers at a time and 136,038 containers annually
2014	Kality	– Addis Ababa at Kality Sub City	– 37 hectares while 3hectare land area is used for container terminal services.	– 1241 containers at a time and 23,131 containers annually
2014	Gelan (RO-RO)	– Oromia National Regional State in Gelan 25 km from the capital	– 23 hectares while 4.5-hectare land area is used for Ro Ro/ Vehicles terminal services.	-
2010	Semera	– Afar National Regional State at Semera city which is 592 km from Addis Ababa and 270 km from Djibouti	– 160 hectares while 2.5-hectare land area is used for container terminal services	– 1180 containers at a time and 2378 containers annually
2013	Dire Dawa	– In Dire Dawa city administration which is 550 km from Addis Ababa.	– 0.78 hectare while 0.78-hectare land area is used for container terminal services	– 368 containers at a time and 3852 containers annually
2013	Kombolcha	– Amhara National Regional State at Kombolcha town, which is 380 km from Addis Ababa	– 15 hectares while 4-hectare land area used for container terminal services	– 1888 containers at a time and 4891 containers annually
2013	Mekelle	– Tigray National Regional State at Mekelle city, which is 783 km from Addis Ababa	– 3 hectares while 3-hectare land area is used for container terminal services	– 1440 containers at a time and 7789 containers annually
2019	Woreta	– Amhara National Regional State at Woreta town, which is 620 km from Addis Ababa	– 20 hectares while 3-hectare land area is for container terminal services	– 900 containers at a time

2.7 Research gap

Today, the dry port concept has gained significant attention among researchers all around the world, due to its potential to improve hinterland intermodal transportation, generate economic benefits, and reduce environmental impacts (Khaslavskaya & Roso, 2020). However, the current studies on dry port focus on the location optimizations of dry port (Jeevan *et al.*, 2017), and most of the literature also mainly covers the implementation of dry ports, their site selection, and the correlations between seaports and dry ports (Chen *et al.*, 2018), dry port sustainability and environmental perspective (Khaslavskaya & Roso, 2020) and less research conducted on evaluation of factors that affect dry port operations.

Jagan Jeevan *et al.*, (2018) conduct an empirical study through a web-based survey of Malaysian dry port stakeholders to investigate the determinants of influential factors of dry port operations. They identify 12 significant important factors for Malaysian dry ports. In Ethiopia, most of the research conducted on Modjo Dry Port concentrated on customer service quality and performance assessment. The study has been made by Abdurezak (2016) on the determinants of Modjo dry port performance. The result of the analysis indicated that cargo handling equipment, customs operations, port infrastructure, size of dry port, port staff, reliability of port operations and quality of logistics service are found to be important factors in determining the performance of Modjo dry port but fails to address ranking the factors influencing dry port operations according to its significant impact. In the same manner, another study was made by Kebede (2019) on the practices and challenges of dry ports operations of Modjo. His findings suggest that six significant challenging factors such as government policy, socio-cultural influence, hinterland conditions, technological advancement, information accuracy and capacity are identified as Modjo dry port operations challenges. The challenges of dry port management and its effect on import goods clearance of Modjo dry port made by Zeleke (2019) indicated that ICT, customs service's, staff competence and importers behavior are major challenges of Modjo Dry Port management. But both researchers are also failing to rank the factors and sub-factors according to the level of influence they have on dry port operations. Generally, the dry port concept is a recent phenomenon in Ethiopia compared to other economically emerged countries. As a result, it might be difficult to identify problems that can affect the effectiveness and efficiency of dry ports in the country. So, all studies conducted in

Ethiopia as well as in MDP did not identify the factors that affect dry port operations and the influence of each factor on dry port operations through systematic procedures, which has significant operational improvement to the port. In this study, the researcher bridges this gap and presents to evaluate and rank factors affecting dry port operations in the case of Modjo Dry Port in Ethiopia using the Analytical hierarchy process (AHP).

2.8 Conceptual framework

Factors that affect dry port operations are quite large. Jagan Jeevan *et al*, (2018) identified 5 main factors and 12 subfactors that influenced dry port operations. Similarly Khaslavskaya & Roso (2020), investigated challenging factors face dry ports during implementation and development phase. Similarly, Kebede (2019) identified six challenging factors of MDP. By compiling these references and others as discussed above in the literature review, several factors affecting dry port operations are observed. Based on the literature reviewed, the following conceptual framework was developed only for factors currently affecting the operations of Modjo Dry Port. The conceptual framework explains the underlying process, which is applied to guide this study to obtain the desired goal.

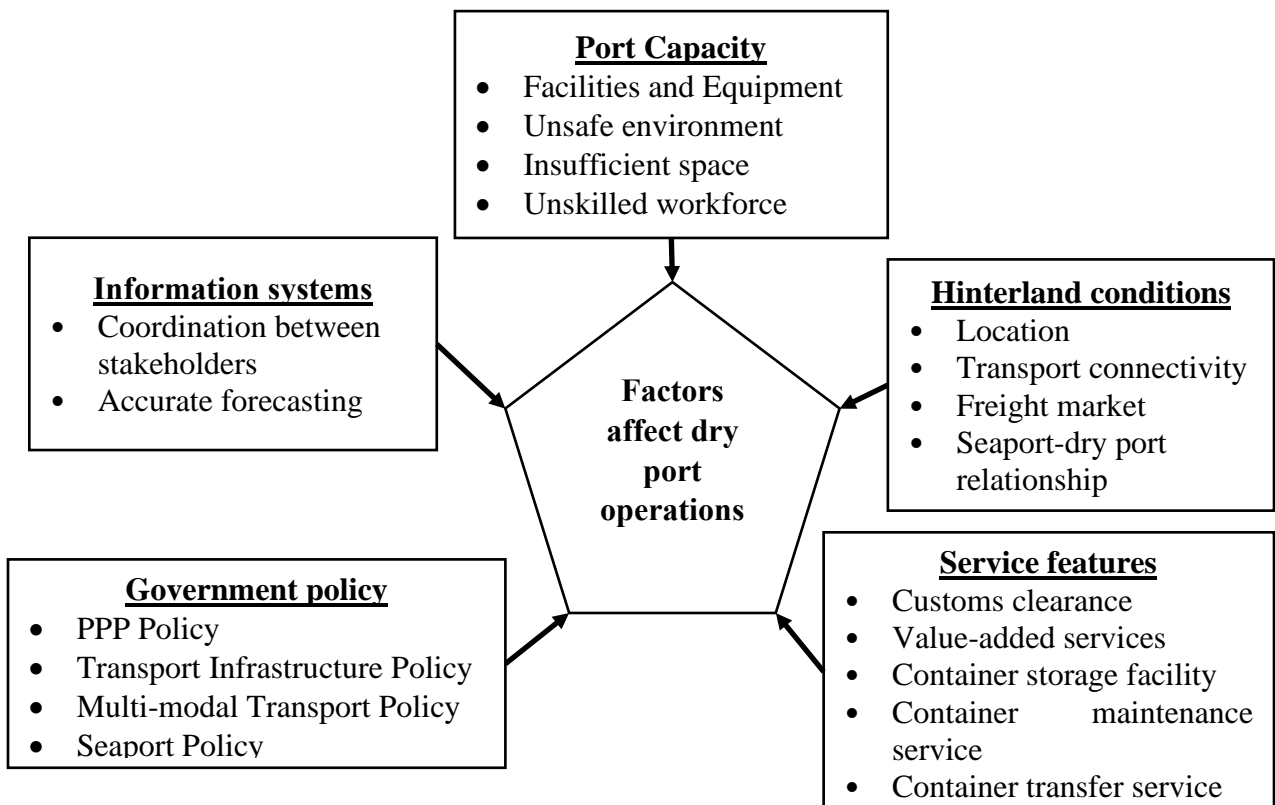


Figure 2.4: Conceptual framework of the study (Own construction)

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Description of the study area

This study was conducted at Modjo Dry Port (MDP). The dry port is located approximately 73 km from the capital city Addis Ababa and about 750 km from Djibouti (the main gateway to the seaport for Ethiopia). It is one of the dry ports stationed in the central part of Ethiopia that regularly operates. The dry port helps many importers and exporters customers than the other operational dry ports. As the largest dry port in the country, Modjo Dry Port can hold 600,000 containers annually and it handles more than 76 pc of the nation's imports/exports. According to an unpublished report of ESLSE, the dry port covers about 180 hectares of land, from which 31.7hectare land area have been devoted for container terminal services. In addition to the road transport system, the dry port is connected with a railway system with a capacity to move 3,500tn of cargo on a single trip and the train can make two trips in a day to Djibouti, while truck transport takes more than four days for a two-way trip. MDP works with two systems known as unimodal transport and multimodal transport. The study would engage in evaluating and ranking factors that affect dry port operations and its critical success factors.

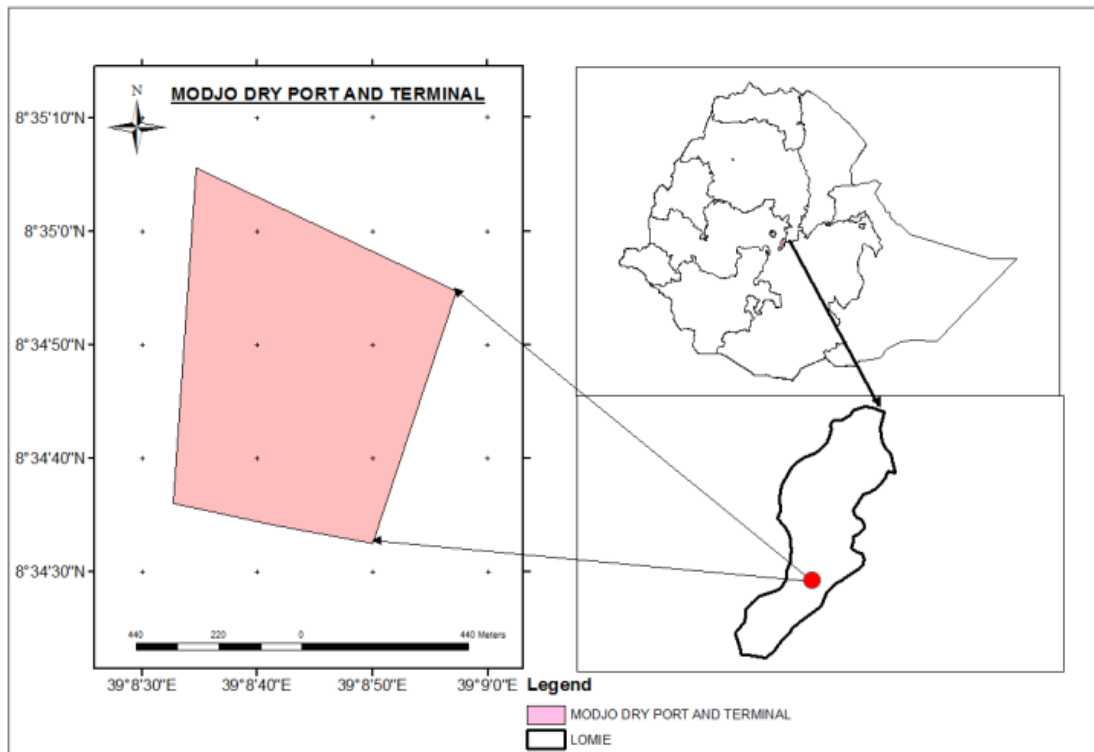


Figure 3.1: Location map of study area

3.2 Research approach

It is important to identify and understand the research approaches to be undertaken. This is because it influences the research instruments to be employed and the ultimate goal of the whole thesis work. Despite that, this study employed a mixed approach, which involves both aspects of quantitative and qualitative approaches. For this study, the overall research activity flow chart is illustrated as follow.

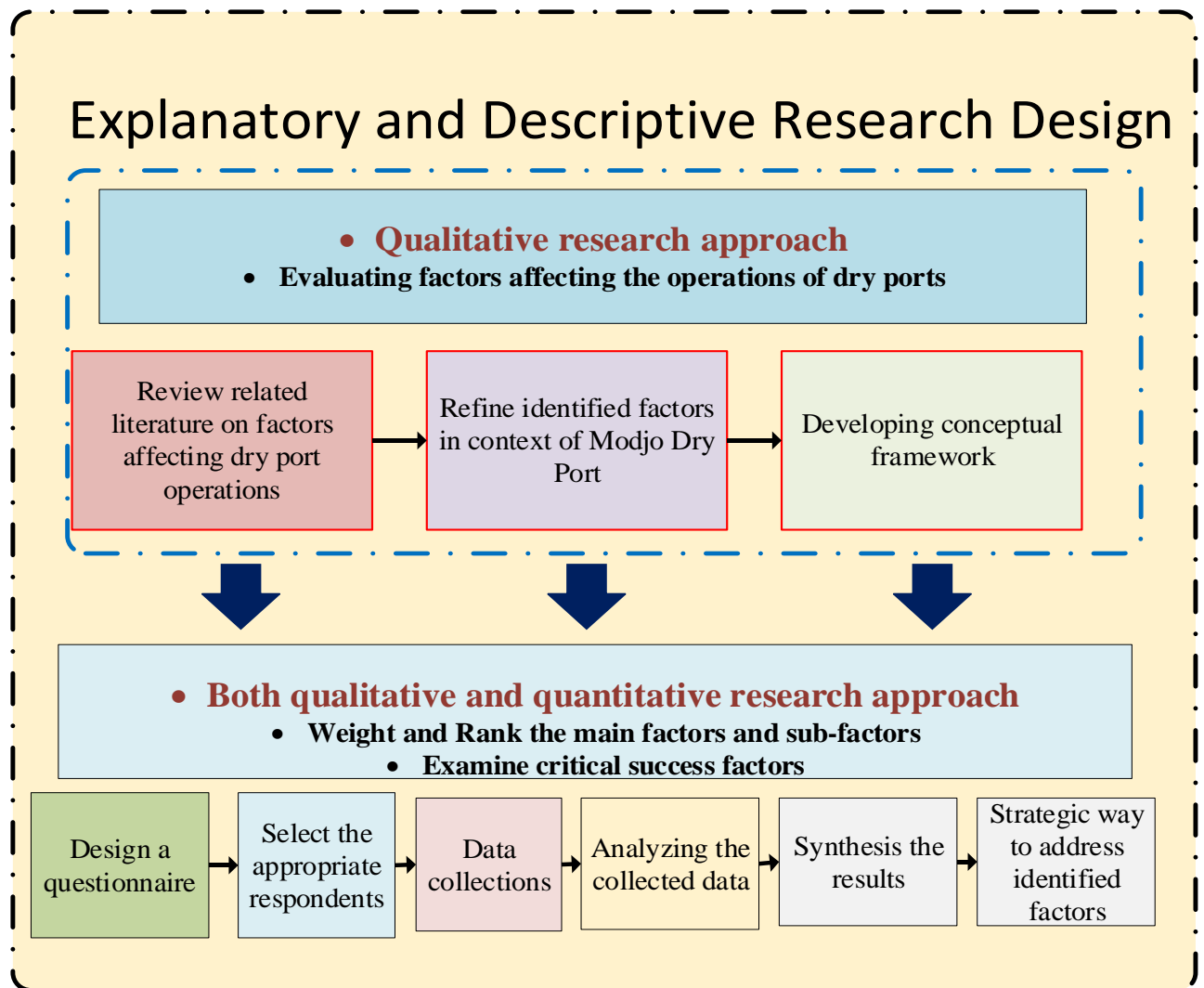


Figure 3.2: Research activity flow chart

The quantitative research approach emphasizes numerical value to describe, record, analyze and interpret the existing conditions. It is based upon the measurement of amount or quantity and applies to the process that can be expressed in terms of quantity. It is important to generate

extensive information that is summarized and presented in tabular and figure form. Generally, it helps to transform reality into numeric value rather than meaning (Kapur, 2018).

In the qualitative research approach, it is concerned with subjective assessment of attitudes, opinions and behavior where investigative methods include questionnaire, interviews, observation by participation, and interpretation of written material. Such a research approach generates results in a non-quantitative form in describing the existing conditions. It is concerned with qualitative phenomena that are related to or evolving quality or kind (Kapur, 2018).

Based on these facts this study utilized both quantitative and qualitative research approaches to reach the research conclusion for the research objectives. Since employing a combination of two types of research approaches gives better interpretation to enhance the information and better integrate results might emerge from the analysis.

In this study, a quantitative research approach was employed to collect numeric representation data from qualified experts on factors selected through pairwise comparisons and 5-point Likert scale questionnaires as well as from different published documents. While a qualitative research approach was employed during the collection of qualitative data. It was collected through observation, review of related literature and interviews with qualified experts of MDP and terminal to get qualified judgments on the particular factors selected from different literature reviews as outlined above on conceptual framework.

3.3 Source of data

The sources of data were both primary and secondary. The primary data source is the primary information that was collected directly from Modjo Dry Port staff, customs office, and shippers. In these data collections, the information obtained was primarily through structured questionnaires, field observation and interviews with participants. Meanwhile, for the secondary data source, it is the information that was extracted from the published documents such as from books, journals, reports, official websites, that related to the research topic.

3.4 Sample size and sampling techniques

The target population of this study was the stakeholders of Modjo Dry Port. When the researcher neither has the time nor the resources to collect data from the entire population, there

is a need to select a sample by applying sampling techniques to reduce the number of cases. The sample should represent the population in all respects. There are mainly two types of sampling techniques such as non-probability sampling and probability sampling.

In non-probability sampling, randomization is not necessary to select a sample from the case or population of interest. Instead, subjective methods are used to decide elements that are included and not included in the sample. In non-probability sampling techniques, the sample representatives do not need to be random, but a clear justification or rationale is needed for the inclusion of individuals or some cases rather than others. Hence, non-probability sampling is a technique of sampling where the samples from the entire population are chosen but not all populations have equal chances of being included (Etikan *et al.*, 2016). Convenience sampling and purposive sampling are the most well-known nonprobability sampling used by different researchers.

Convenience samples are also known as accidental sampling. In this sample selection, elements may be selected simply as they are just near to or happen to be where the researcher is conducting the data collection. Here in this sampling method data are collected from the area where density is known to be high such as in the roads, trails, around corridors, parking and hence samples might not be representative of the interest population but assumption associated with this sampling method is the members of the target population are homogeneous. Convenience sampling can be used in both qualitative and quantitative studies. Generally, convenience sampling is to collect information from participants who are easily available to the researcher. This makes convenience sampling easy, inexpensive and the issues are readily available (Etikan *et al.*, 2016).

The purposive sampling technique is also known as judgment sampling is a strategy in which persons or events are selected carefully and typically used in qualitative research. It is a non-random technique, which does not need basic theories or a set number of participants. It uses the judgment of an expert in selecting cases or it selects cases with a specific purpose in mind. This type of sampling method is used to conduct exploratory research or field research. Hence, the selection or identification of individuals or a group of individuals is concentrated on people with particular characteristics (knowledge, experience, willingness, and availability of experts)

who will better be able to assist the researcher with the relevant research areas (Etikan *et al.*, 2016).

In probability sample selection, each sample has an equal chance of being chosen or the population has a non-zero chance of being selected using a random selection procedure. Probability sampling techniques are more preferable when the researcher went to generalize his/her study for the use of the entire population by using a probabilistic method to control bias during the sampling (Etikan & Bala, 2017).

Therefore, from these points of view, a researcher must determine a type of sampling technique reasonably applicable to his/her study. The sampling technique to be used is based on the nature, type and purpose of the research study. In this study, the researcher clustered the questionnaire survey into two cases.

In the first case, the researcher was interested in concepts related to evaluate and rank factors that affect MDP operations, pairwise data was collected from experts to carry out quantitative and qualitative research, hence non-probability sampling or non-random sampling technique is chosen to conduct this research. Because according to Hameed Taherdoost (2016), study shows, the case study research design and qualitative research are mostly associated with non-probability sampling. Considering convenient sampling, a judgmental sampling technique was used to conduct this research where the experts in a particular field were selected based on deep knowledge or experience on the subject matter.

In the second case, the researcher went to measure the critical factors that contributed to the success of Modjo Dry Port operations, in which a stratified random sampling technique was used to collect quantitative data from the target population. Where stratified sampling is obtained by dividing the universe into different subgroups that are more homogeneous than the targeted population (Etikan & Bala, 2017).

3.5 Respondent selection

In Analytical Hierarchical Process (AHP) respondents should be those with the most suitable knowledge or experience to increase validity. One needs to know the area of expertise needed to make the decisions and selecting a judge that has both knowledge and practical experience with the matter is necessary. In that case, one might select several judges if they are available.

But, consistency of the judgments and their validity in practice affect the sample size of judges required to make the comparisons in the case of importance or likelihood questions (Saaty & Özdemir, 2014). Similarly, Waris *et al.* (2019) suggested that, as AHP is an objective and subjective approach that addresses specific issues, a large sample size is not required. Because a large sample size is causing a higher degree of inconsistency which is more than the acceptable level.

Increasing the number of respondents or judges large enough affects the consistency ratio. Consistency indicates the level of acceptance of decision-makers in pairwise comparisons which reflects the quality of decisions (Saaty & Özdemir, 2014).

According to Saaty & Özdemir (2014), the problems regarding the validity and usefulness of respondents of a small sample size can be answered in how richly or sparsely the problem is structured for pairwise comparison judgments in deciding the greater smaller of sub-criteria. Because as the scope of the question narrows, it is easier for judges to make comparison judgments and ensure their accuracy. In addition to this selection of judges is not according to sample size as in taking statistics instead how much and how well they know the subject.

From this point of view in the case of non-probability sampling, the researcher initially selected 13 experts from Modjo Dry Port. Of this 11 of them agreed to participate in the questionnaire survey, then the structured questionnaires were designed and distributed to them. After gathering all of the experts' answers, the consistency of their answers was calculated separately. Six of those respondents were filled wrongly and the consistency index regarding their answers was considerably higher than the acceptable range. Hence these questionnaires were sent back to the respondents to be filled out again. Only two respondents were responsible to revise their comparisons and the other four refused to refill questionnaires. Finally based on respondents' interest, educational qualification, year of experience, knowledge with the matter and checked consistency index only seven respondents are screened to conduct this survey, while the rest are rejected. So, according to Saaty & Özdemir (2014), this number is reasonable to conduct AHP pairwise comparisons, since the method does not depend on a large sample size.

In the case of probability or random sampling, the purposive sample size will be used through which the following formula is applied from the targeted population as Yamane (1967) provides a simplified formula to calculate sample sizes.

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

Where, N = is the population size, n = is the sample size, e = is the level of precision which is 95% according to the researcher

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

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

Table 3-1: Sample size

Type of targeted Population	Population size	Proportion	Sample size
Modjo Dry Port terminal operations	192	0.634	122
Customs Clearing Office	26	0.634	16
Shipper company (import/export)	12	0.634	8
Total	230	146/230	146

In addition, to conduct face-to-face interviews, five top position respondents, two from the customs office, two from terminal operations and one from the shipping company were selected.

3.6 Tools and methods of data collection

Data collection methods were focused on the following basic techniques. These included closed-ended questionnaires, interviews, secondary/existing documents and field observations data collections focusing on qualitative and quantitative data as defined in the previous section.

Questionnaires: it is a primary data collection method where qualitative and quantitative data sources were collected through survey questionnaires and interview questions. In this study, survey questionnaires were designed in two cases and interview questions were conducted.

In the first case, as described in this paper the researcher has adopted standard structured questionnaires (closed-ended) that can allow for collecting information from different experts. As mentioned before AHP tool is employed to evaluate and rank factors according to their relative weights. Pairwise comparisons on factors or criteria selected from the literature review were firstly judged by experts whether it affects MDP operations or not. All experts agreed that these factors exist but with different significant impacts. Then, to collect pairwise comparison data, a questionnaire was designed in the form of a pairwise comparison matrix and distributed among the respondents (experts of MDP) to collect their judgments. At the same time, the researcher conducts interviews with each expert and guides them on how the questionnaires are filled. For this, the Saaty scale ranges from “equally important” (number 1) to “extremely more important than” (number 9) as shown in Table 3.2 is used to measure the relative importance/influence of the factors over the other.

Table 3-2: A rating scale for pairwise comparison (Abdul Rahman & Ahmad Najib, 2017)

S.N.	Scale	Scale Numeric value(s) a_{jk}	Interpretation
1	Equally important	1	j and k are equally important
2	Fairly important	3	j is fairly important than k
3	Moderately important	5	j is moderately important than k
4	Strongly important	7	j is strongly important than k
5	Extremely important	9	j is extremely important than k
6	Intermediate values to reflect fuzzy inputs	2,4,6,8	
7	Reflecting the dominance of the second alternative compared to the first	Reciprocals	

i.e. one implies that the two elements are the same or are equally important. On the other hand, number nine implies that one element is extremely more important than the other one in a

pairwise matrix. Concerning this, each expert entered their desired amount for each criterion, and finally, their judgments have been converted into group judgments using geometrical mean method equation 2.

To measure the practical level of dry port operation considering the critical factors contributing to the success of Modjo Dry Port operations, the questionnaire survey was designed and the data is collected through a 5-point Likert scale. Responses were forwarded to each statement using a 5-point Likert scale, where 1 = Strongly Disagree, 2 = Disagree, 3 = Moderate, 4 = Agree and 5 = Strongly Agree. The response added up to produce a score for the measures.

Interview: in this case, a semi-structured questionnaire survey was conducted through face-to-face interviews with purposely selected professionals. This interview aimed to obtain in-depth information about factors that affect Modjo Dry Port operations and factors contributing to the success of its operations.

Secondary data/existing documents: The secondary or existing data refers to data that was collected or used by someone before. This was collected in the form of a desk review of the study area from documents including various reports, official websites and publications.

Field observations: in addition to questionnaires, interview and reviewing existing documents of study area site observation is also needed. These methods are essential for the researcher to support his investigation in taking action depending on existing work conditions. Because observational research conclusions or findings are considered as strong in their validity to extract a depth of information from a particular behavior.

3.7 Methods of data analysis and interpretation

The data collected were analyzed both quantitatively and qualitatively. The researcher analyzed pairwise data obtained from expert's judgment, by AHP mathematical models. The data were analyzed quantitatively in Saaty (2008) rating scale ranges from 1-9 to investigate the level of the significant impact these factors had on operations of the dry port. The mathematical models in AHP have it's own procedures as described below and the results of these models are reported using tables in the form of weights, percentages and ranks.

To analyze quantitative data collected through five-point Likert's scale rating, descriptive statistics tools that are available in Microsoft spreadsheet are used and the results of the methods

are reported using tables in the form of percentages, mean and standard deviation.

Table 3-3: Five-point Likert's scale response (Pimentel, 2019)

Rate/score	Mean range	Response options
1	[1.00 -1.80)	Strongly disagree
2	[1.80 -2.60)	Disagree
3	[2.60 -3.40)	Moderate
4	[3.40 -4.20)	Agree
5	[4.20 -5.00)	Strongly agree

Data obtained through interviews, field observation, and reviews of different documents were analyzed qualitatively to support the findings of the study. This qualitative data has been incorporated with the quantitative results in the data analysis parts.

Analytic Hierarchy Process: The Analytic Hierarchy Process (AHP) is a multi-criterion decision-making (MCDM) technique originally developed by mathematician Thomas L. Saaty, 1980 and is a tool with numerous applications. It allows complex problems with multiple and sometimes conflicting criteria to be addressed. AHP is primarily based on one-to-one comparison related to a decision hierarchy which uses a predefined comparison scale either with factors affecting the decisions or with the importance of these factors on decision points (Kuruoglu *et al.*, 2015). It has proven to simplify complex decision analysis because it allows for the quantification of subjective criteria to be synthesized together with qualitative criteria in a simple, powerful and structured manner (Yavuz, 2015).

Among the advantages of using AHP for decision-making is that it offers the opportunity to consider the different importance of criteria and, consequently, to assign different weights so that some criteria dominate the decision. AHP is easy to use and flexible (Emrouznejad & Marra, 2017). Compared to other decision-making approaches/methods, the main distinguishing feature of the AHP is the direct consideration and application of personal judgment (Kuruoglu *et al.*, 2015). This approach points out a set of elements that are mutually related to the problem going to be investigated.

The reason for using the AHP method in this study is that it involves complex calculations, but it can be very much understandable as a clear, straightforward, and well-documented method. In addition, it supports group decision-making through consensus by calculating the geometric mean of the individual pairwise comparisons and providing a useful mechanism for checking the consistency of the evaluation measures and alternatives.

There is a structured process of successfully applying AHP in decision-making, which can be summarized as; first structure the decision hierarchy, second pairwise comparisons, third deriving relative weights, fourth consistency checking, and fifth prioritizing the factors (Waris *et al.*, 2019) as shown in Figure 3.3.

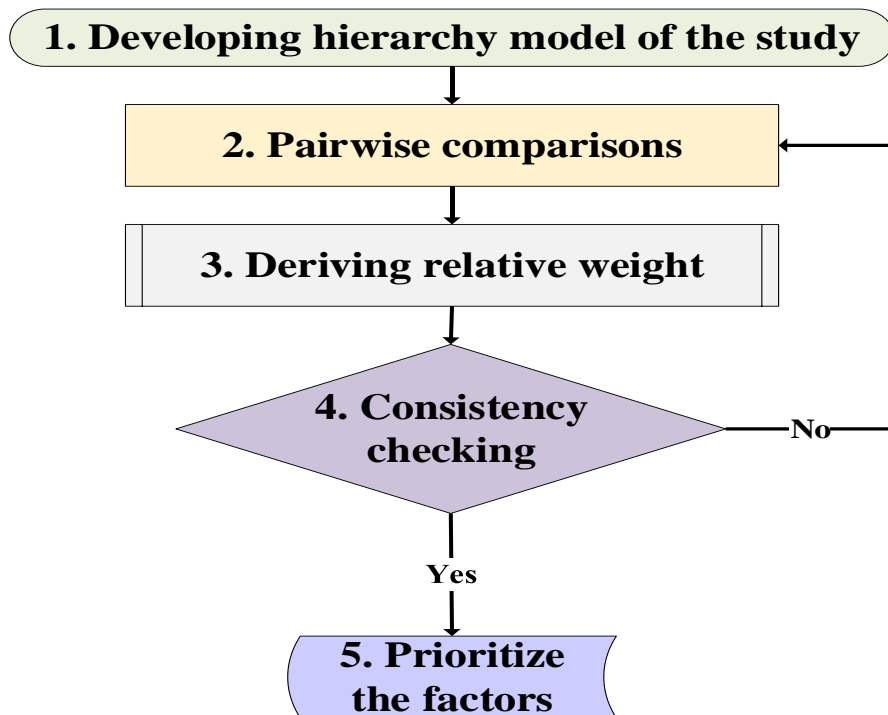


Figure 3.3: Analytical Hierarchy Process flow chart

Step 1: Structure the decision hierarchy; The construction of hierarchy is a top-down process (starts from the higher level to lower level) and comprises several levels. The elements of the same hierarchy level must be correlated with the other corresponding factors of the structure. In such a way the goal is located at the top level, at the second level are the criteria, which can be divided into sub-criteria according to the level of detail required. The number of details in hierarchical levels is a function of problem intricacy and the degree of quantification for each

of the elements (Algarín *et al.*, 2017). In this study, 5 main factors as 2nd level and 19 subfactors as 3rd level of decision hierarchy are constructed corresponding to the goal which is factors that affect the operations of dry port as 1st level of hierarchy.

Step 2: Pairwise comparison; To establish the relative importance/impact of the main factor and sub-factors, decision-makers are asked to complete pairwise comparisons of the elements at each level of the hierarchy. In pairwise comparison the elements in each set of the hierarchy are compared with their corresponding group members. The preferred criterion cell of the matrix has the value and the other has the inverted value (1 / value) (Russo & Camanho, 2015). That is, for the comparison matrix of “n × n”, n(n-1)/2, judgments can be omitted. If the element a_{ij} of the matrix is known, the reciprocal values of the comparisons are placed in the a_{ji} position as can be seen in Equation 1 (Algarín *et al.*, 2017).

$$A = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{bmatrix} \quad 1$$

The above matrix “A” represents the judgments of factors for the n × n matrix, where “n” is the number of factors being evaluated. A matrix “A” of paired comparisons must be developed where the terms a_{ij} are the result of the comparison between the elements i and j. Each element a_{ij} in a pairwise comparison matrix represents the degree preference of the ith factors over the jth factors. The individual preference of decision-maker k can be represented as a_{ijk} .

Once the overall decision maker judgments are computed the next step is individual preferences needed to be combined to generate a single preference matrix. According to the literature, Geometric Mean Method (GMM) and Arithmetic mean method, are used in aggregating individual judgments into a single preference matrix (Dano, 2020). This study employed the GMM due to its suitability, especially small sample size and homogenous group participation (Ossadnik *et al.*, 2016) and consistency of combining individual ratings over other methods (Dano, 2020). Hence using the geometric mean method formula given in Equation 2 they are inserted into the comparison matrix ‘A’ (Singer & Özşahin, 2018).

$$a_{ij} = \sqrt[n]{a_{ij1} * a_{ij2} * a_{ij3} * \dots * a_{ijk}} \quad 2$$

Step 3: Deriving relative weights; In this step the relative weights for each main factor and sub-factor of decision hierarchy was obtained. Different approaches to estimate the relative weights from the comparison matrix are developed by researchers. From these, Geometric Mean Methods (GMM) is used to generate relative weight. It is calculated by multiplying each row of the matrix and taking the n^{th} root of the multiplication. Where ‘n’ is the number of entries or elements being evaluated in the matrix. But, Saaty suggested that the eigenvalues are not consistent with the GMM approach. The other one is the eigenvector method. According to Saaty (2013) “the principal eigenvector to derive the priorities is mathematically necessary because of the need for transitivity of all order in the dominance of the judgments among the elements being compared”. Hence eigenvector was used to conduct this study.

In this step, the aim is to obtain a normalized matrix and normalized weight (eigenvector) of the factors. Normalized matrix was obtained in such a way, Calculate the sum of numbers in each column of pairwise comparison matrix and then divide each element of column on the sum of numbers of related columns to create a new matrix named by normalized matrix or relative weight (Goswami & Mitra, 2020).

The normalized weight of the factors and sub-factors was derived from Equation 3, and this basically indicates the relative importance/influence of the criterion being evaluated. In that case, to determine the influential level of the factors or sub-factors involved, the normalized weights of each factor or sub-factors can be obtained by using Equation 3 using (Abdul Rahman *et al.*, 2019). Excel software is used to calculate the relative weights in the AHP model from the pairwise comparison matrices.

$$w_k = \frac{1}{n} \sum_{j=1}^n \left(\frac{a_{kj}}{\sum_{i=1}^n a_{ij}} \right) \quad (k = 1, 2, 3, \dots, n) \quad 3$$

Where a_{ij} stands for the entry of row i and column j in a comparison matrix of order n and a_{kj} is the pairwise criterion based on specific row and column or aggregated individual ratings obtained from experts.

Step 4: Checking the consistency ratio; The optimal decision-making in pairwise comparison (AHP) is mainly associated with the permissible value of consistency ratio. This permissible value acts as a gateway to observe the consistency and inconsistency of the decision matrix

(Waris *et al.*, 2019). In order to calculate the consistency ratio, an index was formulated to measure the consistency of weights.

Hence the consistency ratio (CR) can be calculated using Equation 4 to determine the consistency of the pairwise comparison matrix. Where, RI is the random index for the matrix size and the value presented in Table 3.4 below in two rows, where the first row represents the sequence of the randomly generated matrix (number of elements being compared) and the second row represents the corresponding index of consistency for randomly generated judgments (Abdul Rahman *et al.*, 2019; Saaty, 2008; Hamed Taherdoost, 2017).

$$CR = \frac{CI}{RI} \quad 4$$

Table 3-4: Random index (RI) (Abdul Rahman *et al.*, 2019)

No	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

And, the Consistency Index (CI) computed using Equation 5 as follows (Abdul Rahman *et al.*, 2019):

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (n = 1,2,3 \dots k, \text{matrix size}) \quad 5$$

Where, the λ_{max} is a maximum eigenvalue of n x n comparison matrix 'A' that is calculated as equation 6 below (Abdul Rahman *et al.*, 2019; Asuquo *et al.*, 2014).

$$\lambda_{max} = \frac{\sum_{j=1}^n \left[\frac{\sum_{k=1}^n w_k a_{kj}}{w_j} \right]}{n} \quad 6$$

where, w_k = the weight value of specific criterion, a_{kj} = the pairwise criterion base on specific row and column, w_j = the weight value of the criterion. Then, from equation 4 to 6 the consistency of the pairwise comparison needs to be evaluated. In this regard, the consistency ratio (CR) has also been found to be less than or equal to 0.1 or 10%, otherwise decision-makers are required to revise their initial judgments (Darko *et al.*, 2018; Saaty, 2008).

Step 5: Prioritize the factors: Once the CR values of main factors and sub-factors have been considered consistent and at the acceptable level (less than or equal to 10%) the next step is

ranking factors based on priority weights. These priority weights of the factors represent the importance or significant impact level of these factors on MDP operations.

Priority weights have two types: local priority weights and global priority weights. The local priority weights represent the relative weights of the nodes within a group of factors concerning their categories. The local priority weights are derived from each set of pairwise comparisons in each level for both main factors and sub-factors. Meanwhile, the global priority weights are obtained by multiplying the local priority weight of the sub-factors by the global priority of main factors (the same as local priority weight of main factors) with their corresponding categories (Abdul Rahman *et al.*, 2019).

Finally, the results of analyzed data were presented in tables, descriptive and explanatory research was employed to explain the analyzed results. The overall work activity flow chart is shown in Figure 3.2.

3.8 Research reliability and validity

Reliability is concerned with the repeatability or consistency of data or results when the research is repeatedly using the same methods (Taherdoost, 2016). In this study, the survey results from experts are checked by a consistency ratio which is the way to distinguish whether the data is accepted or rejected. While validity refers to the extent to which the survey questionnaires considered precise, correct and accurate findings establishing the correct operational measures for the studied concepts. The validity of survey questionnaires was validated by presenting the elements to the experts of the enterprise and the research advisor. The results led to corrections with small changes, which were made before running the survey.

CHAPTER FOUR: RESULTS AND DISCUSSIONS

This section presents the results and analysis of data to reach the research findings. The findings are related to the research questions which guide the study. Data were analyzed to evaluate and rank factors that affect Modjo Dry Port operations and its critical success factors. These factors were identified during the literature review. Both primary and secondary data were used to analyze the results. Primary data were obtained from field observation, interviews with experts and survey questionnaires that were distributed to the respondents by using a pairwise comparisons matrix and five-point Likert scale. Where those respondents were directly involved in the dry port operations, custom office and shipping company. Whereas secondary data was obtained from documented and published information.

4.1 Demographic Information of respondents

In the first case, as mentioned in chapter three, 13 experts were chosen to participate in a pairwise comparison questionnaire survey to collect primary data. Of them, 11 experts accepted to participate in the survey. The respondents are selected based on their educational background, years of experience, knowledge of the field of study and availability of experts in the dry port. Among those experts' answers, 6 questionnaires contained inconsistent (incorrectly filled) answers. These questionnaires were sent back to the respondents to be filled out again. Only 2 of them returned questionnaires and 4 experts who refused to revise and correct his/her answers, were excluded from the analysis. Therefore, the results of the pairwise questionnaire survey in this research were based on the responses of 7 experts. The respondents included 1 female and 6 males. So, about 85.7% of the respondents are male and the rest 14.3% are female. The demographic results regarding educational background, years of experience, and age are shown in Table 4.1. Of respondent's educational background results 85.7% had 2nd degree and the rest 14.3% had 1st degree. Concerning years of experience, all of the respondents had between 5 and 20 years of experience. All the participants in the survey had more than 5 years of field experience and had a minimum of bachelor's degrees. Most of those respondents had acquired additional postgraduate qualifications.

Table 4-1: Demographic Information of pairwise comparison respondents

Expert	Working background	Educational qualification	Years of field experiences	Age	Sex
1	MDP director	2 nd degree	20	47	Male
2	Head of operation clearing	2 nd degree	12	49	Male
3	Senior yard planner	2 nd degree	7	38	Male
4	Terminal operation manager	2 nd degree	9	53	Male
5	Container operation officer	2 nd degree	11	43	Male
6	Order deliver officer	1 st degree	5	32	Male
7	Head of general cargo and RORO operation	2 nd degree	9	37	Female
Interviewee	One terminal operations manager, one senior operation officer, two customs clearing officers and one shipper (Import/Export)				

In the second case based on the sample selected, 146 questionnaires were distributed and 123 (84.24%) questionnaires were returned and met the required criteria. The response rate and personal profile are shown under Annex B in Table 6.

4.2 Develop a hierarchy model of the study

To use the AHP method, the first step is developing a decision hierarchy tree containing numbers of levels. The first level of the model is related to the general goal of the hierarchy. Factors affecting dry port operations were selected as the first level of the decision tree. The number of factors affecting the operations of dry ports is quite large. From the study of literature review, as shown in the conceptual framework, this study identifies 24 factors, which were categorized as main factors and sub-factors to develop a hierarchical model. These factors, named as main factors (secondary level) which consists of; Dry port capacity, Hinterland conditions, Service features, Information systems, Government policy while tertiary level consists of sub-factors such as; Facilities and equipment, Safe environment, Insufficient space, Unskilled workforce, Coordination between stakeholders, Accurate forecasting, PPP policy, Transport infrastructure policy, Multi-modal transport policy, Seaport policy, Strategic

location, Transport connectivity, Freight market, Seaport-dry port relationship, Customs clearance, Value-added services, Container storage service, Container maintenance service, Container transfer service. The model was basically consisting of three levels, 1st level as a goal, 2nd level as the main factor and 3rd level as sub-factors. On the hierarchically structured model developed, each main factor was grouped with a number of sub-factors as the underlying elements that can influence the contribution of the main factor. The hierarchical model of this study is shown in Figure 4.1.

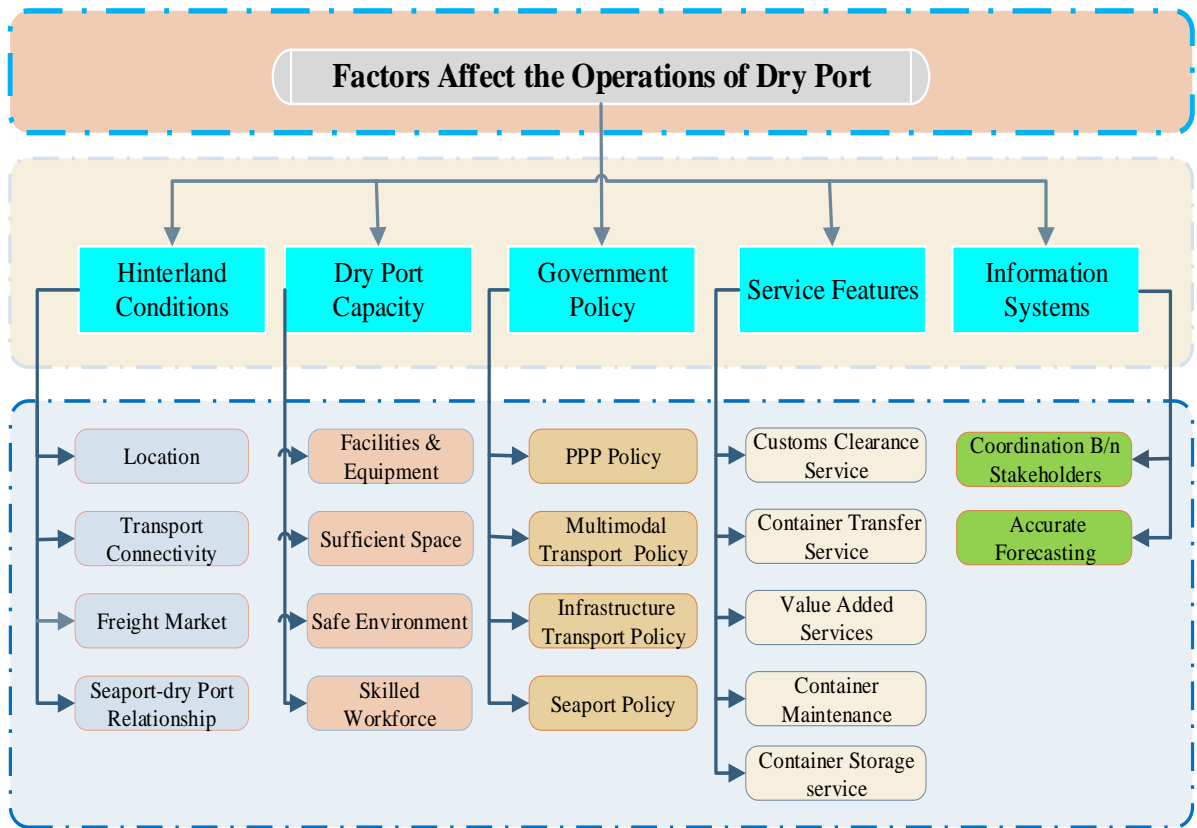


Figure 4.1: Structure the decision hierarchy model (Author, 2021)

4.3 Data collection for pairwise comparisons

After the hierarchical structure model has been established, the researcher formulated a close-ended questionnaire that developed a corresponding model to get the expert’s opinion and collect related data. The data was collected from the MDP experts using the pairwise comparison technique. The main purpose of the questionnaire is to elaborate a pairwise comparison of each level concerning each element in the next higher level of the hierarchy. The

technique required the experts to evaluate the factors involved based on the rating scales shown in Table 3.2.

4.4 Aggregations of respondent’s rate to pairwise comparison matrix.

The analysis of the completed questionnaires featured in collective ratings of all the respondents or individual preferences needed to be combined to generate a single preference matrix. In this step, the judgments provided by the experts for main factors and sub-factors were aggregated and tabulated into the pairwise comparison matrix. As it described before this study employed the geometric mean method (GMM) to combine individual ratings using Equation 2 (Aminbakhsh et al., 2013; Singer & Özşahin, 2018). Taking the main factors ‘Service feature’ with ‘government policy’ as the example, the aggregated respondents pairwise comparison can be determined as follows;

$$a_{31} = \sqrt[7]{5 * 7 * 5 * 3 * 5 * 5 * 5} = 4.88$$

Table 4-2: Evaluation of the main factors concerning the goal

Main factors	Dry Port Capacity	Hinterland conditions	Service feature	Information systems	Government policy
Dry Port Capacity	1.00	4.88	0.33	0.20	3.00
Hinterland conditions	0.20	1.00	0.14	0.14	0.33
Service feature	3.00	7.17	1.00	0.31	4.88
Information system	5.12	7.17	3.23	1.00	5.77
Government policy	0.33	3.00	0.20	0.17	1.00
Total	9.65	23.22	4.90	1.82	14.98

In the same manner, aggregated individual ratings for other subfactors are summarized in Annex A from Table 1-5. As it is shown in the Tables the diagonal values of the comparison matrix are equal to 1 which indicates that the weight value of the factor concerning itself is equal.

4.5 Deriving the relative weights of the main factors and sub-factors

In this step, to synthesize the judgments to obtain the relative weight of the comparison matrix for the factors evaluated concerning main factors, it was begun by adding the values in each column as shown in Table 4.2 to obtain a normalized matrix.

The normalized matrix of main factors and sub-factors was derived from the pairwise comparisons matrix by dividing each of the entries by the sum of their respective columns, from which the addition of all the elements on each column sums to 1. Taking the main factors ‘Dry Port capacity’ with ‘Dry Port Capacity’ as an example, the normalized matrix of factors can be determined as follows; $1/9.65 = 0.10$ (Table 4.3).

After similar calculations were applied to determine the normalized matrix of other all main factors and sub-factors are summarized in Table 4.4 – 4.8, the next step is deriving the normalized weights for each factor being evaluated.

The relative weight (eigenvector) of the main factors and sub-factors basically indicates the relative impacts of one factor over the other factors. This indicates the priority of each element in the pairwise comparison matrix in terms of its overall contribution to the decision-making process (Abdul Rahman *et al.*, 2019). To determine the significant impact level of the main factors and sub-factors evaluated, the normalized weights of each main factor and sub-factors can be calculated and tabulated in the last column of the comparison matrix from Equation 3. Taking the main factors ‘Dry Port capacity’ as the example, the normalized weight of factors can be determined as follows;

$$w_k = \frac{1}{n} \sum_{j=1}^n \left(\frac{a_{kj}}{\sum_{i=1}^n a_{ij}} \right) = \frac{1}{5} \sum_{j=1}^5 \left(\frac{1.00}{9.65} + \frac{4.88}{23.22} + \frac{0.33}{4.90} + \frac{0.20}{1.82} + \frac{3.00}{14.98} \right) = 0.1378$$
$$= \mathbf{13.78\%}$$

Table 4-3: Normalized matrix and relative weights of main factors

Main factors	Dry Port capacity	Hinterland conditions	Service feature	Information systems	Government policy	Normalized Weight 100%
Dry Port capacity	0.10	0.21	0.07	0.11	0.20	13.78
Hinterland conditions	0.02	0.04	0.03	0.08	0.02	3.83
Service feature	0.31	0.31	0.20	0.17	0.33	26.41
Information systems	0.53	0.31	0.66	0.55	0.39	48.70
Government policy	0.03	0.13	0.04	0.09	0.07	7.29
Total	1.00	1.00	1.00	1.00	1.00	100.00

The result of Table 4.3 indicates that Information systems are the dominant factor with a weight of 48.70% followed by Service features with a weight of 26.41%, Port capacity with a weight of 13.78%, Government policy with a weight of 7.29% and Hinterland conditions with a weight of 3.83% which takes the last place.

Similar calculations were applied to determine the normalized weight (eigenvector) of all other main factors and sub-factors involved in this study as summarized in Table 4.4 – 4.8.

Table 4-4: Normalized matrix and relative weights of dry port capacity

Dry Port capacity	Facilities & Equipment	Unsafe environment	Unskilled workforce	Insufficient space	Relative Weight 100%
Facilities & Equipment	0.64	0.45	0.51	0.73	58.41
Unsafe environment	0.08	0.05	0.03	0.03	4.73
Unskilled workforce	0.12	0.19	0.09	0.05	11.05
Insufficient space	0.16	0.32	0.37	0.19	25.80
Total	1.00	1.00	1.00	1.00	100.00

According to Table 4.4, there are four factors, which must be compared in pairs and the results of the survey indicate that Facilities and Equipment (58.41%) is accounted as the most influential factor followed by Insufficient space (25.80%), Unskilled workforce (11.05%) and Unsafe environment (4.73%).

Table 4-5: Normalized matrix and relative weights of hinterland conditions

Hinterland conditions	Location	Transport connectivity	Freight market	Seaport-dry port relationship	Relative Weight 100%
Location	0.06	0.09	0.03	0.03	5.15
Transport connectivity	0.43	0.64	0.74	0.53	58.76
Freight market	0.33	0.15	0.18	0.34	25.13
Seaport-dry port relationship	0.17	0.12	0.05	0.10	10.96
Total	1.00	1.00	1.00	1.00	100.00

From Table 4.5, there are four factors, compared in pairs under hinterland conditions and the results of the survey indicates Transport connectivity (58.76%) is accounted as the most significant impact factor followed by Freight market (25.13%), Seaport-dry port relationship (10.96%) and Location (5.15%).

Table 4-6: Normalized matrix and relative weights of government policy

Government policy	PPP Policy	Transport Infrastr'r Policy	Multi-modal Transport Policy	Seaport Policy	Relative Weight 100%
PPP policy	0.66	0.77	0.56	0.44	60.71
Transport Infrastructure Policy	0.14	0.16	0.32	0.31	23.10
Multi-modal Transport Policy	0.11	0.05	0.09	0.19	10.81
Seaport Policy	0.09	0.03	0.03	0.06	5.39
Total	1.00	1.00	1.00	1.00	100.00

The result of Table 4.6 indicates that PPP Policy is the most influential factor with a weight of 60.71% followed by Transport Infrastructure Policy (23.10%), Multi-modal Transport Policy (10.81%), and Seaport Policy (5.39%) which takes the last place.

Table 4-7: Normalized matrix and relative weights of Service features

Service features	Customs clearance service	Value-added services	Container storage service	Container maintenance service	Container transfer service	Relative Weight 100%
Customs clearance	0.58	0.40	0.54	0.33	0.67	50.38
Value-added services	0.08	0.06	0.03	0.12	0.04	6.35
Container storage service	0.10	0.20	0.09	0.19	0.06	12.80
Container maintenance service	0.07	0.02	0.02	0.04	0.02	3.41
Container transfer service	0.18	0.32	0.32	0.32	0.21	27.05
Total	1.00	1.00	1.00	1.00	1.00	100.00

According to Table 4.7, there are five factors, compared in pairs under service features and the survey of the results indicated that customs clearance is the dominant influential factor with weight of 50.38% followed by container transfer service (27.05%), container storage service (12.80%), value-added service (6.35%) and Container maintenance service (3.41%).

Table 4-8: Normalized matrix and relative weights of information systems

Information systems	Accurate forecasting	Coordination b/n stakeholders	Relative Weight 100%
Accurate forecasting	0.24	0.24	23.64
Coordination b/n stakeholders	0.76	0.76	76.36
Total	1.00	1.00	100.00

According to Table 4.8, there are two factors, compared in pairs under information systems and the results of the survey indicate that Coordination between stakeholders (76.34%) is accounted as the most influential factor followed by Accurate forecasting (23.64%).

4.6 Checking the consistency of pairwise comparison matrix

In this step before ranking the factors, the consistency of the comparison matrix is checked to measure the level of reliability of the results. This is because comparisons made using the AHP method are subjective and the acceptability of judgments is determined by checking the consistency value of the comparison matrix. The checking of the consistency value is referred

to as the consistency ratio (CR) value. The consistency ratio value can be determined using Equation 4, to do that the value of the consistency index (CI), should be known first. However, to get the CI value, the λ_{max} also needs to be determined using Equation 6 thus the value of λ_{max} for the comparison matrix of the main factors and sub-factors calculated are shown in Table 4.9. Taking the ‘main factors’ as the example, the value of λ_{max} can be determined as follows:

$$\lambda_{max} \text{ for main factors} = \frac{\sum_{j=1}^n \left[\frac{\sum_{k=1}^n a_{jk} w_k}{w_j} \right]}{n}$$

$$\text{where, } \left[\frac{\sum_{k=1}^n a_{jk} w_k}{w_j} \right] = \begin{bmatrix} \mathbf{1.00} & 4.88 & 0.33 & 0.20 & 3.00 \\ 0.20 & \mathbf{1.00} & 0.14 & 0.14 & 0.33 \\ 3.00 & 7.17 & \mathbf{1.00} & 0.31 & 4.88 \\ 5.12 & 7.17 & 2.23 & \mathbf{1.00} & 5.77 \\ 0.33 & 3.00 & 0.20 & 0.17 & \mathbf{1.00} \end{bmatrix} * \begin{bmatrix} 0.1378 \\ 0.0383 \\ 0.2641 \\ 0.4870 \\ 0.0729 \end{bmatrix} / \begin{bmatrix} 0.1378 \\ 0.0383 \\ 0.2641 \\ 0.4870 \\ 0.0729 \end{bmatrix} = \begin{bmatrix} 0.725 \\ 0.195 \\ 1.459 \\ 2.741 \\ 0.369 \end{bmatrix} / \begin{bmatrix} 0.1378 \\ 0.0383 \\ 0.2641 \\ 0.4870 \\ 0.0729 \end{bmatrix} = \begin{bmatrix} 5.27 \\ 5.09 \\ 5.52 \\ 5.63 \\ 5.06 \end{bmatrix}$$

$$\lambda_{max} \text{ for main factors} = \frac{\sum_{j=1}^5 (5.27 + 5.09 + 5.52 + 5.63 + 5.06)}{5} = 5.31$$

Meanwhile, in the case of sub-factors, a similar calculation was also applied to calculate their λ_{max} values and the results are summarized in Table 4.8.

Table 4-9: The value of λ_{max} and CR of comparison matrix of the main factors and sub-factors

Comparison matrix	λ_{max}	CR value
Main factors	5.31	0.07
Sub-factors for ‘Dry Port Capacity’	4.23	0.08
Sub-factors for ‘Hinterland Conditions’	4.20	0.07
Sub-factors for ‘Government Policy’	4.26	0.09
Sub-factors for ‘Service Features’	5.34	0.08
Sub-factors for ‘Information Systems’	2.00	0.00

Using the previously determined eigenvalue of the matrix, λ_{max} calculates the consistency index (CI), based on Equation 5, where n is the number of factors used in the decisions. Taking the ‘main factors’ as the example, the value of CI can be determined as follows: where $\lambda_{max} = 5.31$ and n is 5 then;

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{5.31 - 5}{5 - 1} = 0.0775$$

Once the CI value has been known and the value of Random index (RI) can be referred from Table 3.4 corresponding to the matrix size then the CR value can be calculated using Equation 4, to check the level of consistency of the comparison matrix. Taking the ‘main factors’ as the example, the value of CR can be determined as follows, where CI = 0.0775 and CR = 1.12 which is corresponding to n = 5.

$$CR = \frac{CI}{RI} = \frac{0.0775}{1.12} = 0.069 < 0.1$$

According to Waris *et al.* (2019), the CR value is recommended to be less than or equal to 0.1 to be acceptable as it is nearly consistent. If it is more than 0.1, then the inconsistency of the judgments is too large, and it could lead to errors in the results.

In the case of sub-factors, a similar calculation was also applied to calculate their CR values and the results are summarized in Table 4.9. Based on this acceptance level, the judgments provided by the experts were considered as reasonably consistent and acceptable. Because the CR values of main factors and all sub-factors were recorded to have an acceptable consistency level, which is less than 0.1.

4.7 Finalizing global weight and rank of the main factors and subfactors

In this step the global weight values of the main factors and sub-factors can be finalized once the consistency ratio (CR) values of all factors have been considered to be consistent and at the acceptable level (which is 0.1 or less). The global weights of the main factors were similar to the local weights whereas the global weight values of the sub-factors need to be calculated by multiplying the local weights of main factors and the local weight of sub-factors of each respective group as summarized in Table 4.10.

According to the results in Table 4.10, the weight values were presented in the form of percentages to give a clear indication of the weight differences between each factor. The main factor of Information Systems was determined to be the most significant factor that influenced the operations of Modjo Dry Port with a percentage weight of 48.70%. The dominant influence of the Information system factor was followed by the factors of service

Table 4-10: Global weights and Rank of overall factors (Survey results)

Main factors	Local weight	Local rank	Subfactors	Local weight	Local rank	Global weight	Global rank
Dry Port capacity	13.78%	3	Facilities and equipment	58.41%	1	8.05%	4
			Unsafe environment	4.73%	4	0.65%	16
			Unskilled workforce	11.06%	3	1.52%	12
			Insufficient space	25.80%	2	3.56%	7
Hinterland conditions	3.83%	5	Location	5.15%	4	0.20%	19
			Transport connectivity	58.76%	1	2.25%	9
			Freight market	25.13%	2	0.96%	13
			Seaport-dry port relationship	10.96%	3	0.42%	17
Government policy	7.29%	4	PPP policy	60.71%	1	4.43%	6
			Transport Infrastructure Policy	23.10%	2	1.68%	10
			Multimodal transport policy	10.81%	3	0.79%	15
			Seaport Policy	5.39%	4	0.39%	18
Service feature	26.41%	2	Customs clearance	50.38%	1	13.31%	2
			Value-added services	6.35%	4	1.68%	11
			Container storage service	12.80%	3	3.38%	8
			Container maintenance service	3.41%	5	0.90%	14
			Container transfer service	27.05%	2	7.14%	5
Information systems	48.70%	1	Accurate forecasting	23.64%	2	11.51%	3
			Coordination between stakeholders	76.36%	1	37.19%	1

feature with a weight of 26.41%, Dry Port Capacity with a weight of 13.78%, Government Policy with a weight of 7.29% and the lastly Hinterland Conditions with a weight of 3.83%, which took the last place. Similarly, the influence of each subfactor on the overall objective of the study i.e., factors that affect Modjo Dry Port operations is summarized as shown in Figure 4.2.

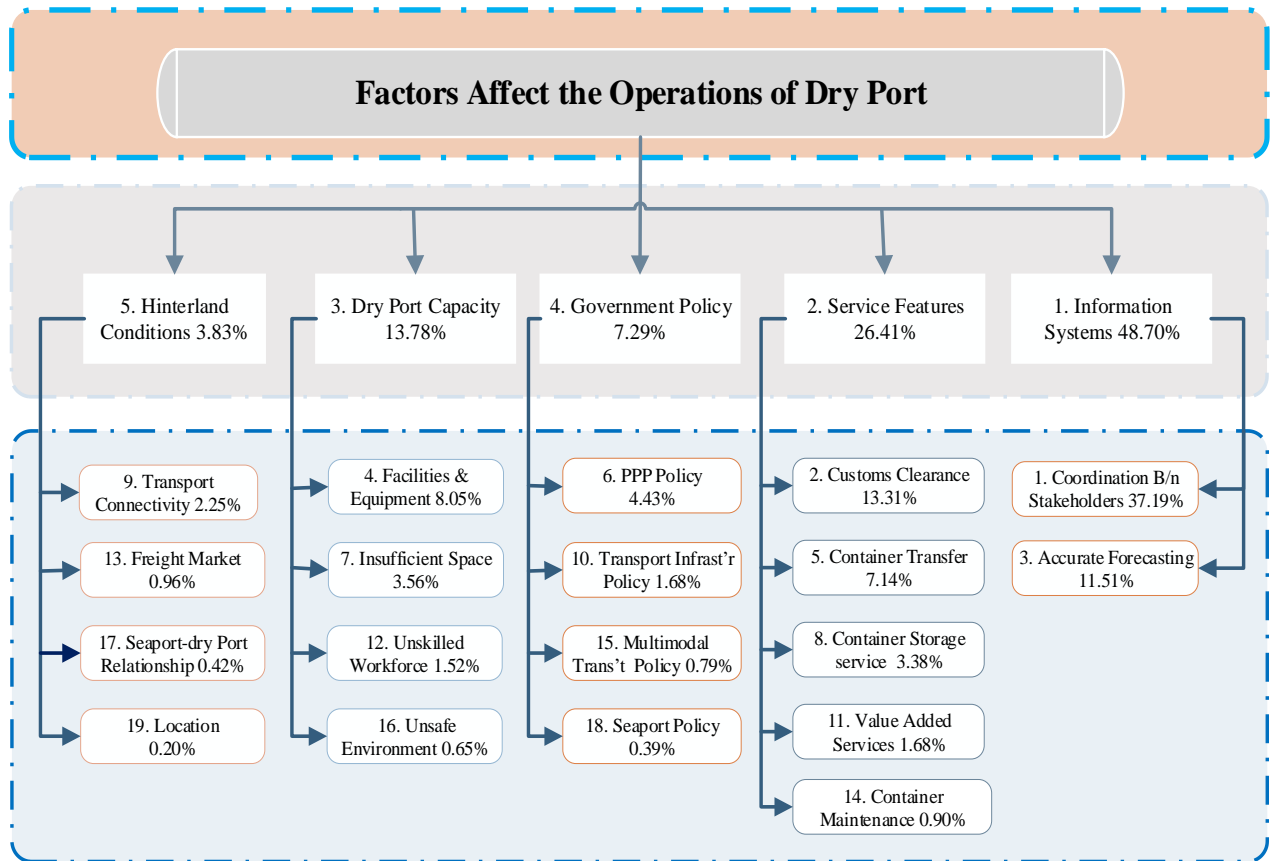


Figure 4.2: Hierarchy model that ranks factors to the overall objective.

4.8 Synthesizing the results

Once the global weights of each factor (the contribution of a particular factor to the overall objective) are obtained as shown in Table 4.10, 7th column then it was used to evaluate the final rank of each factor from most significant impact to least significant impact as shown in Figure 4.2 and it helps in synthesizing the finding of the study. Based on model results, in this section, the influence of each factor on MDP operations is analyzed

4.8.1 Influence of information systems on Modjo Dry Port operations

In this study, the result of the study shows, low-level usage of information systems for coordinating stakeholders and for accurate forecasting is identified as influential factors affecting MDP operations. Efficient information sharing between stakeholders, providing for utilization of available assets, and for accurately forecasting the influence of throughput is

crucial for effective decision-making in daily operations of dry ports (Jeevan *et al.*, 2017). But this is impractical in MDP as it is discussed as follows.

A. Coordination between stakeholders

Regarding coordination between stakeholders such as freight forwarders, transport companies, rail/truck operators, crane operators, customers and all dry port stakeholders considered to be an important element that provides reliable and timely information for hundreds of port communities. The result of pairwise comparisons from Figure 4.2 shows that lack of coordination for information sharing among stakeholders was ranked as the first influential factor that affects the operations of MDP with a weight of 37.19%. This was due to the low level of usage of information systems for collaboration and coordination in dry port and current communications among participants are mainly through paper communication, mail, fax, internet and telephone. Modjo Dry Port is characterized by poor coordination between logistics participants (WB, 2017). These coordination failures constraint information flow and limit the efficiency of dry port operations.

An interview with a dry port expert stated that the lack of advanced information systems in Modjo Dry Port makes it difficult to integrate dry port users with different offices, which causes operational inefficiencies. Even the available information systems are not performed for what it was designed for. For example, the Container Tracking System (CTS) exists in the dry port which is used for tracking cargo to provide information about the progress of cargo to concerned officials, but not for the customers (Teshome, 2017). Therefore, from this finding, it is possible to say Modjo Dry Port has no advanced information systems to coordinate all stakeholders, which has a significant impact on its daily operations.

B. Accurate forecasting

Accurate information forecasting enables optimizing the entire dry port operations by providing real-time visibility, quick and accurate information, efficient data exchange, and better flexibility to react to unexpected demand (Jagan Jeevan *et al.*, 2018). However, from the result of this study, lack of an appropriate information system for accurate forecasting was found to be the third factor that affects MDP operations. This was due to the absence of adequate information systems in MDP for real-time cargo tracking along the logistics supply chain

(especially for rail transport) and the current container tracking systems are effective only for road transport at focal points in supply chains such as Galafi, Mile, Awash and Modjo Dry Port gate (interviewee with experts). The systems track information about container number and conditions, driver name, shipper, location and consignee at each point, only for road transport and the systems are ineffective for railway transport this makes it difficult in obtaining accurate information about container arrival time at the dry port.

According to Jagan Jeevan *et al*, (2018), real-time data about the status and positioning of objects is highly important to efficiently plan and organize activities including multiple stakeholders in port operations. This retrieved positioning data is essential for forecasting arrival times (timeless operations), resource utilization, speedy operation and route prediction. In addition to the REID-based container tracking and tracing (CTT) system, it is suggested that Global Position Systems (GPS) enables exact position detection, location and tracking of movable objects such as vehicles, containers and equipment. This will be an important solution for Modjo Dry Port to obtain accurate data to make appropriate decisions before objects are crowded there which improves operations of the dry port, especially during peak time.

4.8.2 Influence of service features on Modjo Dry Port operations

With regard to service features, factors that affect MDP associated in this study were related to customs clearance, container transfer (handling, rail to truck, truck to rail) service, container storage (warehousing, empty container) service, value-added (stuffing/unstuffing, packaging, labeling) service and container maintenance/repair service. Each factor is discussed as follows.

A. Customs clearance service

Shippers need faster, more standardized and uniform service while governments require more revenues from customs clearance (Jagan Jeevan *et al.*, 2018). In MDP there is a growing awareness of the significance of customs clearance procedures to improve time efficiency and reduce logistics cost. However, the result of the pairwise comparison shows that customs clearance/inspections related procedures are the second-ranked influential factor that affects MDP operations with a weight of 13.31%. According to the interview with expert's, customs clearance procedure problems are due to unfulfilled import/export document from consignee, forged documents, reworks which required additional adjustment, lack of strong legal

framework, control system failure, corruption, insufficient space for inspection, inadequate handling equipment to bring containers to the customs inspection area, lack of advanced technology to speed up the procedures at each focal points and absence of cargos scanning machines (manual inspection) contributed to the poor customs clearance services in dry port operations.

Research consistent with this finding was conducted by Teshome (2017) showed that the absence of an installed automated system, advanced technology approach and clear and simple procedure in MDP impeding effective and efficient customs clearance services. Similarly, Alo *et al.* (2020) stated that handling and clearing cargo takes an average of 9 days in MDP, 13 days in Djibouti and to fulfill the necessary document up to 2 days. This causes customs processing systems to be very much lengthy, customers wait from one to two weeks for inspection of their cargo. Due to these problems' customs clearance process affects the operations of Modjo Dry Port.

In Modjo Dry Port the introduction of a single-window system as shown in Figure 4.3 (b) is effective, which is the best practice in simplifying the customs clearance process by reducing the number of documents required by the number of government authorities involved in controlling import/export in Ethiopia. However, handling of cargo, physical examinations, document inspection and tax re-assessment processes took about two weeks (interview with experts). The newly introduced electronic Customs Management System (ECMS) that replaced the outdated Automated System for Customs & Data (ASYCUDA++) also produces bottlenecks in MDP due to network problems, power interruption, the inefficiency of the system and under capacity (interviewee with experts). From these findings, the researcher concludes that there is an inefficiency of customs clearance procedures which affect the operations of the dry port.

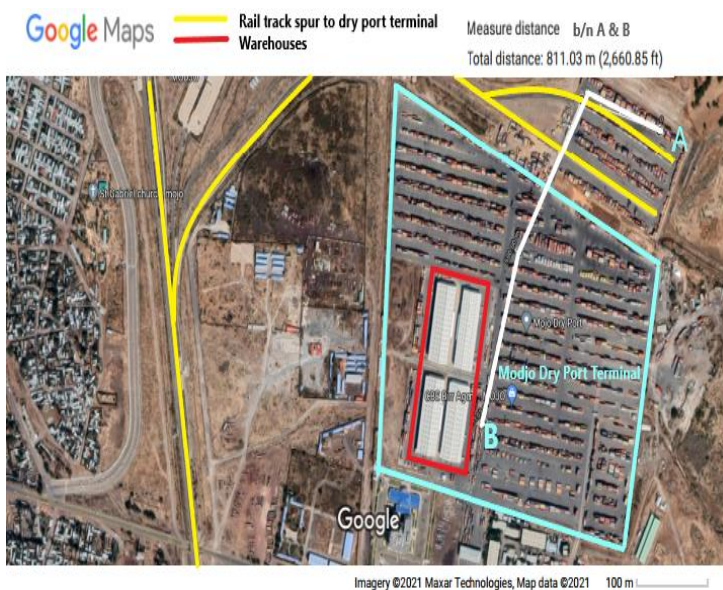
B. Container transfer service

Considering container transfer service, the movement and transfer of container from rail to truck and/or from truck to rail required adequate material handling, sufficient terminal space and infrastructures for ease of move container, sufficient container freight station for loading/unloading, skilled material handling operators and integration of transport modes

(UNESCAP, 2019). Inconsistent with this the result shows that a lack of appropriate container transfer service ranked as the fifth factor that influences the operations of MDP which causes long delivery time, congestion and increases total logistics cost. Handling and transfer of containers in MDP take an average of nine to fifteen days (Alo *et al.*, 2020).

From field observation, during data collection, the container yard facility layout is the main challenge causing delays to container transfer service. As shown in Figure 4.3 (a), the rail track spur to Modjo Dry Port is at a long distance from the container terminal, which results in long movement of material to handle and delayed transfer time. In MDP the distance between container terminal and rail infrastructure is as long as about 0.8 km that leads to a number of moves which is causing high material handling operational cost and increasing total delivery time.

According to UNESCAP (2019a), rail-served dry ports should position their rail infrastructure in such a way that will reduce the number of moves required before a container is placed on a train for dispatch to onward destinations. However, this is not practical in MDP, which affects the fast delivery of containers between rail to truck and vice versa. Therefore, the finding suggests that inefficient container transfer service in the enterprise is caused by unstandardized terminal and facility layout, lack of transport mode integrations, type of handling equipment used (absence of portal crane), insufficient spaces are identified.



(a) source: Photo taken from Google map



(b) Source: photo taken by researcher 2021

Figure 4.3: Rail track at MDP (a) and Single window system customer service (b)

C. Container storage service

The other function of dry ports is providing container storage areas to cut the problem of seaport congestion and assisting ease import and export procedures. In addition to storing unstaffed goods in warehouses, the dry port is used as temporary storage of containers waiting for pick up. The result of the comparison shows the lack of container storage service in the enterprise ranked as the eighth factor affecting its operations with weight of 3.38%. The dry ports need to have an immediate site of terminal long-term storage service for its customers with less charge for service they used (Zainuddin *et al.*, 2018). However, due to the shortage of storage area and facilities in MDP, the maximum period allowed to store containers in the dry port is only 15 days, which does not fully meet what is required by its customers.

D. Value-added services

Availability of range value-added service is another key element that will attract and increase the number of customers in dry ports. The dry ports offer value-adding services such as storing, labeling, stuffing/unstuffing and packaging to make the port attractive to its customers (UNESCAP, 2015). In contrast, the result from Figure 4.2 shows that the absence of appropriate value-added service in enterprise ranked as the eleventh factor that affects MDP operations with a weight of 1.68%.

An interview with experts stated that value-added services such as packaging/re-packaging, labeling, barcoding, are not offered by the enterprise and its advantage didn't get attention in dry port and a lot of tasks required to be aware of the actors. Providing value-added services close to the client, dry ports can expand their customer base and thus improve the dry port operations Jagan Jeevan *et al.*, (2018). The advantages of value-added services are not only for dry ports but also customers can gain cost and time benefits from value added services. Therefore, Modjo Dry Port as a distance dry port serves a large hinterland area, but the absence of a range of value-added services is affecting its effective operations and client's benefits.

E. Container maintenance service

Another service offered by dry ports to its customers engaged in this study was container maintenance service. For the current growth of trade on seaborne, containerization leads to cost savings mainly by reducing manpower and better protection against cargo damages. The average price for a 20ft container was approximately varied between 1,450 - 2,700 USD in the years from 2011 – 2018 and the price is related to the current price of steel (Hoffmann *et al.*, 2020). However, from the result of pairwise comparisons, the absence of container maintenance services in MDP ranked as the fourteenth factor that affects the operations of the dry port.

According to the interviewed opinion, due to the absence of container maintenance service in the enterprise, the number of damaged, deformed and corroded containers stacked in the dry port terminal for more than a year. Therefore, the finding of the study reveals that the absence of container maintenance and repair service in the dry port affecting its operations through reduced economic advantage and increased capital cost causes for container shortage in dry port, increased congestion and space shortage around dry port terminal.

4.8.3 Influence of dry port capacity on Modjo Dry Port operations

In this section, dry port capacity was associated with the availability of adequate facilities and Equipment, skilled workforces, sufficient space for current and future expansions and a secure and safe environment which are effective characteristics of dry port operations. Each factor is discussed as follows.

A. Facilities and equipment

Availability of sufficient facilities such as bonded warehouse, container yard, truck parking, container freight station and equipment such as reach stackers, forklift and cranes has an important role in dry ports operations. The result of pairwise comparisons show that facility and equipment related problems are ranked as the fourth factor that affects MDP operations with a weight of 8.05%. In MDP material handling equipment was limited with load capacity, maximum height reached and the amount available in the dry port (Teshome, 2017). The interview results with experts of Modjo Dry Port, considering the lack of appropriate material handling equipment in quantity and limited capacity are currently challenges to MDP

operations. For example, due to the limited capacity of materials handling equipment such as reach stackers and forklift, stacking more than four containers high is impossible in MDP as shown in Figure 4.4. This takes large terminal space horizontally for stacking and for storage of containers.

According to Stoilova & Martinov (2019), for cost-efficient operations of dry ports, choice of material handling type is based on annual container throughputs, the reach-stacker system is effective up to 200,000 TEU per year, beyond this a portal crane system may be justified. As data from ESLSE shows Modjo Dry Port reached annual throughput of 600,000TEU per year, but there is no portal crane system such as rail-mounted gantry cranes and rubber-tyre gantry cranes in the dry port. The advantage of a portal crane system is not only cost-effectiveness but also the ability to stack dense containers in very little terminal space.

From field observation, considering facilities such as parking for trucks, container freight station (CFS), dry bulk storage, cold storage, bonded warehouse, customs inspection area and sufficient offices for administrations (currently they use containers as offices) are not sufficient in MDP. From this, it is possible to conclude that MDP is not well equipped with the necessary equipment to handle the current flow of containers through it and existing facilities do not meet the level of containers and cargo handled in the enterprise.



Figure 4.4: Container stacking and handling equipment (Photo taken by researcher, 2021)

B. Unskilled workforce

In order to successfully address new problems, competency requirements for port personnel should go beyond those in the port operations and management only, rather cover as well necessary skills, knowledge and abilities in the general business, management fields and logistics (Thai, 2014).

Regarding the statement, due to lack of skilled workforce at managerial and operations level in Modjo Dry Port is ranked as the twelfth factor that affects its operations. Information obtained from the interview shows that currently there is a high shortage of skilled workforce. There is a lack of logistics professionals and majorities of the workers in the enterprise doing their job by experience. Most of the workers in the enterprise graduated from related fields and they are not professional in the area. The high turnover rate of qualified and experienced workers, makes the enterprises always perform their operations by an unfamiliar/unskilled workforce which affects its operations.

The training and education of dry port workers play a significant role in successful operations to respond to future challenges and increasing global trade volume. According to Hinkka *et al.* (2016), the port operations required a skilled workforce for an efficient way of handling, better work organizations, improvements and adjustment of available infrastructures and better use of technology. Therefore, instead of hiring workers from related fields, the enterprise is required to train its workers as they update their knowledge with current technology, reduce turnover rate and allow private logistics experts to participate in the operations of the dry port.

C. Insufficient space

Apart from an insufficiently skilled workforce, the other factor that affects the operations of MDP capacity is associated with a shortage of space. The result from comparisons shows that the absence of sufficient space for current container throughput in MDP is ranked as the seventh factor that affects dry port operations. For the current growth of container throughput volumes, the availability of sufficient container storage space within dry ports is a matter of significant concern (Cullinane *et al.*, 2012). Modjo Dry Port, as one of the largest dry ports in the country, also faced the challenge of space shortage for holding containers from Djibouti port. According to the interviewee result, the enterprise carried out massive expansion work to tackle space shortage for containers terminal and for construction infrastructures in the dry port to reduce logistics cost and congestion at the port, but again there was a shortage of space to hold traffic flow. Currently, Modjo Dry Port occupies a total land of 150 hectares, of which 31.7 hectares were devoted for the container terminal. Also, the fourth phase expansion work is undergoing to increase holding capacity up to 22,000 containers at a time from 17,539 which is the current capacity. In MDP the major cause of space shortage is the presence of customers who want to

store their cargo cheaply at the dry port while they search for customers. These long-held affect the operations of the dry port through increasing the number of containers per stack, and containers take up space at the container yard which causes a shortage of space and congestion. In addition, from the field observations, several damaged containers took large terminal areas and the arrangement of containers in the terminal is also not in the form of space utilized as shown in Figure 4.4 which causes space shortage. Not only the terminal area but also improper use of warehouse layout in MDP affect the performance of warehouses to handle the current increasing flow of unstuffed containers from the terminal to the warehouse (Georgise *et al.*, 2020). Therefore, from this finding, the researcher concludes that the absence of regulations reforms on long hold of containers in the terminal, lack of arranging containers inappropriate ways (vertically utilizing) and stacking damaged containers for long periods causes a shortage of spaces in the enterprise. Additionally, the lack of upgrading dry port space and sophisticated equipment for utilizing terminal space is not proportional to the current increasing throughput.

D. Unsafe environment

A safe environment (free from theft, corruption and accidents) of cargo movement to and from a dry port is important in enhancing smooth operations of dry ports. Not only on movement but also at ports and other logistics nodes where modal shifts from one mode to other, product safety and security risks are particularly high. The result of pairwise comparisons shows that the sixteenth factor that affects MDP operations is due to the absence of a safe environment from and to the seaport as well as in the dry port. According to the interview result from experts, the major security problem happened by theft and pilferage when the container is on road transport from and to Djibouti seaport. The current theft control mechanism is the security seals attached to the door of the container as shown in Figure 4.5 in such a way that an unauthorized/unofficial removal can be identified. From field observation security seal status is checked manually as shown on the figure which might cause an error. An interviewed expert stated that manual checking security seals are not safe and sometimes without damage or break of the security seals, container doors can be opened. To reduce errors from manual procedure and security problems on shipping containers, RFID-based electronic seals were introduced which contain data such as seal status, seal number, protocol information and sealing/opening times. But this is not practical in the enterprise.

The result of the interviewee with experts shows that there was also a security problem in the enterprise during the inspection, improper staffing (high weight goods can be upper) and unstaffed goods to and from the warehouse can be stolen/lost. This was due to the absence of closed-circuit television (CCTV) in MDP. Whereas the cause of safety problems in the enterprise was due to the lack of skilled workforce those who operate material handling equipment.



Figure 4.5: Seal fastened to container door, (Photo taken by researcher 2021)

4.8.4 Influence of government policy on Modjo Dry Port operations

Dry ports are a system with a high investment that requires government support and legislation to perform effectively and efficiently. Government policy on the dry port associated with this study is PPP policy, Multimodal transport policy, transport infrastructure policy and seaport policy. The impacts of these policies on the dry port operations are discussed as follows and their causes, effects are also identified.

A. Public-Private Partnership (PPP) policy

Encouraging Public-Private Partnership (PPP) as a government policy is important for dry port operational improvements especially when there are financial constraints and lack of adequate technical skills relating to the adaptation to new technologies & land, lack of access to capital. According to Nguyen & Notteboom (2017), the PPP approach in dry port operations achieves better performance and higher efficient use of available resources when operated by the private sectors and public management will be improved when governed by public sectors especially focusing on the roles of regulating, planning and monitoring. However, the survey results of this study considered the absence of an appropriate PPP approach was found to be the sixth factor that affected MDP operations. Currently, the involvement of private sectors is allowed

on truck transport as a shipper, but there are no private logistics experts' sectors involved and Modjo Dry Port is owned and operated by Ethiopia Shipping and Logistics Service Enterprise (ESLSE) which is a public sector company. Therefore, the government policy excludes the involvement of private logistics expertise in managerial and operations levels affecting the operations of the dry port.

B. Multi-modal transport policy

Multimodal transport system is identified as an efficient way of transporting international cargo through a single transport document to make the movement of goods more efficient, faster transit times and reduced logistics transport costs between origin and destination (Alo *et al.*, 2020). From the overall factors investigated in this study the fifteenth factor that affects the operations of MDP is the lack of appropriate multi-modal transport policy. The interview result with experts shows that complex multimodal document, an exclusive policy of private sectors from the system (monopolized by the government), the enterprise gives more attention to import trade than export which results to obtain rail economic scale and absence of transparency while assigning truck by the different association is the major policy hinder multimodal transport systems service uniformity. Therefore, lack of a clear government multimodal transport policy to ensure least-cost intermodal solutions to container and cargo haulage between dry port and seaports, to make clear regulations on system procedure affecting the dry port operations. In addition to this, the deficiency of government interventions in selecting least-cost modal choices affects rail economic scale and influences the level of competition between rail and road.

C. Transport infrastructures policy

Regarding transport infrastructures policy, the initiations of governments to increase transport infrastructure between dry port, seaport and other destinations is important to dry port operations Jagan Jeevan *et al.*, (2018). Not only that, government policy has the ability to restrict the gross vehicle weights or heavy road vehicles by high charges to road transport. This restriction is to avoid the damage to road pavements from the operation of overloaded vehicles and heavy loads also may exceed the design capacities of the trucks and trailers, thus stressing their tyres, braking systems, and suspensions, which results in the trucks less safe and increases

risks of accidents. The result of pairwise comparisons considering transport infrastructure policy was found to be the tenth factor that affects Modjo Dry Port operations. This is due to the absence of appropriate gross vehicle weight restriction on road transport and the absence of sustainable transport infrastructures maintenance, expansion by the government (Interview).

According to UNCTAD (2018), in Ethiopia the gross vehicle weight allowed for road transport was 58 - 63 tons which is very high compared to South-East Asia and the Republic of Korea, now apply a gross vehicle weight restriction of 40-45 tons. Similarly, the gross vehicle weight allowed for road transport in Ethiopia is high compared to African regional communities. For example, in the East African Community (EAC), the average gross vehicle weight allowed is 50 tons. In the Common Market for Eastern and Southern Africa (COMESA) and the Southern African Development Community (SADC) average gross vehicle weight is 48 tons. So, from the finding, it is possible to conclude that there is no appropriate infrastructure policy to reduce transport infrastructure maintenance cost and high operational/maintenance vehicle cost, which affects dry port operations in reducing transport services.

D. Seaport policy

In this study, the eighteenth factor affecting the operations of MDP is engaged with government seaport policy. According to Jagan Jeevan *et al.* (2017) encouraging coastal shipping or short sea shipping might be necessary to improve dry port operations, via increasing container throughput at seaports and subsequently enhancing dry port utilization, reducing train turnaround time and preventing port excessive demurrage charge. Consolidated export freight goods through MDP to Djibouti port need fast shipping service in order to reach their destinations. But the result of interviews with experts shows that due to long ship turnaround time, it causes unnecessary charges at port and delays the shipper. This finding is consistent with the research conducted by Nitsche (2021) states that the longship turnaround between Djibouti and Europe about 30 to 36 days results in long waiting periods. Therefore, according to the finding, the study concludes that the absence of regulatory enforcement or government seaport policy makes it difficult to reduce terminal congestion, unnecessary charges and delays that affects the smooth operations of the dry port.

4.8.5 Influence of hinterland conditions on Modjo Dry Port operations

Finally, last but not least factor that affect MDP operations provided in this study were factors related to hinterland conditions such as transport connectivity with seaport and other dry ports, availability of freight market, relationship between seaport-dry port and the location of dry port. Each factor is discussed as follows.

A. Transport connectivity

For effective and frequent delivery of containers to and from the seaport, dry ports should have sufficient transport connectivity in order to improve their operations. From Figure 4.2 the result of pairwise comparisons shows that the absence of adequate transport connectivity is ranked as the ninth factor that affects MDP operations. The dry port was connected to its seaport with two modes of transport (railway and road), even though the condition of the railway and especially the road was below the standards. Except for Addis Ababa-Adama expressway, the rest of the long distance to Djibouti trunk road was in very poor condition regards to its pavement thickness, width and single carriageway (UNCTAD, 2018), which is difficult for trucks to comfortably and safely pass each other while moving at speed in opposite directions, and also not wide enough to accommodate vehicles stopped on the hard shoulder.

Regarding the railway from MDP to Djibouti, only about 42 km is with double track and the rest about 600 km is with single track (Figure 4.6) and double-stack container service from and to seaport impractical. Each train service is two trips per day which is able to carry 106 TEU and 53 FEU per trip.



Figure 4.6: Single-track line Adama to Djibouti, Ethiopia source (JICA, 2018)

In addition to line haul transport connectivity, appropriate local delivery transport infrastructure is also important for effective operations of dry ports. The result of interviewees with experts

of Modjo Dry Port shows that the absence of efficient transport connectivity of dry port with the industrial zone (production area) affects shipping frequency and makes congestion to dry port. For example, one of the most export products consolidated at Modjo Dry Port was coffee, and this product is mostly from the western and southern part of the country, which is more than about 400 km was not connected with high-capacity transport infrastructure and the existing road infrastructure conditions is below the standards. Similarly, Hawassa industrial park, one of the largest textiles and apparel industrial park in Africa export through MDP was not connected with an appropriate transport infrastructure and the current road conditions deteriorated, narrow and high traffic congestion along the corridor which led to delay shipping schedule, hinder shippers time and cost. Currently, the Modjo-Hawassa highway is under construction to solve these problems. Therefore, low-level line haul and local delivery transport connectivity with Modjo Dry Port affects its operations.

B. Freight market

Regarding the availability of a freight market from the industrial/production zone to seaports, through dry ports, importantly supports dry port operations Jagan Jeevan *et al*, (2018). From Figure 4.2 the thirteenth factor affecting Modjo Dry Port operations was due to insufficient freight market, trade imbalance (more import and less export) through the dry port. The freight goods from Adama, Dukam and Hawassa industrial parks are currently delivered to Djibouti port through this dry port but it is still difficult to obtain sufficient freight markets to reduce empty running from the dry port to the seaport. According to interview results, a large proportion of Ethiopia's containerized exports are stuffed in Djibouti, contributing to empty container running and inefficiencies of freight in the systems. Furthermore, a lack of integrations between existing operational dry ports is observed. This will lead, high logistics costs and port congestion. So, the finding revealed that lack of sufficient freight market hampers the effective operation of Modjo Dry Port.

C. Seaport dry port relationship

The smooth relationship between the dry port and its seaport directly affects the operational throughput and time of delivery. The short delivery of the physical flow of goods between dry ports and seaports is based on the smooth flow of information/documents which involves

several interdependent actors from government agencies and business entities (Sholihah *et al.*, 2018). These independent actors play their own activities and roles expected to cooperate in handling the flow of goods and information. The result of comparison from Figure 4.2 shows that lack of smooth relationship between Djibouti port and MDP was found to be the seventeenth factor that affects MDP operations. According to interviewees with expert opinion, a seaport in Djibouti and dry port in Ethiopia have good relationships but sometimes conflict is raised between dry port operators and port operators. They named the reason as an error of information/documents, lack of clear legal framework, and lack of standard communication systems between the seaport and the dry port crate bottleneck on the flow of goods which hinders effectiveness operations of Modjo Dry Port. Therefore, the smooth coordination between actors/stakeholders and each node can reduce information errors, delay work procedures and unnecessary cost which improves MDP and Djibouti port operations.

D. Location

Dry ports located at trade-generating centers (potential industrial and agriculture centers), at a considerable distance from its seaports (greater than 300 km) could achieve economies of scale and consequently lower logistics costs (ESCAP, 2019). According to this study from Figure 4.2, the last factor affecting MDP operations was associated with its location. Considering the distance from seaport MDP was strategically positioned (about 750 km) from the seaport and about 73 km from trade-generating centers (capital city) faces the problems of having frequent cargo volumes that are inadequate to generate economies of scale necessary to make rail haulage reasonable during export. The dry port is currently in competition with Kality (comet) dry port which is located near to trade-generated capital city Addis Ababa and their catchment areas are overlapped. Most of the export goods are consolidated at comet dry port and MDP concentrates on import which causes rail and trucks to empty backhaul to Djibouti port. Therefore, from this finding, the researcher concluded that the dry port location is slightly affecting its operations. Thus, instead of performing its operations separately, integration of the existing dry ports (especially with the comet) is required to improve their effective operations.

4.9 Critical factors contributing to the success of Modjo Dry Port operations

The section presents the survey finding related to critical factors contributing to the success of dry port operations which focused on measuring the practical level of each factor in their operations. These factors are the factors identified and ranked in the previous section, but engaged with critical to the success of dry port operations. A Five-point Likert scale is used to measure practical level based on respondent's agreement considering the factors. The questionnaire was consisted of scaled responses from 1 to 5 such that; 1 = Strongly Disagree, 2 = Disagree, 3= Moderate, 4 = Agree and 5 = Strongly Agree. Based on the response the mean and standard deviation were evaluated to measure the practical level of factors in dry port operations.

Table 4-11: Practical level of critical factors in MDP operations (Survey results)

Statement/description	Mean	StDev.s
Transport linkage with seaport and local delivery	2.87	0.79
Government supports	2.55	0.69
Quality services	2.32	0.77
Adequate technical infrastructures and equipment	2.46	0.64
Advanced technology and innovations	1.75	0.71

Regarding the availability of well-technological advancement and innovations in Modjo Dry Port, the respondents were asked to respond to the level of agreement on the current status. The mean value (1.75) of their response indicated that technological advancement and innovation are practiced/performed at a poor level in MDP. Accurate information sharing among stakeholders enhances dry port operations in utilization facility, on time delivery and forecasting containers throughput for effective decision making, but advanced information systems platforms that integrate and coordinate all stakeholders are inapplicable in the enterprise, which results in an operational bottleneck.

Quality service delivery and adequate technical infrastructures/equipment are the factors performed below the average, with the mean of 2.31 and 2.46 respectively. Numbers of reasons that cause a low level of service quality was identified as insufficient customs clearance process,

lack of standardized information communications technology, insufficient spaces for containers handling, storage, for customs inspections, truck parking and offices for administrations, absence of value-added service, containers maintenance services and adequate handling equipment for container transfer are what makes difficult to offer quality service in the enterprise. Considering adequate technical infrastructures/equipment, from field observations, the dry port is limited in specialized and multipurpose facilities, advanced handling equipment, sufficient and standardized pavement areas, automated and mechanized handling equipment which hinder its successful operations.

As depicted in Table 4.11, the initiation of government to support Modjo Dry Port operations is dedicated at a satisfactory level with a mean value of 2.55. Based on the interviewee's response, in Modjo Dry Port government support for infrastructure investment and upgrading advanced technology was considered insufficient due to financial constraints. Not only that, the deficiency of the government on an organizational regulatory framework to protect corruption, excessive bureaucracy and illegal exercise that hinders successful operations of the dry port is observable. Furthermore, the respondents outline that government support in planning long term and short-term considering technological and global perspective is impractical in Modjo Dry Port.

Apart from that, government interventions in the least-cost modal choice to minimize total logistics cost and protect frequent damage of infrastructure due to high gross vehicle weight is not observable. Respondents forwarded that most shippers/consignees prefer and use road transport than rail to pick up their goods from Djibouti port, which is found at a long distance from Modjo Dry Port (about 750km).

Regarding the statement of transport infrastructure connectivity, the mean range value of 2.87 indicates that Modjo Dry Port has relatively good transport linkage with Djibouti port and other local delivery but not efficient. The dry port is connected by electrified railway and road transport with its seaport. But still, the existing transport connections are not capable of fully eliminating the current high traffic flow, which results in bottlenecks along the corridor. The interview result shows that the railway connected Modjo Dry Port with seaport Djibouti played a vital role in import/export containerized goods but not connected with customers warehouses and industrial parks, which leads customers' to use high-cost road transport. The issue of road

connection availability to the dry port in Ethiopia is a big challenge and the majority of roads connected to the dry port are in poor conditions (UNCTAD, 2018). Only six lanes (double three lanes) tolled expressways from Adama and Addis Ababa are connected with the dry port and the rest are single lane traffic accessible, narrow and partially unpaved, which results in traffic congestion, accidents and increased transport time (opinion of respondents).

4.10 Strategic way to address identified factors

The section gives strategic directions (improvement mechanism) on how to address identified factors that affecting MDP as well as the advantages of the study for port managers both theoretically and practically.

The finding of this work can have numerous advantages both theoretically and practically. Theoretically, this work identifies a number of factors affecting the operations of MDP and critical factors that contribute to its success. Furthermore, the study categorizes the factors into main factors and subfactors that assist to develop a decision-making model. This finding and approach give the dry port managers an important understanding of factors affecting dry port operations. This might help the managers to be aware and check their enterprises considering these factors in giving action plans to relieve operational inefficiencies.

From a practical perspective, the finding ranks factors from most influential to least influential impacts on dry port operations. One of the important implications of the result is that to solve factors that affect dry port operations, managers should pay more attention to top-ranked factors step by step, which could lead to large dry port operational improvement. In addition, the finding helps to make the appropriate decision based on a logical and scientific analysis approach in choosing the challenging or highly operational constraint factors from others without neglecting the associated factors. It contributes an insight to reduce the burden of extra costs of port managers while financing to improve dry port operations as well as optimize the dry port by taking proper action on the most contributing factors, which could lead to large port operational improvements.

Apart from this, the study identified critical factors contributing to the success of dry port operations from the top-ranked factors investigated in the model. And its implication is, the dry port managers and stakeholders should play a more strategic role in taking managerial actions

to address critical success factors that perform poorly as well as factors that have a large significant impact on dry port operations to make long-term strategic decisions that result in significant improvement of dry port operations.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

In this chapter, the summary, conclusion of the study carried out to answer the research questions, the recommendations of the study and future work directions are presented.

5.1 Summary

In dry ports, several factors affect their operations and these factors need to be identified systematically to take managerial actions to overcome its influence or impacts on dry ports operations. This study has been conducted successfully to achieve its objectives. The object of this study was aimed to identify the factors that affect the operations of MDP and ranking the factors according to the level of significant impact from top to bottom by developing the Analytical Hierarchical Process (AHP) model. As well as this work examines the critical factors contributing to the success of MDP operations from top-ranked factors. After several factors affecting dry port operations were identified from the literature review, the factors only affecting MDP operations were extracted considering the current condition of the port. These factors were grouped as main factors and subfactors in a hierarchy structure form toward the goal/objective of the study. A qualitative and quantitative method of research approach was employed to conclude research objectives. Both primary and secondary data were collected from MDP staff through survey questionnaires, interviews, field observations, and review of existing documents. For primary data collection, the researcher used both probability and non-probability sampling techniques in which the samples were selected by stratified and purposive sampling respectively from the target population of MDP. These data were analyzed quantitatively by using mathematical models in AHP and descriptive statistics tools available in Microsoft spreadsheet. Meanwhile, secondary data was collected from published documents or databases such as books, journals, reports, official websites and analyzed qualitatively to triangulate the results. Based on the results and findings of the study, the improvement mechanism for the factors affecting the dry port operations was suggested and recommended.

5.2 Conclusion

This work identified factors that affect the operations of Modjo Dry Port, which is the largest dry port in Ethiopia that handles the major import/export of freight products. The result shows, about 5 main factors and 19 sub-factors were identified. The identified factors are categorized

or structured in a hierarchical level as the main factors grouped with their respective subfactors. The Analytical Hierarchy Process (AHP) model was used to develop hierarchy structures consisting of three levels (goal, main factors and subfactors).

Each factor at the same level was compared in pairs, then analyzed and ranked accordingly from the most influential or significant impact to the least one on the dry port operations. The finding of the study suggests that, at the second level from main factors, information systems was the most dominant factor (48.7%) that affects operations of the dry port. The dominance factor information systems were followed by service features (26.41%), dry port capacity (13.78%), government policy (7.29%) and hinterland conditions (3.83%), which took the last place.

From the overall investigated factors, the absence of appropriate information systems in the enterprise, for coordinating dry port stakeholders (37.19%) and forecasting accurate information (11.51%) were the factors that largely affect the operations of the dry port. Furthermore, custom clearance (13.31%), container transfer (7.14%) and container storage services (3.38%) were factors related to service features, currently affecting operations of the dry port. Inadequate facilities and equipment (8.05%), and insufficient space (3.56%) from dry port capacity, low level of public-private partnership involvement (4.43%) and inappropriate transport infrastructure policy (1.68%) from government policy and absence of standardized transport connectivity (2.25%) from hinterland conditions were the factors highly affecting the operations of the dry port identified in this study.

This finding help managers to take the appropriate decision based on logical and scientific analysis approach in choosing the challenging or highly operational constraint factors from other without neglecting the associate factors. It contributes an insight to reduce the burden of extra costs of port managers while financing to solve factors that affect dry port operations as well as optimize the dry port operations by taking proper action on the most contributing factors, which could lead to large port operational improvements. In this way the port managers should pay more attention to top-ranked factors step by step in order to address factors affect dry port operations.

Regarding the critical factors contributing to the success of Modjo Dry Port operations, the finding reveals that almost all factors were less practiced with a mean ranging from 1.75 to 2.55 and it shows that the result is consistent with the output of the model.

5.3 Recommendations

After analysis of data, from the findings of the study and conclusion drew, the following recommendations were made;

- ✚ From the finding of the study, factors affect dry port operations were ranked from most significant impact to least significant impact. Therefore, it is highly recommended that decision-makers pay more attention to these top-ranked factors to address large operational improvements. They can use the ranking and weight of factors as a strategic plan (road map) for eliminating the challenging factors that highly constraint to their operations.
- ✚ As the finding of the study indicates, Modjo Dry Port has no advanced information systems which is the critical factor contributing to coordinate stakeholders. It is therefore recommended that if the enterprise installs Port Community Systems (PCS) which is the basic foundation for paperless communication that enables coordination between different stakeholders, support for accurate forecasting by integrating with other technology such as Radio-frequency identification (RFID) and GPS. This will help in utilizing available assets, appropriate decisions making, speed up customs clearing procedures and reduce safety and security problems.
- ✚ The finding of this study also suggests lack of facilities and handling equipment are also the other influential factors of the dry port operations requiring immediate action. Instead of using a reach stacker to handle current container throughput, it is better if a portal crane with an appropriate rail track is used. This will help in improving container transfer service, utilize available storage facilities and increase current shortages of spaces in the dry port.
- ✚ According to the findings of this study, the dry port operates with inefficient transport linking with its seaport and other local delivery which is a critical success factor for dry port operations. Therefore, the researcher recommends it is good if the government

declares appropriate infrastructure transport policy to expand transport linkage and limit gross vehicle weight to reduce frequent road and truck maintenance costs.

- ✚ As the finding of the study revealed, value-added service and container maintenance services were also not getting attention which enables the users to get cost benefits and the dry port expands its customer base. Therefore, it is better if the enterprise provides a range of value-added services and container maintenance services to enhance the dry port operations.
- ✚ In addition, the finding shows that there was a shortage of qualified logistics workforce in the enterprise. Therefore, the researcher recommends better training its workforce, reducing the turnover rate and hiring qualified logistics experts. This will improve the efficiency of the dry port operations by reducing human errors and process duplications. Furthermore, rather than monopolizing the enterprise by state ownership, encouraging a public-private partnership policy that allows the involvement of logistics experts both at the managerial and operational levels can improve the operations of the dry port.

5.4 Future work

In this study, the research develops a decision-making AHP model to prioritize and rank the factors that have a large significant impact on dry port operations when compared in pairs. Further research can be focused on the implementation of these factors to improve dry port operations.

The study identified several factors affecting dry port operations and most of them indicate the inefficiency of the dry port to handle current container throughput. The number of containers handled in Modjo Dry Port terminals has increased from time to time and currently reached up to 600,000 containers per year. This increasing throughput requires evaluating/measuring the dry port performance for currently available infrastructure, material handling and terminal layout design need to get focus as future work.

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ANNEXES

Annex A: Pairwise survey questionnaire responses

Table 1: Evaluation of the subfactors with respect to ‘port capacity’

Dry Port capacity	Facilities and Equipment	Unsafe environment	Unskilled workforce	Insufficient space
Facilities and Equipment	1.00	8.38	5.50	3.92
Unsafe environment	0.12	1.00	0.29	0.17
Unskilled workforce	0.18	3.47	1.00	0.26
Insufficient space	0.26	5.91	3.92	1.00
Total	1.56	18.76	10.71	5.35

Table 2: Pairwise comparison values for sub-factors of hinterland conditions

Hinterland conditions	Location	Transport connectivity	Freight market	Seaport-dry port relationship
Location	1.00	0.13	0.17	0.33
Transport connectivity	7.50	1.00	4.11	5.50
Freight market	5.77	0.24	1.00	3.47
Seaport-dry port relationship	3.00	0.18	0.29	1.00
Total	17.27	1.55	5.57	10.30

Table 3: Pairwise comparison values for sub-factors of service features

Service features	Customs clearance	Value-added services	Container storage service	Container maint. Service	Container transfer service
Customs clearance	1.00	7.17	5.77	8.37	3.23
Value-added services	0.14	1.00	0.29	3.00	0.17
Container storage service	0.17	3.47	1.00	4.89	0.29
Container maintenance service	0.12	0.33	0.20	1.00	0.12
Container transfer facility	0.31	5.76	3.47	8.08	1.00
Total	1.74	17.73	10.73	25.34	4.81

Table 4: Pairwise comparison values for sub-factors of government policy

Government policy	PPP Policy	Transport Infrastructure Policy	Multi-modal Transport Policy	Seaport Policy
PPP policy	1.00	4.88	6.06	7.17
Transport Infrastructure Policy	0.21	1.00	3.47	5.00
Multi-modal Transport Policy	0.17	0.29	1.00	3.00
Seaport Policy	0.14	0.20	0.33	1.00
Total	1.51	6.37	10.86	16.17

Table 5: Pairwise comparison values for sub-factors of information systems

Information systems	Accurate forecasting	Coordination between stakeholders
Accurate forecasting	1.00	0.31
Coordination b/n stakeholders	3.23	1.00
Total	4.23	1.31

Annex B: Response on success factors of dry port operations

Table 6: Detail respondents' biographical information

S.No	Description	Response Category	Frequency	Percentages 100%
1	Job designation/role/ occupation/type of organization	Modjo Dry Port terminal operation	102	82.93
		Customs Clearing Office	14	11.38
		Shippers	7	5.69
		Total	123	100.00
2	Educational qualification	Diploma	35	28.46
		First degree	81	65.85
		Second degree	7	5.69
		Third degree	0	0.00
		Total	123	100.00
3	Years of work experience	< 5 Years	39	31.71
		6 - 10 Years	51	41.46
		11- 15 Years	29	23.58
		> 16 Years	4	3.25
		Total	123	100.00
4	Age range (in years)	20-29 Years	19	15.45
		30-39 Years	67	54.47
		40-49 Years	32	26.02
		>50 Years	5	4.07
		Total	123	100.00
5	Sex	Male	88	71.54
		Female	35	28.46
		Total	123	100.00

Table 7. Respondents' response and output on success factors of dry port operations

S.No	Statement/description	Measurement	Frequency	%	Mean	StDev.
1	Modjo Dry Port has well transport linkage with its seaport and local delivery.	Strongly disagree	6	4.88	2.87	0.79
		Disagree	39	31.71		
		Moderate	43	34.96		
		Agree	35	28.46		
		Strongly agree	0	0.00		
Total			123	100.00		
2	Current government supports dry port operations.	Strongly disagree	9	7.32	2.55	0.69
		Disagree	61	49.59		
		Moderate	37	30.08		
		Agree	18	14.63		
		Strongly agree	0	0.00		
Total			123	100.00		
3	Modjo Dry Port delivers quality services.	Strongly disagree	13	10.57	2.32	0.77
		Disagree	68	55.28		
		Moderate	32	26.02		
		Agree	10	8.13		
		Strongly agree	0	0.00		
Total			123	100.00		
4	Modjo Dry Port has adequate technical infrastructure.	Strongly disagree	0	0.00	2.46	0.64
		Disagree	77	62.60		
		Moderate	36	29.27		
		Agree	10	8.13		
		Strongly agree	0	0.00		
Total			123	100.00		
5	Well-advanced technology and innovations are available in MDP.	Strongly disagree	50	40.7	1.75	0.71
		Disagree	54	43.9		
		Moderate	19	15.4		
		Agree	0	0.0		
		Strongly agree	0	0.0		
Total			123	100.0		

Annex C: Interview Guide Questionnaire

1. How do information systems perform in MDP?
2. What factors constraints to utilize dry port capacity?
3. Is that service delivered by enterprise meets customers requirements? If not, which service type affects dry port operations and how?
4. How do the geographical conditions of MDP look like related to transport connectivity, seaport relationship, with other dry ports and availability of freight market?
5. What do you think about government support and measures to enhance dry port operations?
6. What are factors that affect Modjo Dry Port operations?
7. What are factors contributing to the success of MDP operations?